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WIND TURBINES; BELIEVE OF GREENER & HEALTHIER FUTURE

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1. INTRODUCTION:

Today Power is the main concern of every country but power comes from energy. Conventional energy resources like oil and gas are being curtailed due to the reliance of power eager states. We being a developing nation need lot more to achieve and that too require energy. Our way towards success is easier if we concentrate our attention towards the availability of Alternate Energy Resources especially Wind Energy in our regime. This paper is actually a literature survey from various resources about a healthier utilization of Wind Mills.

2. WIND ENERGY AVAILABILITY AND HISTORY OF WIND TURBINES:

2.1. From Where Does Wind Energy Comes From:

All renewable energy (except tidal and geothermal power), and even the energy in fossil fuels, ultimately comes from the sun. The sun radiates 100,000,000,000,000 kilowatt hours of energy to the earth per hour. In other words, the earth receives 10 to the 18th power of watts of power. About 1 to 2 per cent of the energy coming from the sun is converted into wind energy. That is about 50 to 100 times more than the energy converted into biomass by all plants on earth. Also the Temperature Difference in different regions (Water and Land) during day and night and between the Poles and Equation drive the air circulation as shown in Figure 1

To show the information about the distributions of wind speeds, and the frequency of the varying wind directions, one may draw a so-called **wind rose** on the basis of meteorological observations of wind speeds and wind directions.

Figure 3. shows the availability of Wind Energy in our domain

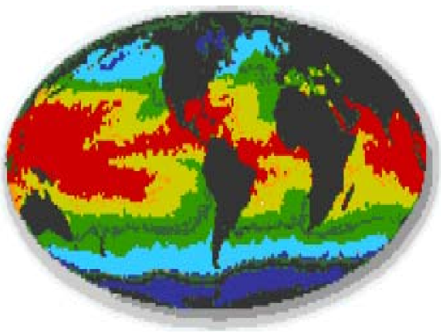

Fig 1. Wind difference due to temperature[5]

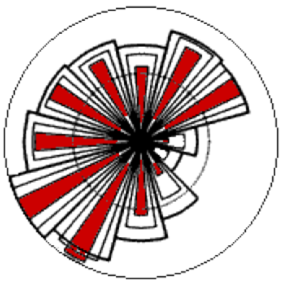

Fig 2. Way of displaying distribution of wind speed and wind directions[5]

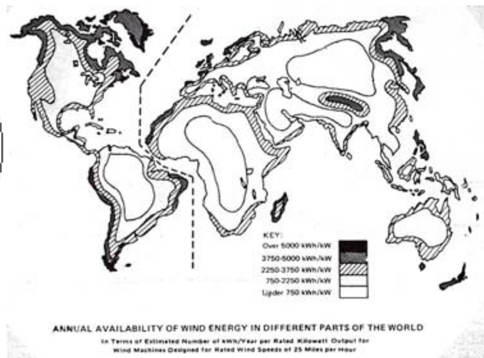

Fig 3. Wind Power in different parts of the world[1]

2.2. History of Wind Turbines:

Islamic World used the vertical axis turbines in Persia as early as about 200 B.C. for grinding grain. In 11th Century wind mills were extensively used in Middle and East and were introduced in Europe in 13th Century by returning Crusaders. By 14th Century Dutch took the lead in improving the design of windmills and used extensively for draining the marshes and lakes of the Rhine River Delta. First Oil Mill was built Holland and in 1586 the first paper mill was constructed. At the end of 16th Century sawmills were introduced to process timber imported. By the middle 19th Century some 9000 mills being used in

Netherland. Similarly more than 10,000 mills were in use in other Dutch Areas. Since the mid nineteenth century more than 6 million small multiblade windmills have been built in US to pump water, generate electricity, for desalination and similar functions. In Denmark by the end of 19th Century there were about 2500 industrial windmills in operation, supplying a total load of about 40000 hp or 30 MW which makes 25% of the total power for the Danish Industry beside its other uses. Similarly there were many improvements in wind turbines by Russians, British, French, Germans as per their requirements.

3. PERFORMANCE AND ANATOMY OF WIND TURBINE:

3.1. Performance of Wind Turbine:

A wind turbine obtains its power input by converting the force of the wind into a **torque** (turning force) acting on the rotor blades. The amount of energy which the wind transfers to the rotor depends on the density of the air, the rotor area, and the wind speed. The cartoon shows how a cylindrical slice of air 1 metre thick moves through the 1,500 m2 rotor of a typical 600 kilowatt wind turbine.With a 43 metre rotor diameter each cylinder actually weighs 1.9 tonnes, i.e. 1,500 times 1.25 kilogrammes.

The area of the disc covered by the rotor, (and wind speeds, of course), determines how much energy we can harvest in a year. The picture gives you an idea of the normal rotor sizes of wind turbines: A typical turbine with a 600 kW electrical generator will typically have a rotor diameter of some 44 metres (144ft.). If you double the rotor diameter, you get an **area** which is **four** times larger (two squared). This means that you also get **four** times as much power output from the rotor.

The power in the wind is proportional to:

- the area of windmill being swept by the wind
- the cube of the wind speed
- the air density - which varies with altitude

The formula used for calculating the power in the wind is
Power = (density of air x swept area x velocity cubed)/2

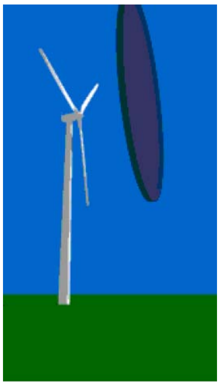

Fig 4. Function of Wind Turbine[5]

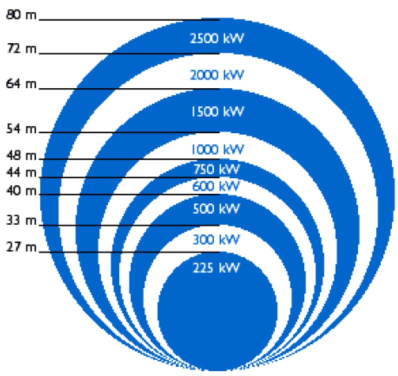

Fig 5. Typical Rotor Sizes for Power[5]

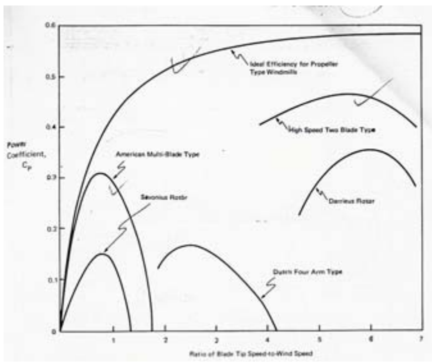

Fig 6. Power Co-efficients vs Speed Ratios of various type of Wind Turbines[1]

3.2. Anatomy of Wind Turbine:

The **nacelle** contains the key components of the wind turbine, including the gearbox, and the electrical generator. Service personnel may enter the nacelle from the tower of the turbine. To the left of the nacelle we have the wind turbine rotor, i.e. the rotor blades and the hub. The rotor blades capture the wind and transfer its power to the rotor hub. On a modern 600 kW wind turbine each rotor blade measures about 20 metres (66 ft.) in length and is designed much like a wing of an aeroplane.

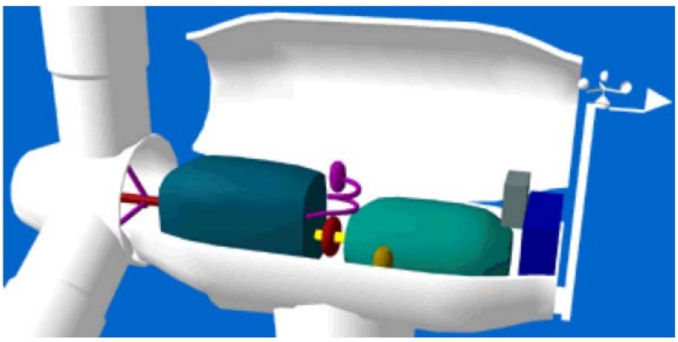

Fig 7. Anatomy of Wind Turbine[5]

The **hub** of the rotor is attached to the low speed shaft of the wind turbine. The **low speed shaft** of the wind turbine connects the rotor hub to the gearbox. On a modern 600 kW wind turbine the rotor rotates relatively slowly, about 19 to 30 revolutions per minute (RPM). The shaft contains pipes for the hydraulics system to enable the aerodynamic brakes to operate. The gearbox has the low speed shaft to the left. It makes the high speed shaft to the right turn approximately 50 times faster than the low speed shaft. The **high speed shaft** rotates with approximately. 1,500 revolutions per minute (RPM) and drives the electrical generator. It is equipped with an emergency **mechanical disc brake**. The mechanical brake is used in case of failure of the aerodynamic brake, or when the turbine is being serviced. The electrical generator is usually a so-called induction generator or asynchronous generator. On a modern wind turbine the maximum electric power is usually between 500 and 1,500 kilowatts (kW). The electronic controller contains a computer which continuously monitors the condition of the wind turbine and controls the yaw mechanism. In case of any malfunction, (e.g. overheating of the gearbox or the generator), it automatically stops the wind turbine and calls the turbine operator's computer via a telephone modem link. The **hydraulics system** is used to reset the aerodynamic brakes of the wind turbine. The cooling unit contains an electric fan which is used to cool the electrical generator. In addition, it contains an oil cooling unit which is used to cool the oil in the gearbox. Some turbines have water-cooled generators. The tower of the wind turbine carries the nacelle and the rotor. Generally, it is an advantage to have a high tower, since wind speeds increase farther away from the ground. A typical modern 600 kW turbine will have a tower of 40 to 60 metres (132 to 198 ft.) (the height of a 13-20 story building). Towers may be either tubular towers (such as the one in the picture) or lattice towers. Tubular towers are safer for the personnel that have to maintain the turbines, as they may use an inside ladder to get to the top of the turbine. The advantage of lattice towers is primarily that they are cheaper. The yaw mechanism uses electrical motors to turn the nacelle with the rotor against the wind. The yaw mechanism is operated by the electronic controller which senses the wind direction using the wind vane. The picture shows the turbine yawing. Normally, the turbine will yaw only a few degrees at a time, when the wind changes its direction. The anemometer and the wind wane are used to measure the speed and the direction of the wind. The electronic signals from the anemometer are used by the wind turbine's electronic controller to start the wind turbine when the wind speed reaches approximately 5 metres per second (10 knots). The computers stops the wind turbine automatically if the wind speed exceeds 25 metres per second (50 knots) in order to protect the turbine and its surroundings. The wind vane signals are used by the wind turbine's electronic controller to turn the wind turbine against the wind, using the yaw mechanism.

Following images show the Wind Turbine Taxonomy

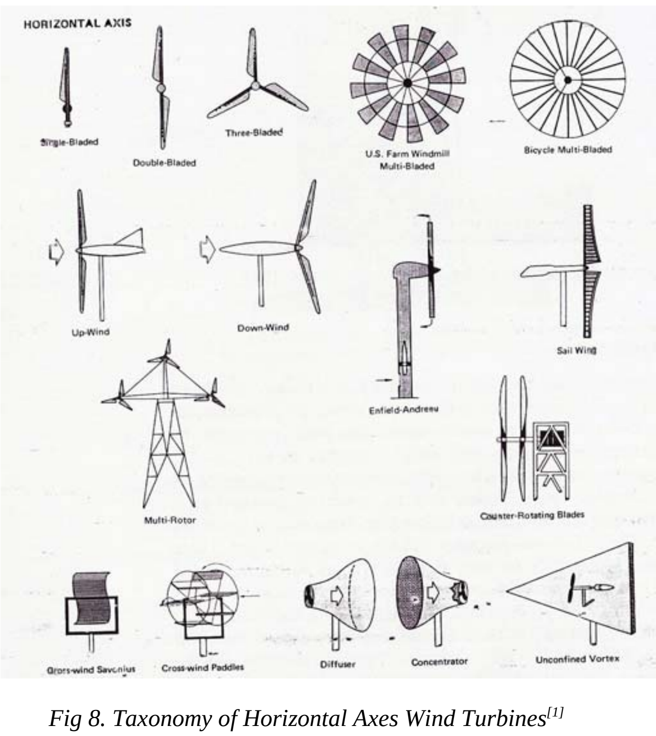

Fig 8. Taxonomy of Horizontal Axes Wind Turbines[1]

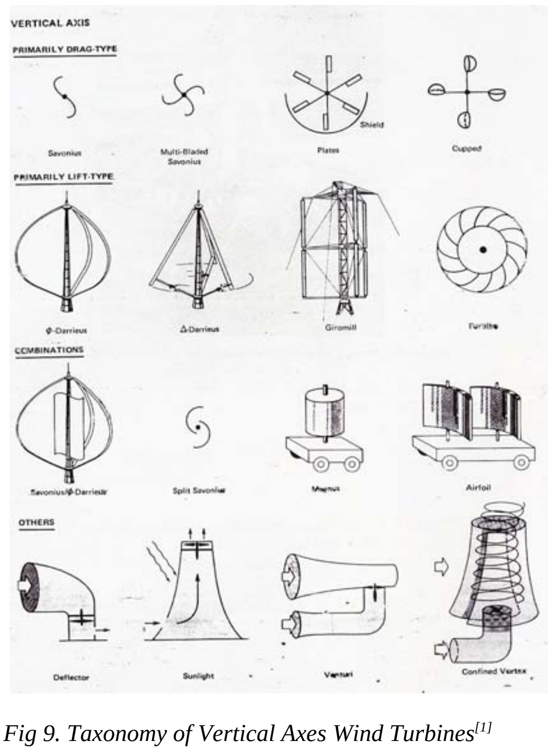

Fig 9. Taxonomy of Vertical Axes Wind Turbines[1]

4. USES OF WIND TURBINE FOR A HEALTHIER AND GREENER FUTURE:

4.1. Uses of Wind Turbine for a Healthier Future:

The following can be most important uses of Wind Turbine in our domain,

- Purification of drinking water for people and livestock in Industrial Contaminated Areas.
- Using underground water solves common health problems
- Creating a village water tap eliminates need to carry water from distant sources especially in the Thar Region of Pakistan. The average wind speed in that area is about 5.6m/s.
- A Hybrid System for the Reverse Osmosis process to get rid of Desalination Problem in Badin District. The electrical energy requirement for RO are about 4.5kWh per m^3 of product for raw water with a salt content of 2000ppm and 12kWh/m^3 for sea water with salt content of 35000ppm. The application of wind turbines in that domain will be very favorable because the region has very good wind conditions with an average wind speed of 4m/s.
- For Electric Power Generation by utilizing the high speed winds of coastal area of Karachi and Baluchistan. The average wind speed in that area is about 5 m/s.

4.2. A Step towards Greener World:

Preliminary studies have shown that the environmental impact of such systems is relatively small compared to conventional power systems. Wind powered systems do not require the flooding or large area or the alteration of natural ecology, as hydroelectric systems do. Furthermore they produce no waste products or thermal or chemical effluents products as fossil fueled and nuclear fuel systems do. The only safety measure required is due to the danger that the rotor might break due to sudden gust of wind but there are many ways to minimize this safety hazard.

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