Renewable Energy Research Laboratory, University of Massachusetts at Amherst

Wind Power: Siting in Communities

Wind Power on the Community Scale

Community Wind Power Fact Sheet # 4

RERL—MTC Community Wind Fact Sheet Series

In collaboration with the Massachusetts Technology Collaborative's Renewable Energy Trust Fund, the Renewable Energy Research Lab (RERL) brings you this series of fact sheets about Wind Power on the community scale:

1. Technology
2. Performance
3. Impacts & Issues
4. Siting
5. Resource Assessment
6. Wind Data
7. Permitting

Inside this Edition: Siting

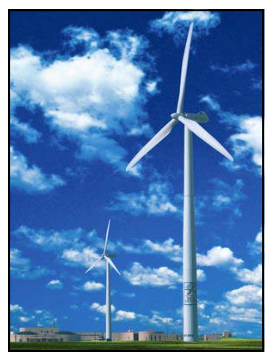
Can my community use windpower?

Towns across Massachusetts are considering wind power, not only because it is one of the cleanest, lowest impact sources of electricity available to us today, but also because a properly sited and well managed wind power project can be a net source of income. This fact sheet introduces the major factors to consider in determining whether your town can benefit from wind power.

Technical / Physical Requirements

Unlike conventional power plants, *where* a wind turbine is located has a major effect on the amount of energy captured from the wind and electricity produced. The quality of a wind site depends on may things including:

- **Wind speed** – This is the most critical site characteristic and, of course, some places have more wind than others. Typically locations with an annual average wind speeds above about 6 m/s (13 mph) at the hub height are considered. Wind maps are a useful screening tool to estimate the wind speed in an area, but may not accurately represent a specific site.
- **Topography, Accessibility** – The site should be open and generally at a higher elevation than the surrounding area. Steep hills or cliffs can create turbulence and should be avoided, however, gradually sloping hills can actually cause an increase in wind speed at the top. The topography of a site must also allow access roads to be built for construction and maintenance equipment.
- **Distance to transmission lines and loads** – Electricity generated by a wind turbine must be fed into the electrical grid. Building new transmission lines to move electricity to where it is needed can be very costly, so sites near existing power lines reduce this expense.
- **Surface roughness** – Tall obstacles on the Earth's surface like trees and buildings can significantly slow the speed of the wind and create turbulence. Turbulence reduces the amount of energy that can be captured and can increase maintenance costs over time. Siting turbines in open fields or in the ocean reduces the effect of surface roughness. Taller towers can also be used to get the rotor above the turbulent zone.



Community-owned 750 kW wind turbine in Moorhead, Minnesota.

Moorhead NEG Micon photo source: National Renewable Energy Laboratory

Environmental Considerations

Wind power's predominantly positive environmental impacts (see Fact Sheet 2, Impacts & Issues) do not eliminate the need to consider the local environmental effects of an installation.

Visual impact – Wind turbines are large structures and are usually built in open areas or on ridgelines making them visible from a distance. Some people simply do not like looking at wind turbines. This can be especially true in historically important areas or in places valued for their natural beauty. Siting turbines away from these areas can minimize this impact.

Noise – While noise from wind turbines is minimal, at sites very close to populations it may become an issue. Usually, there are defined limits to how much a new development can increase the sound level. Again, siting turbines away from population centers will reduce this impact.

Birds & Bats – Sites that lie in heavily used bird migration paths or have endangered species in the area may not be appropriate for wind power. For more detail, see page 2 of this fact sheet, and Fact Sheet 3 "Impacts & Issues."

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Wind turbines on a ridge, Searsburg, Vermont

Wind in Massachusetts

The best wind power sites in Massachusetts are along the coast and on top of ridgelines in the western and central parts of the state. Wind maps of the state can be used to identify areas of high annual wind. Local terrain effects can also create good sites in other areas of the state that may not be identified in wind maps. The TrueWind website includes a map of New England wind resources.

Spacing & Setbacks

As the wind passes though a turbine energy is extracted causing the wind speed in the wake of the turbine to decrease. When several turbines are built near one another, as in a wind farm, it is important to separate the turbines appropriately to minimize these array losses. Spacing turbines too tightly leads to reduced performance and increased maintenance due to higher turbulence at the downwind turbines. Turbine spacing is expressed in terms of the rotor diameter (RD) of the turbine in consideration. So for instance if a 77 m diameter rotor is used, then 2RD means 2 x 77m = 154 m = 505'.

Typically, turbines are spaced 5 to 10 RD apart in the prevailing downwind direction and 2 to 5 RD apart in the crosswind direction, when there is a strongly prevailing direction. Spacing of 2-3 RD might be used along a ridgeline. Greater spacing will minimize the losses from each machine, but will reduce the number of machines that can be built in a site.

The setback distance from property lines is determined by local building codes, and typically takes the height of the structure into consideration, e.g. 1.5 times the turbine height. Additionally, state noise policy will typically keep wind turbines about 3 times the hub-height from residences.

Ice throw: Ice is likely to accumulate on ridge-mounted wind turbines in New England. The ice sloughs off as the blade flexes. For public safety, ridge-line winter trails may need to be moved away from the base of the tower to a distance of 2-4 times the blade-tip height, depending on the site.

Wind Power Siting for Birds

Modern wind turbines have resulted in an average on 1-2 bird deaths by collision per year per turbine. Good siting practice may reduce this risk further. A "Phase I Avian Risk Assessment" is often performed for a site to assess the risk of both collision and habitat impacts for birds and bats. The assessment for a proposed wind power site typically includes a literature review, interviews with local and regional experts (agency staff, environmental organizations, and local birders), and site visits by a trained wildlife biologist. These sources of information provide an indication of the type and number of birds that are known or suspected to use a project site and the area surrounding that site. This information is used to assess the degree of risk to birds, if any, from wind power development at a particular site. In addition, the concerns of regulators and environmental organizations are determined and incorporated into the risk assessment.

The assessment seeks to determine such factors as:

- Whether the site contains important nesting or foraging areas for federally threatened or endangered birds
- Whether the site has high densities or availability of prey or other habitat attributes that could attract or host large numbers of raptors whose flight or migration patterns put them at risk of collision
- Likelihood of impact of any changes in land use.

The study will then make recommendations for that site based on known avian risk factors at wind power plants in similar habitats. Examples of phase 1 avian risk assessments can be obtained on the Internet. See also Fact Sheet 3 "Impacts and Issues," for a discussion of avian impacts.
(source: Kerlinger & Curry, various Avian Risk Assessments.)

For More Information

Turbine Siting, from the Danish Wind Industry Association: www.windpower.org/en/tour/wres/siting.htm

Wind Powering America (Dept. of Energy), siting: www.eere.energy.gov/windpoweringamerica/wind_faq.html

The National Wind Coordinating Committee offers various resources, including: *Siting Issues for Wind Power Plants*, www.nationalwind.org/pubs/wes/ibrief03.htm, and www.nationalwind.org/pubs/wes/wes02.htm, and *Permitting of Wind Energy Facilities*, www.nationalwind.org/pubs/permit/permitting.htm

Wind Energy Explained: Theory, Design and Application, Manwell, McGowan, & Rogers, Wiley, 2002.

Example of wind turbine icing research: www.msue.msu.edu/cdnr/icethrowseifertb.pdf

Example of an Avian Risk Assessment: www.crescentridgewind.com/avianstudy.pdf