LARGE WIND TURBINES — COMMERCIAL APPLICATIONS

Wind Energy

A GUIDE FOR WIND SITE DEVELOPMENT

Wind Power ...Naturally

New York Energy Smart℠
Public Service Commission — NYSERDA

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WIND POWER DEVELOPMENT

Putting wind to work has been a goal of civilization through the ages. Wind is a free, renewable fuel that has been used to power ships, grind grain, and pump water. Technical improvements over the past decade have increased the size and power output capacity of wind turbines, significantly reducing the cost of using wind to generate electricity. Federal- and state-funded research, development, and other financial incentives, such as payments tied to production and tax benefits, have spurred wind project development in recent years.

The New York State Energy Research and Development Authority (NYSERDA) has funded major projects to map New York's wind and encourage the development of wind power across the state. With assistance from NYSERDA, several large-scale wind farms have been developed in New York State and several other projects are at various stages of development.

WHAT ARE THE benefits OF WIND ENERGY?

1. Wind energy is **inexhaustible** and **non-polluting.**
2. Wind energy **reduces our reliance** on foreign petroleum.
3. Wind energy is **compatible** with mixed land use such as grazing or agriculture.
4. Wind energy's sale price is **not susceptible to price fluctuations.**
5. Wind energy projects are modular, and the development and construction **process is relatively fast** when compared with bringing a new coal or nuclear plant on line.

Additional rural benefits include:

Economic diversification — Wind energy provides farming communities with a new source of long-term revenue without a significant impact on existing agricultural operations. New jobs for wind turbine construction, operation, and maintenance are created, some materials and supplies can be purchased locally, and landowners will benefit from long-term land lease payments made by the project owner.

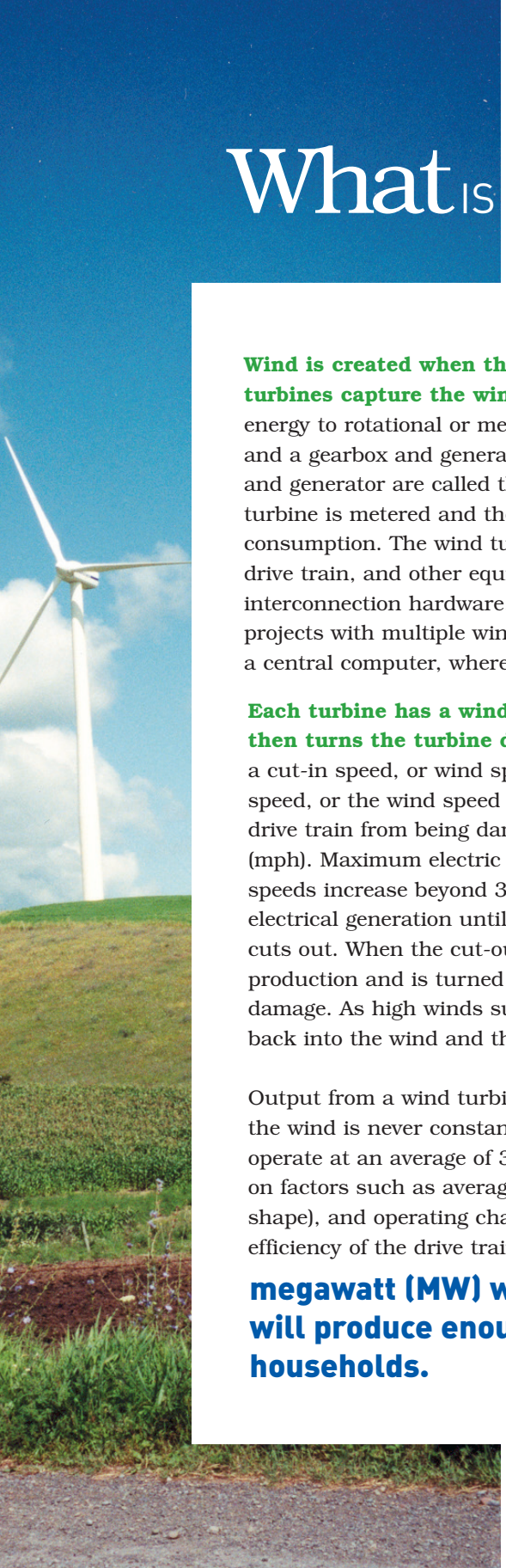
Increased tax base — Wind projects make payments to local taxing authorities (school districts, town, county, or state governments) and do not require increased services from the taxing authority. This broadens the local tax base and provides new local revenue, with the potential to reduce tax burdens on local residents.

WHAT ARE THE STEPS ASSOCIATED WITH DEVELOPING AND CONSTRUCTING A WIND ENERGY PROJECT?

The essential steps are:

- **Locate** a region that offers good wind resource potential, appropriate amounts of land with open and accessible acreage, interested communities and landowners, access to transmission lines, and no obvious environmental concerns.
- **Assess** wind characteristics at specific locations by installing a meteorological tower (about 150 to180 feet tall) and collecting wind data for a year or longer.
- **Develop** a project layout and conduct meetings with local governments and landowners to secure access, permits, and approvals. Perform environmental evaluations to ensure the project poses no significant environmental impact.
- **Negotiate** power sale and interconnection agreements.
- **Evaluate and purchase** wind turbines and finalize installation contracts.
- **Begin construction** — construction requires six to nine months once a notice to proceed is granted.
- **Test and evaluate** functions of the completed plant to ensure proper operation.

This entire process takes about two to three years, depending on local conditions.



What is wind energy and how does it work?

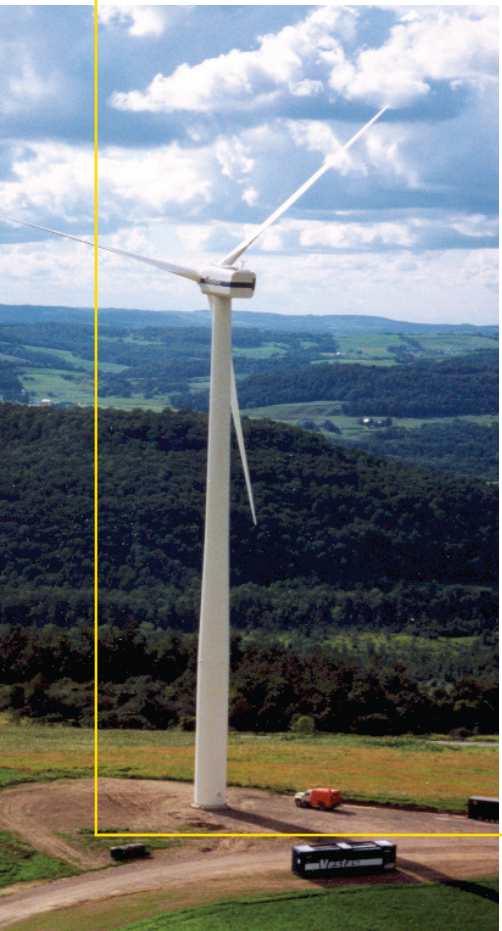
Wind is created when the sun unevenly heats the earth's surface. Wind turbines capture the wind in their blades (or rotor) and then convert the wind energy to rotational or mechanical energy. The rotor drives an attached shaft and a gearbox and generator to produce electrical energy. Together, the gearbox and generator are called the drive train. The electricity generated by the wind turbine is metered and then delivered to the electric transmission grid for consumption. The wind turbine includes a tower that supports the rotor, drive train, and other equipment, such as the controls, electrical cables, and interconnection hardware. Each turbine is controlled by a computer. In large projects with multiple wind turbines, each turbine computer is connected to a central computer, where plant operators can remotely monitor the turbines.

Each turbine has a wind vane that sends a signal to the computer, which then turns the turbine directly into the wind. Wind turbines are designed with a cut-in speed, or wind speed at which it begins to produce power, and a cut-out speed, or the wind speed at which the turbine will be shut down to prevent the drive train from being damaged. Cut-in speeds are typically 7 to 9 miles per hour (mph). Maximum electric generation occurs at speeds of 30 to 35 mph. As wind speeds increase beyond 30 to 35 mph, the generator maintains its maximum electrical generation until wind speeds reach 55 to 65 mph, and then the turbine cuts out. When the cut-out speed is reached, the turbine automatically stops production and is turned from the wind to protect the drive train from mechanical damage. As high winds subside, the computer automatically turns the turbine back into the wind and the unit returns to operation.

Output from a wind turbine or a wind energy plant is always changing because the wind is never constant. Over the course of a year, wind power plants typically operate at an average of 30 to 35 percent of their rated capacity. Output depends on factors such as average wind speeds, the design of the turbines (i.e., blade shape), and operating characteristics like cut-out speed, reliability, and the efficiency of the drive train. **The electricity produced by a 100-megawatt (MW) wind power plant in New York State will produce enough electricity to power about 44,000 households.**

WHAT MAKES A GOOD wind site?

Sustained wind speeds are critical to a project's economic viability. New York has an abundance of land suitable for wind development. Wind turbines require a minimum annual average wind speed above 15 to 17 mph (6.7 to 7.6 meters per second) to be cost competitive in the marketplace. The proximity of turbines to electric transmission lines is another important factor in evaluating the economic viability of a project. Due to the high costs associated with building transmission lines, most wind projects are located within three miles of high-voltage transmission lines. Also, land features (hills and ravines), vegetation, and nearby structures can affect how valuable a site is for wind energy development. **In New York, ridgelines, high hilltops, elevated plateaus, and nearshore and offshore locations relatively free of trees and buildings are favorable** for a wind energy project. Factors such as the accessibility of the land for construction, soil type, and terrain impact construction as well as maintenance needs and costs. Environmental impacts related to view-sheds, noise, birds, wetlands, and historical preservation are crucial to the viability of a project and its community acceptance.



HOW MUCH LAND IS REQUIRED?

Large wind projects require about 30 acres of land per turbine to provide adequate exposure to the wind, proper setbacks from homes and roadways, and appropriate spacing between turbines. Terrain features also need to be considered. Space is needed around a turbine for a 20-foot gravel access road, a 10-by-12-foot concrete pad for an electrical transformer, and the turbine foundation.

Excavating requirements and the **type of foundation needed for each turbine will depend on turbine size, soil conditions, and methods employed.** Foundations are concrete and can be a buried slab with a support column or a buried cylinder. Buried slab foundations are 30 to 50 feet in diameter. Buried cylinder foundations are about 15 feet in diameter. Excavations for both foundation types are approximately 15 to 60 feet in diameter, depending upon the ground conditions.

Power cables between turbines are buried at least three feet below the surface to accommodate farming needs. A project usually includes a substation where power is transformed to be compatible with the high-voltage transmission system or grid.

WHAT IS THE visual impact ON THE LANDSCAPE?

Wind energy projects alter the visual landscape of an area or region. Wind turbines will most likely be the largest structure in the landscape, and the blades attract attention because they rotate. Surrounding terrain features can also influence the look of a wind energy project. **Since wind turbines are commonly located in hilly areas, the surrounding terrain can often obscure the turbines from different viewpoints.** Project views will vary in different seasons and even during different times of the day. To meet Federal Aviation Administration requirements, turbines must be illuminated at night with red or clear strobe lights.

A view-shed analysis and computer-aided visualizations of potential project layouts provide communities with realistic examples of how a project will look from different perspectives. **It is common to modify proposed turbine locations to enhance the visual appeal of a project,** assuming it does not adversely impact the energy output from the project.

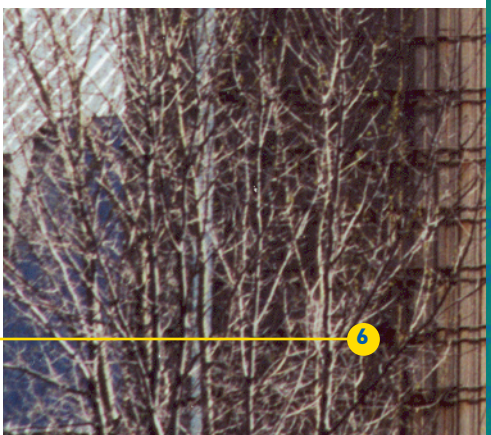
CAN I HEAR THE TURBINES?

Noise issues were associated with some early wind projects; however, noise has been reduced through advances in system designs and the appropriate use of setbacks from residences. At the base of a tower, typical noise levels from turbines are 80 to 90 decibels (dB). Noise levels drop to about 35 dB at one-quarter of a mile (about 1,300 feet) from the turbine, or the same level of noise you would routinely hear inside a home or office. At this distance, the turbines are barely discernible above normal conversation and their noise is typically muted by the naturally occurring noises at a site. If turbines are sited 1,000 feet or more from residences, noise concerns are usually mitigated.

HOW MUCH revenue DO TURBINES PROVIDE?

Payments to landowners are commonly structured in a land lease, but developers may purchase the land or seek wind easements. In a land lease, the developer obtains exclusive access to the land for wind-energy-related requirements for a period of 20 to 30 years. In return, **landowners are paid in a lump sum, or through annual royalty payments based on the amount of energy produced by the turbines installed on the land,** and can continue to use most of the land for routine activities, such as farming. Annual payments depend on a variety of factors and can range from $1,000 to $3,000 per MW.

Wind easements are often used by developers to ensure that vital land and associated airspace are kept available for transmission access and additional turbine installations, or to ensure adequate exposure to the wind. Wind easements are normally negotiated in perpetuity, and landowners are usually compensated with a onetime, up-front payment.



For more information on wind energy please visit the following web sites:

www.PowerNaturally.org

www.awea.org

www.awstruewind.com

www.getenergysmart.org

www.dsireusa.org

www.fennerwind.com

www.atlantic-renewable.com

www.enel.it

www.nationalwind.org

www.nrel.gov

www.eere.energy.gov

www.windustry.org

I think I have land that can be developed for wind —

WHAT ARE THE next steps?

1. Educate yourself first; see how experts have characterized New York State's wind patterns in the Wind Energy Map found at **www.awstruewind.com.** This map will help you learn more about the estimated wind speeds at your site. Then visit sites such as **www.awstruewind.com and www.PowerNaturally.org** to learn more about the development process, wind technology, the major stakeholders in the wind industry, and landowner experiences. Consider the long-term desirability of hosting a wind turbine or participating in a wind energy project, weighing all the risks and rewards associated with such projects. Consult with an attorney regarding landowner rights and responsibilities.

2. Consider the various development strategies as mentioned above. The most common agreement available to a landowner is a land lease with a developer in return for a lump sum payment or annual payments, or perhaps some combination of the two. Developers often start by signing a land lease option and then collect wind data (data is typically collected for one year) before signing a long-term lease. It is important to note that a land lease with a developer does not guarantee that a project will be built on your land. A developer must have both the financial means to build the project and the ability to sell the project's output over the long term to make the project economically viable. If it looks like the site has potential, the developer will install monitoring equipment, pursue power purchase contracts, and initiate other development activities at no cost to the landowner. **The risks to a landowner in a land lease are relatively low, since the landowner does not have a financial position in the project.**

Another landowner strategy is to pursue some level of development activities independently or in a partnership with others. This approach may be more risky, requires significantly more time and financial investment, and makes sense only in areas with a strong market for wind energy. In this strategy, an experienced consultant is hired to collect wind resource measurements on the affected land. The landowner is responsible for the costs of data collection, with the risk that the wind resource is insufficient to attract development. If a good wind resource exists, a landowner can begin additional development activities or negotiations with developers for land leases or other agreements from a stronger position of knowing the wind resource, based on an independent analysis.

3. Make contacts

by using lists of developers and consultants from sources such as the American Wind Energy Association (www.awea.org) and contact industry members to make them aware of local interest. As discussed above, there are a number of factors that help determine if a site is suitable for a wind energy project, so be prepared to answer questions such as:

- **How many acres do you own? What is the current land use?**
- **Are there limitations for construction or operation? What are the neighboring land uses?**
- **What is the elevation of your land? How does it compare with the surrounding area? Is your land the highest, or is it otherwise well exposed to prevailing winds?**
- **How close are you to the nearest high-voltage transmission line? Does it cross your property? Who owns the line? What is the voltage of the line? Wind projects usually require 69 to 115 kV transmission lines; 230 kV service may increase development costs of the project.**

4. Assess community interest

and discuss the potential wind project with neighbors, local government officials, and business interests to determine opinions about wind energy development in the area. Work with local authorities to develop an approach to attract wind energy developers to your area that balances community values and needs.

For a list of references, related links, and additional information on a variety of related topics, visit www.PowerNaturally.org.

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Contact us at 1-866-NYSERDA or visit us at www.PowerNaturally.org.

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