

Mark Mayhew, Project Manager
New York State Energy Research and Development Authority
Albany, NY

WIND ENERGY

Description:

Wind energy is the world's fastest-growing energy technology. Wind energy—or wind power—is the process by which wind turbines convert the kinetic (motion) energy in wind into mechanical power or into electricity. The wind turbine captures the wind in its blades (or rotor) and converts the wind energy to rotational or mechanical energy. The rotor drives an attached shaft, gearbox, and generator to produce electrical energy. Wind turbines can be used to produce electricity for a single home or building, or they can be connected to an electricity grid for more widespread electricity distribution to multiple homes and buildings.

A wind turbine produces alternating current (AC), which must be converted into direct current (DC) and then back into AC to add consistency to the energy produced. Output from a wind turbine is always changing, since the wind is not constant. Wind speed is very important to the output of a turbine. A doubling (2X) of the wind speed will increase output eight-fold (8X). Newer technologies are making the extraction of wind energy much more efficient and allow for energy production at lower wind speeds.

Wind power is not a new technology. In various areas of the world, harnessing the energy of the wind for tasks such as pumping water and grinding grain has existed since before 200 B.C.; and settlers brought windmill technology to the United States in the late 1800s to pump water for farms and ranches and, later, to generate electricity for homes and industry.¹ Across the world, industrialization led to a gradual decline in the use of windmills, but interest in this technology has always risen and waned in response to the price of fossil fuels. Current growing interest is related to the high cost of fossil fuels, concern about the unsustainability of using finite non-renewable fossil fuel sources, and mounting concerns about the significant environmental impact of the carbon emissions associated with these fossil fuel resources.

In contrast to fossil fuels, wind power produces no environmental pollutants; is a sustainable, renewable energy-generating resource; and the wind, itself, is free. In addition, the use of wind power is also growing as a result of technology improvements, cost reductions, laws, and incentives. According to a U. S. Department of Energy report,² the U.S. wind power market surged in 2007—with 5,329 MW of new capacity added and \$9B invested in wind project installations, for a cumulative total of nearly \$28B since the 1980s. The Union of Concerned Scientists,³ reported that the use of wind power across the world grew at an average annual rate of 32 percent between 1998 and 2002, and reported that the

U.S. Department of Energy's (DOE) "Wind Powering America" initiative has set a goal of producing five per cent of the nation's electricity from wind by 2020.

The New York State Energy Research and Development Authority (NYSERDA) has supported the construction and operation of 41.5 megawatts (MW) of wind energy in New York State. NYSERDA currently supports extensive wind resource development and prospecting efforts to identify promising new sites for wind development. These projects could result in the development of over 425 MW of wind energy, having the potential to satisfy increasing consumer demand for green energy and various green energy purchase mandates in neighboring states.

References:

¹ U. S. Department of Energy, "History of Wind Energy," *Technologies*:
http://www1.eere.energy.gov/windandhydro/wind_history.html.

² Ryan Wiser and Mark Bolinger, et al. (May, 2008), *Annual Report on Wind Power Installation, Costs, and Performance Trends—2007*, Washington, DC: U. S. Department of Energy, Energy Efficiency and Renewable Energy:
<http://www.nrel.gov/docs/fy08osti/43025.pdf>.

³ Union of Concerned Scientists, "Farming the Wind: Wind Power and Agriculture," *Clean Energy*:
http://www.ucsusa.org/clean_energy/technology_and_impacts/impacts/farming-the-wind-wind-power.html.

Benefits:

For communities and the environment:

- A sustainable, renewable resource—the supply of wind energy is inexhaustible.
- Wind energy reduces reliance on foreign petroleum and other fossil fuels.
- Wind turbines do not produce air or water pollution and require very little disturbance of land or soil.
- Modern wind turbines are very quiet and can be located within 300 feet of residential structures.
- The footprint of a wind turbine is fairly small and the unit is compatible with mixed land use, such as grazing or agricultural (crops can be grown right up to immediate proximity of a turbine, and turbines can be located within grazing areas—with little impact on crops or stock).
- Agricultural and residential wind turbines can be located in remote areas where connecting to the utility grid may be too excessive or impossible.
- Wind power is a growth industry, stimulating economic development and job opportunities.

- Wind turbines have been successfully used in rural, suburban, and urban areas.
- A commercial wind farm can increase a municipality's tax base, offsetting residents' tax bills.

For consumers:

- Provides a cleaner, healthier living environment for residents.
- *Reduced housing costs:* Wind power has increasing potential for reducing housing costs—making homeownership and rental charges affordable for more people, thereby supporting their ability to remain living in the community. While some reports indicate that the cost of building turbines increased recently, increasing numbers of agencies and reports indicate that the cost of wind power continues to decrease and will shortly become competitive with conventional sources of energy-generation; for example, see:
 - European Wind Energy Association, *Wind Directions*:
http://www.ewea.org/fileadmin/ewea_documents/documents/publications/wind_benefits/Windpower_is_expensive.pdf. Also:
[http://www.ewea.org/index.php?id=60&no_cache=1&tx_ttnews\[tt_news\]=1832&tx_ttnews\[backPid\]=1&cHash=50e9c38dd50cae65d176ebb0b4508e31](http://www.ewea.org/index.php?id=60&no_cache=1&tx_ttnews[tt_news]=1832&tx_ttnews[backPid]=1&cHash=50e9c38dd50cae65d176ebb0b4508e31). Also: <http://www.energyboom.com/wind/new-study-shows-wind-power-reduces-electricity-prices>.
 - American Wind Energy Association, "Wind energy keeps electric rates affordable":
<http://www.awea.org/learnabout/publications/factsheets/upload/Consumer-Benefits-Fact-Sheet.pdf>.
 - Staff and Press Association (April 23, 2012), "US and UK to collaborate on 'floating' wind turbines," *The Guardian* on line:
<http://www.guardian.co.uk/environment/2012/apr/23/us-uk-floating-wind-turbines>.
- Through lease agreements, commercial wind turbines provide a potential second income for landowners and farmers.

Impediments or barriers to development or implementation:

- Environmental aspects of wind technology have an impact on market and community acceptability:
 - *Aesthetics:* While many people think the modern designs of wind turbines are elegant, many others feel they present an aesthetic blight on the landscape.
 - *Noise:* Residents often object to the noise generated by wind turbines. While wind turbines are not silent, they are not excessively loud—producing sounds that are typical to a rural environment. However, advancing technology continues to reduce, and may even eliminate, any noise from wind turbines.

- In many areas, wind strength is too low to economically support the installation of a wind turbine. However, newer technologies are creating wind turbines that efficiently generate power at lower wind strengths than were traditionally required.
- Too much wind is as bad as not enough. Excessive wind can damage the gearbox—reducing a turbine's output or completely stopping a turbine in high-wind conditions.
- The installation of wind systems can involve the use of heavy equipment, which can cause temporary negative impacts to the area near the installation. Control of erosion around a site must be mitigated.
- Wind speed is critical to the viability of a wind turbine, and taller towers may be necessary to achieve the necessary wind resource. However, a local municipality may not allow the installation of tall towers (typically considered greater than 80 feet tall), or may require getting a variance from a local law.
- There is a big difference between a large wind project and a small wind project (number of turbines, land space occupied, noise, geographic location, site location); however, laws created to restrict the development of large wind farms often catch small wind projects in the same net, including a single turbine for a single residence.
- Migratory birds and bats may collide with rotor blades.
- Shadow flicker is created when rotor blades cast a moving shadow over nearby windows during daylight.
- New York State has great wind-power potential in the Adirondacks and Catskill Mountains, but lacks access to transmission lines.

Resource—examples:

- *Alfred State College Farm*, Alfred, New York—a 10 kW turbine on a 100' guyed lattice tower was installed to produce energy for the milking barn and to allow students to monitor power production. The average annual wind resource at this site is about 12mph and the annual output is about 11,000 kWh.
- *Steel Winds Wind Farm*, Lackawanna, New York—the first wind farm in a city, Steel Winds is located right outside of Buffalo on 30 acres of the old Bethlehem Steel Mill along the shores of Lake Erie. It is one of the first wind farms in the nation constructed on a brownfield and is a 2007 *Power Engineering* magazine Best Renewables Project of the Year winner:
http://www.epa.gov/oswercpa/docs/success_steelwinds_ny.pdf.
<http://www.chattanooga.com/newsandvideo/business/2008spring/page25.asp>.

<http://www.renewableenergyworld.com/rea/news/article/2007/06/steel-winds-project-achieves-full-commercial-operations-48803>.

- *Wind Power Law Blog*, "New York State Wind Projects": provides a list of links to operational wind energy projects in New York State:
<http://windpowerlaw.info/wind-power-law-resources/new-york-state-wind-projects/>: scroll down to "New York State Wind Projects."
- *Amy Wilson's single-family home*, Oklahoma City, Oklahoma:
<http://www.earthtechenergysystems.com/news.asp>.

Resource—written and web:

- *New York Wind Maps*—developed under NYSERDA funding, these Web sites contain updated maps of New York's wind speeds. The maps have a horizontal resolution of 200 meters; and tools such as zoom in, zoom out, pan, wind resource report, and more are located above the maps. Various overlays can be selected as well.
NYSERDA *Small Wind Explorer*:
 - Press release:
http://www.nyserda.ny.gov/About/Newsroom/2009-Announcements/2009-10-23-AWS-Truewind-Launches-NY-Small-windExplorer-to-Support-NYSERDA-Small-Wind-Initiatives.aspx?sc_database=web .
 - New York State *Small Wind Explorer*: <http://nyswe.awstruepower.com/>.
 - *Small Wind Explorer*—Frequently Asked Questions:
<http://nyswe.awstruepower.com/SWEFrequentlyAskedQuestions.pdf>.
- U. S. Department of Energy: *Wind Powering America*—a program with specific focus on the use of wind power generation as a source of income for American farmers, Native Americans, and rural landowners. The site provides helpful links to various state agencies that deal with renewable energy, and also gives information as to what is needed to start one's own wind farm.
<http://www.windpoweringamerica.gov/>.
 - Success Stories: http://www.windpoweringamerica.gov/success_stories.asp.
 - Utility-Scale Land-Based 80-Meter Wind Maps:
http://www.windpoweringamerica.gov/wind_maps.asp.
 - *New York Wind Map and Resource Potential*:
http://www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=ny.
- Ryan Wiser and Mark Bolinger (Lawrence Berkeley National Laboratory) (June 29, 2011), *2010 Wind Technologies Market Report*. Washington, DC: U. S. Department of Energy. This annual report provides a comprehensive overview of trends in the U.S. wind power market in 2010; analyzes trends in wind power capacity, industry, manufacturing, turbines, installed project costs, project performance, and wind power prices; describes trends among wind power developers, project owners, and power purchasers; and discusses financing issues.

http://www.windpoweringamerica.gov/pdfs/2010_annual_wind_market_report.pdf. Also: http://www.windpoweringamerica.gov/filter_detail.asp?itemid=3207.

- *American Wind Energy Association*—a National trade organization that promotes the use of wind energy. The Web site includes contact information for developers, consultants, equipment suppliers, and other members. It also provides details on large and small wind technology, policy initiatives, locations of installed wind projects, and links to other information. <http://www.awea.org>.
- *AWS Truewind*—an organization made up of meteorologists, engineers, and environmental specialists, offering a full range of technical services from feasibility studies to wind plant design. The Web site provides good information on the weather and atmospheric conditions of an area for use in the development of an alternative energy system at a particular location. Also included on the site are wind maps and meteorology maps for specific areas of the world (including New York). <http://www.awstruepower.com/>.
- *National Renewable Energy Laboratory/National Wind Technology Center*—as part of the U.S. Department of Energy, this laboratory focuses on wind energy research and development. The Web site includes extensive information on the Laboratory's technology and associated research activities, as well as publications, photos, and links to other wind energy related sites. <http://www.nrel.gov/wind/>.
- *Small Wind Certification Council*—an independent certification body that will certify small wind turbines if they meet or exceed the performance, durability, and safety requirements of the Small Wind Turbine Performance and Safety Standard. This certification will provide a common North American standard for reporting turbine energy and sound performance, and help small wind technology gain mainstream acceptance. <http://www.smallwindcertification.org/>.
- *U.S. Department of Energy Wind Program*—a program that is leading the efforts across the United States to improve wind energy technology so that it can generate competitive electricity in areas with lower wind resources. The Web site contains detailed information about the program, including the types of technologies being developed and additional publications. It also provides information on the Department of Energy's hydropower program. <http://www1.eere.energy.gov/windandhydro/pdfs/43025.pdf>.
- *Wind Energy Technologies*—a Web site containing links that describe the different types of wind turbines, as well as the difference between windmills and wind turbines. http://www1.eere.energy.gov/windandhydro/wind_how.html.
- *Wind Power Law Blog*—a Web blog that focuses on wind energy legal developments, especially regarding land use and zoning law, environmental

concerns, and judicial and regulatory actions. The site also links to sites of numerous New York wind plants. <http://windpowerlaw.info>.

- *Windustry*—a non-profit organization that promotes wind energy through outreach, educational materials, and technical assistance to rural landowners, local communities and utilities, and state, regional, and nonprofit collaborations. The Web site contains links to help rural landowners understand wind energy opportunities. <http://www.windustry.org>.
- Western Resource Advocates, *Green Power Links—Wind Energy*: a web site providing numerous links and resources on wind energy and other green energy alternatives. <http://www.westernresourceadvocates.org/greenpower/links.php/>.
- *Wind Energy Toolkit: Community Resources for Wind Development*—a tool kit designed to provide information on all aspects of wind energy development and to help communities prepare for wind development. The reports and documents in the tool kit are intended to provide objective information necessary for everyone concerned with wind development in a community—from the farmer or landowner who wants to lease his land—to the local officials charged with zoning, planning and permitting—to interested members of the public. The tool kit houses information about the process for siting wind energy facilities in municipalities in this state, and all the considerations that go into the decision-making effort. <http://www.powernaturally.org/Programs/Wind/toolkit.asp>.
- Steve Lindenberg, et al. (July, 2008), *20% Wind Energy by 2030—Increasing Wind Energy's Contribution to U. S. Electricity Supply*, #DOE/GO-102008-2567. Washington, DC: U. S. Department of Energy, Energy Efficiency and Renewable Energy. http://www1.eere.energy.gov/wind/pdfs/wind_manuf_wkshp_proceedings_05-19-09.pdf.
- Wind and Water Power Program (May, 2011), *Building a New Energy Future with Wind Power*, #DOE/GO-102011-3278. Washington, DC: U. S. Department of Energy, Energy Efficiency and Renewable Energy. <http://www1.eere.energy.gov/wind/pdfs/51240.pdf>.
- U. S. Department of Energy (May 29, 2008), "U.S. Continues to Lead the World in Wind Power Growth": <http://www.id.doe.gov/news/PressReleases/PR080530-Wind/080530Wind.pdf>.

Resource—technical assistance contact names:

- Mark Mayhew, Project Manager
Small Wind Incentive Program
New York State Energy Research and Development Authority (NYSERDA)
17 Columbia Circle
Albany, New York 12203
(518) 862-1090 or 1-866-NYSERDA

Fax: (518) 862-1091

msm@nyserda.org or smallwind@nyserda.org.

<http://www.nyserda.ny.gov/>.