NOVEMBER 2017

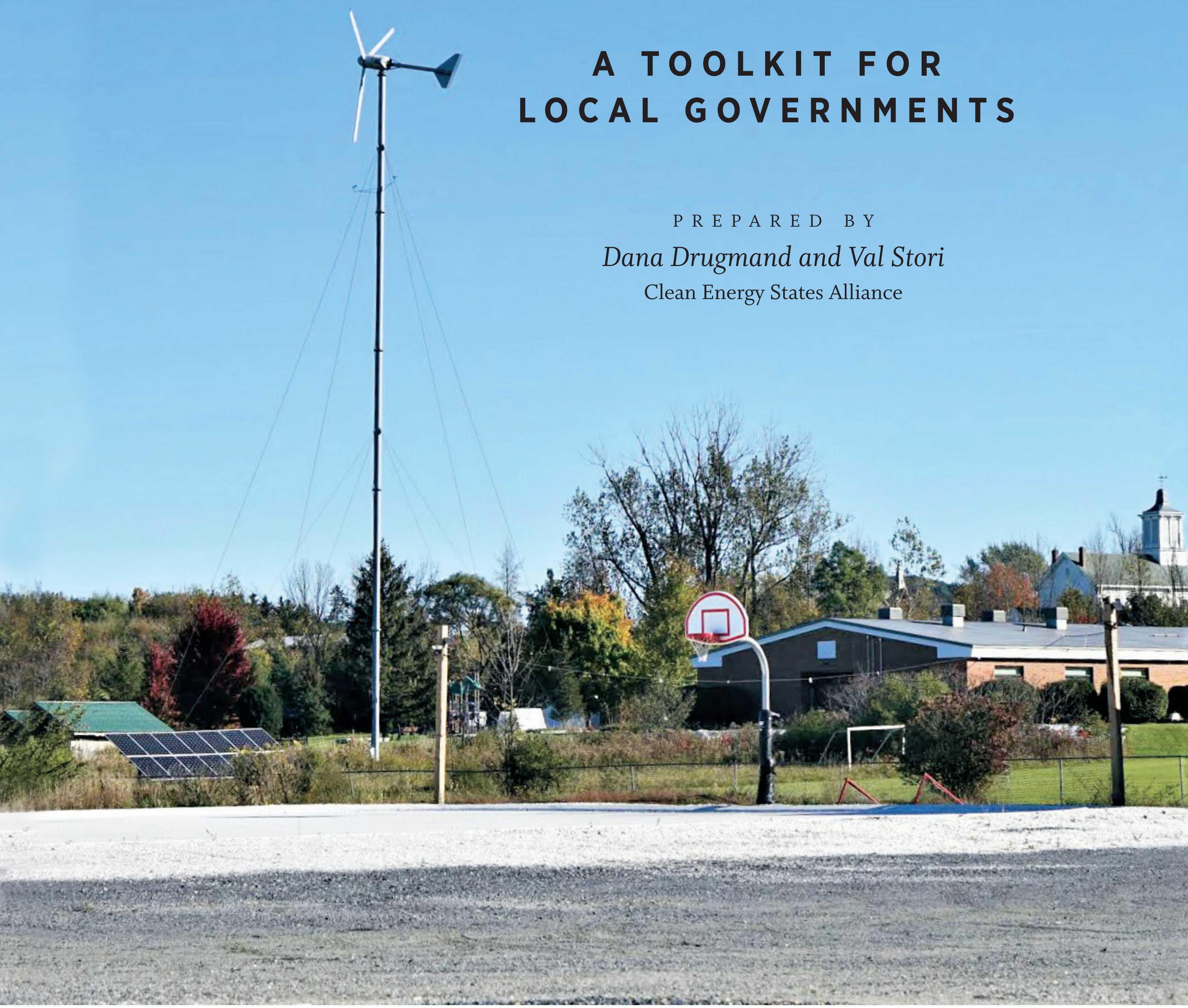
Distributed Wind Energy Zoning and Permitting

A TOOLKIT FOR LOCAL GOVERNMENTS

PREPARED BY

Dana Drugmand and Val Stori

Clean Energy States Alliance



WINDExchange U.S. DEPARTMENT OF ENERGY

Clean Energy States Alliance

Northeast Wind Resource Center

ABOUT THIS TOOLKIT

This toolkit, prepared by the Clean Energy States Alliance, serves as a resource for local governments and planning agencies, at their sole discretion, to facilitate the installation of distributed wind energy systems. Distributed wind energy systems offer an opportunity to power a home, farm, facility, business, or school with renewable energy. The toolkit includes information on what distributed wind is, how to permit a project that maintains the character of a community, and how municipal bodies can shape their zoning regulations and permitting processes to facilitate appropriate distributed wind projects. It includes a model ordinance that can serve as a template for permitting distributed wind projects. The toolkit and the model ordinance are intended neither to give any legal advice nor to be adopted verbatim. Municipalities considering using provisions herein are encouraged to consult with an attorney.

ACKNOWLEDGEMENTS

The authors would like to thank to Mark Mayhew at NYSERDA for providing guidance and review for this toolkit. Also thanks to the Northwest Wind Resource & Action Center for providing permission to use material from its Wind Energy Permit Toolkit.[1] Thank you to Mike Bergey (Bergey Wind Power) and Alice Orell (Pacific Northwest National Laboratory) who provided many of the photos in this guide. And to Rachel Carter at Vermont Farm to Plate who provided permission to include its Blue Spruce Farm case study. Warren Leon and Maria Blais Costello of Clean Energy States Alliance also provided helpful edits and comments on the toolkit. Any remaining errors or omissions are those of the authors alone.

Cover photo: © Val Stori

CONTENTS

Introduction

Distributed Wind—generally small and medium-scale wind energy systems—offers an opportunity to power a variety of buildings, facilities, and homes with reliable, renewable energy. Distributed wind projects often face zoning and permitting challenges, frequently more than for other renewable energy technologies. Unfortunately, distributed wind is often conflated with utility-scale wind and, as such, is discouraged or not permitted by many municipalities. This toolkit is intended to provide information on how communities can appropriately incorporate distributed wind energy generation into their standard zoning and permitting bylaws and processes. Town officials and zoning authorities tasked with permitting small and medium-sized wind turbines may find this guide particularly useful. It focuses on several states in the Northeast, including Massachusetts, New Hampshire, New York, and Vermont. The guidance provided is designed to help streamline permitting for distributed wind systems so that projects can be developed in an efficient manner.

The toolkit includes a model ordinance and suggested best practices for regulating distributed wind. It also outlines some of the benefits and challenges of distributed wind and includes case studies of several successful distributed wind projects.

© Aegis Renewable Energy

What is Distributed Wind?

Technically speaking, distributed wind refers to wind power generation that is "behind-the-meter," i.e., on the customer side of the electricity distribution system infrastructure and used on-site. A distributed wind system can be located at a home, farm, business, or institution (See Figure 1, p. 6). According to the U.S. Department of Energy's Wind Energy Technologies Office, "Distributed wind systems are connected on the customer side of the meter to meet the onsite load or directly to distribution or micro grids to support grid operations or offset large loads nearby."[2] Distributed wind is different from large wind farms (utility-scale wind) in that the power generated at large wind farms is transferred via transmission lines to substations, where the electricity is then distributed to distant load centers and end-users.

Most distributed wind projects consist of one or two turbines. Ninety percent of distributed wind projects installed in 2015 were single-turbine projects[3] and are usually owned by a local entity, such as a homeowner, business, or school district. However, some distributed wind projects are community owned, delivering power to the local grid via low voltage electric lines. And others are third-party owned; the turbine is leased to the property owner.

Most projects are smaller than 50 kilowatts (kW), but they can range from a small 1-kW turbine at a cell phone tower site, to a 50-kW turbine at a home, school or small business, to a 1+ megawatt (MW) turbine at a manufacturing plant or university (See Figures 2–6). In general, distributed wind is broken down into three turbine-size classifications:

- ***Small Wind:*** Turbines up to 100 kW (See Figures 2, 3 and 4, p. 7)
- ***Medium Wind:*** Turbines ranging from 101 kW to 1 MW (See Figure 5, p. 7)
- ***Large-Scale Wind:*** Turbines greater than 1 MW (See Figure 6, p. 7)

The small wind certification standard—a performance, safety, and durability standard on which both federal tax credits and some state incentives rely—defines small wind turbines by a rotor swept area of up to 200 m^2 (up to 50-65 kW) and medium wind turbines by a rotor swept area greater than 200 m^2.

FIGURE 1

Distributed wind systems can be used in many applications such as at schools, homes, and farms. Distributed wind systems are distinguished from wind farms in that the energy produced on-site is used on-site.

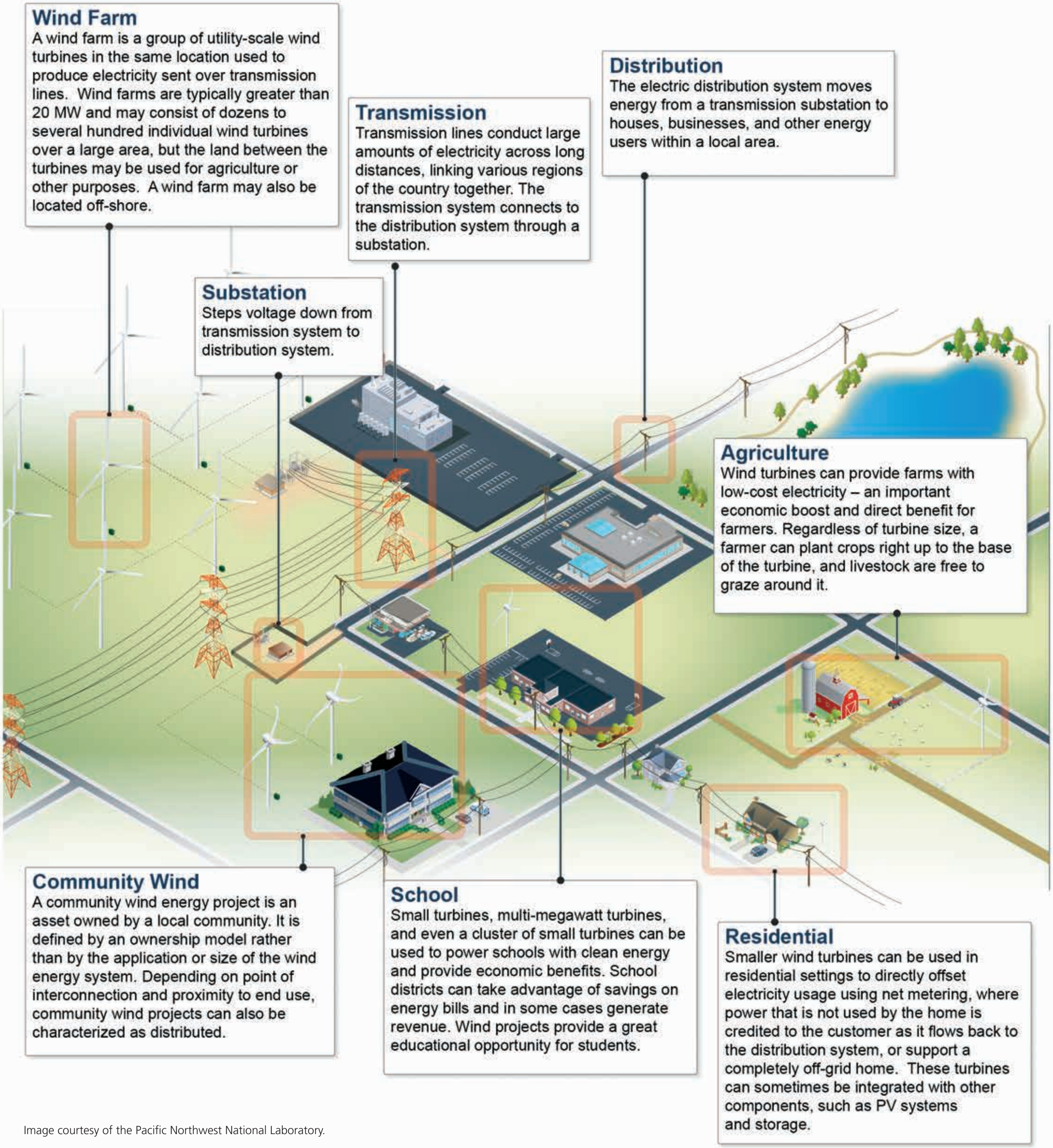


Image courtesy of the Pacific Northwest National Laboratory.

EXAMPLES OF TURBINE SIZE CLASSIFICATIONS

FIGURE 2

Distributed wind turbine at a residential site in Maine 1.8-kW Pika Energy turbine

FIGURE 3

Bergey Excel 10, an 8.9-kW turbine at a residence in Vermont

FIGURE 4

A 100-kW Northern Power Systems turbine at the Triad Recycling Facility in New York

FIGURE 5

Vestas 225-kW wind turbine in downtown Cleveland on the lake shore.

FIGURE 6

A 850-kW Gamesa turbine installed at Harbec Plastics near Rochester, New York.

Distributed Wind's Benefits and Challenges

Wind energy is a clean and renewable source of power. It generates electricity without carbon emissions or other air pollution, thereby resulting in health and climate benefits. It also diversifies the energy supply and increases energy independence. Small, distributed wind empowers individuals to produce their own power. Small wind turbines are typically manufactured here in the U.S. Wind power can offer an important income boost to rural farmers, and it reduces consumers' electric bills, in some cases by 50 percent to 90 percent depending on the wind resource.[4] Additional benefits of distributed wind, according to the U.S. Department of Energy's Wind Energy Technologies Office, include the following:[5]

- Distributed wind does not require new transmission infrastructure and can take advantage of available capacity on local distribution grids
- The social and economic benefits from distributed wind projects stay local
- Grid-connected distributed wind energy systems configured for emergency power can provide electricity to the loads they serve during natural disasters.

On the other hand, distributed wind faces several challenges. In many locations, it is more expensive than distributed solar and there are fewer companies to sell and install the technology. There is often a lack of policy and incentive support. Moreover, many people may not distinguish small distributed wind projects from large-scale industrial wind. Yet the most significant barrier is often identified to be restrictive local zoning and permitting.

Considerations for Local Zoning and Permitting of Distributed Wind

Communities interested in facilitating distributed wind energy projects should review their local jurisdiction's comprehensive plan and zoning code. The zoning code and other land use regulations may be amended by local governments to ease the permitting of distributed wind energy systems. If the comprehensive plan does not contain a wind energy component, communities should first either amend the plan to include a wind energy section or adopt specific wind energy policy. Then, the zoning code can be amended to be in accordance with the comprehensive plan.

It is important to distinguish between types of wind generation systems in imposing regulations. Distributed wind generation, especially on a smaller scale (e.g., less than 100 kW), deserves an easier permitting process than a large industrial wind farm. It is recommended that distributed wind be allowed as a permitted use and identified as such in local zoning ordinances. This provides applicants with a predictable process. It also saves time and money on the part of the permitting authority, because a public hearing is not required. Permit applications can be administratively approved by the zoning administrator or staff. For systems that do not meet all ordinance requirements, approval can be obtained through the conditional or special use process. For example, more than one distributed wind turbine per lot or turbines larger than 100 kW can be permitted through a special use permit issued by the zoning board of appeals or applicable local jurisdictional body (see Figure 7).

In designing a zoning ordinance for distributed wind, local governments may want to consider addressing the following topics.

Aesthetics

Distributed wind has less of a physical land and scenic impact than industrial wind farms. A 10-kW turbine on a guyed, lattice tower quickly disappears with distance. At one-quarter mile away, the turbine is noticeable, but at nearly a

FIGURE 7

The Portsmouth Abbey School in Rhode Island applied for and received a special-use permit and a variance from the Town of Portsmouth to erect a distributed wind turbine. The Vestas 660-kW wind turbine sits atop a 164-foot tower (total height—240 ft.) and is located 750 feet from the nearest neighbor. It produces less than 45 decibels.

half mile, it is barely visible on the horizon (see Figures 8, 9, and 10).

Still, neighbors may be concerned about the turbine's impact on their view. Careful siting can reduce visual impact, and there are various steps an installer can take to minimize visual and acoustic impacts. The Vermont Public Service Department has published a siting guide with recommendations for installing a wind turbine.[6] Another example is the Bedford, NH small wind ordinance § 275-96(H) with provisions pertaining to visual impact.[7]

Safety: Setback and Height Restrictions

Another consideration in wind permitting is the potential safety hazards posed by the turbines. There should be setback requirements to protect nearby structures in the case of a catastrophic failure, which is extremely rare. These could be standard setbacks that apply to other tall, man-made structures. Setback distances are typically defined in terms of a multiple of the total turbine height, including the rotor blades. When establishing setback distances, the intended protective effort should be balanced with economic considerations for wind projects so that accommodating a setback does not unduly threaten the feasibility of the project. In general, the turbine should be located at a distance of at least the total turbine height from an inhabited neighboring dwelling (see Figure 7). Some towns have chosen to require larger setbacks. For example, the town of Porter, NY requires a minimum setback distance of 1.5 times the total turbine height. See ordinance § 200-59(B).[8]

As for height restrictions, the minimum recommended tower height to achieve good energy production is 60 feet. Below that height, the wind resource diminishes, resulting in less energy captured. Recommended best practice is for the entire rotor to be located more than 30 feet higher than any obstacle within 500 feet of the tower, including trees. Some towns have established zoning ordinances limiting turbine tower hub height to as little as 35 feet, but those rules are generally based on outdated fire safety measures.

Jurisdictions may consider exempting small wind turbines from zoning district height

Figures 8–10 below demonstrate siting impacts of a distributed wind turbine from several distances and viewsheds.

FIGURE 8

View of Bergey Excel 10, an 8.9 kW turbine.

© CESA/Val Stori

FIGURE 9

View of same turbine at 0.2 mile distance

© CESA/Val Stori

FIGURE 10

View of same turbine at 0.4 mile distance.

© CESA/Val Stori

limitations, similar to church spires, silos, and cell towers. For example, the Royalton, NY zoning ordinance, Article III, § 200-22(D), provides a height exemption for "wind energy towers or solar collectors erected for private use."[9] Overall, setback and height restrictions should be carefully evaluated, as they can act as barriers to effectively harnessing wind energy.

Safety: Unauthorized Climbing

To guard against the potential for attempted climbing of the turbine tower, ladder rungs should be removed from the bottom 10 to 12 feet of the tower, and appropriate warning signage (e.g., "Danger, High Voltage") should be displayed near the tower base. Fences are unnecessary and should not be required, as they deny critical access to the tower base in the case of emergency.

Sound

Modern, distributed wind turbines typically operate at an ambient sound level of 52 to 55 decibels (dBA), meaning they are no noisier than an average refrigerator.[10] It is recommended that turbines be held to existing sound ordinance standards or 5 dBA over ambient sound, and that exceptions to the maximum decibel level be allowed for short-term events such as utility outages and storms. For an example, an ordinance for small, off-grid wind energy systems in Fairfax, VT allows the maximum sound level (60 dBA) to be exceeded during utility outages and severe storms (Section 6.8(C)(3)).[11]

Distributed Wind and Wildlife

Distributed wind system impacts to wildlife are little to none. Local jurisdictions and community members seeking to facilitate distributed wind energy development can educate the public and local officials on the differences between large-scale, utility wind farms and distributed wind turbines. Small to medium-sized distributed wind turbines post little to no threat to birds and bats. A 2008 wildlife study by the Pennsylvania Department of Conservation of Natural Resources concluded that the probability of bird and bat mortality by small wind turbines is low.[12,13] Additionally, the National Audubon Society endorses properly sited distributed wind turbines.[14]

Turbine Performance Certification

Wind turbine certification is generally not required to obtain permitting, though it may be required for certain government and utility incentive programs. Turbine certification by an independent, third-party certifier is recommended to ensure consumer protection and verify that the turbine meets performance and safety standards. Without certification, a manufacturer's performance and reliability claims remain unverified. In addition, certification for turbines generally larger than 75 kW includes acoustic certification. For small turbines, the certification standard used is AWEA 9.1 - 2009. In the United States there are two independent organizations that are accredited to certify turbines to AWEA 9.1-2009: the Small Wind Certification Council[15] (SWCC), now part of the Solar Rating and Certification Corporation, and Intertek.[16]

There is no comparable certification for medium-size (generally larger than 75 kW) wind turbines. However, the Interstate Turbine Advisory Council (ITAC), managed by the Clean Energy States Alliance, maintains a list of small and mid-size wind turbines that meet the performance, reliability, acoustic and warranty service expectations of the council's member organizations, which are utilities and state clean energy programs. This unified list can be used by ITAC members to qualify eligible wind power projects for incentives. ITAC was created to facilitate a more efficient and effective evaluation process that can build on existing certification schemes.[17]

Model Zoning Ordinance

This model ordinance is intended to aid local governments in adopting policies for safe and effective use of distributed wind energy systems and to ensure public safety, promote good land use practice, and provide a fair and predictable permit process. Below are samples of sections that should be included in an ordinance.

Energy generation may be subject to a number of different permitting requirements, many of which are limited to state-level permitting. For example, in Vermont, state statute protects residential renewable energy generation systems from regulations that will prohibit their development.[18] Local jurisdictions should familiarize themselves with any relevant state statutes before enacting any zoning regulations.

Purpose

In adopting this ordinance, [name of town/county] recognizes that:

- it is in the public interest to produce electricity in a manner that serves the needs of the community while minimizing potentially negative impacts;
- *[town/county]* is interested in promoting electricity production practices that protect the natural and built environment;
- *[town/county]* is interested in harnessing wind's potential in its energy vision/plan; and
- distributed wind energy projects can enhance grid reliability, reduce peak power demands, and diversify the state's energy portfolio.

Definitions

Building Permit: A permit issued by a building inspector or zoning administrative officer approving buildings, structures and projects subject to his/her authority. Note that many jurisdications do not have permit building requirements.

Distributed Wind Energy System: A wind energy generating system consisting of a turbine, tower and associated equipment, and intended for local or on-site electric use.

Height: The height of a wind turbine measured from natural grade to the tip of the rotor blade at its highest point, or blade-tip height.

Rated Nameplate Capacity: The maximum rated output of electric power production equipment, typically specified by the manufacturer with a "nameplate" on the equipment.

Size 1/Small Distributed Wind Energy System: One or more wind turbines with a combined rated nameplate capacity of 100 kW or less; these facilities typically consist of a single small turbine producing electricity for on-site consumption.

Size II/Medium Distributed Wind Energy System: One or more wind turbines with a combined rated nameplate capacity of greater than 100 kW but no greater than 10 MW; these facilities typically consist of one to several medium or large wind turbines serving a local load.

Special Use Permit: A permit provided by the special permitting authority for non-conforming distributed wind systems.

Wind Turbine: An electricity generating device that converts the kinetic energy of wind into electricity; includes a tower, generator, and electric conversion equipment, nacelle (an enclosure housing the generating equipment), rotor with blades, and other related equipment.

Permitted Use and Permit Requirement

Distributed wind energy systems up to 100 kW (Size I) shall be a permitted use in all zoning classifications. Distributed wind energy systems over 100 kW (Size II) shall be a permitted use in all non-residential zoning classifications. More than one distributed wind energy system per lot requires a special use permit and site plan approval. Permitted use for distributed wind energy systems shall be subject to certain conditions.

Wind turbines shall not be constructed, installed, or modified without first obtaining a building permit. If the proposed wind turbines do not satisfy the criteria of the building permit set forth under the adopted bylaws, then the applicant must seek review and petition the Permit Granting Authority for a Special Use Permit. The Special Use Permit will provide for a variance from the prescribed bylaw requirements. This variance from the building permit criteria will only be applicable to that specific non-conforming project. (See Massachusetts' Model Amendment to a Zoning Ordinance for a definition and application of Special Use Permits.[19])

© Bergey Wind Power

Standards: Design, Safety, Siting, Sound

DESIGN

All electrical and mechanical components of wind turbines shall comply with applicable local, state and national codes, regulations, and notification requirements. The visual appearance of wind turbines shall: 1) Maintain a non-reflective finish and be a non-obtrusive color such as white, off-white, gray, or the manufacturer's default color; 2) Not be artificially lighted, except as required by the Federal Aviation Administration (FAA); 3) Not display advertising, excluding the manufacturer label.

There shall be no height restriction on wind turbines, except as imposed by FAA regulations if applicable. Minimum recommended height is 60 feet; height exceeding 60 feet is allowable.

SAFETY

Wind turbines shall satisfy the following:

1) To prevent unauthorized climbing, all climb-

ing apparatus shall be removed from the lowest ten feet of the tower, or ladder access shall be restricted.

2) Appropriate warning signage (e.g. "Danger, High Voltage") shall be placed where it is clearly visible by persons standing near the tower base or other ground-mounted electrical equipment.
3) All electrical and control equipment shall be safely and appropriately enclosed from unintentional access by means such as lockable equipment cabinetry, enclosed tower with lockable access door, or similar.
4) All wiring between wind turbines and substation or point of interconnection shall be underground.

SITING

Wind turbines shall be set back a distance at least equal to the total height of the wind turbine from all inhabited structures, overhead utility lines, public roads and rights of way, and at least five feet from property boundaries. The building inspector or zoning administrative officer may reduce the minimum setback distance if written permission is granted by the entity with care and control over the affected asset.[20]

SOUND

During normal operation, wind turbines shall comply with the sound requirements of the zoning district in which they are located. If the town does not have a sound level ordinance, the turbine shall not exceed five dBA over ambient sounds as measured at neighboring dwellings. The maximum sound level may be exceeded during short-term events, such as utility outages and storms.

Permit Applications

Permit applications for distributed wind energy systems shall comply with all applicable state and local building codes. Building permit applications shall include the following:

1) Plot plan indicating: property lines and physical dimensions of the subject property; location and types of existing major structures on the property; location of the proposed wind turbine(s); the right-of-way of any public road that is contiguous with the property; any overhead utility lines
2) Wind system specifications, including manufacturer and model, rotor diameter, tower height, tower type (freestanding or guyed)
3) Tower foundation and tower blueprint signed by a professional engineer
4) Certification to AWEA 9.1-2009 (for small wind turbines).

The application for a building permit must be accompanied by the fee required for a building permit for a Permitted Accessory Use.[21]

Expiration, Violations, Penalties[22]

Expiration: A permit issued pursuant to this ordinance shall expire if the distributed wind energy system is not installed and functioning within 24 months from the date the permit is issued, or if the system is abandoned.

Violations: It is unlawful for any person to construct, install, or operate a distributed wind energy system that is not in compliance with this ordinance or with any condition contained in a building permit issued pursuant to this ordinance. Distributed wind energy systems installed prior to the adoption of this ordinance are exempt.

Penalties: Any person who fails to comply with this ordinance shall be subject to enforcement and penalties as allowed by applicable law.

Decommissioning

Wind turbines shall be removed within six months after they have reached the end of their useful life, which is determined if no electricity is generated for a continuous period of 12 months. Time extensions are allowed when good faith efforts to repair the wind turbines can be demonstrated.

SAMPLE WIND ENERGY ORDINANCES

Below are a few examples of municipal wind energy ordinances from the Northeast; in each example, highlights of distributed wind-friendly language are identified for consideration in town ordinances. The town examples below have removed permitting barriers and have addressed community concerns such as land use, acoustics, and safety.

© Bergey Wind Power

Marlboro, VT

See Section 470 – Permitted Use Regulation for Small Wind Energy Systems[23]

HIGHLIGHTS

- Designates small wind (50 kW or less) as a permitted use in all zoning districts, subject to certain standards (tower height is limited to 120 feet)
- Noise limit of 60 dBA can be exceeded during short-term events such as utility outages and severe windstorms
- "Findings" section includes good explanation of the benefits of distributed wind and the need to "standardize and streamline the proper issuance of zoning permits for small wind energy systems so that this clean, renewable energy resource can be utilized in a cost-effective and timely manner."[24]

© Gamesa

Rhinebeck, NY

See Zoning Code § 125-47[25]

HIGHLIGHTS

- While this ordinance lumps wind together with solar, it explicitly states that the town wants to promote the use of these energy resources and to remove obstacles to their use. "To the extent practicable…the accommodation of solar and wind energy systems and equipment, and the protection of access to sunlight and wind for such equipment, shall be required in the application of the various review and approval provisions of this chapter."
- Installation requires a building permit, and processing of permit application "shall not be willfully avoided or delayed." Solar and wind generators are "permitted outright as an accessory use."

Beachwood, NJ

See "Beachwood Township Wind Ordinance"[26]

HIGHLIGHTS

- Designates small municipal wind energy systems as a permitted use, subject to certain requirements (setback, appearance, access, etc.)
- No specified height or noise restrictions

Wind Energy in Comprehensive Plans

In addition to —or instead of—producing a stand-alone wind ordinance, a municipality can address distributed wind energy as part of its local comprehensive plan. Such a plan can serve to establish shared community goals, determine long-term utilization of community resources, and provide a framework for implementation of local decisions and regulations. A comprehensive plan is a guiding document for the future of an entire community and is a proactive tool that allows a community to anticipate and prepare for potential future opportunities. It establishes goals and priorities and lays out action steps for meeting those goals.

One of the roles of the comprehensive plan is to identify natural resources that can be managed in ways that will benefit the community as a whole. Planners should consider including an energy component in their comprehensive plan or integrating energy issues throughout existing chapters in the plan. The energy section or policies should clearly define the community's priorities related to renewable energy production to provide support for related development regulations. A plan that includes a goal of increasing renewable energy use could be referenced in zoning ordinances permitting wind energy.

© Nathan Broaddus/Cultivate Photography Multimedia

A municipality that seeks to incorporate wind energy in planning could follow these steps:

1) **Inventory high wind-potential areas**
2) **Analyze compatibility of wind and other land uses**, especially areas that are of special historical or cultural significance
3) **Set goals and objectives for energy development**
4) **Implement regulations to achieve the goals**, e.g., define distributed or small wind as a permitted use in local zoning codes

Many Vermont towns have incorporated energy planning into their municipal plans or comprehensive planning process. Some examples are listed on the Vermont Energy & Climate Action Network (VECAN) website.[27]

The town of Stowe, VT outlines extensive policies and tasks relating to energy in its Town Plan.[28] These fall under the overall energy goal, which is to "encourage the availability, affordability, and efficient use of energy resources, including the development and use of renewable energy resources in a manner that protects public health and safety, reduces carbon emissions and costs, and minimizes adverse environmental and aesthetic impacts."[29] One of the policies listed under this goal states: "The Town of Stowe supports the generation of small net-metered or off-grid renewable energy facilities, including solar arrays, small wind facilities or combined systems intended primarily to serve local residences or businesses long as they meet the following standards..."[30] Specific conditions and standards are then listed for solar and wind.

Another Vermont example is the Northwest Regional Planning Commission's (NRPC) draft Regional Energy Plan.[31] While stating that the Commission does not approve of industrial wind facilities, the Plan explicitly states support for smaller distributed wind: "Smaller, net-metering-scale wind generation may be possible throughout most of the region at lower elevations. More information is needed regarding the viability and affordability of these systems, but generally the NRPC views these types of facilities favorably, provided that impacts to known constraints are avoided, impacts to possible constraints are mitigated, and site-specific concerns are addressed."[32]

© United Wind

Case Studies of Distributed Wind Projects in the Northeast

Four case studies are presented below to exemplify the range of distributed wind projects that have been installed across the Northeast. The first case study of a farm in Vermont provides additional details to show some of the steps in planning and implementing a distributed wind project.

Blue Spruce Farm*

(Agricultural Use)

LOCATION: Bridport, VT
TURBINE TYPE & SIZE: Northern Power Systems 100-24; 120 feet in height, 100-kW capacity
AVERAGE WIND SPEED: About 11.5 mph
ANNUAL ENERGY GENERATED: 150,000+ kWh
ANNUAL CARBON OFFSET: 132 tons

The Audet Family has operated Blue Spruce Farm since 1958 and currently milks about 1,500 cows that produce over 30 million pounds (3.6 million gallons) of milk per year. Dairy operations consume quite a bit of electricity. To offset this cost, Blue Spruce Farm was the first participant in the Green Mountain Power (GMP) Cow Power program, which uses anaerobic digestion to turn manure generated on the farm into about 2.4 million kilowatt-hours of electricity per year. Additionally, in 2013 the Audets partnered with GMP to host a 100-kW wind turbine under a unique arrangement that required no cost from the farm. In exchange for locating the wind turbine on their farm, the Audets receive 10 percent of the electricity, while the remaining 90 percent is sent on to the grid. As GMP focuses on building small-scale renewable energy projects in its service territory it may be possible for more Vermont farmers—who own a significant amount of Vermont's land area—to partner with the utility.

Vermont's wind resource varies a lot from one place to another due to wind direction, ground obstructions, and surface roughness, as well as elevation in relation to the surrounding topography. The strongest wind resources are generally located at higher elevations and that is where Vermont's four utility-scale (not distributed wind) installations—Kingdom Community Wind, Sheffield Wind, Georgia Mountain Community Wind, and Searsburg Wind Farm—are located. But Vermont also has nearly 200 small-scale net-metered wind projects—ranging in size from 0.95 kilowatts (kW) of generating capacity to 100 kW—that are powering homes, schools, businesses, and farms. Farmers can get a first approximation of average annual wind speed on their land using the Renewable Energy Atlas of Vermont.

Installers may also put up an anemometer tower to measure wind speed at the eventual height

* *Note: This story was originally released as part of a series of case studies showcasing farms, businesses, vendors, installers, and technical assistance providers that have made a difference with energy efficiency savings and renewable energy production. The series was produced by the Vermont Farm to Plate Network and written by Alex DePillis.*[33]

of the blades, but this can cost upwards of $30,000. For the Blue Spruce Farm wind turbine, contractor Aegis Renewable Energy (Waitsfield, VT) used a wind site analysis tool developed by AWS Truepower. This analysis tool is based on decades of data collection and predicted an average annual wind speed of 11.5 miles per hour (5.14 meters per second) at 120 feet (37 meters) above the ground.

Because of Vermont's abundant hills and trees, it pays to have a tall wind turbine (i.e., the taller the turbine, the stronger and smoother the wind). At 120 feet, the Northern Power Systems' wind turbine Model 100-24—manufactured in Barre, VT—is well-suited to this moderate wind resource. Each of the three blades is almost 40 feet long, and the turbine includes a mechanism to detect the wind speed and direction to face the blades into the wind. The generator for this turbine starts generating power at seven mph (or three m/s), but wind speeds of 10–20 mph are the bread and butter of this turbine's output profile.

The Northern Power 100-24 is designed for low maintenance. It is gearless, and the generator uses permanent magnets to create the electrical field. No gear box also means the Northern Power 100-24 is quiet. Maintenance personnel climb a ladder inside the turbine to access the generator and blades.

Erecting the turbine was a three-stage process: beginning in early February 2013, Aegis Renewable Energy broke ground for the foundation and began digging trenches for underground electrical service. The contractor first excavated a 15-foot deep hole for the foundation, built the bolt cage assembly and forms for the concrete, and then poured the foundation, which required about 30 yards of concrete.

The concrete foundation cured for 28 days, after which assembly and erection of the tower, nacelle (generator housing), and rotor were completed in two days. Finally, commissioning and utility interconnection took another day and a half. In its first six months, the turbine has operated without interruption. Aegis estimates the turbine will produce about 150,000 kilowatt-hours per year—enough electricity for about 20 Vermont homes.

Tyree House

(Residential Use) CASE STUDY BY NYSERDA

LOCATION: Ellenburg, NY
TURBINE TYPE & SIZE: Bergey Excel-S; 120 feet in height, 10-kW capacity
AVERAGE WIND SPEED: 10.8 mph
ANNUAL ENERGY GENERATED: 19,000+ kWh in total with wind, solar, and geothermal; 8,800 AC kWh with just wind

College professor Mel Tyree wanted his family to live in a comfortable, net-zero energy house in Ellenburg, NY. He also wanted to show that building this kind of home could be accomplished in a cost-effective manner.

Net-zero energy homes are designed to be energy efficient and produce as much energy as they draw from the electricity grid, so utility bills balance out to zero over a 12-month period. They can be zero emission homes if they avoid fossil fuels and use renewable energy, which does not generate greenhouse gas emissions.

Construction was completed on the Tyrees' home in Clinton County in January 2008 with support from the New York State Energy Research and Development Authority (NYSERDA). Ten years after the planning began, Mel is glad that he made the commitment. The renewable energy technologies generate all the energy on-site that his family needs for the home as well as for a plug-in electric car.[34]

The home has 2,000 square feet of living space, a full basement, and an attached one-car garage. A 1,200-square-foot detached barn was also built on their 102-acre property. Collecting the energy provided by the wind, sun, and ground heat provides the Tyree family with a balanced approach to energy generation.

Installing a wind turbine was a good option to generate electricity on this site because it had one acre of land and an average wind speed of 10.8 miles per hour, which is a reasonable wind speed to achieve economic benefits. The system was interconnected in December 2005. Almost nine years after the installation, the wind system has produced 78,000 kWh.

The Tyree house features a solar array and a 10-kW Bergey Excel-S wind turbine

McGlynn Elementary & Middle School

(School Use)

LOCATION: Medford, MA
TURBINE TYPE & SIZE: Northern Power Systems 100-21; 131 feet in height, 100-kW capacity
AVERAGE WIND SPEED: 12 mph
ANNUAL ENERGY GENERATED: About 170,000 kWh
ANNUAL CARBON OFFSET: 110 tons

The Boston suburb of Medford took a leap towards clean energy in 2004, when Mayor Michael McGlynn created the Medford Clean Energy Committee. The Committee chose to pursue a wind energy project[35] and went to work raising funds and holding public information and planning sessions. Locating the turbine at a school provided a valuable educational opportunity, and it also had the potential to reduce the school's electricity bill. The community embraced the idea and by the end of January 2009 the wind turbine installation was complete.

The 100-kW turbine provides about 10 percent of the school's electricity, saving the city $25,000 annually. The turbine comes with a SmartView web monitoring program that allows the teachers and students to view real-time data on wind speed, energy output and carbon emissions offset. On an annual basis the wind turbine produces approximately 170,000 kWh and offsets over 100 tons of CO_2.

© Northern Power Systems

McGlynn Elementary & Middle School, with 100-kW turbine in background

The "Zephyr" wind turbine at Jiminy Peak

Jiminy Peak

(Ski Resort Use)

LOCATION: Hancock, MA

TURBINE TYPE & SIZE: General Electric (GE); 386-feet in height, 1.5-MW capacity

ANNUAL ELECTRICITY GENERATED: 4.6 million kWh

ANNUAL CARBON OFFSET: 7.1 million pounds

In 2007, Jiminy Peak Mountain Resort became the first ski area in North America to install a wind turbine.[36] The opportunity for Jiminy Peak to save on its electric bill was the primary incentive for pursuing this wind project. According to Jim Van Dyke, Vice President of Sustainability, the resort's electrical costs went up by 50 percent during the early 2000s, so they started looking into alternative energy options as a cost-cutting measure.

The 1.5-megawatt turbine, named "Zephyr," was installed in the summer of 2007 and cost about $4 million. Jiminy Peak received a $582,000 grant from the Massachusetts Technology Collaborative that went towards the design and purchase of the turbine. Federal tax rebates and Renewable Energy Credits also helped offset the costs. The project has already reached the expected "payback," the point in time when the total savings exceed the initial costs.

Zephyr generates about 4.6 million kWh of electricity annually, eliminating 3,550 tons of CO_2 emissions produced from conventional fossil fuel electricity. The wind energy meets about one-third of Jiminy's annual electrical demand, but during the winter when wind is strongest, it provides up to half of the ski resort's electricity. Jiminy was awarded the Golden Eagle Award in 2008 from Clif Bar and the National Ski Areas Association for Overall Environmental Excellence with the wind turbine.

Conclusion

The model ordinance and various examples provided in this toolkit can help local jurisdictions to develop and implement the effective policies or regulations for the efficient use of distributed wind energy. There is no “one-size-fits-all” ordinance, and municipalities should adopt standards that address the unique needs and interests of their community. The resources provided in this toolkit should give municipalities the information they need to develop wind-friendly towns.

© Bergey Wind Power

Appendix: Other Resources

DWEA Permitting & Zoning Resource Center

http://distributedwind.org/zoning-resource-center

Information from the Distributed Wind Energy Association (DWEA) on model zoning ordinances, certification, and fact sheets addressing issues like aesthetics, birds, property values, noise, tower height, etc.

"County Strategies for Successfully Managing and Promoting Wind Power: Implementing Wind Ordinances in America's Counties"

http://distributedwind.org/assets/2012/12/NACo-County-Strategies-for-Successfully-Managing-and-Promoting-Wind-Power-in-Americas-Counties.pdf

This DWEA guide contains good information about distributed wind some guides on developing wind energy ordinances at the county level, including best practice recommendations and examples.

Model Ordinance (or amendment) example for Massachusetts

www.mass.gov/envir/smart_growth_toolkit/bylaws/wind-small.pdf

This model ordinance, prepared by the Massachusetts Division of Energy Resources (DOER) and the Massachusetts Executive Office of Energy and Environmental Affairs, was designed to assist municipalities in developing their own by-laws or standards for small wind.

New York State Wind Energy Toolkit

https://www.nyserda.ny.gov/-/media/Files/EERP/Renewables/wind-energy-toolkit.pdf

A comprehensive guide on developing wind energy in New York State covering many aspects including permitting. This guide was developed for the NYSERDA by AWS Truewind, LLC.

"Touro Law Institute for Land Use & Sustainable Development Law, Zoning for Small- and Medium-Scale Wind Energy: Model Ordinance and Resource Guide"

www.cesa.org/assets/2017-Files/NYSERDA-Touro-Model-Small-Medium-Wind-Ordinance-Resource-Guide.pdf

A distributed wind model ordinance and resource guide intended to help New York municipalities amend their zoning codes to facilitate the development of distributed wind projects.

WINDExchange Wind Energy Ordinances database

https://apps2.eere.energy.gov/wind/windexchange/policy/ordinances.asp

A searchable database of wind energy ordinances across the U.S.

Wind For School Project

https://windexchange.energy.gov/windforschools

More than 140 schools across the U.S. have installed distributed wind turbines. This website contains an interactive map of all school wind project locations.

Endnotes

1 Available at *http://nwwindcenter.org/sites/default/files/windpermittoolkit_mt_sept-2015.pdf*

2 "How Distributed Wind Works," Wind Energy Technologies Office at U.S. Department of Energy, *https://energy.gov/eere/wind/how-distributed-wind-works*

3 "2015 Distributed Wind Market Report," U.S. Department of Energy, August 2016, *https://energy.gov/sites/prod/files/2016/08/f33/2015-Distributed-Wind-Market-Report-08162016_0.pdf*

4 "Small Wind Electric Systems: A Vermont Consumer's Guide," U.S. Department of Energy, Energy Efficiency and Renewable Energy Office, *http://www.nrel.gov/docs/fy07osti/41219.pdf*

5 "Distributed Wind," Wind Technologies Office at U.S. Department of Energy, *https://energy.gov/eere/wind/distributed-wind*

6 "Siting a Wind Turbine on Your Property," Vermont Public Service Board, *http://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/Resources/Wind/psb_wind_siting_handbook.pdf*

7 Available online at *http://www.ecode360.com/14331383#14331414*

8 Available online at *http://ecode360.com/16127435#16127435*

9 Town of Royalton, NY, Chapter 200: Zoning, Article III, § 200-22(D), *http://ecode360.com/28000656*

10 "Small Wind Electric Systems: A Vermont Consumer's Guide," U.S. Department of Energy, Energy Efficiency and Renewable Energy Office, p.3, *http://www.nrel.gov/docs/fy07osti/41219.pdf*

11 *http://www.fairfax-vt.gov/vertical/sites/%7BA7F085CD-5C79-4CCF-8878-6AF1EF4F216C%7D/uploads/Development_Regulations-_Fairfax_-_FINAL_2016.pdf*

12 DWEA Briefing Paper: *Birds/Avian Mortality, http://distributedwind.org/wp-content/uploads/2012/08/DWEABriefingPaper_Birds.pdf*

13 PA DCNR Study: *http://distributedwind.org/assets/docs/PandZDocs/bird-and-bat-study-trec-center-erie-pa.pdf*

14 Audubon's Position on Wind Power, *http://www.audubon.org/content/audubons-position-wind-power*

15 Small Wind Certification Council, *http://smallwindcertification.org/home*

16 "Wind Turbine Certification," Intertek, *http://www.intertek.com/wind/turbine-certification*

17 See *https://www.cesa.org/projects/ITAC*

18 *http://anr.vermont.gov/sites/anr/files/specialtopics/muniday/documents/Act-248-Permitting-Energy-Porject-Presentation-Municipal-Day-2015.pdf*

19 See *http://www.mass.gov/envir/smart_growth_toolkit/bylaws/wind-small.pdf*

20 Ibid

21 Ibid

22 Ibid

23 "Zoning Regulations Town of Marlboro, Vermont," March 2007, Article IV Section 470, *http://marlborovt.us/wp-content/uploads/2014/02/Marlboro-Zoning-Regulations_-0306071.pdf*

24 Ibid

25 Available online at *http://ecode360.com/140842282#14084282*

26 "Beachwood Township Wind Ordinance," Adopted September 17, 2008, *http://www.njcleanenergy.com/files/file/Renewable_Programs/Wind/Beachwood%20Wind%20Ordinance%209_17_08.pdf*

27 See *http://www.vecan.net/sample-municipal-energy-chapters*

28 "Stowe Town Plan," Adopted by the Stowe Select board on June 8, 2015, *http://www.townofstowevt.org/vertical/sites/%7B97FA91EA-60A3-4AC6-8466-F386C5AE9012%7D/uploads/STOWE_TOWN_PLAN_adopted_6.8.15.pdf*

29 Ibid

30 Ibid

31 "Regional Energy Plan Draft," Northwest Regional Planning Commission, April 27, 2017, *http://www.nrpcvt.com/Publications/Energy/DraftEnergyPlan.pdf*

32 Ibid at p. 51.

33 Available at *http://www.bluesprucefarmvt.com/wp-content/uploads/2016/03/Case-Study.pdf*

34 See *https://www.nyserda.ny.gov/-/media/Files/Publications/Case-Studies/Wind-Program-and-Solar-PV-Program/tyree-cs.pdf*

35 See *http://medfordenergy.org/gogreen/medford-wind-turbine*

36 Lean more at *http://www.jiminypeak.com/green*




CLEAN ENERGY STATES ALLIANCE (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country. CESA works with state leaders, federal agencies, industry representatives, and other stakeholders to develop and promote clean energy technologies and markets. It supports effective state and local policies, programs, and innovation in the clean energy sector, with an emphasis on renewable energy, power generation, financing strategies, and economic development. CESA facilitates information sharing, provides technical assistance, coordinates multi-state collabo-rative projects, and communicates the views and achievements of its members. **Learn more at *www.cesa.org*.**

THE NORTHEAST WIND RESOURCE CENTER (NWRC) is one of five regional wind resource centers in the U.S. It provides salient, unbiased information on land-based wind for New England and New York, and on offshore wind for that same region plus New Jersey. The NWRC also provides targeted outreach and direct engagement with stakeholders and decision makers about wind energy deployment for the region. Additionally, the NWRC manages the Offshore Wind Hub, a comprehensive repository of documents related to offshore wind development along the U.S. Atlantic coast. The NWRC is supported in part by the U.S. Department of Energy and is managed by Clean Energy Group. The Maine Ocean & Wind Industry Initiative serves as key liaison to the wind industry. **Learn more at *https://northeastwindcenter.org*.**

WINDEXCHANGE is the U.S. Department of Energy (DOE) Wind Program's platform to make high-quality information and outreach materials readily available about wind energy. In addition, WINDExchange aims to provide new tools, such as wiki-based resources, to help stakeholders better understand wind energy and exchange best practices. The WINDExchange Newsletter is issued by the U.S. DOE's Wind Program twice a month to inform program partners and interested individuals of wind energy events, webinars, financial opportunities, new publications, state success stories, and other wind related activities. **Learn more at *https://energy.gov/eere/wind/windexchange*.**