Wind Power in New England

A fact sheet series from the Union of Concerned Scientists

Wind Power: An Overview

WIND POWER IS one of the world's fastest growing electric power sources. It produces clean, pollution-free electricity, does not deplete natural resources, and is widely available. When sited in good locations, wind energy is one of the least expensive renewable energy options available—and can even be cost-competitive with conventional energy resources. And while it does have a potential impact on the local environment, wind power can create exciting opportunities for local and regional communities.

Electricity generation is the largest source of industrial air pollution in the United States, according to the EPA. Fossil fuel-fired power plants produce more than 40 percent of the country's total emissions of carbon dioxide, the heat-trapping gas primarily responsible for global warming. They also generate one-fourth of total U.S. emissions of nitrogen oxides (which cause smog and can aggravate asthma) and two-thirds of total sulfur dioxide emissions (which cause acid rain).

About half of all U.S. electricity is generated from coal, and coal power plants emit tons of mercury and dioxin into the air over their operating lives. Mercury builds up in fish, which can cause birth defects when eaten, and dioxin can cause cancer. Mining and drilling for fossil and nuclear fuels creates scars on vast areas of land in the United States and around the world. Wind power, on the other hand, can generate electricity without these harmful problems.

Searsburg, VT

photo © Northeast Wind

What Makes a Good Wind Site?

New England has excellent wind resources, particularly on mountain ridges and along the coast. But not every windy location makes an ideal site for a wind turbine. In order to produce electricity economically, wind turbines need to be sited in the right places. The quality of a wind site depends on many things including:

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Wind speed. Wind speed is the most important factor in choosing a turbine site. Commercial sites are typically located in areas with average wind speeds above 13 miles per hour (mph). Even small increases in wind speeds make a significant difference in power output. For example, a wind turbine at a 16 mph site can produce 50 to 60 percent more electricity than the same turbine at a 13 mph site, which results in a similar percentage reduction in fossil fuel use and also makes electricity less expensive.

Topography and accessibility. The local landscape can greatly affect wind performance. Good wind sites are open and generally higher than the surrounding area. Steep hills or cliffs can create wind turbulence that reduces energy output and can lead to higher maintenance costs; gradually sloping hills, on the other hand, can *increase* wind speeds. Good sites also need to accommodate access roads for construction and maintenance equipment.

Surface roughness. Tall obstacles such as trees and buildings can slow the speed of the wind and create turbulence at low altitudes. Siting turbines in open fields or in the ocean reduces the effect of surface turbulence, while taller towers can be used to get the turbines blades above turbulent areas.

Distance to transmission lines. Electricity generated by a commercial wind turbine must be fed into the electrical grid (the network of wires connecting power plants with electricity users). Building new transmission lines can be very costly, so sites near existing power lines reduce this expense.

Local Benefits

Wind projects can benefit communities in several ways. Local town governments receive *tax revenues* or *annual payments in lieu of tax* from project owners; as operating a wind farm does not require town services such as water or sewage, these payments can be used for other town needs or services. Wind turbines can provide *electricity at a fixed cost* to municipal utilities that own them, or to towns or groups of customers that sign long-term contracts for their electricity. This benefit enables a town to project its energy costs in budget planning and to be less affected by sudden changes in fossil fuel prices. Wind power also creates renewable energy certificates (see sidebar) that towns or other electricity customers can purchase to support renewable energy.

Wind power projects create *high-quality jobs*—about one to two jobs per turbine during construction, and about 6 to 20 permanent jobs for operating and maintaining every 100 megawatts (MW) of installed generating capacity. Tourism and retail economies benefit from wind power as well, both from construction workers (who spend their dollars on housing, restaurants, and local goods) and from out-of-town visitors to wind facilities.

Property owners commonly receive *lease payments* for use of a portion of their land (ranging from $2,000 to $5,000 per MW of installed capacity). Wind turbines occupy two percent or less of the total land area, allowing the surrounding land to be used for other purposes. Landowners can also receive *production royalties* based on a percentage of the project's annual revenues.

In the only national study to date, sales data from 25,000 properties within five miles of wind turbines, compared with similar properties without views of wind turbines, showed no evidence of wind power reducing *property values*.


Arklow, Ireland

photo © NREL

Renewable Energy Certificates (RECs)

Renewable energy generation creates two distinct products: electricity and the environmental attributes associated with the generation of that electricity, such as zero toxic pollution and global warming emissions. These attributes have value to people who want cleaner energy, and can be sold in the form of RECs (also known as tradable renewable certificates or green tags).

In New England, the grid operator issues RECs for each megawatt-hour (MWh) of electricity generated by a renewable energy project. Purchasers of RECs—including homeowners, businesses, institutions, and utilities—can provide developers with additional revenue to build new generating facilities.

Impact on the Natural Environment

Unlike fossil fuels, wind power generates electricity without polluting air and water. Wind projects can, however, have an impact on the environment, primarily wildlife and land use.

Wildlife. The most common concern associated with wind power is its impact on bird populations. The high bird mortality at Altamont Pass, CA, using older-style turbines, created the perception that wind turbines are especially hazardous to birds. Biologists have exhaustively studied the bird collisions at Altamont Pass; the risk factors they identified largely do not exist in New England, and do not even exist to the same degree elsewhere in the United States. A 2004 report found that modern wind turbines kill an average of 3.1 birds per MW per year in the United States. With 11,600 MW of installed wind capacity as of December 2006, this is equal to approximately 36,000 bird fatalities—a very small number when compared with the millions of birds killed by communication towers, transmission lines, buildings, and other human structures.

Bat fatalities have been experienced at some wind power sites. These fatalities vary from wind plant to wind plant, and tend to occur during the fall migratory period. Effects on bats have not been quantified as thoroughly as birds, but a cooperative effort among bat experts, the wind industry, and government agencies has been launched to better understand bat behavior near wind turbines, and to prevent collisions.

Land Use. The direct footprint of a wind turbine is relatively small—a 1.5 MW turbine measures about 15 feet across its base, while its concrete foundation (which is set underground) measures about 30 feet on a side. In the area immediately surrounding the turbines, trees must be cleared to allow for maintenance, as well as for overhead transmission lines as needed in remote locations. Some land is also used to build access roads. Wind turbines are spaced at least two to five rotor diameters (or about 500 to 1,000 feet) apart to maximize performance. This can mean as little as two acres per MW in rolling terrain or up to 50 acres per MW in flat areas. However, less than two percent of that land area is needed for the wind turbines, leaving 98 percent of the land free for other uses. Today, modern wind turbines around the world co-exist safely with schools, highways, hiking trails, and farms.

> Tourism and retail economies benefit from wind power, both from construction workers assembling the turbines and out-of-town visitors to wind facilities.

Impact on the Human Environment

For most people, the primary impact of wind power is visual. Wind turbines can elicit strong reactions because they are usually in prominent locations due to their higher wind speeds. To some people, wind turbines are graceful sculptures that embody clean, pollution-free energy. To others, wind turbines are industrial machines that compromise the natural landscape. Aesthetic considerations are difficult to quantify; the question of whether a community is willing to accept an altered skyline in return for cleaner power is an issue for public discussion. A recent survey of Vermont residents showed that 81 percent find a view of turbines beautiful or acceptable, and other surveys have found that public acceptance increased after turbines have been installed.

Other factors to consider include:

Lighting. Federal Aviation Administration (FAA) rules generally require objects over 200 feet high (e.g., all commercial-scale wind turbines) to be lit for aviation

Wind Turbine Sizes

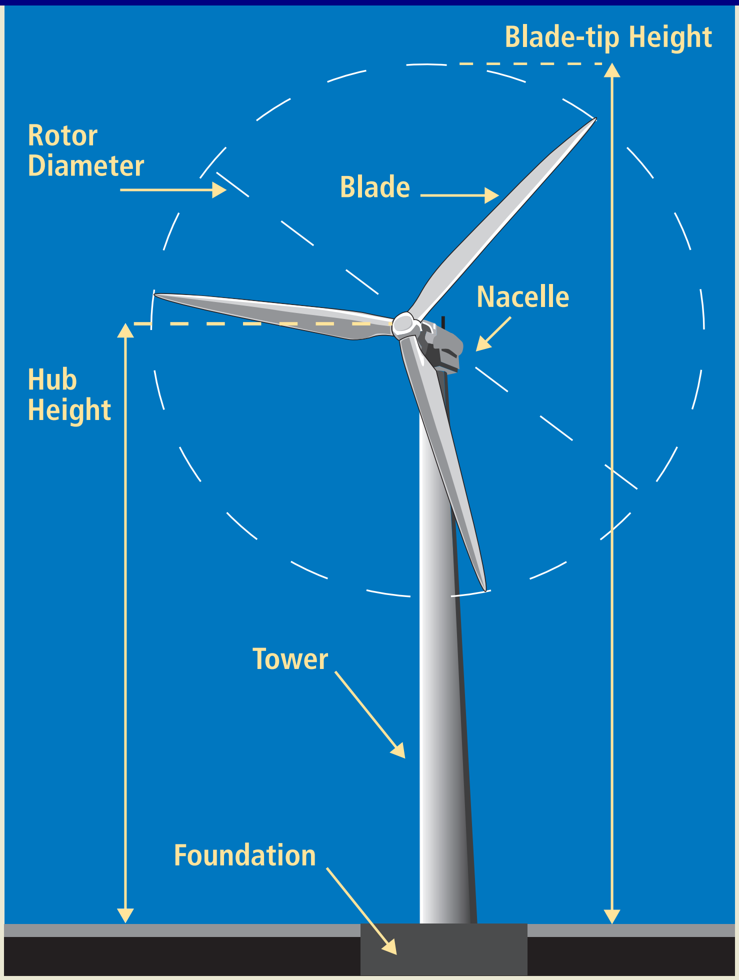

Illustration: Amanda Wait/DG Communications

Land-based wind turbines vary in size and capacity. Wind turbines in the United States typically fall into the three size categories listed below. To put the turbines' estimated electricity output in perspective, an typical household uses 6,000 kWh of electricity each year.

Small (less than 30 kW generating capacity)

Used for: homes, small farms, or commercial buildings
Rotor diameter: 1 m – 13 m (4 ft – 43 ft)
Hub height: 18 m – 37 m (60 ft – 120 ft)
Annual electricity output: 20,000 kWh*

Medium (30 kW – 500 kW generating capacity)

Used for: large farms or factories
Rotor diameter: 13 m – 30 m (43 ft – 100 ft)
Hub height: 35 m – 50 m (115 ft – 164 ft)
Annual electricity output: 600,000 kWh

Large (500 kW – 2 MW generating capacity)

Used for: commercial (grid) electricity generation
Rotor diameter: 47 m – 90 m (155 ft – 300 ft)
Hub height: 50 m – 90 m (164 ft – 262 ft)
Annual electricity output: 4,000,000 kWh

* Annual electricity output is an estimate, provided for comparison purposes only. Output is based on sea-level mean winds of 7 m/s (15.6 mph) and incorporates manufacturer data for the following turbines: Bergey XL-S (small/7.5 kW); Fuhrländer FL 250 (medium/250 kW); GE 1.5 SL (large/1.5 MW).

safety. In Feburary 2007, the FAA standardized lighting requirements for multi-turbine wind projects; its research has determined that lighting each turbine is not necessary to provide sufficient warning to aircraft. The proposed new rules would require no more than a half-mile unlit gap between turbines.[1]

Noise. Modern wind turbines are relatively quiet. Wind turbines are generally sited at least three times the hub height or more from residences. While the way sound carries depends on terrain and wind patterns, from several hundred feet away wind turbines are generally about as noisy as a refrigerator.

Signal Interference. Older metal–bladed wind turbines have been known to cause "ghosting" on television screens, but today's fiberglass composite blades typically do not interfere with broadcast signals. Wind turbines can sometimes affect radar and air navigation systems. In Europe, most of these effects have been successfully mitigated, but the potential for interference has delayed the development of several wind power projects in the Midwest. The FAA and Department of Defense are working to implement mitigation measures that may include adding filters to radar software or altering the layout of a wind project.

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Clean Energy Policy

To encourage supply diversity and reduce the pollution associated with power generation, many states have implemented renewable electricity standards, also known as renewable portfolio standards (RPS). An RPS requires a percentage of retail electricity sales to come from clean, renewable resources. As of March 2007, 21 states (including Connecticut, Maine, Massachusetts, and Rhode Island) and the District of Columbia have established renewable standards. New Hampshire is currently considering an RPS, and Vermont has implemented a clean energy program that has policy elements of an RPS, but does not currently have a percentage requirement.

Permitting Process

The permitting process is designed to ensure that each proposed project is reviewed for its impact on the local environment and economy. The process varies by state, and generally requires the developer to obtain permits covering a wide range of issues at the local, state, and federal level. For example, the permitting process for Cape Wind, the nation's first proposed offshore wind project, involves 17 state and federal agencies. Issues covered under the permitting process include zoning and building, wetlands, natural heritage, endangered species, aviation issues, and regulatory compliance.

Additional Resources

Many organizations provide information on wind power, including technology, benefits, and policy. To learn more about these issues, contact the groups below:

National Renewable Energy Laboratory
www.nrel.gov

National Wind Coordinating Collaborative
www.nationalwind.org

Database of State Incentives for Renewable Energy
www.dsireusa.org

American Wind Energy Association
www.awea.org

ENDNOTES

1 Federal Aviation Administration. 2007. Advisory circular: Obstruction marking and lighting. AC 70/7460-1K. Washington, DC: U.S. Department of Transportation. February. Online at: *https://www.oeaaa.faa.gov/oeaaaEXT/content/AC70_7460_1K.pdf*.

This overview was adapted largely from information in the University of Massachusetts Renewable Energy Research Laboratory's community wind fact sheet series (*www.ceere.org/rerl*). More detailed information about the issues raised in this overview is available in the following fact sheets in the Union of Concerned Scientists/Massachusetts Technology Collaborative "Wind Power in New England" series:

Benefits to Local Communities
Wind Energy: A Climate Solution
The Impact of Our Energy Choices
Reducing Pollution from the Electricity Sector

Fully referenced versions of these fact sheets are available on the UCS website at *www.ucsusa.org* and the MTC website at *www.masstech.org*.

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