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SOME METHODS OF GENERATING ELECTRICITY FROM THE WIND

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ABSTRACT

A method for generating electricity using high wind pressure generated by fast moving vehicles channeling the induced wind in the direction of the wind turbine; converting the energy of the wind into mechanical energy by using wind turbine; and converting the mechanical energy into electrical energy by using a generating device and can be used for applications.

Introduction. Wind energy is electric power that is generated by means of wind turbines. Wind energy is produced, as wind encounters an obstacle on its way and transfers a portion of its kinetic power to such obstacle. This principle is used in wind turbines, or wind generators, where wind moves turbine blades, generating mechanical power, which is then transformed into electricity by means of generators. More and more attention must be paid to methods of generating alternative power. The use of alternative energy allows reducing the costs of heating, it is friendlier for the environment (non-renewable resources that cause environmental pollution from their use, like coal, oil or natural gas, are not used) and increases the autonomy from suppliers of traditional energy resources. Wind energy is considered to be an energy that is capable of renewing itself, since it is the consequence of the Sun's activity. The use of wind power is an industry that is developing very rapidly. More and more wind turbines are installed worldwide every year. A total of approximately 460 GW of wind power is generated worldwide every day, which amounts to about 4% of the total power generation and consumption worldwide. Wind turbines are frequently installed on land or above water bodies like oceans or seas and, usually, the turbines installed on land are capable of generating power for the cheapest price, as the investment pays off in less than 10 years since installation thereof. While turbines installed in the sea are more expensive and the care for them, as well as their maintenance is more expensive, their power generation properties are also better, because wind blows on the surface of water bodies almost all year round. Wind turbines are usually considered to be the least predictable method of generating power, since the output of power by one turbine can change even within the limits of 10% over a period of an hour, which can cause different problems. Usually wind turbine parks are developed in a wide area and consist of multiple individual turbines, which makes the total amount of generated wind power more predictable since changes in weather conditions can be predicted a day in advance, thus the total electricity consumption in the region is increased or reduced and the electricity is transferred via the grid to other areas. Wind power can be successfully linked with hydroelectric plants, which can control the generated electric power. Despite the drawbacks and advantages of wind installations, their use benefits the surrounding environment. Wind energy is a limitless resource that does not produce hazardous waste. Installation of such stationary structures in the sea requires respect for the shipping industry, which is already operating in the seas, meaning that safe distances to wind turbines must be determined to ensure that in the event of wind energy structures falling into water, they would not endanger nearby ships.

Wind energy is a commercially available renewable energy source, with state-of-the-art wind plants producing electricity at about $0.05 per kWh. However, even at that production cost, wind-generated electricity is not yet fully cost-competitive with coal- or natural-gas-produced electricity for the bulk electricity market. The wind is a proven energy source; it is not resource-limited in the United States, and there are no insolvable technical constraints. This paper describes current and historical technology, characterizes existing trends, and describes the research and development required to reduce the cost of wind-generated electricity to full competitiveness with fossil-fuel-generated electricity for the bulk electricity market. Potential markets are described.

THE RESOURCE. Winds arise because of the uneven heating of the earth's surface by the sun. One way to characterize winds is to use seven classes according to power density: class 1 is the lowest and class 7 is the greatest. The wind power density is proportional to the wind velocity raised to the third power (velocity cubed). For utility applications, class 4 or higher energy classes are usually required. Class 4 winds have an average power density in the range of 320-400 W/m2, which corresponds to a moderate speed of about 5,8 rnls (13 mph) measured at a height of 10 m. Researchers estimate that there is enough wind potential in the United States to displace at least 45 quads of primary energy annually used to generate electricity [1]. This is based on "class 4" winds or greater and the judicious use ef land. For reference, the United States used about 30 quads of primary energy to generate electricity in 1993 [2]. A quad is a quadrillion (1015) BTUs or about equivalent to the energy in 167,000,000 barrels of oil.

CONVERSION TECHNIQUES. Wind energy appears to be a conceptually simple technology: a set of turbine blades driven by the wind turns a mechanical shaft coupling to a generator which produces electricity. Figure 2 is a simplified schematic drawing of wind turbines, showing the major components. These include the rotor blades, gearbox, generator, nacelle and tower. It is the reduction of this simple concept to practice which results in significant engineering and materials challenges. The general goals of wind energy engineering are to reduce the cost of the equipment, improve energy capture from the wind, reduce maintenance, increase system and component lifetimes, and increase reliability while at . the same time addressing aesthetics and environmental effects. This requires significant efforts in fundamental aerodynamics, materials engineering, structures, fatigue, power electronics, controls, and manufacturing techniques. Modern turbines are either horizonal-axis or vertical-axis machines, Figure 2, that make full use of lift-generating airfoils (older generation windmills relied primarily on drag forces rather than aerodynamic lift forces to turn the rotor). Each type of turbine has advantages and disadvantages. Both types are

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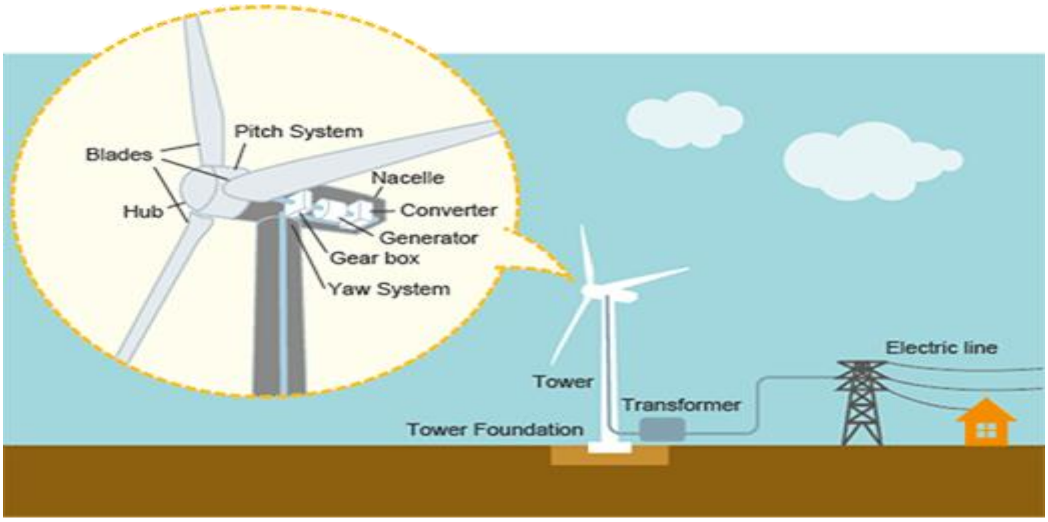
commercially available although the horizontal-axis turbine is predominant. Horizontal-axis turbines are built with differing numbers of blades, typically two or three. Turbines for utility applications are normally installed in clusters of 5 to 50 MW which are called windplants or wind farms. Modem wind turbines have efficiencies of about 40%, with availabilities typically exceeding 97%. Capacity factor (ratio of annual produced energy to annual nameplate energy) has typical field value of 20 to 25%. Capacity factor is very site specific because it reflects the fraction of the time that the wind blows. In areas of relatively constant winds, e.g., trade winds, capacity factor can be as great as 60% to 70%. A description of various types of wind turbines is found in Eldridge.

Easy-installable/operable wind power plant with no need to worry about depletion



Introduction of wind power generation has been increasing in the world, which has the following characteristics:

- No CO_2 emission
- Wind is a safe energy source existing everywhere, and there is no need to worry about depletion like fossil fuel
- Simple equipments and easy operation
- Few affection to nature environment

In the world today, progress of technologies to develop larger WTGs are remarkable, and it makes electric output per one WTG unit increased and large field of WTGs called "wind farm" has developed. Technologies of building offshore WTGs are progressing as well.

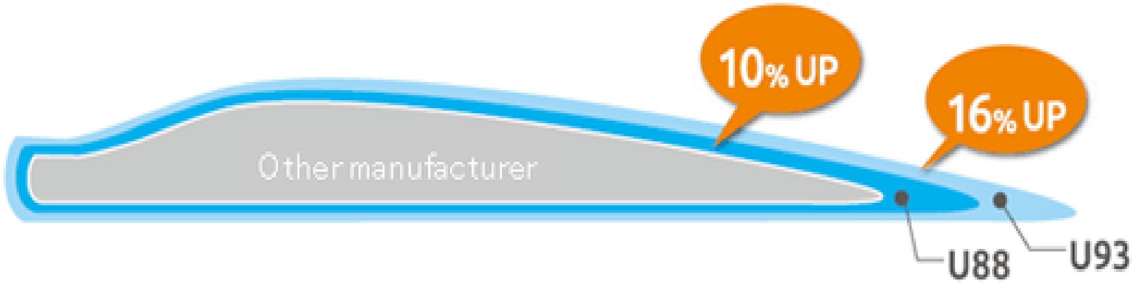
Highly-reliable wind turbine technology. Hermetically-closed permanent magnet synchronous generator (PMSG) achieving an increased power generating efficiency with no need of external excitation system

For permanent magnet excitation, the generator achieves maintenance-free operation and reduced failure rate by removing slip rings for external excitation. Due to no need of external excitation system, power generating efficiency increases. With the use of water cooling and internal fan cooling systems, the generator does not take in air from outside, which is suitable for use in an environment with many fine particles in space or coastal/offshore areas.

Generator for 2 MV WTG

Longer blade produces higher annual energy production even with low wind speed

Using longer blade allows more wind energy to be converted into electricity. For 2 MW WTG type U93, blades with 45 m length and 93 m diameter, that is 16% longer than other manufacturers, are applied, which increases the area receiving wind and produces higher annual energy production even with low wind speed.



MW WTG

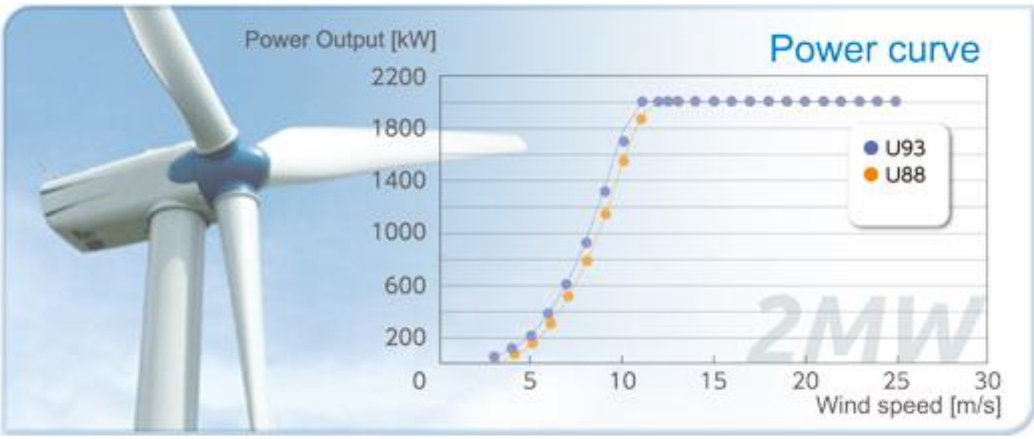
Toshiba's 2 MW **2**

WTG can be characterized by the following features:

- Model: U88E

- High reliability achieved by means of medium-speed gear (1:72)
- Small permanent magnet synchronous generator (PMSG)
- Hermetically-closed generator with water cooling system

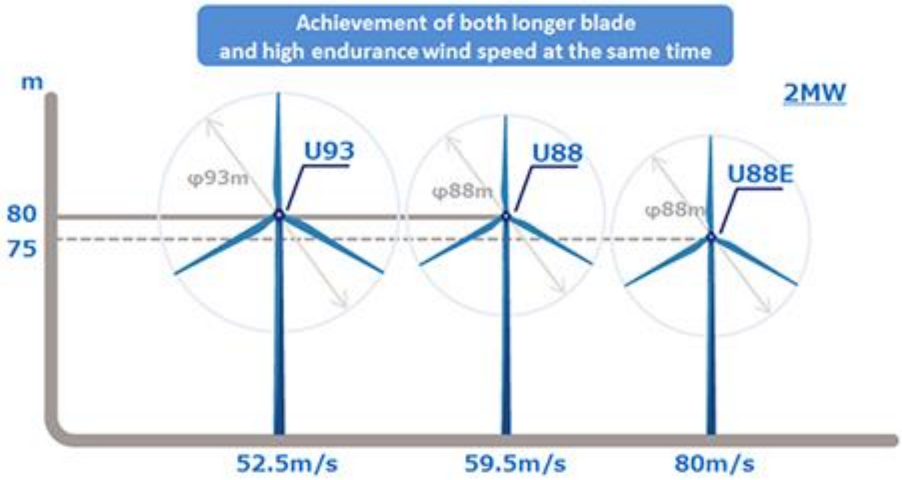
Model		U88E	U88	U93
Rotor Diameter		88 m		93 m
Hub Height		75 m	80 m	80 m
Design Class		IEC SA*	IEC IIA	IEC IIIA
Wind Speed	Extreme wind speed(V_{e50})	70 m/s	59.5 m/s	52.5 m/s
	Avg.	8.5 m/s		7.5 m/s
	Cut-in	3 m/s		3 m/s
	Rated	12 m/s		11.5 m/s
	Cut-out	25 m/s		25 m/s
Rated Rotating Speed		6 to 17.5 rpm		
Temperature Condition	General	-20 °C to +45 °C (During Operation)		
		-20 °C to +55 °C (Out of Operation)		
	Cold	-30 °C to +45 °C (During Operation)		
		-40 °C to +55 °C (Out of Operation)		



* IEC standard: Reference wind speed 50 m/s, average wind speed 8.5 m/s, extreme wind speed (Ve50) 70 m/s.

* Consult with us for wind speeds exceeding 70 m/s

Achieving high wind resistance with long blades –Design/Manufacturing– ※1



We have variety of WTGs with long blades that covers wide range of endurance wind speed, and so we are able to provide WTGs that are suitable for each site. We also keep developing large WTGs for onshore/offshore in order to decrease the unit cost.

ISSUES. Wind energy is environmentally positive. Annual wind generated electricity production in California displaces the energy equivalent of 5 million barrels of oil and avoids the release of 2.6 billion pounds of greenhouse gases per year, in addition to avoiding other emissions such as sulfur and nitrogen oxides which contribute to smog and acid rain. However, some environmental concerns must be addressed. The death of birds by flying into operating turbines is a concern, especially when the birds are raptors such as golden eagles. There are numerous investigations under way to determine the significance of the concern, and to define and validate mitigation techniques. A typical example is the investigation being performed by researchers from the University of California at Santa Cruz [14]. Researchers are collecting data to understand the effect of wind turbines on the population of golden eagles in one area of the Altamont Pass wind resource area. The approach is to radio-tag and track a sufficient number of eagles so that the population dynamics can be understood. Other researchers are investigating mitigation techniques such as eliminating tower members suitable for bird perching, using acoustic warning devices, appropriately painting warning colors and patterns on turbine blades, controlling vegetation around the towers to minimize prey availability, and siting turbines more carefully. The avian situation is an emotional issue, with arguments ranging from doomsday to the other extreme that the population is actually increasing because of the wind turbines.

Another concern is aesthetics. What is beautiful to an engineer may simply be ugly to others. Therefore, wind plant siting and layout are important. It appears that wind plants that have an orderly layout in rows may be preferable to layouts which follow ridges and flow patterns. In general, use of small wind turbine clusters located at multiple sites may be preferred to one very large plant. Aesthetics is a challenge that can be met by developing and using better siting guidelines and by better educating the public about the value of wind plants.

CONCLUSION. Wind energy will be one of the most important, widely applied of the renewable energy forms during the next several decades. There are substantial challenges to be met, but all appear solvable. Successful research and development will potentially result in generation from wind energy of about 10% of the electricity used in the United States. A strong l,J.S. wind industry will be competitive to supply wind turbines to the rest of the world, along with the significant environmental and societal benefits of wind energy.

1. The captain of the ship must keep a safe distance from stationary structures in the sea. Meanwhile, stationary structures may not be installed in the sea in a manner that forces ships to change their course to keep such a safe distance. It is important to keep a safe distance between shipping corridors and sea wind parks in order to coordinate the interests of the shipping and energy sectors. The regulatory enactments that are currently effective have been drawn up for the needs of 1972 - 1982, when the shipping intensity and the proportion of stationary structures considerably differed from current figures.

2. Currently there is no international document that regulates the mandatory and safe distance of shipping routes from stationary structures in the sea. As sea wind parks are developing worldwide, both developers of wind parks, as well as organisations involved in the shipping sector, have to develop a document on an international level which would regulate the safe distance between stationary structures in the sea and shipping routes. 3. In order to determine the area required for the falling of one wind turbine during an accident, it is important to consider the height of the wind turbine and calculate the complete perimeter, or the area of the circle that must be allocated for the possible falling of a single wind turbine into the water. The author proposes to use the formula for the determining the area of a circle for such calculations. Assuming that a safe distance of shipping from stationary structures is the height of the wind turbine R + 500m. The direction of the falling of the wind turbine during an accident cannot be predicted, therefore a circular line around the turbine with the radius equal to the height of the turbine must be drawn.

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