* Wind Energy:

Defination: Wind energy refers to process of creating electricity using wind, or air flow that occurs naturally in earth's atmosphere. Modern wind turbine are used to capture kinetic energy from wind & generate electricity. wind is a clean, free & readily available renewable energy source.

Each day around the world, wind turbines are capturing wind's power & converting it to electricity.

wind power generation plays an incresingly important role in way we power our world in a clean, sustainable manner.

II Components:

(1) Turbines: Turbines are classfied into two types

(2) Horizontal Axis Wind Turbine (HAWT):- Rotor is mounted on horizontal axis.

(3) Vertical Axis Wind Turbine (VAWT):- Rotor is mounted on vertical axis. Most turbines have two or three blades. Two blade turbines are cheaper but has blade chatter problem.

(4) Tower:- There are three type of tower present, Tilt-up, fixed guyed & free standing. These are used to position turbine in best possible position to produce more power from wind. Tilt-up towers are held in position

using four guy ropes. fixed guyed tower are in position using four guy ropes but they are parmanently fixed in place. for doing any maintanance it is needed to climb on tower. free standing towers have very solid foundation.

(5) Inverter: Most of wind turbines produce A.C. current. We cannot feed it for utilization directly due to voltage & frequency variation Inverter is used to convert fluctuating AC to DC and then back to smoother AC, which can be synchronized with grid or application. Battery based wind turbine are operating of 12 or 48 volts. Inverter converts this low voltage to high voltage upto 230V.

(6) Batteries: Most of wind turbine system do not supply power to application directly. Instead the power generated is stored in batteries. Most commonly used batteries are lead acid battery.

(7) Charge controller: It is used in wind turbine system to prevent batteries from being overcharged over discharge. It monitors flow of power in & out. Now days charge controller have dump load capacity capability. This allows them to store additional charge when batteries gets full. Charge controllers are also provided with maxi. power point tracking (MPPT) charging.

(8) Nacelle: It contains gearbox, brake sys, & electric generator.
(9) Blade: They capture wind and transfer its power to rotor hub. Blade length depends on wind turbine ratings.
(10) Rotor hub: It is attached to low shaft speed of wind turbine.
(11) Low speed shaft: Low speed shaft of wind turbine connects rotor hub to gearbox this rotates about 19 to 30 revolutions per minute (RPM)
(12) Gear Box: It joins low speed shaft to high speed shaft. It rotates high speed shaft to about 50 times faster than low speed shaft.
(13) High speed shaft: It rotates about 1500 rpm & drives electric generator. It has emergency mechanical disc brakes. It is used in case of failure of aerodynamic brakes.
(14) Electrical Generator: These are-either induction generator or asynchronous generator.
(15) Yaw mechanism: It uses electrical motor to turn nacelle to face of wind. Yaw mechanism is operated by electronic controller.
(16) Tower:- It carries nacelle & rotor. It is better to have large magnitude away from ground. Towers are either tubular

tower or lattice tower. Tubular towers are more safer for working personnel as they use an inside ladder to get to top of turbine. Lattice tower are cheaper.

III Advantage, Disadvantage } Refer ppt.

IV Types of wind turbine:

(1) Horizontal axis wind turbine:-

It is also known as HAWT type turbine that have a horizontal rotor shaft and an electrical generator which is both located at top of tower.

A HAWT has a similar design to wind mill it has blades that look like propeller that spin on horizontal axis.

It also includes main shaft of a HAWT fixes in horizontal direction to ground and this makes it different from vertical axis wind turbine.

In simple words, rotating axis of a horizontal axis wind turbine is positioned in a horizontal direction to ground. Nowaday large 3-blade horizontal axis wind turbin generates most of worlds wind energy. This turbine tower has generator and a rotor shaft that must be directed into wind.

The HAWT are available in numerous sizes from 100 W to 100 KW. These are usually deployed in streamlined air conditions that allow constant airflow & direction to pick up maxi. wind power.
It is of poramount importance that the component's like rotor, transmission, generator and tower should not only be as efficient as possible but they must also function effectively in combination.

Important points :-
(1) Lift is main force.
(2) Much lower cyclic stress.
(3) 95% existing turbines are HAWT.
(4) Nacelle is placed at top of tower.
(5) Yaw mechanism is required.

Advantages } Refer ppt.
Disadvantages }

* Vertical Axis wind Turbine :
It is also called VAWT, have main rotor shaft arranged vertically.
The main shaft of VAWT is fixed in vertical direction to ground. while some other major parts placed at turbine base
In simple word rotating shaft of the VAWT is positioned in vertical or perpendicular direction to ground.
Gearboxes & generator of these turbines can position closer to ground by driving them directly from assembly of rotor to base's gearbox, increasing maintainability
VAWT has much for fatigue as compared to gearbox of HAWT. It has major advantage in areas where direction of wind fluctuates significantly.
It has major disadvantage, that turbine generates low average energy compared to HAWT.
A VAWT is specially planned to be economical, practical, efficient & quite. These turbines work well for use in inhabited area, which HAWT is best for commercial area.

Advantage
Disadvantage
} Refer ppt

Site selection criteria for wind turbine:

(1) Development of newer & different rating wind turbines increases more reliability of generation of electrical power from wind for better service quality as well as improving labour market.

(2) Problem of selection of construction sites for wind farms is major economic, technical & management problem. Good location's selection leads to success of wind power plant.

(3) Generally four types of sites are considered to be suitable for wind power plant: These are

(i) Plane land sites

(ii) Hill tops sites

(iii) Sea-shore sites

(iv) Off-shore shallow water sites.

Extra factors can be :-

(1) Privately owned free hold land.

(2) Population Density

(3) Good road access site.

(4) Soil condition.

(5) Site Geography & size

(6) Electric & magnetic field (EMF)

(7) Land Cost

(8) Labour Availability

(9) Incentives

(10) Altitude of proposed site.

* Hydrogen energy :

I Hydrogen is a clean fuel that when consumed in a fuel cell produces only water. Hydrogen can be produced from variety of domestic resource such as natural gas, nuclear power, biomass, renewable power like solar & wind. These qualities makes it an attrective fuel option for transportation & electricity generation application.

Hydrogen is an energy carried that can be used to store, move & deliver energy produced from other sources.

II Uses :-

Rocket fuel is a major use of hydrogen energy. NASA begun using liquid nitrogen in 1950's as rocket fuel & was one of the first to use hydrogen fuel cell to power electrical systems on spacecraft.

It produces electricity by combining hydrogen and oxygen atoms. Hydrogen reacts with oxygen across an electrochemical cell similar to that of battery to produce electricity water and small amount of heat.

Small fuel cell can power laptop computers and even cell phones & military application. Large fuel cell can provide electricity for backup or emergency power in buildings & supply electicity in places that are not connected by electric grid.

Working :-

Diagram : Refer ppt.

Hydrogen cell generates electricity using chemical reaction. Each fuel cell has two electrodes, negative anode & positive cathode. Reaction to produce electricity happens at these electrodes, with an electrolyte carrying electrically charged particles between them & a catalyst to speed up reaction.

Fuel cell is an electrochemical device in which chemical energy of conventional fuel is converted directly & efficiently into low voltage, DC electrical energy.

A fuel cell is often described as primary battery in which fuel & oxidizer are stores externally to battery & fed to it as needed.

Fuel gas diffuses through anode & is oxidizer diffuses through cathode and is reduced by electron that have come from anode by way of external circuit.

Fuel cell is a device that keeps fuel molecules from mixing with oxidizer molecules, permitting however transfer of electrons by metallic path that may contain a load of available fuel, hydrogen has given most promising results, although cell consuming coal, oil or natural gas would be economically more useful for large scale application.

* H_2-O_2 cell for ~~ox~~ electrical generation :-
* Construction & working :-
Cell has three chamber seperated by two porous electrodes, anode & cathode. Middle chamber is filled with strong solution of potassium hydroxide. Surfaces of electrodes are chemically treated to repel electrolyte, so that there is minimum leakage of potassium hydroxide into other chamber. Gases diffuse through electrodes, undergoing reaction as.

$$4KOH \rightarrow 4K^{+} + 4(OH)^{-}$$

Anode : $2H_2 + 4(OH)^{-} \rightarrow 4H_2O + 4e^{-}$
Cathod : $O_2 + 2H_2O + 4e^{-} \rightarrow 4(OH)^{-}$
cell reaction : $2H_2 + O_2 \rightarrow 2H_2O$

water formed is drawn off from side. Electrolyte provides $(OH)^{-}$ ion needed for reaction, and remains unchanged at end since these ions are regenerated. Electrons liberated at anode find their way to cathode through external circuit. this transfer is equivalent to flow of a current from cathode to anode.
Such cell when poperly designed and operated have open circuit voltage of about 1.1v. fuel efficiency as high as 60-70% may be obtained.