



Cape Cod Commission

Cape Light Compact

**Model Bylaw**  
for  
**Land-based Wind Energy Conversion**  
**Facilities**

Funded by a Community Planning & Development Grant (CP-04-05)  
from the Massachusetts Technology Collaborative

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## Table of Contents

<b>SECTION 1: INTRODUCTION.....</b>	<b>4</b>
<b>SECTION 2: MODEL BYLAW FOR LAND-BASED WIND ENERGY CONVERSION FACILITIES FOR TOWNS IN BARNSTABLE COUNTY, MASSACHUSETTS.....</b>	<b>7</b>
<b>APPENDIX A: WIND TURBINE SCHEMATICS.....</b>	<b>29</b>
<b>APPENDIX B: SIMPLIFIED SIGHT LINE DIAGRAM .....</b>	<b>30</b>
<b>APPENDIX C: MODEL BYLAW (WITHOUT COMMENTARY) .....</b>	<b>31</b>

## Section 1: Introduction

This model bylaw is presented to help towns encourage the appropriate development of wind resources within each community. It is designed to inform the public processes that will assist towns in identifying preferred locations for wind turbines and in creating a clear regulatory path that will embrace turbine deployment. The model bylaw is presented to help towns address many of the issues raised in the 2002 Regulatory Assessment completed by Michael Pessolano and Ridley Associates for the Cape Light Compact. The Regulatory Assessment looked into the regulatory barriers to land-based, small-scale renewable energy and distributed generation facilities on Cape Cod and Martha's Vineyard. The report concludes that in many communities the regulatory process did not specifically prohibit wind turbines, however, the lack of appropriate height limits and the absence of applicable use definitions resulted in a de-facto prohibition on modern wind turbines. This is generally because most bylaws on the Cape were developed to accommodate the type of windmills historically used in the region for agricultural uses and in salt works (e.g. Eastham Windmill). However, modern wind turbine technology is relatively new to New England and presents a use with characteristics of a completely different scale than those historically found on the Cape. The technology is also rapidly evolving as the industry grows and advances. This rapid change widens the disconnect between many local bylaws and the current state of the art. It is therefore the intent of this model bylaw to provide the towns in Barnstable County with a framework from which local bylaws may be crafted, to provide a tool to understand the land use issues relating to this type of use and to enable towns to plan for modern wind turbines.

The model bylaw also relies heavily on the Assessment of Distributed Generation Technology ("Technology Assessment") completed by Boreal Renewable Energy Development and Serchuk Associates in June 2004 for the Cape Cod Commission and Cape Light Compact. The Technology Assessment was initiated to gain an insight into the current technology to inform the development of an appropriate bylaw. Copies of the Assessment of Distributed Generation Technology and Regulatory Assessment are available for download at the Cape Cod Commission or Cape Light Compact web sites ([www.capecodcommission.org/windenergy/home.htm](http://www.capecodcommission.org/windenergy/home.htm) and [www.capelightcompact.org](http://www.capelightcompact.org)).

Wind energy is a rapidly developing technology that has many benefits. Utilizing a renewable energy source provides an alternative to the consumption of finite fossil fuels and offsets harmful emissions from fossil fuel electricity generation. Regionally, utilizing distributed energy sources helps to diversify the energy mix in the New England region, and may improve system reliability. When used for municipal purposes, wind energy facilities may have direct local benefits to communities in terms of cost savings and supply security. Although more environmentally benign than other commercial-scaled sources of electricity, wind energy facilities have potential impacts, such as visual impacts or impacts on protected species or habitat. These relative benefits and detriments must be weighed by individual towns as they use this guide to develop a process for reviewing local projects.

The degree to which a community embraces wind energy developments will depend on the values of individual towns and each community's vision for its future. Accommodating and

utilizing renewable energy facilities should be part of a community-wide, sustainable energy strategy. Such a strategy could include the formation of local energy committees, efforts to reduce demand and improve energy efficiency at the local level, and public outreach and education initiatives to increase the communities' level of understanding of energy issues. Towns could consider incorporating renewable energy policies within the Local Comprehensive Plan (LCP) that would articulate the community's vision as well as provide important direction to all Boards and Commissions on municipal policy in this area. The development of such policies would help educate the community and assist in identifying appropriate locations for wind turbines.

Cape Cod has excellent wind resources and therefore it is a favorable location for the development of wind energy facilities. The most likely types of development on land will be small to medium-sized distributed generation facilities, rather than large-scale wind facilities. Large-scale wind facilities require large, developable tracts of land, which are in limited supply in the region. Distributed generation is a term used to describe energy generation that is located at or near the end-user, rather than generation supplied by large power plants to the New England electrical grid. In the case of wind energy generation, distributed generation could take a variety of forms. For example, wind turbines may or may not be connected to the New England grid and may provide all or part of an end-users energy demand. The use of the turbine will in large part dictate the type and scale of the machines utilized.

### **Use of the model bylaw**

This model bylaw is intended to be used in two ways.

1. The bylaw aims to provide a general regulatory framework that provides a broad range of issues generally relevant to siting distributed generation wind facilities on land. The bylaw is therefore structured to offer suggested language, with the understanding that each community will have the task of modifying the text to suit the goals of each municipality.
2. The bylaw also provides background information on each of these issues so that towns have some context with which to make informed decisions as local bylaws are developed. To assist in this aim, a commentary is provided throughout to provide a general explanation of the issue and possible approaches that may be taken.

The model bylaw assumes that the user has considerable understanding of the benefits of utilizing renewable energy and that communities will seek to adopt local wind bylaws in order to facilitate (rather than prohibit) wind energy facilities. As the model bylaw is intended to assist towns in developing their own bylaws, it focuses on the characteristics of distributed generation facilities as they relate to land use and planning. As with all zoning bylaws, the model bylaw is constructed to address specific characteristics of the use with the purpose of protecting the health, safety and welfare of the public. The bylaw does not attempt to provide

a list of the benefits of using renewable energy unless relevant to bylaw development; however, it is assumed that individual applicants will provide comprehensive information regarding the benefits of a project in support of their application. Furthermore, considerable information concerning the specific benefits of renewable energy may be obtained via the internet. For example, the Environmental Protection Agency, US Department of Energy and American Wind Energy Association web sites have documents and links to resources in these areas. A limited number of relevant resources are provided in Appendix D. The model bylaw often refers to potential impacts resulting from this kind of land use. Unless expressly stated, this term is used to reference both potential beneficial and adverse impacts. It should also be emphasized that the bylaw is not intended to be applicable to residentially scaled facilities. Such facilities may require alternative approaches, although the commentary on issues provided in this model bylaw may provide a starting point for residential bylaw development. A clear regulatory path is also needed to overcome regulatory barriers to this type of installation.

Many towns on Cape Cod are exploring wind energy development and some have already adopted, or are considering adopting amendments to their existing zoning bylaws for reviewing wind energy conversion facilities. It is not the intent of this model bylaw to drastically change those amendments, but rather to suggest a process for reviewing proposals for these facilities that is flexible enough to work with each town's individual approach. It is anticipated that local bylaws will draw from this framework and will be adapted to meet the individual needs of the town. A bylaw may be similar to the model or may vary substantially, depending upon local conditions and community opinions and the degree to which towns wish to encourage commercial-scale wind facilities. In either event, each town will have to carefully consider the issues presented herein and it will be up to each town to decide how applicable the provisions of the model bylaw are to each community. The Cape Cod Commission welcomes the opportunity to work with individual towns on crafting their own bylaws.

As with any bylaw, the requirements are equally applicable to all types of applicant (i.e. private developer, municipality or non-profit), however, it is also assumed that the SPGA may consider waiving certain requirements of the Special Permit if appropriate.

All text shown in italics is intended to illustrate and explain issues relating to siting distributed generation facilities, and is not intended to read as a proposed regulation. To clarify this point, the appendix includes a version of the bylaw without any commentary or explanatory text. The appendix also includes schematic diagrams that illustrate the typical configuration of a modern wind turbine and an illustrative line-of-sight diagram.

## **Section 2: Model Bylaw for Land-based Wind Energy Conversion Facilities for Towns in Barnstable County, Massachusetts**

### **01.0 Purpose and Intent**

It is the express purpose of this bylaw to accommodate distributed generation, wind energy conversion facilities (not residentially scaled facilities) in appropriate locations, while minimizing any adverse visual, safety and environmental impacts of the facilities. The bylaw enables the review of wind energy conversion facilities by the town's Planning Board or Zoning Board of Appeals in keeping with the town's existing bylaws. This bylaw is intended to be used in conjunction with other regulations adopted by the town, including historic district regulations, site plan review and other local bylaws designed to encourage appropriate land use, environmental protection, and provision of adequate infrastructure development on Cape Cod.

*Commentary: This section is intended to articulate the overall purpose of the bylaw to provide a regulatory process for accommodating wind turbine technology and to enable the review of projects while minimizing any adverse impacts on the community. The model bylaw is not intended to be applicable to residentially scaled wind turbines as the scale and characteristics of such development may require alternate approaches. Individual towns could add to this section by referencing applicable policies in Local Comprehensive Plans or other town policies applicable to the use of renewable energy that reflect the community's future goals.*

### **02.0 Definitions**

**Clear area:** Area surrounding a wind turbine to be kept free of habitable structures.

**Distributed Generation:** Energy generation that is located at or near the end-user.

**Height:** The height of a turbine measured to the tip of the blade at its highest point.

**Nacelle:** The frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather.

**Rotor:** The blades and hub of the wind turbine that rotate during turbine operation.

**Special Permit Granting Authority (SPGA):** Board designated by zoning ordinance or bylaw with the authority to issue special permits.

**Wind energy conversion facility:** All equipment, machinery and structures utilized in connection with the conversion of wind to electricity. This includes, but is not limited to, all transmission, storage, collection and supply equipment, substations, transformers, site access, service roads and machinery associated with the use. A wind energy conversion facility may consist of one or more wind turbines.

**Wind Monitoring or Meteorological (“test” or “met”) Towers:** Tower used for supporting anemometer, wind vane and other equipment to assess the wind resource at a predetermined height above the ground.

**Wind turbine:** A device that converts kinetic energy of the wind into rotational energy to turn an electrical generator shaft. A wind turbine typically consists of a rotor, nacelle and supporting tower.

### **03.0 District Regulations**

#### **03.1 Use Regulations**

All wind energy conversion facilities or wind monitoring towers shall require a building permit and may be permitted as follows and irrespective of whether the use is a principal or accessory use:

##### **03.1.1 Wind Energy Conversion Facility**

The construction of any wind energy conversion facility shall be permitted in all commercial, industrial and municipal zoning districts, subject to issuance of a Special Permit and provided the proposed use complies with all Dimensional and Special Permit Regulations set forth in Sections 3 and 4 of this bylaw (unless waived by the SPGA).

*Commentary: There are two permitting options that can be used to accommodate land uses within a community. Each of these options is described briefly below:*

*1. Allowing by right.*

*A use can be permitted by right, where the basic assumption is that the facility could go anywhere within an area provided certain dimensional requirements are met. The town has no discretion in issuing permits for as-of-right proposals and the public has no opportunity for comment.*

*2. Special Permit*

*A use may also be allowed upon issuance of a Special Permit, where the basic assumption is that the facility could go anywhere within an area, provided certain discretionary and dimensional requirements are met. This approach would allow the town to review projects with some discretion and solicit input from members of the public through a public hearing process.*

*A town could use either of these approaches in conjunction with geographic criteria that, when applied to wind energy facilities, could permit them in certain zoning districts, specially created areas (called overlay districts) or anywhere within the community.*

*This model bylaw recommends that a Special Permit be required for all wind turbines in certain zoning districts (although the specific zoning districts may vary from town to town). The Special Permit approach is preferred over permitting wind energy conversion facilities by right to allow consideration of site specific conditions and to receive input and comment from the public.*

*Although the model bylaw suggests identifying existing zoning districts for this kind of use, it should be noted that establishing overlay zones/districts may be more appropriate for some Cape towns. Overlay districts can cross zoning district boundaries or may be portions of a zoning district and may require additional pre-planning on behalf of each jurisdiction to identify and map areas where wind turbines would be desirable. For example, a town may wish to promote these facilities on certain educational, industrial or municipal land and discourage them within historic districts or sensitive habitat areas. An overlay district approach would provide additional flexibility that could provide for multi-family residential or neighborhood-serving facilities in addition to the commercial and municipal applications addressed in the bylaw. This planning process could be informed by the "Land-based Wind Energy Facility Siting Considerations" map developed by the Cape Cod Commission. This map generally identifies opportunities for distributed wind generation and areas of sensitivity. Towns can use this map as a tool to direct development toward the most advantageous sites. Copies of this map may be obtained from the Cape Cod Commission and copies of the maps have been distributed to each town on the Cape. If an overlay approach were taken, the text of the model bylaw above would require modifications.*

*The Working Group concluded that with the contrast in scale between modern wind turbines (ranging from around 130 feet to over 450 feet to the tip of the blade according to the 2004 Technology Assessment) and most other man-made structures in the region, that it was most appropriate for towns to allow discretion when considering proposed projects. The Working Group concluded that the Special Permit would provide the most appropriate framework and flexibility for reviewing proposals. Through the Special Permit process, the benefits afforded by renewable energy generation could be weighed against any adverse impacts identified through a public hearing process. The Special Permit process would consider the scale and characteristics of individual projects regardless of the amount of electricity produced. Larger turbines are likely to have different impacts than smaller turbines and therefore the SPGA would have the authority to weigh these impacts during their review.*

### **03.1.2 Wind Monitoring or Meteorological Towers**

Wind monitoring or meteorological towers shall be permitted in all commercial, industrial and municipal zoning districts subject to issuance of a building permit for a temporary structure.

*Commentary: Wind resources vary dramatically from site to site, and with the height above the ground surface. This variation in wind resource can dramatically change the economic viability of a wind turbine as small increases in wind speed can make a big difference in the amount of power that can be extracted. This variation requires that the characteristics of the wind regime at a site be fully understood before a wind turbine is proposed or erected. The most common and effective way of measuring the wind regime at a site is using a wind monitoring or meteorological ("met") tower. These structures typically use anemometers that are attached to the tower to measure the wind for a year or more. Although the height of the tower will vary depending on the local topography and vegetation, the most common type of met tower consists of a temporary structure between 130 and 160 feet high, supported by guy wires. These*

structures generally do not require a foundation. It should be noted that in some cases, anemometers could be located on existing tall structures such as telecommunications towers, however, in such cases additional supporting structures (such as a boom) may be needed to avoid errors created by the disturbance of the wind caused by the supporting structure.

The model bylaw recommends that met towers be allowed upon issuance of a building permit for a temporary structure for the purposes of measuring the wind regime at a given location. The rationale for this approach is to make it simple for met towers to be erected to collect wind data. However, it should be noted that state building code and many local bylaws may limit the time period for these structures to twelve months or less. Generally, sufficient wind data will be obtained within a 12-month timeframe; however, additional time may be required if equipment malfunctions or if weather anomalies are encountered. In such cases or if additional time is needed, another option for towns would be to require the issuance of a building permit. Building permits do not generally have time limits but would require that zoning use and dimensional requirements be met. Therefore, appropriate changes would need to be made to use tables and height limits to accommodate met towers as an allowed-by-right use.

Alternatively, although the bylaw recommends a building permit be issued for met towers, there are some land use issues that towns may consider more appropriately addressed through a discretionary permit (i.e. Site Plan Review or Special Permit). It should be noted that some towns currently require that a Special Permit be issued for temporary structures. Some of the land use issues relevant to met tower installation are briefly described below:

- a. *Vegetation clearing.* To erect the most commonly used type of met tower, some clearing of land is typically required both to create room to lay the tower on the ground before winching it into an upright position, and to provide room for the guy wires. For a 130-foot tower and a 160-foot tower respectively, a minimum diameter of 160 to 240 feet needs to be clear to accommodate the guy wires with an area of between 135 to 165 feet available to lay the tower on the ground. For larger met towers, such clearing could result in over an acre and a half of vegetation being removed, although clearing of the entire area may not be necessary in all cases. This may be a concern in some areas, especially if the wind measurements reveal that the site does not have sufficient wind resources for a turbine.
- b. *Surety.* Most met towers are an asset for individual project developers and are therefore unlikely to be left in-situ after wind monitoring is complete. However, if abandonment is a concern, towns may wish to require some kind of surety (i.e. letter of credit, escrow, bond or other) to cover the cost of removing the met tower.
- c. *Height.* Because of the structure's height and its supporting guy wires, locating such a tower in close proximity to airport approaches may not be appropriate in all cases.

Towns could address these issues through a discretionary permit of some kind (i.e.

*Special Permit or Site Plan Review) and through specific guidance on appropriate locations for met towers. For instance, such guidance could encourage towers to be located in previously cleared areas or discourage location in certain protected open space, wetlands or rare species habitat or in close proximity to airports. Similarly, towns could establish a minimum amount of clearing for met tower installation or set a threshold over which a discretionary approval would be necessary. Details of the amount of clearing would be detailed on application plans. A discretionary process would also allow the town to require re-vegetation as appropriate and provide a mechanism for requiring some kind of surety for removal that is typically not available through a building permit process.*

### **03.2 Site Control**

The applicant shall submit documentation of the legal right to install and use the proposed facility at the time of application for a Special Permit. Documentation should also include proof of control over the setback or clear areas, if required under Section 3.3.2. Control shall mean legal authority to prevent the use of any structure within the setback or clear area for human habitation or other use permitting human occupancy.

*Commentary: This section requires that proof of the right to install the facility be provided to ensure that all necessary permissions have been received prior to permit review. This section also requires that control over the clear area (if required) be established so that potential conflicts with existing or future development are avoided.*

### **03.3 Dimensional Requirements**

All wind energy conversion facilities shall comply with the requirements set forth in this section, unless waived by the SPGA as part of the Special Permit review process.

#### **03.3.1 Height**

Wind energy conversion facilities shall be no higher than \_\_\_\_ feet (*see commentary below*) above the natural grade. The height of all wind turbines shall be measured to the highest point reached by the rotor blades. The SPGA may allow this height to be exceeded as part of the special permit process if the project proponent can demonstrate that the additional height is needed and that the additional benefits of the higher tower outweigh any increased adverse impacts. Monopole towers are the preferred type of support for wind turbines.

*Commentary: The height of turbines used in distributed generation applications is likely to vary considerably, and as such developing a height requirement for a model bylaw has proven challenging. With the highest turbine/tower combinations reaching heights of 450 feet and most distributed generation applications exceeding 200 feet, the Working Group felt that the SPGA should have the ability to require proponents to go through a more stringent review the higher the proposed structure. Towns must develop their own approaches to tackle this issue; however, three approaches are offered here for consideration:*

1. *Special Permit/Variance process. With this process, a Special Permit would be required for all facilities up to a specified height. This height limit could only be exceeded by obtaining a variance. Under state zoning law, variances require that a*

*finding be made that circumstances affecting the site but not affecting other sites in the district create a substantial hardship to the proponent and that relief granted would not derogate from the intent of the bylaw. This is generally considered a very difficult finding to make and such an approach would be very restrictive.*

2. *Special Permit process with no height limit. If no height limit were created, towns could rely on the SPGA to weigh the benefits and detriments of the project regardless of height without any additional requirements. The SPGA would use the criteria established by each town for granting Special Permits in their deliberations; however, the absence of any height limit would provide no certainty in the process for the developer and public alike.*
3. *Special Permit process with additional Special Permit findings. Conceptually, this process would establish a height threshold above which the SPGA would be required to make additional findings. This would provide some certainty in the process by establishing a height with which the community would be comfortable. However, that height could be exceeded if the developer could demonstrate the need for a greater height and that the relative benefits outweighed any adverse impacts.*

*The model bylaw suggests using the third option by establishing a height threshold, above which a proponent would be required to demonstrate that the benefits of the higher tower (e.g. in energy production) outweigh any adverse impacts. The text offered in the model bylaw leaves the height threshold blank. The height inserted could range between 200 and 450 feet depending on the community. For example, the existing character of a community would be a major factor in determining the appropriate height threshold. However, it is important to emphasize that the Technology Assessment noted that to be commercially viable, a turbine would need to be at least 200 feet tall.*

*Although most modern wind facilities utilize monopole towers, it is possible that lattice towers or guyed towers may be used on occasion. Therefore, the bylaw states a preference for monopoles, as their sleeker profiles make them generally less visible than lattice or guyed towers.*

### **03.3.2 Setback or Clear Area**

a) Each wind energy conversion facility and its associated equipment shall comply with the building setback provisions of the zoning district in which the facility is located.

b) In addition, the following setbacks shall be observed:

1. In order to ensure public safety and to protect the interests of neighboring property owners, the minimum distance from the base of any wind turbine tower to any property line, dwelling, business or institutional use shall be equal to the total height of structure to the highest point. This setback is considered a "clear area."
2. The setback or clear areas should be kept free of all dwelling, business or institutional uses as long as the facility is in place; however, these area

need not be cleared of trees or other vegetation. Setbacks shall be measured from the outside surface at the base of the turbine tower. The SPGA may reduce the clear area as appropriate based on site specific considerations and if the project is consistent with the Special Permit granting criteria of the town.

*Commentary: The model bylaw recommends that a clear area be established for the purposes of protecting public health and safety and adjacent property interests in the unlikely event of a catastrophic failure (i.e., turbine collapse, broken rotor blade) or in the event that ice forms on the rotors and falls to the ground. It should be emphasized that modern wind turbines are engineered so that the risk of collapse is minimal. However, in some instances liability insurance may be difficult or expensive to obtain if there is any risk of personal or property damage from the facility. It is anticipated that the SPGA would have the authority to reduce this distance based on site-specific considerations and a balancing of the relative risks. Detailed engineering reports, product certification and evidence of liability insurance could be provided by the proponent to demonstrate the limited risk of collapse in support of a waiver or reduction to this requirement. Such a determination should be accompanied by a finding that the waiver is consistent with the criteria established for Special Permits by the town. For example, in some cases it may be appropriate to reduce or waive this requirement if there is mutual agreement among adjacent property owners, or if adjacent public recreation areas are deemed to be appropriate uses within the clear area.*

*Ice formation on the rotor blades is unlikely to be a frequent occurrence on turbines located on the Cape, but is possible under more extreme weather conditions. Modern turbine blades are designed to minimize the potential for ice build up and are designed to shut down if any imbalance is detected such as with ice accumulation. Therefore, ice is unlikely to be thrown great distances as a result of the turning of the rotors. Any ice formed will slide off the rotor on restart and may present a drop-hazard to areas immediately under the turbine. However, according to the Renewable Energy Research Laboratory, University of Massachusetts, Amherst fact sheet "Siting in Communities", in ridgeline applications public trails are recommended to be relocated away from the turbine a distance of between two and four times the blade-tip height for public safety reasons. Therefore, the SPGA should weigh the potential risk from ice and the proximity of adjacent uses in its determination.*

*It is also worth noting that compliance with state noise regulations would also necessitate that turbines be sited away from adjacent property lines. In many cases, this distance would exceed that required for the clear area. For instance, according to the Renewable Energy Research Laboratory fact sheet "Siting in Communities", the current industry rule-of-thumb for locating turbines away from dwellings is considered to be a distance of three times the hub height, which far exceeds the distance of the clear area in the model bylaw.*

#### **04.0 Special Permit Regulations**

The SPGA shall grant a Special Permit only if it finds that the proposal complies with the provisions of this bylaw (unless waived) and is consistent with the applicable

criteria for granting Special Permits.

*Commentary: Most zoning bylaws require that the SPGA find that specific criteria are met before a Special Permit can be granted. These criteria vary greatly in their scope from town-to-town, but the minimal requirements are that the proposed use would not be detrimental to the neighborhood or derogate from the intent or purpose of the bylaw. The criteria also generally include more specific issues to be considered by the SPGA such as noise, traffic, visual character and suitability. These criteria would be applicable to all Special Permit projects, not just wind energy facilities. Therefore, this section of the bylaw is intended to reference the existing applicable criteria for approving Special Permits.*

*The SPGA would also have the authority to waive certain requirements where appropriate. Waiving certain Special Permit requirements would not be considered a variance, but rather the SPGA would have to make a finding that the waiver was appropriate and was consistent with the Special Permit granting criteria.*

#### **04.1 General**

Proposed wind energy conversion facilities shall be consistent with all applicable local, state and federal requirements, including but not limited to all applicable electrical, construction, noise, safety, environmental and communications requirements.

#### **04.2 Design Standards**

*Commentary: The design and scale of modern wind turbines means that they will be visible from adjacent public areas and residential properties, as well as from locations some distance away. The general industry rule-of-thumb is that the bottom of the turbine rotor should be at least 10 feet above any obstacle within 300 feet to avoid turbulence in the air column. As a result, the rotors will have to be located well above most other landscape features. Typically, aircraft safety lighting will be required for air navigation purposes in accordance with Federal Aviation Administration (FAA) requirements. The following standards are intended to minimize potential impacts to the greatest extent possible through effective design and carefully considered siting. Towns may wish to identify areas that are suitable for this kind of development and/or apply specific design standards in others. For instance, for locations in close proximity to airports it may not be appropriate to locate structures of this kind due to potential conflicts with air navigation. Similarly, whereas in most cases the structures should be designed to be less visible, it may be appropriate for taller turbines to be highly visible if aircraft commonly traverse the site.*

##### **04.2.1 Visual Impact**

The proponent shall demonstrate through project siting and proposed mitigation that the wind energy conversion facility minimizes any impact on the visual character of surrounding neighborhoods and the community. This may include, but not be limited to, information regarding site selection, turbine design, buffering, lighting and cable layout.

*Commentary: Because of the Cape's relatively flat topography and low horizons*

*emphasized by a low tree canopy, taller structures (over 50 feet in height) can break the horizon line and dominate the landscape unless carefully sited. Distinctive open landscapes such as marshes, agricultural fields and cranberry bogs may provide vistas that could be altered by taller structures. Similarly, the Cape's cultural and natural resources could also be potentially altered by siting in historic districts or sensitive habitat areas.*

*Visual impacts are a subjective matter depending on whether wind turbines are viewed as either a positive (improvement) or a negative (detraction) on the viewscape. Visual impact is assessed largely by qualitative judgments, as it is concerned with the human appreciation of, and interaction with, the landscape. Generally, when wind turbines are seen spinning, they are perceived as being useful and therefore, beneficial by some, while others may view them as a blight on the natural environment. On Cape Cod, where tall man-made structures are relatively rare, careful siting of larger wind turbines will be necessary to insure the success of these projects.*

*Because of the significance of this issue, the Special Permit application includes a requirement for a crane or a balloon test and visual simulations to be completed to give community members an opportunity to assess the locations from which the turbine will be visible. As discussed in the previous section, most Cape towns have Special Permit criteria that require consideration of the project's affect on visual character. This test would be important in informing the SPGA of those relative impacts.*

*Depending on the site, a number of strategies could be adopted that may assist in minimizing potential visual impacts. While not an exhaustive list of potential strategies, developers could consider the following as plans are developed to address any community concerns and demonstrate that the facility minimizes impact on the neighborhood and visual character.*

- Use of Screening/buffering: In certain instances, views from adjacent properties can be minimized by locating turbines in a manner that uses existing mature landscaping or structures to block views to the turbines. For instance, if a site was determined to be potentially impacted, the proponent may have the flexibility to adjust the location of the turbine in such a way as to limit the line of sight to part or all of the structure by using existing buildings or vegetation for screening purposes. A simple line-of-sight analysis to nearby sensitive receptors could be completed by the proponent to establish whether such screening can be used. Where appropriate, proponents could plant landscape buffers to mitigate visual impacts. This could involve the planting of trees in close proximity to the viewer so that line of sight to the turbines would be limited. However, it should be noted that planting near the turbine should be avoided, as the increased turbulence created by the vegetation will decrease the turbines efficiency. The turbine would therefore have to be constructed taller to compensate for this impact, which will likely offset any mitigated visual impacts.*
- Scenic vistas: In areas where there are distinctive scenic vistas, landscape and scenic roadways, towns could consider prohibiting facilities of this kind. Alternatively, if important viewsheds have been identified, locating*

*turbines such that they appear toward the edge of the viewshed (rather than dominating the view) could potentially lessen their impact.*

- *Cultural Resources: Because of the sensitivity of many historic districts, and because of the historical and architectural significance of many structures within historic districts, towns must determine whether wind energy conversion facilities are appropriate in these districts. Historical Commissions and Historic District Commissions would be involved in the review of any applications to locate such facilities within an historic district and would be involved in an advisory role for applications in close proximity to an historic district. Some of these Historic Boards and Commissions have policies addressing wind facilities. For instance, the Old Kings Highway Historic District, which covers a large part of the Cape, has guidelines for energy conscious design. These guidelines are in addition to any requirements of the zoning in that area. The guidelines support the use of wind generators provided that they adhere to several criteria (these include: minimizing visual impact on the neighborhood; using extensive landscaping to minimize visual impact; and designing the device to blend with features in the immediate areas). In some cases, it may be appropriate for a project proponent to file with the Massachusetts Historical Commission or appropriate body in order to establish the proximity of nearby historic or archaeological resources.*

#### **04.2.2 Color**

Wind energy conversion facilities shall be painted a non-reflective color that blends with the sky and clouds.

*Commentary: The model bylaw recommends that irrespective of the color, the turbine should be finished with a non-reflective paint. Light gray or a light blue hues are generally more appropriate color choices for taller structures; however, the SPGA should determine the appropriate color on a case-by-case basis. The SPGA could consider the color of surrounding water towers and other tall structures to determine the most appropriate color for the facility so that it is least visible against the skyline/horizon. Although not common, in some locations where icing of the blades has been an issue, turbine rotors have been painted black so they absorb heat and prevent the build up of ice on the rotor blades. Although this is unlikely to be a major issue on the Cape, if proposed, the SPGA would have to decide whether reducing icing using black blades outweighs the potentially greater visual impacts of a darker structure.*

#### **04.2.3 Equipment Shelters**

All equipment necessary for monitoring and operation of the wind energy conversion facilities should preferably be contained within the turbine tower. If this is infeasible, ancillary equipment may be located outside the tower, provided it is contained either within an underground vault, or enclosed within a separate structure or behind a year-round landscape or vegetated buffer.

*Commentary: Most modern turbines are monopole designs that accommodate the ancillary control systems within the tower structure. However, in the event that ancillary equipment (such as transformers) cannot be accommodated within the tower, the bylaw recommends that the equipment be hidden from view either in an*

*underground vault, structure or behind an effective year-round buffer. In such cases, fences may also be proposed to provide security for ground-based facilities.*

*If telecommunications providers are encouraged to use the turbines, associated ground-based facilities will be needed to accommodate telecommunications equipment and should also be screened from view. In this case, federal regulations regarding telecommunications towers require all equipment to be contained within a secure, fenced area.*

#### **04.2.4 Lighting and Signage**

- a) Wind turbines shall be lighted only if required by the Federal Aviation Administration (FAA). The proponent shall provide a copy of the FAA's determination to establish the required markings and/or lights for the structure.
- b) Lighting of equipment structures and any other facilities on site (except lighting required by the FAA) shall be shielded from abutting properties.
- c) Signs on the facility shall be limited to:
  1. those needed to identify the property, and the owner and warn of any danger; and,
  2. educational signs providing information on the technology and renewable energy usage.
- d) All signs shall comply with the requirements of the Town's sign regulations.

*Commentary: In general, the FAA does not require obstruction markings or lighting for structures under 200 feet, although this varies depending on topography and the structure's proximity to airports or flight paths. For higher structures, the FAA will likely require lights to be placed on the nacelle (not the rotor blades), however, the FAA makes a separate determination for each application.*

*Typically, most wind energy conversion facilities will have no other lights other than those required by the FAA, but in the event that some exterior security lighting is needed, the model bylaw recommends that they have shielding that prevents light spilling onto adjacent properties.*

*Typically no signage will be necessary, however, certain projects may wish to use the facility as an educational tool and therefore the bylaw recommends that educational signage be permitted. In addition, signs indicating the facility owner should be allowed.*

### **04.3 Environmental Standards**

#### **04.3.1 Wetlands**

Wind energy conversion facilities shall be located in a manner consistent with all applicable local and state wetlands regulations. Wetland buffer areas may be used for the purposes of providing a clear area.

*Commentary: Cape Cod and the Islands have many wetland resource areas, including*

*salt marshes, bordering vegetated wetlands, cranberry bogs and vernal pools, all of which play significant roles in maintaining the health of the natural environment. Consistent with the purposes of local, state, and regional wetland regulations, which strive to preserve and protect wetland functions, siting wind turbine facilities within wetlands or their buffers should be avoided whenever possible. There may also be significant engineering challenges associated with establishing stable foundations within wetland environments, ultimately posing considerable cost and ongoing maintenance concerns.*

*However, in the event that an appropriate site is found near a wetland (e.g. cranberry bogs), the bylaw references existing wetlands regulations and specifically notes that wetland buffer areas can be within the required clear area.*

#### **04.3.2 Land Clearing/Open Space/Rare Species**

Wind energy conversion facilities shall be designed to minimize land clearing and fragmentation of open space areas and shall avoid permanently protected open space when feasible. Wind turbines should be sited to make use of previously developed areas wherever possible. Wind energy conversion facilities shall also be located in a manner that does not have significant negative impacts on rare species in the vicinity (particularly avian species, bats, etc.).

*Commentary: Depending on the location, land clearing associated with wind development may have a detrimental impact on certain kinds of protected open space areas and habitat. Clearing could be required to install met towers, install transmission cables, for maintenance and construction access, and also to minimize the wind turbulence generated by surrounding vegetation. As such, there could potentially be large amounts of clearing that could fragment habitats or alter the character of vegetated open space areas.*

*As such, the bylaw recommends that wind turbines be located in areas that have been previously disturbed and that protected open space areas be avoided whenever feasible. As part of the Special Permit review, the SPGA should establish the amount of clearing and require that the proponent fully explain the purpose of all clearing requested.*

*In addition, the Cape Cod and the Islands are host to a wide variety of migratory birds and rare species, and the protection of those species and their habitat is a priority reflected in state, regional and local regulations. All efforts should be made to avoid impacting rare species or their habitat. However, where an otherwise feasible project site may impact rare species (including both terrestrial habitats and the "airspace" habitat associated with rare or migratory birds) the Massachusetts Natural Heritage and Endangered Species Program (NHESP) may issue a conservation permit consistent with the existing requirements of the Massachusetts Endangered Species Act (MESA). Mitigation may be an appropriate alternative, to be determined by NHESP.*

### **04.3.3 Stormwater**

Stormwater run-off and erosion control shall be managed in a manner consistent with all applicable state and local regulations.

*Commentary: The construction and operation of wind energy conversion facilities may have local impacts on storm water filtration and erosion due to foundation construction, site grading, new impervious areas or from the removal of existing vegetation, and may introduce threats to water resources through use, storage, generation of hazardous materials or waste at the site.*

*Many towns have local bylaws that are aimed at controlling erosion resulting from construction. State regulations have specific stormwater management requirements for projects regulated by local Conservation Commissions, including policies for use of best management strategies in wellhead protection areas where high-pollutant loads are likely. However, many towns have limited regulations applicable to stormwater management in areas not under Conservation Commission control. Therefore, towns may wish to adopt some of the provisions of the Massachusetts Stormwater Policy Guidelines to address some of these issues, particularly for development proposed in drinking-water source areas.*

### **04.3.4 Noise**

The wind energy conversion facility and associated equipment shall conform with Massachusetts noise regulations (310 CMR 7.10). An analysis, prepared by a qualified engineer, shall be presented to demonstrate compliance with these noise standards and be consistent with Massachusetts Department of Environmental Protection guidance for noise measurement.

*Commentary: Other than construction noise that would be regulated by normal Town processes, two types of noise are generated by wind turbines: aerodynamic (i.e., noise from the blades moving through the air) and mechanical (from the gearbox, generator and other equipment). At higher wind speeds, the ambient noise level will likely mask both these sources of noise, but at lower wind speeds noise generated by the turbine may be detectable.*

*State regulations prohibit increases of more than 10dB over the ambient noise and production of significant pure tone noises for all uses and would therefore be applicable to new wind facilities. Both of these levels are measured at the property line and at the nearest inhabited residence. Local regulations often have similar noise limitations, although they can vary from town to town. For the SPGA to evaluate whether the project is in conformance with these requirements, the bylaw recommends an analysis by a qualified engineer. Massachusetts Department of Environmental Protection provides guidance for how these noise measurements are prepared. Furthermore, the analysis should include noise generated from any telecommunications carriers located on the turbine tower.*

### **04.3.5 Shadowing/Flicker**

Wind energy conversion facilities shall be sited in a manner that does not result in significant shadowing or flicker impacts. The proponent has the burden of proving that this effect does not have significant adverse impact on neighboring or

adjacent uses either through siting or mitigation.

*Commentary: Shadows cast from wind turbines generally occur in close proximity to the turbine, although this will vary depending on the time of year/day, latitude and turbine height. Flicker effects can occur when the sun shines through the rotor blades at certain times of day and result in the temporary blocking of the sun's rays with each pass of a rotor blade. Concerns about these temporary phenomena are usually perceived as a nuisance by nearby receptors (i.e., homes and businesses) rather than a potential hazard, but are nonetheless important considerations in siting turbines.*

*These effects are predictable as the location and position of the sun can be accurately plotted and computer-modeling tools are also available to predict the area that will have a shadow cast upon it or be subject to flicker. The effects on neighboring properties can also be mitigated, thus avoiding potential adverse impacts. For instance, tree planting in key locations can block the shadow of the turbine from sensitive receptors. The degree to which shadow/flicker is an issue will depend on the time and type of use affected. The bylaw therefore recommends that the proponent demonstrate that these effects do not adversely impact neighboring uses and propose appropriate mitigation where needed and at the SPGA's discretion.*

#### **04.4 Safety Standards**

No hazardous materials or waste shall be discharged on the site of any wind energy conversion facility. If any hazardous materials or wastes are to be used on site, there shall be provisions for full containment of such materials or waste. An enclosed containment area, designed to contain at least 110 percent of the volume of the hazardous materials or waste stored or used on the site may be required to meet this requirement.

The wind energy conversion towers shall also be designed to prevent unauthorized access (for example, by construction of a fenced enclosure or locked access).

*Commentary: Some hazardous materials, e.g., lubricating oil, coolant, etc., may be stored within the nacelle or tower for the purposes of maintenance. Furthermore, it is possible that some kind of oil leak may occur within the structure or at times of maintenance. Therefore, the bylaw recommends that the structure be designed to contain any spills or leaks. This would be of particular importance on the Cape if the turbine were located in a wellhead protection district.*

*Some turbine towers, especially lattice-type towers, have been identified as potential "attractive nuisances," and therefore the bylaw recommends that they be designed to limit unauthorized access. It is likely that project proponents will have already taken such steps to limit liability and prevent damage to their equipment.*

#### **05.0 Use by Telecommunications Carriers**

Wind energy conversion facilities may be used to locate telecommunications antennas, subject to applicable regulations governing such uses, and subject to the following requirements:

- a) All ground-mounted telecommunications equipment shall be located in either a shelter, within the wind turbine tower or otherwise screened from view year-round (either through effective landscaping or existing natural vegetated buffers);
- b) Antennas shall be flush-mounted to be in keeping with the design of the wind turbine tower; and
- c) All cabling associated with the personal wireless facility shall be contained within the tower structure or enclosed within a conduit painted to match the turbine mount.

*Commentary: Tall structures are necessary for personal wireless companies to provide service to their customers. This has historically meant locating antennas within tall buildings or structures (e.g., church steeples, flagpoles) or on purpose-built towers. While using disguised antennas within existing structures has resulted in few visual impacts, new telecommunications towers can often have negative visual impacts on communities. Depending on the location, a wind turbine may provide an opportunity for attaching antennas that may reduce the number of new telecommunications towers.*

*The bylaw recommends that locating telecommunications towers on wind energy conversion facilities could be appropriate, provided they are compatible with the design of the tower. For instance, flush-mounted antennas, sensitive cable design and appropriately sited ground equipment would avoid visual clutter on the tower and around the tower base. The model bylaw recommends that these requirements are additional to all other applicable regulations for telecommunications towers.*

## **06.0 Modifications**

All modifications to a wind energy conversion facility made after issuance of the Special Permit shall require approval by the SPGA in accordance with the town's existing process for modifications to Special Permit approvals.

*Commentary: Following the issuance of the Special Permit and after the commencement of operations of the facility, it is conceivable that changes to the project may occur over time. This could range anywhere from minor changes to the machinery to entire re-fits of the turbine structure. This section aims to incorporate towns existing process for evaluating modifications into the bylaw. For instance, minor changes may be relatively simple approvals by the SPGA or Building Commissioner if no significant alterations result, whereas more significant changes to the operations or exterior appearance may warrant an additional public hearing process.*

## **07.0 Monitoring and Maintenance**

**07.1** After the wind energy conversion facility is operational, the applicant shall submit to the town at annual intervals from the date of issuance of the Special Permit, a report detailing operating data for the facility (including but not limited to days of operation, energy production, etc.).

**07.2** The applicant shall maintain the wind energy conversion facility in good condition. Such maintenance shall include, but not be limited to, painting, structural

integrity of the foundation and support structure and security barrier (if applicable), and maintenance of the buffer areas and landscaping if present.

07.3 Notice shall be provided to the town of any change in owner of the facility.

*Commentary: The requirement for annual operating reports is recommended to assist the town in two ways. Firstly, the annual report will give the town a complete picture of whether the turbine has been abandoned. Secondly, the data will provide a public benefit to the project as valuable information can be shared with the community on the benefits of renewable energy.*

## **08.0 Abandonment or Discontinuation of Use**

**08.1** At such time that a wind energy conversion facility is scheduled to be abandoned or discontinued, the applicant will notify the town by certified U.S. mail of the proposed date of abandonment or discontinuation of operations. In the event that an applicant fails to give such notice, the facility shall be considered abandoned or discontinued if the facility is inoperable for 180 days. In the case of a multi-turbine facility, the SPGA shall determine in its decision what proportion of the facility would be inoperable for the facility to be considered abandoned.

**08.2** Upon abandonment or discontinuation of use, the owner shall physically remove the wind energy conversion facility within 90 days from the date of abandonment or discontinuation of use. This period may be extended at the request of the operator and at the discretion of the SPGA. "Physically remove" shall include, but not be limited to:

- a) Removal of the wind turbine and tower, all machinery, equipment, equipment shelters, security barriers and all appurtenant structures from the subject property,
- b) Proper disposal of all solid or hazardous materials and wastes from the site in accordance with local and state solid waste disposal regulations,
- c) Restoration of the location of the wind energy conversion facility to its natural condition, except that any landscaping, grading or below-grade foundation may remain in the after-condition.

**08.3** If an applicant fails to remove a wind energy conversion facility in accordance with this section of this bylaw, the town shall have the authority to enter the subject property and physically remove the facility. The SPGA may require the applicant to provide a form of surety (i.e. post a bond, letter of credit or establish an escrow account or other) at the SPGA's election at the time of construction to cover costs of the removal in the event the town must remove the facility. The amount of such surety shall be equal to 150 percent of the cost of compliance with this section. The applicant shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for a Cost of Living Adjustment after 10 and 15 years.

*Commentary: The current design life of modern wind turbines is around 20 years, although as wind technology evolves, turbines may operate well beyond this timeframe. It is possible that at the end of a turbine's design life a replacement turbine may be installed on the existing tower (although whether this is practical is subject to a number of variable factors relating to the size, weight and physical forces associated with the turning rotors). In the case of a multi-turbine wind facility, it is possible that some of the turbines may be inoperable while others in the same facility are operating normally or if planned maintenance is scheduled. The bylaw recommends that the SPGA provide some guidance on what proportion must be operational for the facility to be considered abandoned at the time of the Special Permit.*

*It is conceivable that a wind energy conversion facility could become abandoned if operated by a private entity that is no longer solvent. However, even a non-functioning turbine has value and would likely be salvaged rather than abandoned. Given the nature of the wind energy conversion facility, it is impossible for the structure to be re-used as something else (unlike a building, for example) and given the scale of the structure, it is likely to present a permanent negative visual impact on a community if abandoned.*

*Therefore, the bylaw recommends requiring removal of the facility when abandoned and restoration of the site to its pre-existing condition. However, an exception is made for installed landscaping and grading completed at installation. Removal of the below-grade foundations could also be required by the town. However, removal of below grade structures could have greater impacts than leaving them in place. The SPGA will have discretion over this at the time of review.*

*Furthermore, removal of a facility may be very expensive and therefore the bylaw recommends that the SPGA require a surety of some kind, such as a bond, letter of credit or escrow, be established prior to the start of operations. The surety should be based on an estimate from a qualified engineer provided by the applicant and should be for 150 percent of the cost at the time.*

## **09.0 Term of Special Permit**

A Special Permit issued for any wind energy conversion facility shall be valid for 25 years, unless extended or renewed. The time period may be extended or the Special Permit may be renewed upon satisfactory operation of the facility. At the end of that time period, the wind energy conversion facility shall be removed by the applicant.

*Commentary: As discussed earlier, the design life of a turbine is approximately 20 years, but may be longer for more modern machines. The bylaw recommends that the initial Special Permit be valid for a minimum of 25 years. As the technology is rapidly changing, newer turbines and rotor designs that upgrade the equipment or improve efficiency may be desirable. The bylaw allows extension of the permit if the facility is operating satisfactorily and changes in the turbine design could be accommodated through the modification process currently applicable to all Special Permits.*

## **10.0 Application Procedures**

### **10.1 Special Permit Granting Authority (SPGA)**

The SPGA for wind energy conversion facilities shall be the Planning Board.

*Commentary: Towns have different preferences for SPGAs. The model bylaw recommends that the Planning Board (PB) serve as the Special Permit Granting Authority for wind energy conversion facilities. Towns may choose instead to have the Zoning Board of Appeals serve as the SPGA.*

### **10.2 Pre-Application Conference**

Prior to the submission of an application for a Special Permit under this regulation, the applicant is strongly encouraged to meet with the SPGA at a public meeting to discuss the proposed wind energy conversion facility in general terms and to clarify the filing requirements. The SPGA shall meet with an applicant under this regulation within 21 days following a written request submitted to the SPGA and the Town Clerk. If the SPGA fails to meet with an applicant who has requested such a meeting within 21 days of said request and said meeting has not been postponed due to mutual agreement, the applicant may proceed with a Special Permit application under this regulation without need for a pre-application conference.

### **10.3 Pre-Application Filing Requirements**

The purpose of the conference is to inform the SPGA as to the preliminary nature of the proposed wind energy conversion facility. As such, no formal filings are required for the pre-application conference. However, the applicant is encouraged to prepare sufficient preliminary architectural and/or engineering drawings to inform the SPGA of the location of the proposed facility, as well as its scale and overall design.

*Commentary: While not a requirement, the purpose of a pre-application conference is to give the SPGA advance notice of an application for a wind energy conversion facility and to remove, to the extent possible, some of the pressure that boards experience once a formal Special Permit has been applied for. This process benefits the applicant as it is designed to educate the SPGA and allows the applicant to receive comment on the likely concerns raised by the scale and placement of the wind energy conversion facility. It also allows the applicant to receive feedback on the filing requirements and discuss possible waivers from the requirements. However, the timeframes provided above may need to be adapted to suit each jurisdiction's needs.*

### **10.4 Professional Fees**

The town may retain a technical expert/consultant to verify information presented by the applicant. The cost for such a technical expert/consultant will be at the expense of the applicant.

*Commentary: Review of wind energy conversion facilities is not routine for many local permitting boards. Therefore, the bylaw recommends that the town hire an independent expert funded by the applicant to assist in the town's review.*

### **10.5 Additional Requirements**

Within 30 days of the pre-application conference, or within 21 days of filing an

application for a Special Permit, the applicant shall arrange for a balloon or crane test at the proposed site to illustrate the height of the proposed facility. The date, time and location of such test shall be advertised in a newspaper of general circulation in the town at least 14 days, but not more than 21 days prior to the test. In addition, notice shall be provided to the town, abutters and abutting Historic Commissions and an identical courtesy notice shall be sent to the Town Clerk of all adjacent towns.

*Commentary: Because of the scale of modern wind turbines, the model bylaw recommends that a crane or balloon test be completed to provide interested parties with a sense of the height of the turbine. Similar tests are often conducted for proposed telecommunications towers that are considerably smaller than modern wind turbines and allow a thorough assessment of the visibility of the structure. The test is recommended to be advertised in the local press in a reasonable amount of time before the date to allow residents an opportunity to attend the test. The bylaw offers a suggested notice period similar to those adopted in many communities for review of telecommunications towers, however, different timeframes can be adopted by each town.*

## **10.6 Application Filing Requirements**

*Commentary: The following provides a suggested listing of information that a SPGA may wish to require from the proponent as part of the Special Permit application. For the most part, the requirements reflect information that is commonly included for other types of development reviewed under this process. Individual towns may wish to tailor the requirements for their own needs and in a manner that is consistent with other filing procedures.*

The following shall be included with an application for a Special Permit for each wind energy conversion facility:

### **10.6.1: General Filing Requirements**

- a) Name, address, telephone number and original signature (photo-reproductions of signatures will not be accepted) of applicant and any co-applicants. Co-applicants may include the landowner of the subject property or the operator of the wind energy conversion facility. If telecommunications antenna are proposed, a telecommunications carrier should be a co-applicant.
- b) If the applicant or co-applicant will be represented by an agent, the name, address and telephone number shall be provided as well as original signature authorizing the agent to represent the applicant and/or co-applicant shall be provided. Photo-reproductions of signatures will not be accepted.
- c) Documentation of the legal right to install and use the proposed facility and proof of control over the clear area, per Section 03.2 of these regulations.

### **10.6.2: Location Filing Requirements**

- a) Identify the subject property by including the town as well as the name of the locality, name of the nearest road or roads, and street address, if any

- b) Tax map and parcel number of subject property
- c) Zoning district designation for the subject parcel (submit copy of town zoning map with parcel identified)
- d) A line map to scale showing the lot lines of the subject property and all properties within 300 feet of the property lines, as well as the location of all buildings, including accessory structures, on all properties shown.

**10.6.3: Siting and Design Filing Requirements**

**10.6.3.1 VICINITY/SITE MAP**

A one-inch-equals-40 feet vicinity plan, signed and sealed by a Registered Professional Engineer or Licensed Surveyor showing the following:

- a) Property lines for the subject property and all properties adjacent to the subject property within 300 feet.
- b) Outline of all existing buildings, including purpose (e.g., residential buildings, garages, accessory structures, etc.) on subject property and all adjacent properties within 300 feet. Distances, at grade, from the proposed wind energy conversion facility to each building on the vicinity plan shall be shown.
- c) Proposed location of wind energy conversion facility, including all turbines, fencing, associated ground equipment, transmission infrastructure and access roads. Including:
  - 1) Location of all roads, public and private, on the subject property and on all adjacent properties within 300 feet including driveways proposed to serve the wind energy conversion facility,
  - 2) All proposed changes to the existing property, including grading, vegetation removal and temporary or permanent roads and driveways,
  - 3) Representations, dimensioned and to scale, of the proposed facility, including cable locations, parking areas and any other construction or development attendant to the wind energy conversion facility.
- d) Tree cover and average height of trees on the subject property and adjacent properties within 300 feet.
- e) Contours at each two feet Above Mean Sea Level (AMSL) for the subject property and adjacent properties within 300 feet.
- f) Representation of location of viewpoint for the sight-line diagram referenced below.

**10.6.3.2 SIGHT LINES AND PHOTOGRAPHS**

Sight lines and photographs as described below:

a) Sight-line representation. A sight-line representation shall be drawn from representative locations that show the lowest point of the turbine tower visible from each location. Each sight line shall be depicted in profile, drawn at one inch equals 40 feet. The profiles shall show all intervening trees and buildings. There shall be at least two sight line representations illustrating the visibility of the facility from surrounding areas such as the closest habitable structures or nearby public roads or areas.

*Commentary: An example of a sight-line representation, see Appendix B attached. This requirement could be waived through the pre-application conference if no significant visual concerns are anticipated. Such a diagram would assist the SPGA in making a finding concerning the impact of the project on the surrounding neighborhood as required under the towns Special Permit granting criteria.*

b) Existing (before condition) photographs. A color photograph of the current view shall be submitted from at least two locations to show the existing situation.

c) Proposed (after condition). Each of the existing-condition photographs shall have the proposed wind energy conversion facility superimposed on it to accurately simulate the proposed wind energy conversion facility when built and illustrate its total height, width and breadth.

*Commentary: The model bylaw suggests that some kind of photosimulation be provided to superimpose a rendering of the proposed turbine on a photograph of the existing setting.*

#### 10.6.3.3 ELEVATIONS

Siting elevations, or views at-grade from the north, south, east and west for a 50-foot radius around the proposed wind energy conversion facility.

Elevations shall be at either one-quarter inch equals one foot or one-eighth inch equals one foot scale and show the following:

a) Wind energy conversion facility and if applicable the security barrier and associated equipment, with total elevation dimensions of all parts of the facility.

b) Security barrier. If the security barrier will block views of the wind energy conversion facility, the barrier drawing shall be cut away to show the view behind the barrier.

c) Any and all structures on the subject property.

d) Existing trees and shrubs at current height and proposed trees and shrubs at proposed height at time of installation, with approximate elevations dimensioned.

e) Grade changes, or cuts and fills, to be shown as original grade and new grade line, with two-foot contours above mean sea level.

#### 10.6.3.4 MATERIALS

a) Specifications for the proposed wind energy conversion facility shall be

provided for all equipment and attendant facilities.

b) Materials of the proposed wind energy conversion facility specified by type and specific treatment. These shall be provided for the wind turbine tower and all other proposed equipment/ facilities.

c) Colors of the proposed wind energy conversion facility represented by a color board showing actual colors proposed.

#### 10.6.3.5 LANDSCAPE PLAN

A Landscape plan including existing trees and shrubs and those proposed to be added or removed, identified by size of specimen at installation and species.

#### 10.6.3.6 LIGHTING PLAN

If lighting of the site or turbine is proposed (other than FAA lights), the applicant shall submit a manufacturer's computer-generated point-to-point printout, indicating the horizontal foot-candle levels at grade, within the property to be developed and 25 feet beyond the property lines. The printout shall indicate the locations and types of luminaires proposed.

### **10.6.4: Environmental Requirements**

#### 10.6.4.1 NOISE FILING REQUIREMENTS

The applicant shall provide a statement listing the existing noise levels and the maximum future projected noise levels from the proposed wind energy conversion facility. Such statement shall be certified and signed by a qualified engineer, stating that noise projections are accurate and meet the noise standards of this bylaw and applicable state requirements.

#### 10.6.4.2 OTHER

The applicant shall submit information illustrating how the project is consistent with the environmental standards of this bylaw.

*Commentary: Many of the environmental standards in the model bylaw rely on compliance with exiting regional, state and local regulations (for example, wetlands, rare species and stormwater regulations). As such, towns may also wish to develop a checklist as part of their submittal requirements that ensures that the relevant agencies have been contacted where appropriate. This would provide important information to assist them in determining that there are no detrimental impacts resulting from the project as required under local Special Permit granting criteria.*

## Appendix A: Wind Turbine Schematics

Figure 1: Detail of wind Turbine

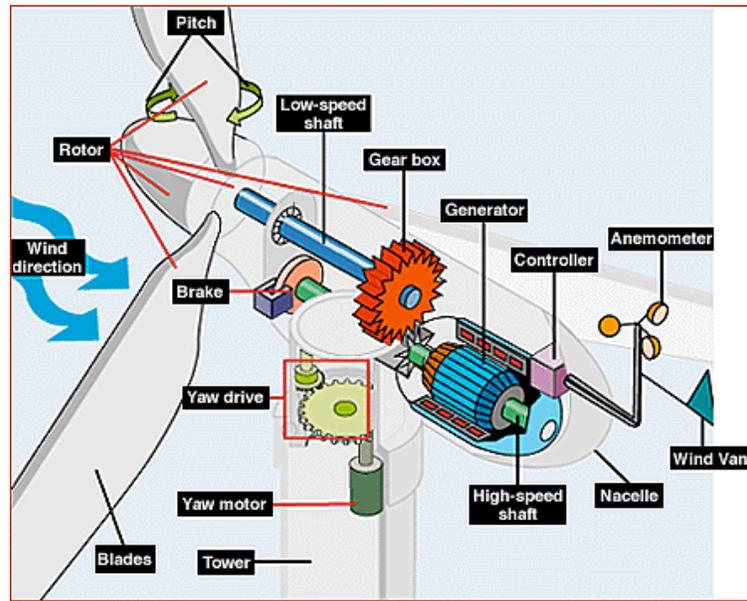
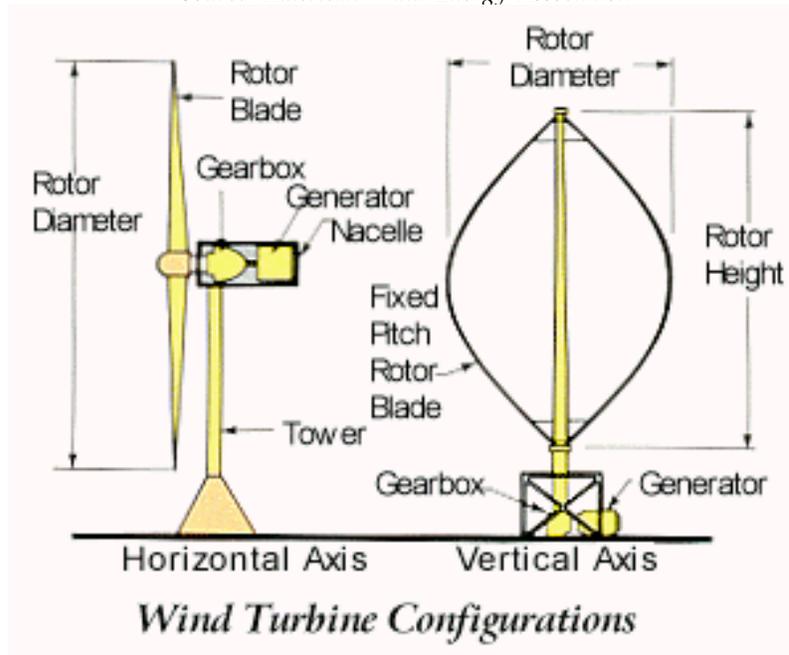
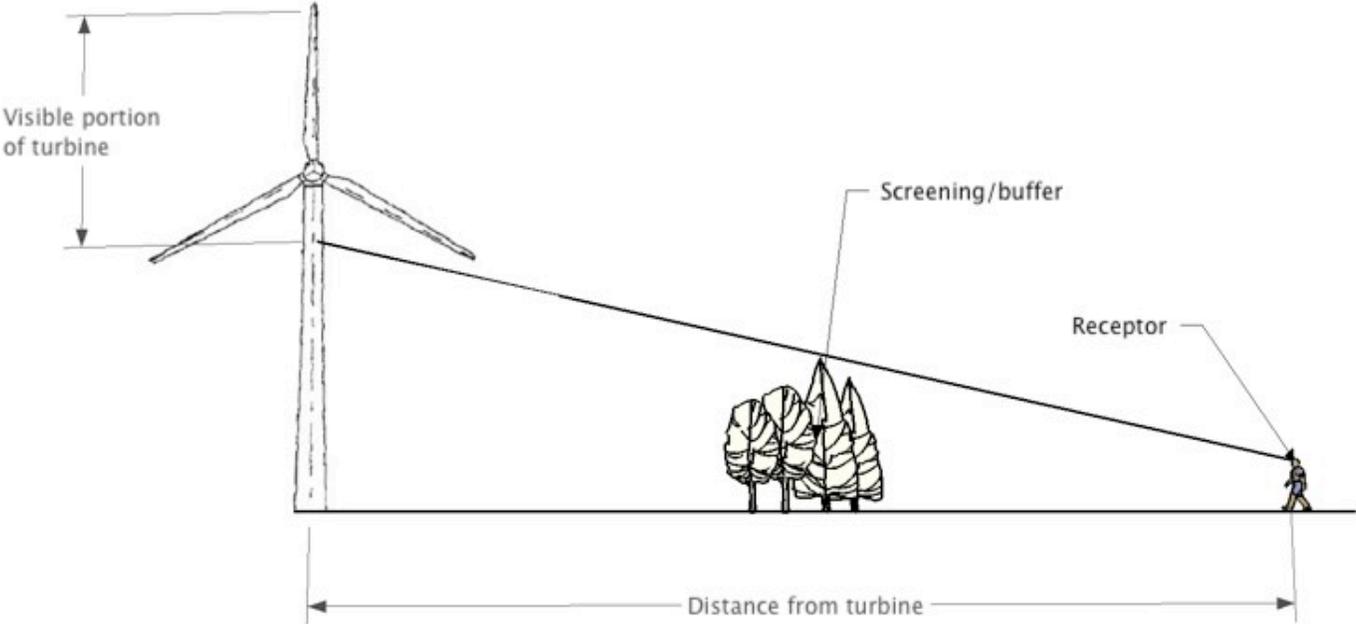


Figure 2: Wind Turbine Configurations

Source: American Wind Energy Association



# Appendix B: Simplified Sight Line Diagram



## **Appendix C: Model Bylaw (without commentary)**

### **Model Bylaw for Land-based Wind Energy Conversion Facilities for Towns in Barnstable County, Massachusetts**

#### **01.0 Purpose and Intent**

It is the express purpose of this bylaw to accommodate distributed generation, wind energy conversion facilities (not residentially scaled facilities) in appropriate locations, while minimizing any adverse visual, safety and environmental impacts of the facilities. The bylaw enables the review of wind energy conversion facilities by the town's Planning Board or Zoning Board of Appeals in keeping with the town's existing bylaws. This bylaw is intended to be used in conjunction with other regulations adopted by the town, including historic district regulations, site plan review and other local bylaws designed to encourage appropriate land use, environmental protection, and provision of adequate infrastructure development on Cape Cod.

#### **02.0 Definitions**

**Clear area:** Area surrounding a wind turbine to be kept free of habitable structures.

**Distributed Generation:** Energy generation that is located at or near the end-user.

**Height:** The height of a turbine measured to the tip of the blade at its highest point.

**Nacelle:** The frame and housing at the top of the tower that encloses the gearbox and generator and protects them from the weather.

**Rotor:** The blades and hub of the wind turbine that rotate during turbine operation.

**Special Permit Granting Authority (SPGA):** Board designated by zoning ordinance or bylaw with the authority to issue special permits.

**Wind energy conversion facility:** All equipment, machinery and structures utilized in connection with the conversion of wind to electricity. This includes, but is not limited to, all transmission, storage, collection and supply equipment, substations, transformers, site access, service roads and machinery associated with the use. A wind energy conversion facility may consist of one or more wind turbines.

**Wind Monitoring or Meteorological ("test" or "met") Towers:** Tower used for supporting anemometer, wind vane and other equipment to assess the wind resource at a predetermined height above the ground.

**Wind turbine:** A device that converts kinetic energy of the wind into rotational energy to turn an electrical generator shaft. A wind turbine typically consists of a rotor, nacelle and supporting tower.

#### **03.0 District Regulations**

### **03.1 Use Regulations**

All wind energy conversion facilities or wind monitoring towers shall require a building permit and may be permitted as follows and irrespective of whether the use is a principal or accessory use:

#### **03.1.1 Wind Energy Conversion Facility**

The construction of any wind energy conversion facility shall be permitted in all commercial, industrial and municipal zoning districts, subject to issuance of a Special Permit and provided the proposed use complies with all Dimensional and Special Permit Regulations set forth in Sections 3 and 4 of this bylaw (unless waived by the SPGA).

#### **03.1.2 Wind Monitoring or Meteorological Towers**

Wind monitoring or meteorological towers shall be permitted in all commercial, industrial and municipal zoning districts subject to issuance of a building permit for a temporary structure.

### **03.2 Site Control**

The applicant shall submit documentation of the legal right to install and use the proposed facility at the time of application for a Special Permit. Documentation should also include proof of control over the setback or clear areas, if required under Section 3.3.2. Control shall mean legal authority to prevent the use of any structure within the setback or clear area for human habitation or other use permitting human occupancy.

### **03.3 Dimensional Requirements**

All wind energy conversion facilities shall comply with the requirements set forth in this section, unless waived by the SPGA as part of the Special Permit review process.

#### **03.3.1 Height**

Wind energy conversion facilities shall be no higher than \_\_\_\_ feet (*see commentary below*) above the natural grade. The height of all wind turbines shall be measured to the highest point reached by the rotor blades. The SPGA may allow this height to be exceeded as part of the special permit process if the project proponent can demonstrate that the additional height is needed and that the additional benefits of the higher tower outweigh any increased adverse impacts. Monopole towers are the preferred type of support for wind turbines.

#### **03.3.2 Setback or Clear Area**

a) Each wind energy conversion facility and its associated equipment shall comply with the building setback provisions of the zoning district in which the facility is located.

b) In addition, the following setbacks shall be observed:

1. In order to ensure public safety and to protect the interests of neighboring property owners, the minimum distance from the base of any wind turbine tower to any property line, dwelling, business or institutional

use shall be equal to the total height of structure to the highest point. This setback is considered a "clear area."

2. The setback or clear areas should be kept free of all habitable structures so long as the facility is in place; however, these area need not be cleared of trees or other vegetation. Setbacks shall be measured from the outside surface at the base of the turbine tower. The SPGA may reduce the clear area as appropriate based on site specific considerations and if the project is consistent with the Special Permit granting criteria of the town.

#### **04.0 Special Permit Regulations**

The SPGA shall grant a Special Permit only if it finds that the proposal complies with the provisions of this bylaw (unless waived) and is consistent with the applicable criteria for granting Special Permits.

#### **04.1 General**

Proposed wind energy conversion facilities shall be consistent with all applicable local, state and federal requirements, including but not limited to all applicable electrical, construction, noise, safety, environmental and communications requirements.

#### **04.2 Design Standards**

##### **04.2.1 Visual Impact**

The proponent shall demonstrate through project siting and proposed mitigation that the wind energy conversion facility minimizes any impact on the visual character of surrounding neighborhoods and the community. This may include, but not be limited to, information regarding site selection, turbine design, buffering, lighting and cable layout.

##### **04.2.2 Color**

Wind energy conversion facilities shall be painted a non-reflective color that blends with the sky and clouds.

##### **04.2.3 Equipment Shelters**

All equipment necessary for monitoring and operation of the wind energy conversion facilities should preferably be contained within the turbine tower. If this is infeasible, ancillary equipment may be located outside the tower, provided it is contained either within an underground vault, or enclosed within a separate structure or behind a year-round landscape or vegetated buffer.

##### **04.2.4 Lighting and Signage**

- e) Wind turbines shall be lighted only if required by the Federal Aviation Administration (FAA). The proponent shall provide a copy of the FAA's determination to establish the required markings and/or lights for the structure.
- f) Lighting of equipment structures and any other facilities on site (except lighting required by the FAA) shall be shielded from abutting properties.

- g) Signs on the facility shall be limited to:
  - 3. those needed to identify the property, and the owner and warn of any danger; and,
  - 4. educational signs providing information on the technology and renewable energy usage.
- h) All signs shall comply with the requirements of the Town's sign regulations.

### **04.3 Environmental Standards**

#### **04.3.1 Wetlands**

Wind energy conversion facilities shall be located in a manner consistent with all applicable local and state wetlands regulations. Wetland buffer areas may be used for the purposes of providing a clear area.

#### **04.3.2 Land Clearing/Open Space/Rare Species**

Wind energy conversion facilities shall be designed to minimize land clearing and fragmentation of open space areas and shall avoid permanently protected open space when feasible. Wind turbines should be sited to make use of previously developed areas wherever possible. Wind energy conversion facilities shall also be located in a manner that does not have significant negative impacts on rare species in the vicinity (particularly avian species, bats, etc.).

#### **04.3.3 Stormwater**

Stormwater run-off and erosion control shall be managed in a manner consistent with all applicable state and local regulations.

#### **04.3.4 Noise**

The wind energy conversion facility and associated equipment shall conform with Massachusetts noise regulations (310 CMR 7.10). An analysis, prepared by a qualified engineer, shall be presented to demonstrate compliance with these noise standards and be consistent with Massachusetts Department of Environmental Protection guidance for noise measurement.

#### **04.3.5 Shadowing/Flicker**

Wind energy conversion facilities shall be sited in a manner that does not result in significant shadowing or flicker impacts. The proponent has the burden of proving that this effect does not have significant adverse impact on neighboring or adjacent uses either through siting or mitigation.

### **04.4 Safety Standards**

No hazardous materials or waste shall be discharged on the site of any wind energy conversion facility. If any hazardous materials or wastes are to be used on site, there shall be provisions for full containment of such materials or waste. An enclosed containment area, designed to contain at least 110 percent of the volume of the hazardous materials or waste stored or used on the site may be required to meet this requirement.

The wind energy conversion towers shall also be designed to prevent

unauthorized access (for example, by construction of a fenced enclosure or locked access).

### **05.0 Use by Telecommunications Carriers**

Wind energy conversion facilities may be used to locate telecommunications antennas, subject to applicable regulations governing such uses, and subject to the following requirements:

- a) All ground-mounted telecommunications equipment shall be located in either a shelter, within the wind turbine tower or otherwise screened from view year-round (either through effective landscaping or existing natural vegetated buffers);
- b) Antennas shall be flush-mounted to be in keeping with the design of the wind turbine tower; and
- c) All cabling associated with the personal wireless facility shall be contained within the tower structure or enclosed within a conduit painted to match the turbine mount.

### **06.0 Modifications**

All modifications to a wind energy conversion facility made after issuance of the Special Permit shall require approval by the SPGA in accordance with the town's existing process for modifications to Special Permit approvals.

### **07.0 Monitoring and Maintenance**

**07.1** After the wind energy conversion facility is operational, the applicant shall submit to the town at annual intervals from the date of issuance of the Special Permit, a report detailing operating data for the facility (including but not limited to days of operation, energy production, etc.).

**07.2** The applicant shall maintain the wind energy conversion facility in good condition. Such maintenance shall include, but not be limited to, painting, structural integrity of the foundation and support structure and security barrier (if applicable), and maintenance of the buffer areas and landscaping if present.

**07.3** Notice shall be provided to the town of any change in owner of the facility.

### **08.0 Abandonment or Discontinuation of Use**

**08.1** At such time that a wind energy conversion facility is scheduled to be abandoned or discontinued, the applicant will notify the town by certified U.S. mail of the proposed date of abandonment or discontinuation of operations. In the event that an applicant fails to give such notice, the facility shall be considered abandoned or discontinued if the facility is inoperable for 180 days. In the case of a multi-turbine facility, the SPGA shall determine in its decision what proportion of the facility would be inoperable for the facility to be considered abandoned.

**08.2** Upon abandonment or discontinuation of use, the owner shall physically

remove the wind energy conversion facility within 90 days from the date of abandonment or discontinuation of use. This period may be extended at the request of the operator and at the discretion of the SPGA. "Physically remove" shall include, but not be limited to:

- a) Removal of the wind turbine and tower, all machinery, equipment, equipment shelters, security barriers and all appurtenant structures from the subject property,
- b) Proper disposal of all solid or hazardous materials and wastes from the site in accordance with local and state solid waste disposal regulations,
- c) Restoration of the location of the wind energy conversion facility to its natural condition, except that any landscaping, grading or below-grade foundation may remain in the after-condition.

**08.3** If an applicant fails to remove a wind energy conversion facility in accordance with this section of this bylaw, the town shall have the authority to enter the subject property and physically remove the facility. The SPGA may require the applicant to provide a form of surety (i.e. post a bond, letter of credit or establish an escrow account or other) at the SPGA's election at the time of construction to cover costs of the removal in the event the town must remove the facility. The amount of such surety shall be equal to 150 percent of the cost of compliance with this section. The applicant shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for a Cost of Living Adjustment after 10 and 15 years.

## **09.0 Term of Special Permit**

A Special Permit issued for any wind energy conversion facility shall be valid for 25 years, unless extended or renewed. The time period may be extended or the Special Permit may be renewed upon satisfactory operation of the facility. At the end of that time period, the wind energy conversion facility shall be removed by the applicant.

## **10.0 Application Procedures**

### **10.1 Special Permit Granting Authority (SPGA)**

The SPGA for wind energy conversion facilities shall be the Planning Board.

### **10.2 Pre-Application Conference**

Prior to the submission of an application for a Special Permit under this regulation, the applicant is strongly encouraged to meet with the SPGA at a public meeting to discuss the proposed wind energy conversion facility in general terms and to clarify the filing requirements. The SPGA shall meet with an applicant under this regulation within 21 days following a written request submitted to the SPGA and the Town Clerk. If the SPGA fails to meet with an applicant who has requested such a meeting within 21 days of said request and said meeting has not been postponed due to mutual agreement, the applicant may proceed with a Special Permit application

under this regulation without need for a pre-application conference.

### **10.3 Pre-Application Filing Requirements**

The purpose of the conference is to inform the SPGA as to the preliminary nature of the proposed wind energy conversion facility. As such, no formal filings are required for the pre-application conference. However, the applicant is encouraged to prepare sufficient preliminary architectural and/or engineering drawings to inform the SPGA of the location of the proposed facility, as well as its scale and overall design.

### **10.4 Professional Fees**

The town may retain a technical expert/consultant to verify information presented by the applicant. The cost for such a technical expert/consultant will be at the expense of the applicant.

### **10.5 Additional Requirements**

Within 30 days of the pre-application conference, or within 21 days of filing an application for a Special Permit, the applicant shall arrange for a balloon or crane test at the proposed site to illustrate the height of the proposed facility. The date, time and location of such test shall be advertised in a newspaper of general circulation in the town at least 14 days, but not more than 21 days prior to the test. In addition, notice shall be provided to the town, abutters and abutting Historic Commissions and an identical courtesy notice shall be sent to the Town Clerk of all adjacent towns.

### **10.6 Application Filing Requirements**

The following shall be included with an application for a Special Permit for each wind energy conversion facility:

#### **10.6.1: General Filing Requirements**

- a) Name, address, telephone number and original signature (photo-reproductions of signatures will not be accepted) of applicant and any co-applicants. Co-applicants may include the landowner of the subject property or the operator of the wind energy conversion facility. If telecommunications antenna are proposed, a telecommunications carrier should be a co-applicant.
- b) If the applicant or co-applicant will be represented by an agent, the name, address and telephone number shall be provided as well as original signature authorizing the agent to represent the applicant and/or co-applicant shall be provided. Photo-reproductions of signatures will not be accepted.
- c) Documentation of the legal right to install and use the proposed facility and proof of control over the clear area, per Section 03.2 of these regulations.

#### **10.6.2: Location Filing Requirements**

- a) Identify the subject property by including the town as well as the name of the locality, name of the nearest road or roads, and street address, if any

- b) Tax map and parcel number of subject property
- c) Zoning district designation for the subject parcel (submit copy of town zoning map with parcel identified)
- d) A line map to scale showing the lot lines of the subject property and all properties within 300 feet of the property lines, as well as the location of all buildings, including accessory structures, on all properties shown.

**10.6.3: Siting and Design Filing Requirements**

**10.6.3.1 VICINITY/SITE MAP**

A one-inch-equals-40 feet vicinity plan, signed and sealed by a Registered Professional Engineer or Licensed Surveyor showing the following:

- a) Property lines for the subject property and all properties adjacent to the subject property within 300 feet.
- b) Outline of all existing buildings, including purpose (e.g., residential buildings, garages, accessory structures, etc.) on subject property and all adjacent properties within 300 feet. Distances, at grade, from the proposed wind energy conversion facility to each building on the vicinity plan shall be shown.
- c) Proposed location of wind energy conversion facility, including all turbines, fencing, associated ground equipment, transmission infrastructure and access roads. Including:
  - 1) Location of all roads, public and private, on the subject property and on all adjacent properties within 300 feet including driveways proposed to serve the wind energy conversion facility,
  - 2) All proposed changes to the existing property, including grading, vegetation removal and temporary or permanent roads and driveways,
  - 3) Representations, dimensioned and to scale, of the proposed facility, including cable locations, parking areas and any other construction or development attendant to the wind energy conversion facility.
- d) Tree cover and average height of trees on the subject property and adjacent properties within 300 feet.
- e) Contours at each two feet Above Mean Sea Level (AMSL) for the subject property and adjacent properties within 300 feet.
- f) Representation of location of viewpoint for the sight-line diagram referenced below.

**10.6.3.2 SIGHT LINES AND PHOTOGRAPHS**

Sight lines and photographs as described below:

a) Sight-line representation. A sight-line representation shall be drawn from representative locations that show the lowest point of the turbine tower visible from each location. Each sight line shall be depicted in profile, drawn at one inch equals 40 feet. The profiles shall show all intervening trees and buildings. There shall be at least two sight line representations illustrating the visibility of the facility from surrounding areas such as the closest habitable structures or nearby public roads or areas.

b) Existing (before condition) photographs. A color photograph of the current view shall be submitted from at least two locations to show the existing situation.

c) Proposed (after condition). Each of the existing-condition photographs shall have the proposed wind energy conversion facility superimposed on it to accurately simulate the proposed wind energy conversion facility when built and illustrate its total height, width and breadth.

#### 10.6.3.3 ELEVATIONS

Siting elevations, or views at-grade from the north, south, east and west for a 50-foot radius around the proposed wind energy conversion facility.

Elevations shall be at either one-quarter inch equals one foot or one-eighth inch equals one foot scale and show the following:

a) Wind energy conversion facility and if applicable the security barrier and associated equipment, with total elevation dimensions of all parts of the facility.

b) Security barrier. If the security barrier will block views of the wind energy conversion facility, the barrier drawing shall be cut away to show the view behind the barrier.

c) Any and all structures on the subject property.

d) Existing trees and shrubs at current height and proposed trees and shrubs at proposed height at time of installation, with approximate elevations dimensioned.

e) Grade changes, or cuts and fills, to be shown as original grade and new grade line, with two-foot contours above mean sea level.

#### 10.6.3.4 MATERIALS

a) Specifications for the proposed wind energy conversion facility shall be provided for all equipment and attendant facilities.

b) Materials of the proposed wind energy conversion facility specified by type and specific treatment. These shall be provided for the wind turbine tower and all other proposed equipment/facilities.

c) Colors of the proposed wind energy conversion facility represented by a color board showing actual colors proposed.

#### 10.6.3.5 LANDSCAPE PLAN

A Landscape plan including existing trees and shrubs and those proposed to be added or removed, identified by size of specimen at installation and species.

#### 10.6.3.6 LIGHTING PLAN

If lighting of the site or turbine is proposed (other than FAA lights), the applicant shall submit a manufacturer's computer-generated point-to-point printout, indicating the horizontal foot-candle levels at grade, within the property to be developed and 25 feet beyond the property lines. The printout shall indicate the locations and types of luminaires proposed.

### **10.6.4: Environmental Requirements**

#### 10.6.4.1 NOISE FILING REQUIREMENTS

The applicant shall provide a statement listing the existing noise levels and the maximum future projected noise levels from the proposed wind energy conversion facility. Such statement shall be certified and signed by a qualified engineer, stating that noise projections are accurate and meet the noise standards of this bylaw and applicable state requirements.

#### 10.6.4.2 OTHER

The applicant shall submit information illustrating how the project is consistent with the environmental standards of this bylaw.

## **Appendix D: Resources for Wind Energy Issues**

American Wind Energy Association: A national trade association that represents hundreds of wind energy member companies and advocates from the United States and around the world.

Website: <http://www.awea.org>

British Wind Energy Association: A national industry association with links and resources for information about wind power.

Website: <http://www.BWEA.org/>

The Center for Energy Efficiency and Renewable Energy: A research program based in the University of Massachusetts, Amherst.

Website: <http://www.ceere.org>

Danish Wind Industry Association: A national trade association for Denmark, a country that is a world leader in wind energy development. The site has a large number of resources on the technology.

Website: <http://www.windpower.org/en/core.htm>

Environmental Protection Agency: Provides a variety of information on New England renewable projects.

Website: [http://www.epa.gov/ne/eco/energy/renewable\\_energy.html](http://www.epa.gov/ne/eco/energy/renewable_energy.html)

The National Renewable Energy Laboratory: Operates the National Wind Technology Center and other wind-related programs for the U.S. Department of Energy.

Website: <http://www.nrel.gov/wind/>

The National Wind Coordinating Committee: Provides a forum for identifying issues that affect the use of wind power.

Website: <http://www.nationalwind.org>

Sandia National Laboratories: Involved in renewable energy technologies, including wind, for more than 20 years.

Website: [http://www.sandia.gov/Renewable\\_Energy/wind\\_energy/homepage.html](http://www.sandia.gov/Renewable_Energy/wind_energy/homepage.html)

US Dept. of Energy's Energy Efficiency and Renewable Energy Network provides information on wind energy.

Website: <http://www.eren.doe.gov/RE/wind.html>