

DEVELOPMENT OF WIND ENERGY WITH ENVIRONMENTAL PERSPECTIVE

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Use of wind energy re-emerging

Wind energy is re-emerging with technological advance and large scale wind farms.

Wind energy can be used for a wide variety of needs, such as irrigation, farming, and electricity generation. Research is underway to develop wind power generation systems. Wind energy is re-emerging with technological advance and large scale wind farms, which have improved price competitiveness. The effort to find clean energy sources that do not cause the greenhouse effect is also a contributing factor. The size of wind generators has increased from units that 100kW units in the early 1980 's to the present day 's MW scale wind turbines.

Wind generators use the kinetic energy arising from the movement of air.

The US and Europe have made considerable progress in the use of wind energy. After 1891, when Denmark 's Poul la Cour developed the world 's first wind turbine, European countries such as Denmark and Germany have been leaders in wind technology. The European Wind Energy Association predicts that by 2020, wind turbines will provide more than 100,000MW of energy, about 10% of Europe 's power needs. The EWEA predicts that wind turbine capacity will grow by 40% annually, outpacing the growth of other sources of clean energy.

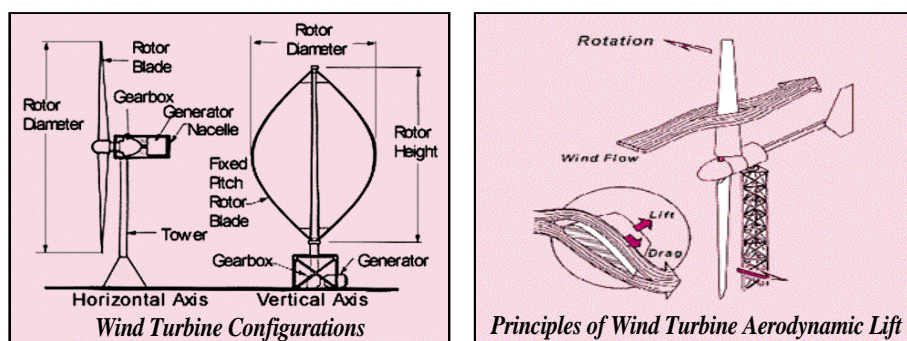
Principles of wind energy

Wind generators use the kinetic energy arising from the movement of air. Turbines convert the wind 's energy to electrical energy. In theory, up to 59.3% of the wind 's kinetic energy can be converted, but in practice, the rate is only about 20% to 40%.

A wind turbine is composed of several parts. the rotor includes a blade and hub, the gear box which accelerates the rotation and drives the turbine, control devices, brakes, electricity control device, and the tower.

The blade of a wind turbine operates on the same principle as an airplane wing. The top surface of the blade curves outward while the bottom is flat. Wind passes by the top more quickly and pressure is lower on the top than on the bottom surface. The difference in pressure causes the blade to move upward, and this sets the two blades

Figure 1. Wind Turbine Diagram and Operating Principle



Source: www.awea.org/faq/basicop.html

spinning around the pivot.

The wind turbine's power is determined by wind speed and blade length. The wind provides electric power equal to $P = 0.5 \times \text{density} \times \text{area} \times \text{velocity}^3$ and therefore the wind turbine's power is proportional to the variables of wind speed and wing area. These variables are important in a turbine's design. For a 1.5MW and 10kW wind turbine, the wing diameters are 70 meters and 7 meters respectively. The tenfold difference in wing diameter results in a power difference exceeding one hundredfold. Therefore, large scale systems are far more efficient.

To generate wind energy, a wind speed of at least 6 meters per second is required. An efficient method is to build a generator system in an area with relatively high wind speeds. On islands, small-scale systems are also efficient.

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Efficiency and the market for wind energy

Wind energy is cost-competitive compared to energy from fossil fuels. The price of wind energy, which was 40 cents per kWh in 1980, fell to 4 cents per kWh in 2000. Wind energy systems are spreading around the world, and recently the growth rate has increased. In 2000, 3,500MW of wind generators were built, and a total of 34 billion kWh of electricity was generated by a total of 17,000MW existing wind generators.

Wind energy is cost-competitive compared to energy from fossil fuels.

The wind energy market has a promising future. In the US, the construction of 2,000MW of wind generators is planned for this year, and European countries are also building generators. The world's wind generation capacity is expected to exceed 22,000MW by the end of 2001. According to a forecast by the American Wind Energy Association, the world's wind energy facilities will exceed 48,000MW by

2010, and the market for wind turbines is expected to reach 45 billion dollars.

Interest in wind energy is growing due to its low cost: in the US, wind energy costs 3 cents per kWh, while electricity from natural gas is expected to cost 15 to 20 cents by the end of this year.

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Currently, the US and Europe are the main markets for wind energy, but it is expected to expand through the world. In late 2000, Germany had the world's largest wind energy facilities, followed by the US, Spain, and Denmark. Germany has about ten thousand wind turbines in operation, supplying 11.5 billion kWh or about 2.5% of the country's energy needs. In Denmark, 10% of the country's energy is supplied by wind energy, and this proportion is expected to exceed 50% by 2030. Wind energy is also becoming a hot topic in China and India. In late 2000, India had a wind generation capacity of 1,200MW.

Environmental benefits of wind energy

Installing one 750kW wind turbine would have a similar effect to planting 500 acres of forest.

Wind energy is an effective method of reducing air pollution. A 750kW wind turbine generates 2 million kWh of electricity a year. If the same amount of energy was generated with fossil fuels, the process would expel 1,500 tons of carbon dioxide, and about 500 acres of forest would be needed to absorb this amount of carbon dioxide. Therefore, installing one 750kW wind turbine would have a similar effect to planting 500 acres of forest.

Besides the absence of carbon dioxide, wind energy also avoids the creation of SO_x, NO_x, and other pollutants.

Wind generation requires little irrigation and wind turbines can be installed on small plots of land. To generate 1kWh of electricity, a coal generator needs 1.9 liters of water, and a nuclear generator needs 2.3 liters. A wind generator needs only 0.004 liters.

In the US, an average plot of 50 acres is used for a 1MW wind turbine. However, 95% of the land is used for farming or ranching, and the wind turbine actually occupies only 2.5 acres. Wind energy needs only 40% of the land needed for methods such as coal or solar energy.

Noise pollution from wind turbines is no longer a problem for wind energy. Design innovations have reduced wind turbine noise to 40 decibels (similar to the noise made by a refrigerator) from 250 meters.

Development status of wind energy in Korea

In Korea, Cheju Island plans to build a 150MW wind energy facility by 2006, and is currently building a test facility. In the first stage, a 10MW test facility will be completed by 2002. This facility will generate 22 million kWh of electricity, equivalent to 7,100kl of petroleum. In August 2000, a total of 4.3MW of wind energy facilities were in operation.

In addition to introducing foreign wind generators, Korean researchers and manufacturers are working to improve domestic technology. In the early 1990 's, domestic efforts focused on small-scale turbine research. For example, testing was conducted on a domestically made 20kW wind turbine in Wonlyong, Cheju Island. In the mid 1990 's, a 160kW energy research site was built in Wonlyong, where researchers tested mid-sized turbines and developed domestic wind technology. After the mid 1990 's, a 50kW to 300kW wind turbine was tested in Mu-an Chollanam-do. In August 1998, Korea 's first commercial wind generator, a 600kW wind turbine, was installed in Haengwon, Cheju Island. The government is promoting research to to domestically produce 750kW wind turbines by late 2002.

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Future of wind energy

Korea, as a country lacking energy resources, should actively develop wind energy facilities. Thanks to technological advance, wind energy has gained price-competitiveness compared to petroleum energy, and the competitiveness of wind energy will further improve in the future.

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Environmental concerns are another reason to promote wind energy. Wind energy has little effect on the environment, helps use land efficiently, and does not exhaust natural resources. Considering that wind energy is environmentally safe and non-polluting, it is expected that wind energy will rapidly spread through the world.

Research on wind energy should focus on developing affordable and large-scale wind turbines. Wind energy technologies have already entered the practical stage, and the competition among many countries producing wind turbines has made it necessary to achieve price competitiveness through research and innovation. **VIP**