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The importance of using wind energy

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Anotation:*Wind power is one of the fastest-growing renewable energy technologies. Usage is on the rise worldwide, in part because costs are falling.*

Key words: *where horizontal-axis wind turbines, rotor, electric generator*

Global installed wind-generation capacity onshore and offshore has increased by a factor of almost 50 in the past two decades, jumping from 7.5 gigawatts (GW) in 1997 to some 487 GW by 2016, according to figures from the Renewable Energy Network for the 21st Century (REN21). Production of wind electricity doubled between 2009 and 2013. Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones. Offshore wind power offers tremendous potential.

Wind turbines first emerged more than a century ago. Following the invention of the electric generator in the 1830s, engineers started attempting to harness wind energy to produce electricity. Wind power generation took place in the United Kingdom and the United States in 1887 and 1888, but modern wind power is considered to have been first developed in Denmark, where horizontal-axis wind turbines were built in 1891 and a 22.8-metre wind turbine began operation in 1897.

Wind is used to produce electricity using the kinetic energy created by air in motion. This is transformed into electrical energy using wind turbines or wind energy conversion systems. Wind first hits a turbine's blades, causing them to rotate and turn the turbine connected to them. That changes the kinetic energy to rotational energy, by moving a shaft which is connected to a generator, and thereby producing electrical energy through electromagnetism.

The amount of power that can be harvested from wind depends on the size of the turbine and the length of its blades. The output is proportional to the dimensions of the rotor and to the cube of the wind speed. Theoretically, when wind speed doubles, wind power potential increases by a factor of eight.

Wind-turbine capacity has increased over time. In 1985, typical turbines had a rated capacity of 0.05 megawatts (MW) and a rotor diameter of 15 metres. Today's new wind power projects have turbine capacities of about 2 MW onshore and 3–5 MW offshore.

Commercially available wind turbines have reached 8 MW capacity, with rotor diameters of up to 164 metres. The average capacity of wind turbines increased from 1.6 MW in 2009 to 2 MW in 2014.

Wind is caused by the uneven heating of the atmosphere by the sun, variations in the earth's surface, and rotation of the earth. Mountains, bodies of water, and vegetation all influence wind flow patterns[2], [3]. Wind turbines convert the energy in wind to electricity by rotating propeller-like blades around a rotor. The rotor turns the drive shaft, which turns an electric generator. Three key factors affect the amount of energy a turbine can harness from the wind: wind speed, air density, and swept area.[4]

EquationforWindPower

$$P = \frac{1}{2}\rho A V^3$$

- **Windspeed**

The amount of energy in the wind varies with the cube of the wind speed, in other words, if the wind speed doubles, there is eight times more energy in the wind ($2^3 = 2x2x2 = 8$). Small changes in wind speed have a large impact on the amount of power available in the wind [5].

- **Densityoftheair**

The more dense the air, the more energy received by the turbine. Air density varies with elevation and temperature. Air is less dense at higher elevations than at sea level, and warm air is less dense than cold air. *All else being equal*, turbines will produce more power at lower elevations and in locations with cooler average temperatures[5].

- **Sweptareaoftheturbine**

The larger the swept area (the size of the area through which the rotor spins), the more power the turbine can capture from the wind. Since swept area is $A = pir^2$, where r = radius of the rotor, a small increase in blade length results in a larger increase in the power available to the turbine[5].

Wind energy (or wind power) describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generatorcanconvertmechanicalpowerintoelectricity