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Significant Approach, Opportunities and Challenges of the Wind Power as Renewable Energy

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ABSTRACT

The vast global wind energy resource, which is greater than all of the world's power consumption, and the relatively low penetration of current wind energy technologies as a means of electricity generation globally, remain incompatible, despite common descriptions of modern wind energy technology as mature. A method for capturing wind energy that close this gap by strategically placing wind turbines in areas that more closely resemble the actual resource. In order to do this, technology research is concentrated on creating vast arrays of small wind turbines that can gather wind energy at low altitudes utilizing novel engineering principles derived from biology. As a result of this strategy, wind energy may be used in much more places because smaller wind turbines can be placed.

KEYWORDS: *Wind Energy, Wind Farms, Renewable Energy, Vertical-Axis Wind Turbines.*

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INTRODUCTION

The kinetic energy in the wind is a promising source of renewable energy with significant potential in many parts of the world. The energy that can be captured by wind turbines is highly dependent on the local average wind speed. Regions that normally present the most attractive potential are located near coasts, inland areas with open terrain or on the edge of bodies of water. Some mountainous areas also have good potential. In spite of these geographical limitations for wind energy project siting, there is ample terrain in most areas of the world to provide a significant portion of the local electricity needs with wind energy projects.

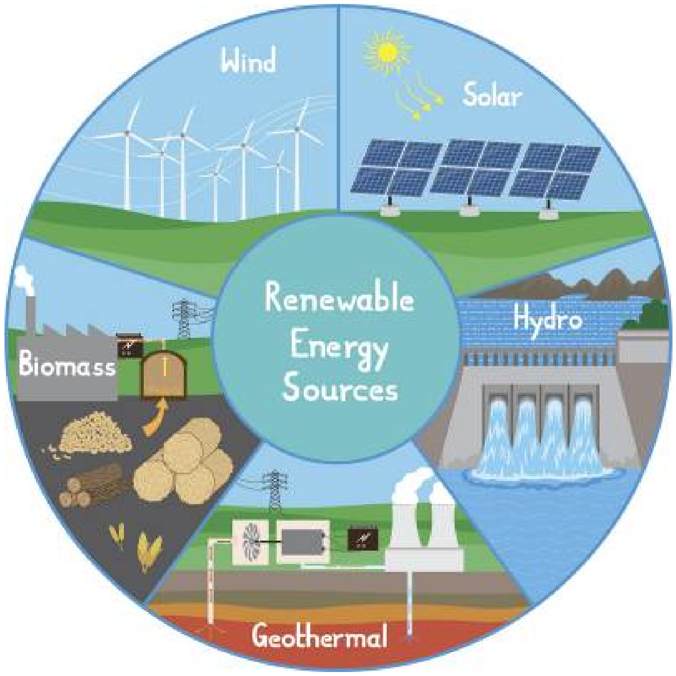

Fig.1 Renewable Energy

Renewable Energy

Renewable energy is energy that is collected from renewable resources that are naturally replenished on a human timescale. It includes sources such as sunlight, wind, the movement of water, and geothermal heat. Although most renewable energy sources are sustainable, some are not. Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished.

The most popular renewable energy sources currently are:

- Solar energy.
- Wind energy.
- Hydro energy.
- Tidal energy.
- Geothermal energy.
- Biomass energy.

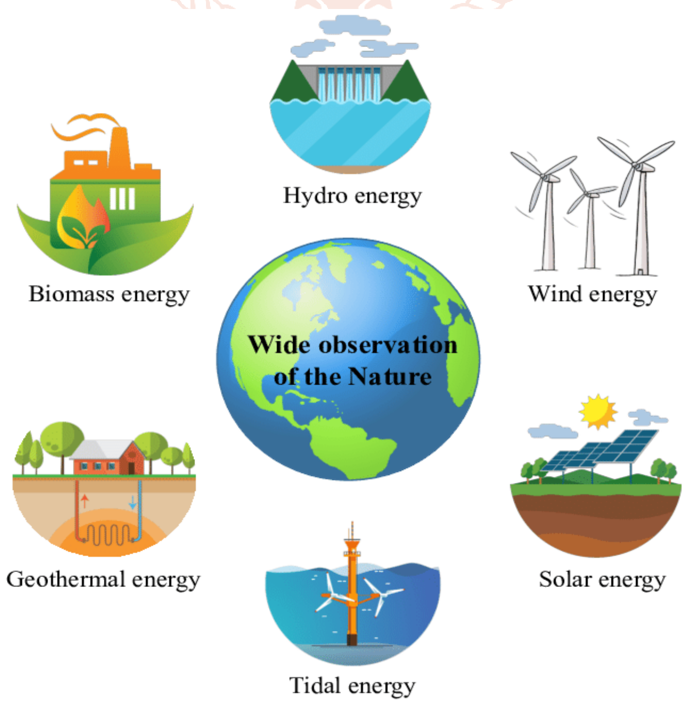

Fig.2 Energy Resources

Wind Strategy

Wind power or wind energy is mostly the use of wind turbines to generate electricity. Wind power is a popular, sustainable, renewable energy source that has a much smaller impact on the environment than burning fossil fuels. Historically, wind power has been used in sails, windmills and wind pumps but today it is mostly used to generate electricity. Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network. New onshore (on-land) wind farms are cheaper than new coal or gas plants, but expansion of wind power is being hindered by fossil fuel subsidies. Onshore wind farms have a greater visual impact on the landscape than some other power stations. Small onshore wind farms can feed some energy into the grid or provide power to isolated off-grid locations. Offshore wind farms deliver more energy per installed capacity with less fluctuation and have less visual impact. Although there is less offshore wind power at present and construction and maintenance costs are higher, it is expanding. Offshore wind power currently has a share of about 10% of new installations.

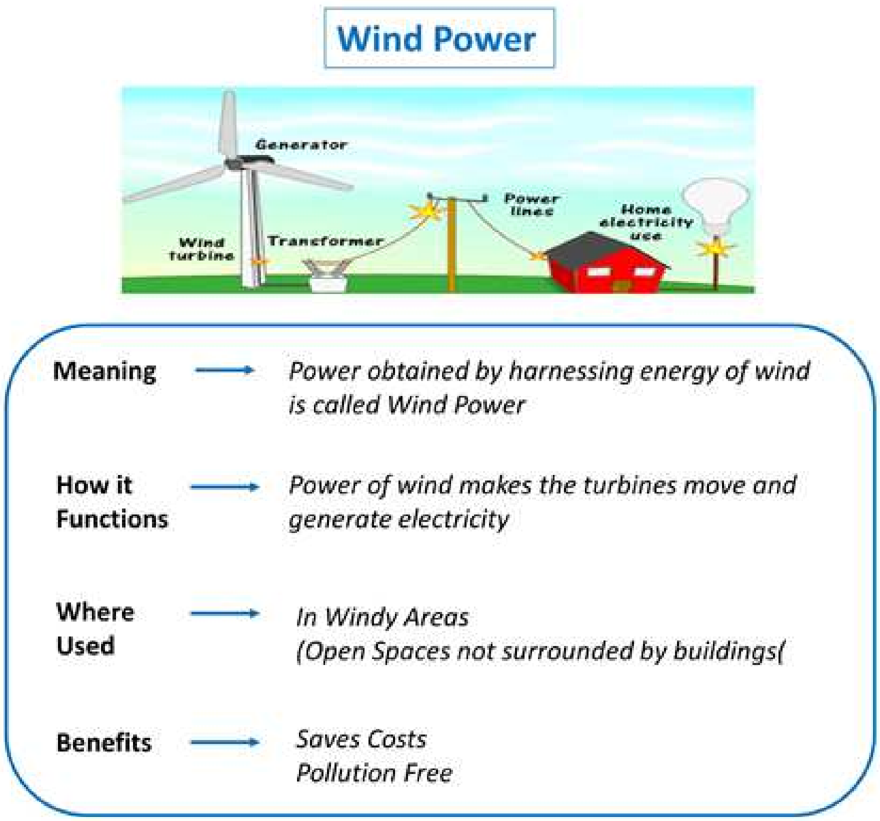

Fig.3 Wind Strategy

Wind Energy

Wind energy is the kinetic energy of air in motion, also called wind. Total wind energy flowing through an imaginary surface with area A during the time t is:

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(Avt\rho)v^2 = \frac{1}{2}At\rho v^3$$

where ρ is the density of air; v is the wind speed; Avt is the volume of air passing through A (which is considered perpendicular to the direction of the wind); Avtρ is therefore the mass m passing through A. 1⁄2 ρv2 is the kinetic energy of the moving air per unit volume.

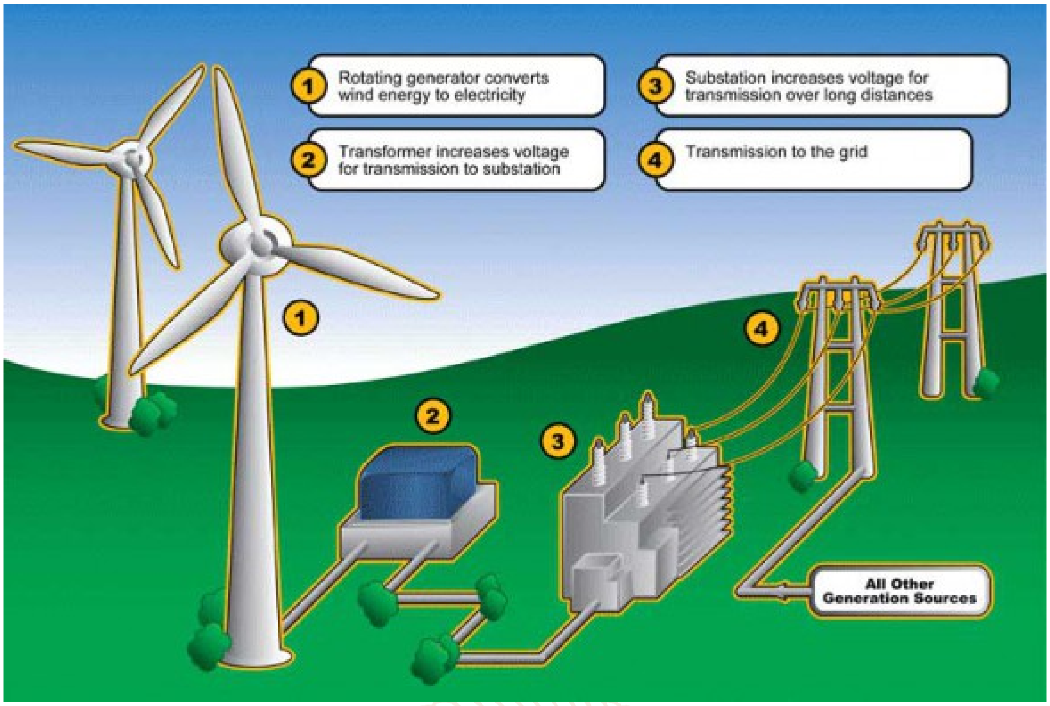

Fig.4 Wind Energy

Wind Turbines

Modern wind energy systems operate automatically. The wind turbines depend on the same aerodynamic forces created by the wings of an aeroplane to cause rotation. An anemometer that continuously measures wind speed is part of most wind turbine control systems. When the wind speed is high enough to overcome friction in the wind turbine drivetrain, the controls allow the rotor to rotate, thus producing a very small amount of power. This cut-in wind speed is usually a gentle breeze of about 4 m/s. Power output increases rapidly as the wind speed rises. When output reaches the maximum power the machinery was designed for, the wind turbine controls govern the output to the rated power. The wind speed at which rated power is reached is called the rated wind speed of the turbine, and is usually a strong wind of about 15 m/s. Eventually, if the wind speed increases further, the control system shuts the wind turbine down to prevent damage to the machinery. This cut-out wind speed is usually around 25 m/s.

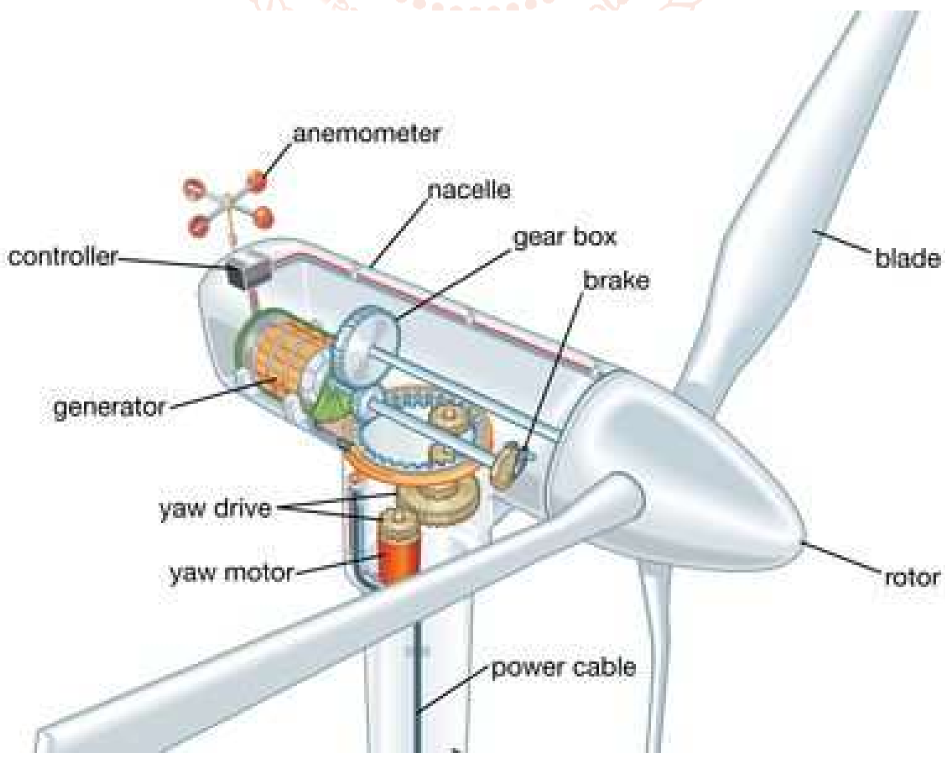

Fig.5 Layout of Wind Turbine

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.

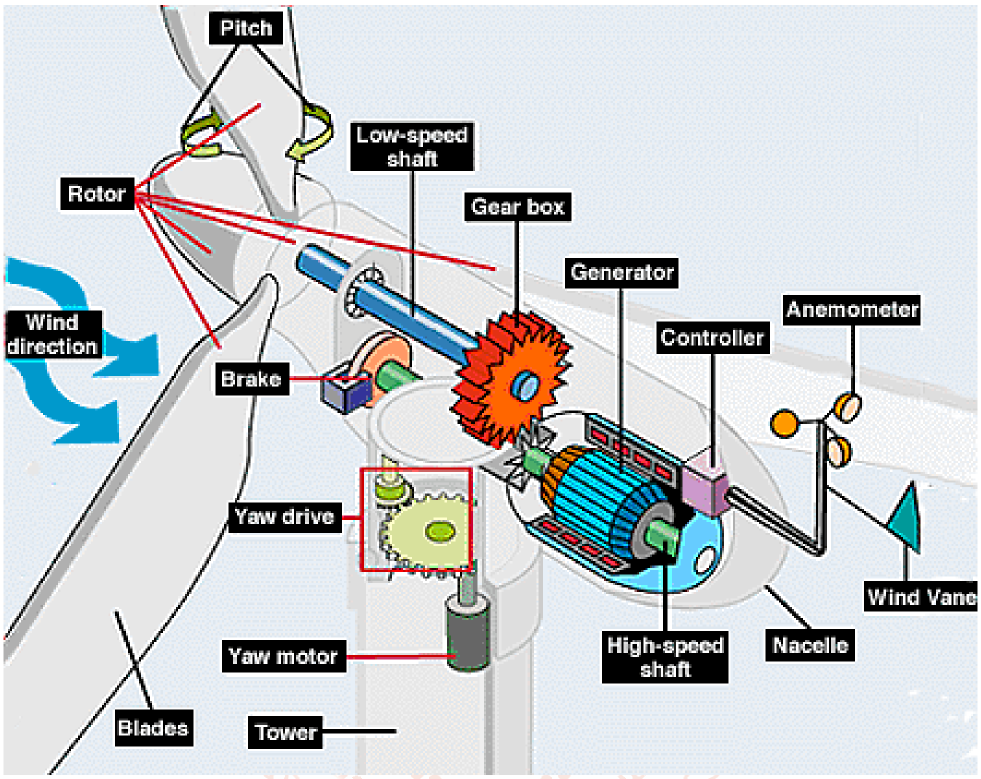

Fig.6 Conversion Techniques

Technical Challenges

Advanced wind turbines must be more efficient, more robust, and less costly than current turbines. DOE, its national laboratories, universities, and the wind industry are working together to accomplish these improvements through various research and development programs. Each program is aimed at specific goals ranging from improving the current generation of turbines and components to defining, researching, and testing the innovative turbines of the next century.

Fig.7 Technical Challenges

Environmental 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.

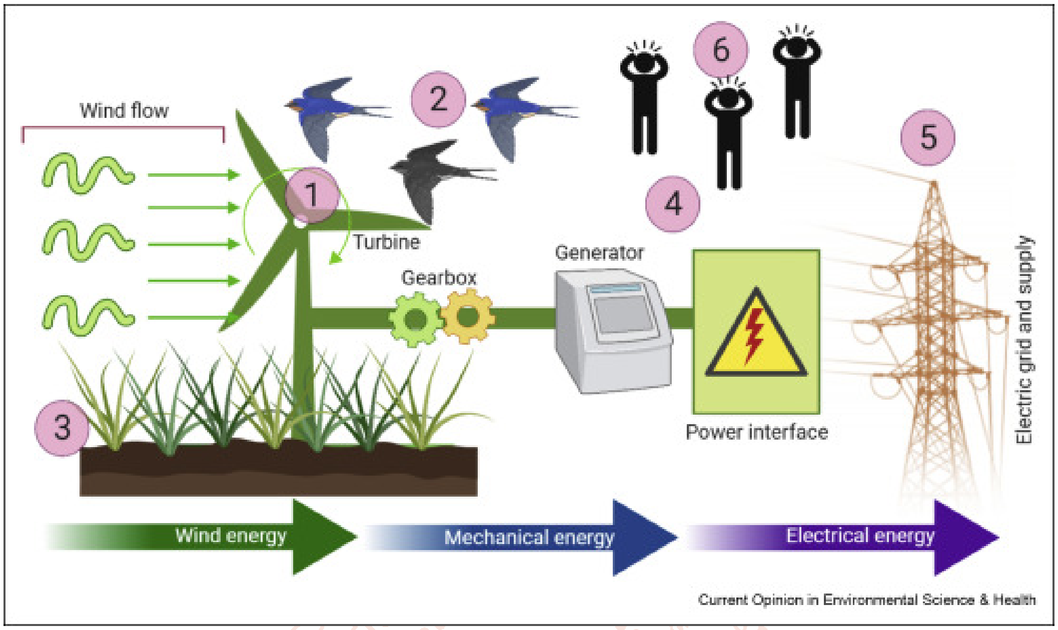

Fig.8 Environmental Issues

Integration into Electricity Systems

Electricity systems must supply power in close balance to demand. The average load varies in predictable daily and seasonal patterns, but there is an unpredictable component due to random load variations and unforeseen events. To compensate for these variations, additional generation capacity is needed to provide regulation or set aside as reserves. Generators within an electrical system have varying operating characteristics: some are base-load plants; others, such as hydro or combustion turbines, are more agile in terms of response to fluctuations and start-up times. There is an economic value above the energy produced to a generator that can provide these ancillary services. Introducing wind generation can increase the regulation burden and need for reserves, due to its natural intermittency. The impact of the wind plant variability may range from negligible to significant depending on the level of penetration and intermittency of the wind resource.

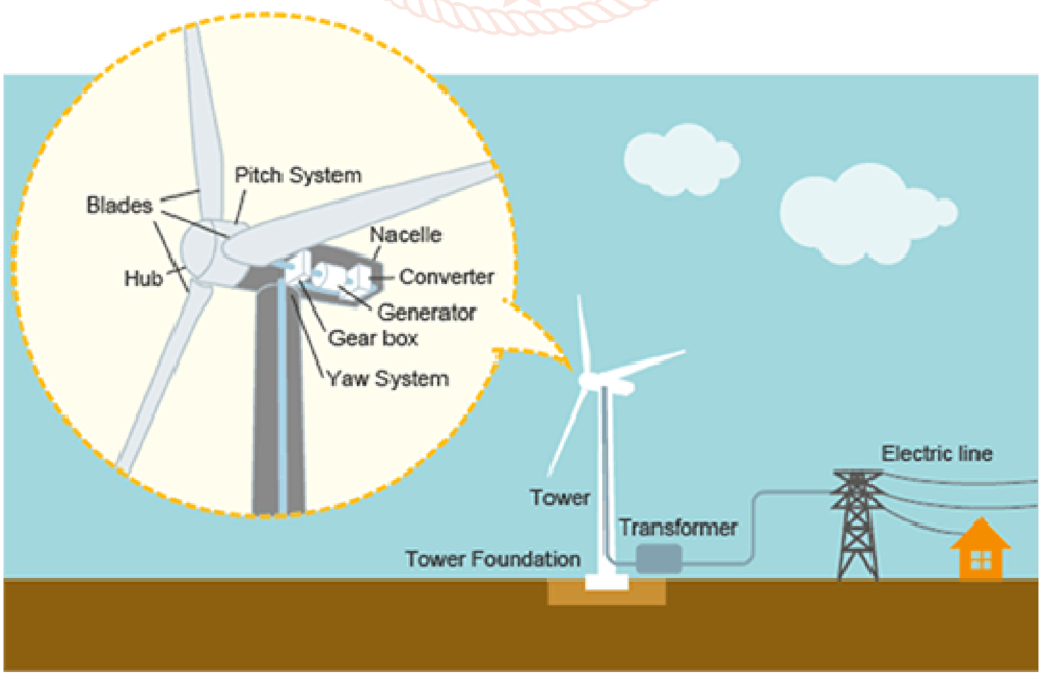

Fig.9 Electricity layout`

CONCLUSIONS:

Wind power or wind energy describes the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. When wind turbines are used to generate energy, the emissions of carbon dioxide, nitrogen oxide, and SO_2 will eventually decline. Thus, the usage of wind energy may help to mitigate acid rain, climate change, and other severe environmental issues. The general conclusion is that there are some environmental disturbances connected to wind power, and public acceptance of these are dependent on the attitudes toward the need for renewable energy as well as the planning and performance of different wind power system projects.

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