Wind Power Today

Wind Power

Wind power is much more than the gentle breeze that causes the trees to sway or the waves to move across a lake. The power in the wind can blow a semitrailer truck off the road and flatten buildings. And it can be harnessed to be a non-polluting, never-ending source of energy to meet electric power needs around the world.

Wind power is a form of renewable energy – energy that is replenished daily by the sun. As portions of the earth are heated by the sun, air rushes to fill the low pressure areas, creating wind power. But the wind's characteristics may conceal its true power. The wind is slowed dramatically by friction as it brushes the ground and vegetation, it may not feel very windy at ground level. Yet the power in the wind may be five times greater at the height of a 40-story building (the height of the blade tip on a large, modern wind turbine) than the breeze on your face. Furthermore, the wind is accelerated by major land forms, so that entire areas of the country may be very windy while other areas are relatively calm. Since our country's founders tended to build our cities and towns where the wind doesn't blow strongly, the vast majority of people don't live in high-wind areas. Yet, when wind power is converted to electricity, it can be sent long distances to serve the needs of the cities and towns where we do live.

Creating Electricity

Wind **power** is converted to **electricity** by a **wind turbine**. In a typical, modern, large-scale wind turbine, the kinetic energy in the wind (the energy of moving air molecules) is converted to rotational motion by the **rotor** – typically a three-bladed assembly at the front of the wind turbine. The rotor turns a **shaft** which transfers the motion into the **nacelle** (the large housing at the top of a wind turbine **tower**). Inside the nacelle, the slowly rotating shaft enters a **gearbox** that greatly increases the rotational shaft speed. The output (high-speed) shaft is connected to a **generator** that converts the rotational movement into electricity at **medium voltage** (a few hundred volts). The electricity flows down heavy electric cables inside the tower to a **transformer**, which increases the voltage of the electric power to the **distribution voltage** (a few thousand volts). (Higher voltage electricity flows more easily through electric lines, generating less heat and fewer power losses.) The distribution-voltage power flows through underground lines to a collection point where the power may be combined with other turbines. In many cases, the electricity is sent to nearby farms, residences and towns where it is used. Otherwise, the distribution-voltage power is sent to a **substation** where the voltage is increased dramatically to **transmission-voltage** power (a few hundred thousand volts) and sent through very tall transmission lines many miles to distant cities and factories.

Applications

Wind turbines come in a variety of sizes, depending upon the use of the electricity. The large, **utility-scale** turbine described above may have blades over 40 meters long, meaning the diameter of the rotor is over 80 meters – nearly the length of a football field. The turbines might be mounted on towers 80 meters tall (one blade would extend about half way down the tower), produce 1.8 **megawatts** of power (1.8 **MW** or 1800 **kilowatts**, 1800 **kW**), supply enough electricity for 600 homes, and cost over a million and a half dollars!

Wind turbines designed to supply part of the electricity used by a home or business are much smaller and less costly. A residential- or **farm-sized turbine** may have a rotor up to 15 meters (50 feet) in diameter and be mounted on a metal lattice tower up to 35 meters (120 ft) tall. These turbines may cost from as little as a few thousand dollars for very small units up to perhaps $40,000-$80,000.

Very small turbines may be designed to charge **batteries** to supply electricity to homes that are not connected to the utility system. In those systems, the batteries store the electricity until it is needed. Such systems usually include an **inverter** that "conditions" (modifies) the power so that it is suitable to run typical appliances. Of course, the batteries and other necessary equipment increase the cost of the system, and the quantity of electricity available is limited by the battery storage capacity.

Wind Projects

A typical large wind project involves many, many players. The main responsibility for the project lies with the **developer.** The developer negotiates with the **landowner** for the right to “harvest the wind” above the land and to place the turbine on a small plot of land – typically less than 1 acre is removed from normal use (farming, grazing, etc.) for each 50 acres of wind resource captured. (Turbines must be spaced a certain minimum distance apart to avoid "shadowing" each other and reducing power output.) Leasing the right to harvest the wind over a farm can more than double the annual net income from cultivation or grazing. The developer also must find financing, secure a contract with a **utility** to buy the electricity produced, purchase the equipment and contract to have it installed, and arrange for operation of the project. Recently, some landowners have become part owners of the projects on their land. This approach increases the **community** involvement in a project, though the legal arrangements may be quite complicated.

Wind Power Markets

Perhaps there is no “typical” wind power project. Some are built to enable utilities to comply with minimum requirements to purchase renewable energy established by state and local governments (“renewable portfolio standards” or “renewable energy standards”). Others may supply "green pricing" programs in which customers voluntarily purchase wind-generated electricity from their utility. In good wind resource areas, a new, large wind project may produce electricity at less cost (over the 25-year life of a project) than any other new power plant, regardless of the fuel source. While it is true that wind power output varies over time, utilities have learned to integrate wind power with their existing electricity generators. About 20% of Denmark's electricity is generated by wind power, yet Danish utilities report no loss of reliability and no need for expensive new equipment or energy storage.

Making an Impact

The wind resource in the United States is vast. Using today’s technology, there is theoretically enough wind power flowing across the country to supply all of our electricity needs. North Dakota alone could supply about one third of the nation’s electricity. Adequate winds for commercial power production are found at sites in 46 states. However, less than 1% of the nation’s electricity is currently supplied by wind power. Only a small portion of the country’s vast potential will likely be tapped in the near term unless there is a shift in our energy policy priorities toward long-term support for renewable energy development. President Bush has stated that wind energy can provide as much as 20% of the nation’s electricity. AWEA believes this goal is both feasible and affordable: the barriers to wind energy’s expansion on a large scale are regulatory -- not physical -- and can be overcome. The choice is ours.