

Summer 6-2010

Wind Energy Glossary: Technical Terms and Concepts

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Nordman, Erik Edward, "Wind Energy Glossary: Technical Terms and Concepts" (2010). *Technical Reports*. 5.
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Wind Energy Glossary

TECHNICAL TERMS AND CONCEPTS

WEST MICHIGAN WIND ASSESSMENT

The terms in this glossary are organized into three sections: (1) Electricity Transmission Network; (2) Wind Turbine Components; and (3) Wind Energy Challenges, Issues and Solutions.

Electricity Transmission Network

- Alternating Current (AC)** An electrical current that reverses direction at regular intervals or cycles. In the United States, the standard is 120 reversals or 60 cycles per second. Electrical grids in most of the world use AC power because the voltage can be controlled with relative ease, allowing electricity to be transmitted long distances at high voltage and then reduced for use in homes.
- Direct Current (DC)** A type of electrical current that flows only in one direction through a circuit, usually at relatively low voltage and high current. To be used for typical 120 or 220 volt household appliances, DC must be converted to AC, its opposite. Most batteries, solar cells and turbines initially produce direct current which is transformed to AC for transmission and use in homes and businesses.
- Efficiency** Describes the amount of active electrical power generated as a percentage of the wind power received by the turbine.
- Grid-Connected System** A residential electrical system such as solar panels or wind turbines which act like a central generating plant, supplying power to the commercial grid (Figure 1).
- Inverter** A device that converts direct current (DC) electricity to alternating current (AC) either for stand-alone systems or to supply power to an electricity grid.

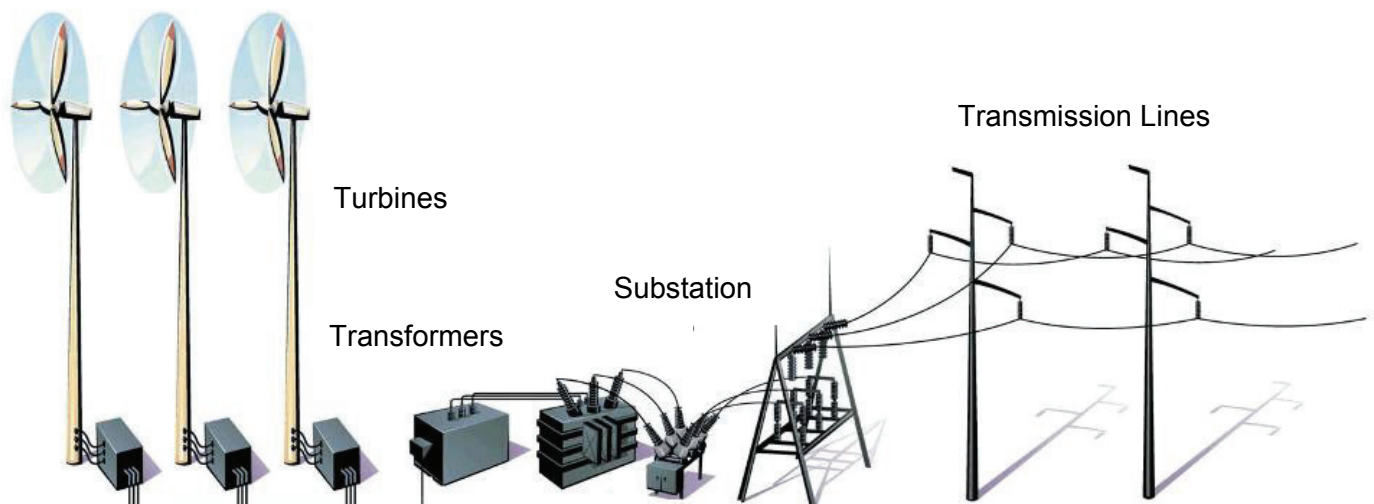


Figure 1: Connecting a wind farm to the electricity transmission grid. (KidWind Project)

Load	In reference to wind developments, load describes the energy demand placed on a power generating facility or the energy consumed by a group of customers or set of equipment. Usually expressed in amperes or watts.
Megawatt (MW)	1,000 kilowatts (kW) or 1 million watts (W); standard measure of electric power generating capacity. Large utility scale wind turbines usually produce 900 kW to 2 MW per turbine.
Megawatt-Hour (MWh)	The amount of energy used if work is done at an average rate of 1 million watts for 1 hour.
Renewable Portfolio Standards (RPS)	Laws developed federally or by states mandating that electricity providers obtain a minimum fraction of their energy from renewable resources. In 2008, Michigan passed an RPS requiring that 10% of the state's energy come from renewable sources by 2015.
Storage Battery	Also known as a rechargeable battery. Can transform energy from electric to chemical form and vice versa. Can be connected to turbines to temporarily store electricity in chemical form during peak production times and release electrical energy when demand is high.
Substation	A facility that steps up or steps down the voltage in utility power lines. Voltage is stepped up where power is sent through long-distance transmission lines. It is stepped down where the power is to enter local distribution lines.
Transformer	Multiple individual coils of wire wound on a laminate core. Transfers power from one circuit to another using magnetic induction, usually to step voltage up or down. Works only with AC.

Wind Turbine Components

Anemometer	Measures the wind speed and transmits wind speed data to the controller.
Blades	The aerodynamic surface that catches the wind. Most commercial turbines have three blades.
Braking System	A device to slow a wind turbine's shaft speed down to safe levels electrically or mechanically.



Figure 2a. Wind farm in Wisconsin with 86 turbines each at 1.5 MW capacity (Forward Wind Energy Center, 2009). (Dept of Energy – NREL)



2b. Researcher entering the hub of a 1.5 MW wind turbine in Texas (GE Wind, TX, 2002). (Dept of Energy – NREL)

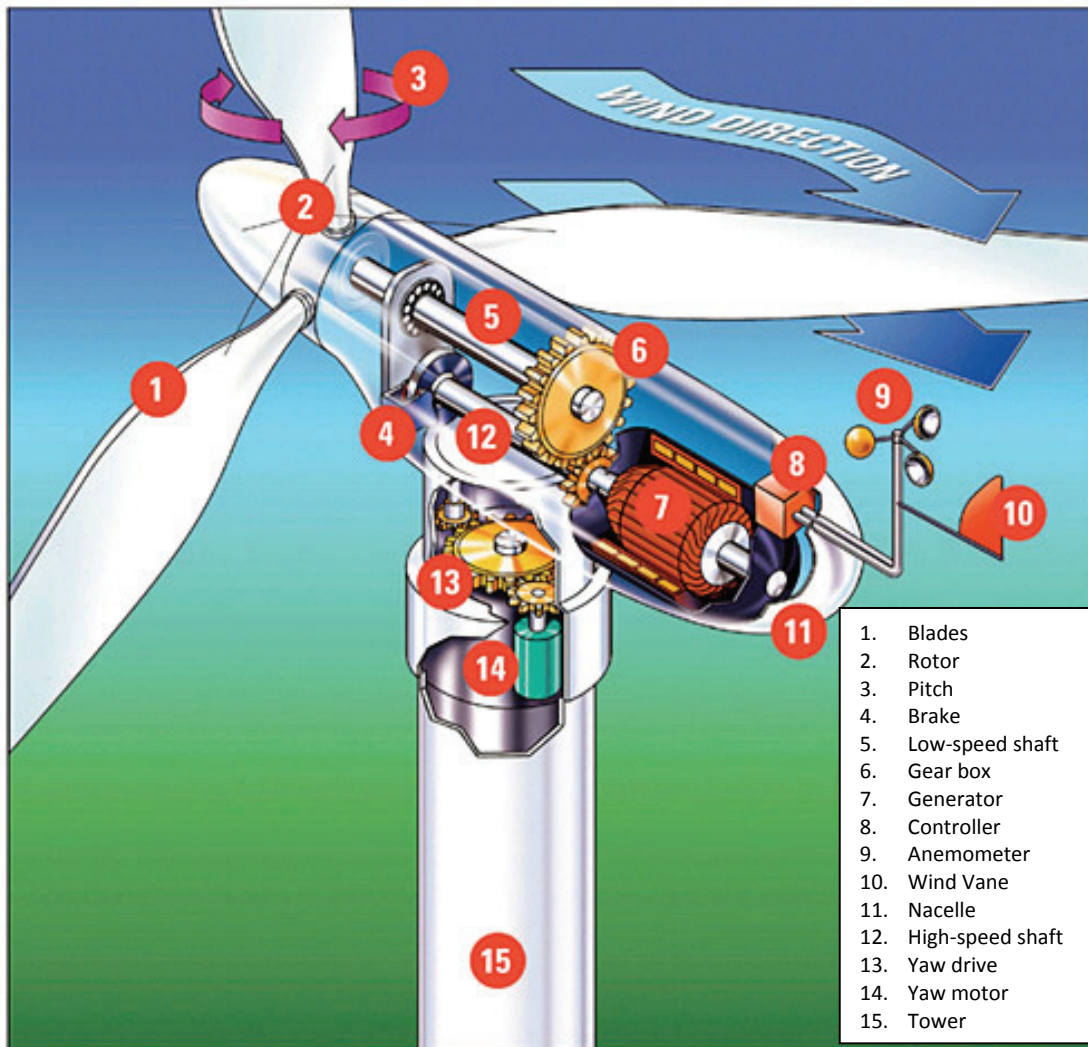


Figure 3: General components of horizontal axis wind turbine. (Canadian Geographic Learning Centre)

Capacity factor	The average power output of a wind development divided by its maximum power capability, its rated capacity . Capacity factor depends on the quality of the wind at the turbine. Higher capacity factors imply more energy generation. On land, capacity factors range from 0.25 (reasonable) to over 0.40 (excellent). Offshore, capacity factors can exceed 0.50.
Controller	The controller starts up the turbine generator at wind speed of about 8 to 16 mph and shuts off the generator at about 65 mph.
Cut-in Speed	The wind speed at which the turbine blades begin to rotate and produce electricity, typically around 10 mph.
Cut-out Speed	The wind speed at which the turbine automatically stops the blades from turning and rotates out of the wind to avoid damage to the turbine, usually around 55 to 65 mph.
Gear Box	Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speed of the shaft to the speed required by the generator. The gear box is heavy and power losses from friction are inherent in any gearing system.
Generator	A device that produces electricity from mechanical energy, such as from a rotating turbine shaft.

Nacelle	The nacelle sits atop the tower and contains the gearbox, shafts, and generator of a wind turbine. Some nacelles are large enough for a helicopter to land on.
Pitch	The angle between the edge of the blade and the plane of the blade's rotation. Blades are turned, or pitched, out of the wind to control the rotor speed.
Rated Wind Speed	The wind speed at which the turbine is producing power at its rated capacity . The rated wind speed generally corresponds to the point at which the turbine can perform most efficiently. Because of the variability of the wind, the amount of energy a wind turbine actually produces is lower than its rated capacity over a period of time.
Rotor Hub	The center of a turbine rotor, which holds the blades in place and attaches to the shaft. The rotor refers to both the turbine blades and the hub (Figure 2b).
Shaft	The rotating part in the center of a wind turbine or motor that transfers power. A high-speed shaft drives the generator. A low-speed shaft is turned by a rotor at about 30 to 60 rpm.
Tower	The base structure that supports and elevates a wind turbine rotor and nacelle.
Wind Turbine	A machine that captures the force of the wind. Also called a wind generator when used to produce electricity. Most commercial wind generators are horizontal axis wind turbines (Figure 2 and 3). If wind energy is used directly by machinery, such as for pumping water, cutting lumber or grinding stones, the machine is called a windmill .
Wind Vane	Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.
Yaw	To rotate around a vertical axis, such a turbine tower. The yaw drive is used to keep a turbine rotor facing into the wind as the wind direction changes.



Figure 4a. Transporting a turbine blade of 1.5 MW test turbine which when complete have a rotor diameter of 250 feet. (Colorado, 2008)



4b. Lifting the 163,000 lb. nacelle and rotor hub for a 1.5 MW turbine at Tatanka Wind Energy (North Dakota, 2007).



4c. Installing the blades for a 1.3 MW turbine at the Nine Canyon Wind Project (Washington, 2002).

All photos from US Dept. of Energy, National Renewable Energy Laboratory.

Wind Energy Challenges, Issues and Solutions

Bird Mortality	Mortality from bird collisions with the turbine blades, towers, power lines, or with other related structures, and electrocution on power lines.
Carbon Dioxide (CO₂)	A naturally occurring gas, and also a by-product of burning fossil fuels and biomass as well as land-use changes and other industrial processes. CO ₂ is the principal greenhouse gas that is produced by human activity and influences climate change.
Climate Change	Changes in a climate system over decades or longer. The term often refers to changes in climate that can be attributed directly or indirectly to human activities that altered the composition of the global atmosphere – changes that are beyond the natural climate variability observed over comparable time periods.
Direct Employment	The total number of people employed in companies belonging to a specific sector.
Emissions	The discharges of pollutants into the atmosphere from stationary sources such as smokestacks, other vents, or the surfaces of commercial or industrial facilities, and mobile sources such as motor vehicles, locomotives and aircraft. With respect to climate change, emissions refer to the release of greenhouse gases into the atmosphere over a specified area and period of time.
Energy Payback	The time period it takes for a wind turbine to generate as much energy as is required to produce the turbine, install it, maintain it throughout its lifetime and, finally, scrap it (Figure 4).
External Costs	Costs incurred in activities which may cause damage to a wide range of receptors, including human health, natural ecosystems and the built environment, and yet are not reflected in the monetary price paid by consumers.

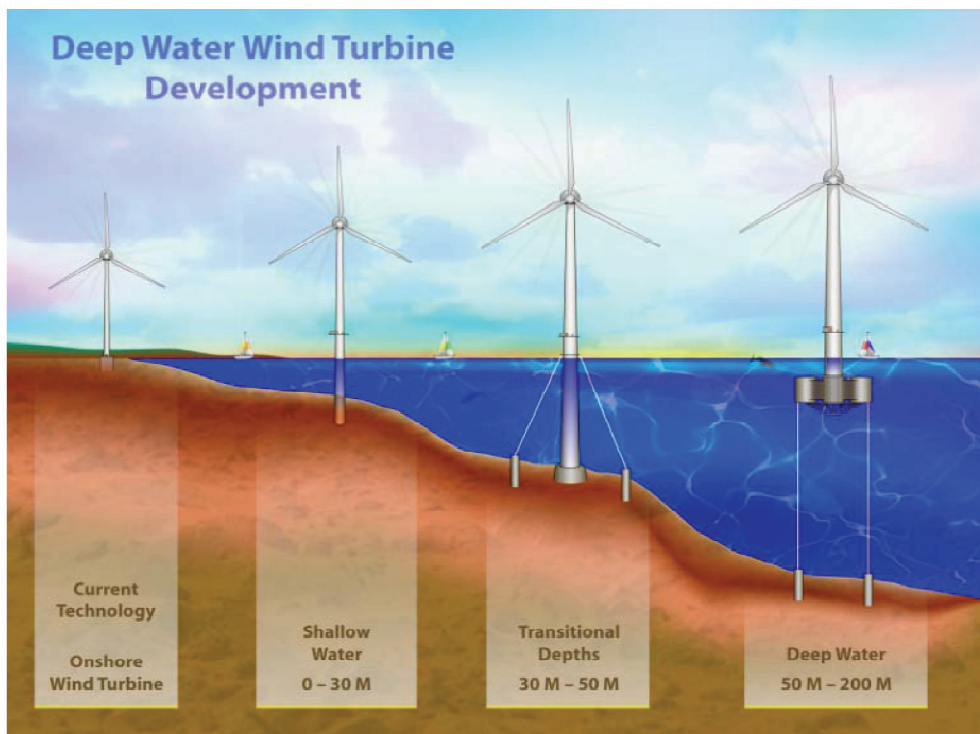


Figure 5. Offshore turbine technology. The tripod foundation has been used in a few projects, but the floating turbine designs have not been used commercially to date. (US Dept. of Energy, National Renewable Energy Laboratory)

Geographic Information System (GIS)	A software system which stores and processes data on a geographical or spatial basis. GIS can be used to evaluate potential sites for wind farms and consider a variety of geographic data simultaneously, such as wind conditions, population and bird migration routes.
Guy Wires	A tensioned cable designed to add stability to tall, narrow structures; frequently used to support ship masts, radio masts and wind turbines.
Indirect Employment	Indirect employment includes employment throughout the production chain, including those who supply raw materials and intermediate components to, for example, a wind turbine.
Life Cycle Assessment	An evaluation of the environmental impacts of a given product or service, such as a wind farm, throughout its life cycle, including manufacturing the parts, installation, operation and disposal.
Nitrogen Oxides (NO_x)	Refers to NO and NO ₂ , which are often produced by combustion under high pressure and high temperature, such as in the engine of a car. NO _x is a major contributor to acid depositions, the formation of ground-level ozone in the troposphere, and photochemical smog.
Offshore Wind Developments	Wind projects installed in shallow waters off the coast. Turbine construction has to be modified to accommodate the depth of the water (Figure 5). A number of countries have built offshore wind developments, but currently there are no offshore wind farms in the U.S..
Onshore Wind Developments	Wind farms installed on land (Figure 3d). Land-based wind farms are significantly cheaper to build than offshore facilities, but the wind is generally stronger and more steady offshore.
Participatory Planning	A planning process open to high levels of public engagement. The success of a wind farm development is influenced by the nature of the planning and development process, and public support tends to increase when the process is open and participatory. Thus, collaborative approaches to decision-making in wind power implementation can be more effective than top-down, imposed decision-making.
Renewable Energy	Energy which comes from renewable resources such as sunlight, wind, rain, tides and geothermal heat, which are naturally replenished. Fossil fuels, such as coal and oil, are considered non-renewable resources because they are consumed much faster than nature can create them.
Sulphur Dioxide (SO₂)	A heavy, pungent, colorless gas formed primarily by the combustion of fossil fuels. It is harmful to human beings and vegetation, and contributes to the acidity in precipitation.
Wind Lease	An agreement signed by a landowner that grants a developer the right to use their land for wind development, and in return, provides compensation to the landowner. Typically, the developer owns any turbines that are put up and does all of the work of developing the project. Wind leases are binding legal documents that typically cover 30 to 60 years or more. These agreements can allow turbines to be constructed on privately owned, actively farmed land (Figure 2a).
Wind Power Class	A way of quantifying on a scale the strength of the wind at a project site. The Department of Energy defines the wind class at a site on a scale from 1 to 7 (1 being low and 7 being high) based on average wind speed and power potential to offer guidance about where wind projects might be feasible. Class 3 is typically the minimum required for utility-scale wind development.

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This publication is a result of work sponsored by Michigan Sea Grant College Program, R/CCD-11, under: NA100AR4170071 from National Sea Grant, NOAA, U.S. Department of Commerce, and funds from the State of Michigan.

