Different Types and Parts of a Horizontal Axis Wind Turbines

Contents

Onshore and Offshore Wind Turbines

Onshore wind turbines	Offshore wind turbines
Advantages • It requires cheaper foundations • Easily integrated with the electrical- grid network • cheaper Installation and access during the construction phase. • It can be operated and maintained easily and cheaply Source:Onshore Vs Offshore Wind Turbines	These are two types, namely Near shore and Off shore. Advantages: • The roughness of the water surface is very low Wind and obstacles to the wind are less. so, large turbines can be installed • Noise pollution is also not a factor because these are too far from shores • Less affected to turbulence in wind and low wind shear
Disadvantages • Negative visual impact or noise. • Limited availability of lands • Restrictions associated with obstructions like buildings, mountains, etc. • Noise pollution • Affected to more turbulence Sources:Wind Power,Types of Wind Farms	Disadvantages: • Installing offshore wind-turbines is much more complex and costly • Connection to the utility grid is also much more complex and expensive • Operation and maintenance is also a complex task with off shore wind turbines Source:Offshore Technology
 Fig 5(a) Onshore Wind turbines	 Fig5(b) Offshore wind turbines

Parts of a Horizontal Axis Wind Turbine

The basic parts of a horizontal axis wind turbine(HAWT) is foundation, tower, nacelle, Generator, Rotor Blades.

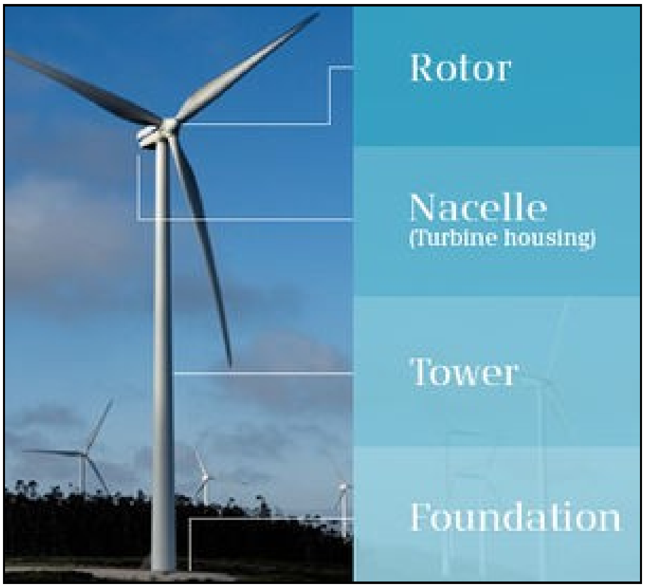


Fig 6 Wind turbine parts
Foundation: A very good foundation is required to support the tower and various parts of a wind turbine which weighs in tonnes.

Tower

A tower that supports the nacelle and rotor hub at its top. These are made from tubular steel, concrete, or steel lattice. Height of the tower is an important in design of HWAT. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity. Generally output power of the wind system increase with increase in height and also reduces the turbulence in wind. The theoretical view of tower height versus power out is shown in figure 7 . click on the link to get more about size of the towers

Wind Turbine Tower Size

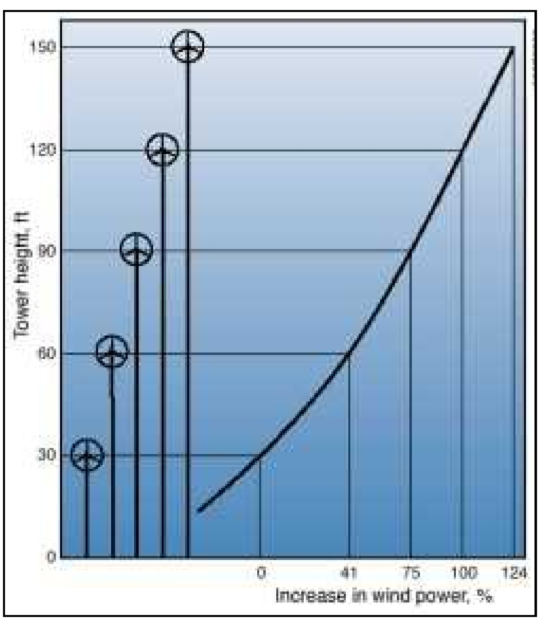


Fig 7 Tower height Vs Power output
Source:The Fundamentals of Wind Energy

Different types of wind turbine towers	Structure
Tubular Tower: They are constructed from rolled steel plates welded together with flanges top and bottom, being sprayed with several coats of gray weatherproof paint at the construction yard. They have doors top and bottom allowing entrance to the vertical ladders inside used to access the power cables and the yaw mechanism. There are also a set of vertical ladders on the outside of the tower accessing the nacelle for maintenance and other checks.	

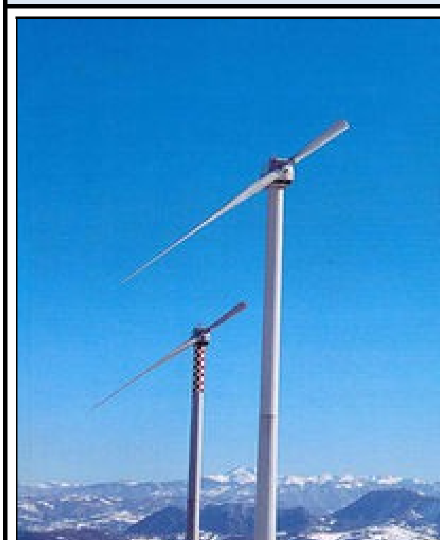
	 Fig 8(a) Tubular tower
Lattice tower: A Lattice tower can be constructed with perfectly shaped steel rods that are put together to form a lattice. These towers are very strong and inexpensive to manufacture and easy to transport and erect.	 Fig 8(b) Lattice tower
Guyed wind tower: These are very strong and most economical when properly installed. But it requires more space around the tower for guy wires	 Fig 8(c) Guy tower
Tilt up wind towers: These type of towers are used for consumer wind energy. These turbines have locking system, while working the turbine is locked. It can easily locked and lowered to ground to perform repairs.	 Fig 8(d) Tiltup tower

Free standing tower: These can be used for small wind turbines with cautions.	 Fig 8(e) Free stand tower

Sources:Winder Tower,Wind Towers

Blades

Wind turbine blades are used to extract the kinetic energy of wind and convert to mechanical energy. These blades are made up of fiber glass-reinforced polyester or wood-epoxy. Wind turbines have one or two or three or multiple blades based up on the construction. Most of the HAWT have three blades. These are connected to rotor hub. Multiple blade concept is used in earlier days for pumping water and grinding etc.

Single blade HAWT	Two blade HAWT	Three blade HAWT
It reduces the cost and weight of the turbine. These are rarely used due to tower shadow effects, needs counter weights on the other side of the blade, less stability.	It requires more complex design due to sustain of wind shocks. It is also less stable. It saves the cost and weight of one rotor blade.	Modern wind turbines uses three blade concept. Because this structure have high strength to withstand heavy wind storms. Less effect due to tower shadow. Produce high output
 Fig 9(a) Single blade turbine	 Fig 9(b) Two blade turbine	 Fig 9(c) Three blade turbine

Sources:Wind Turbine Blades,Wind Turbine Design Styles

Nacelle

A housing which contains all the components which is essential to operate the turbine efficiently is called a nacelle. It is fitted at the top of a tower and includes the gear box, low- and high-speed shafts, generator, controller, and brakes. A wind speed anemometer and a wind vane are mounted on the nacelle.

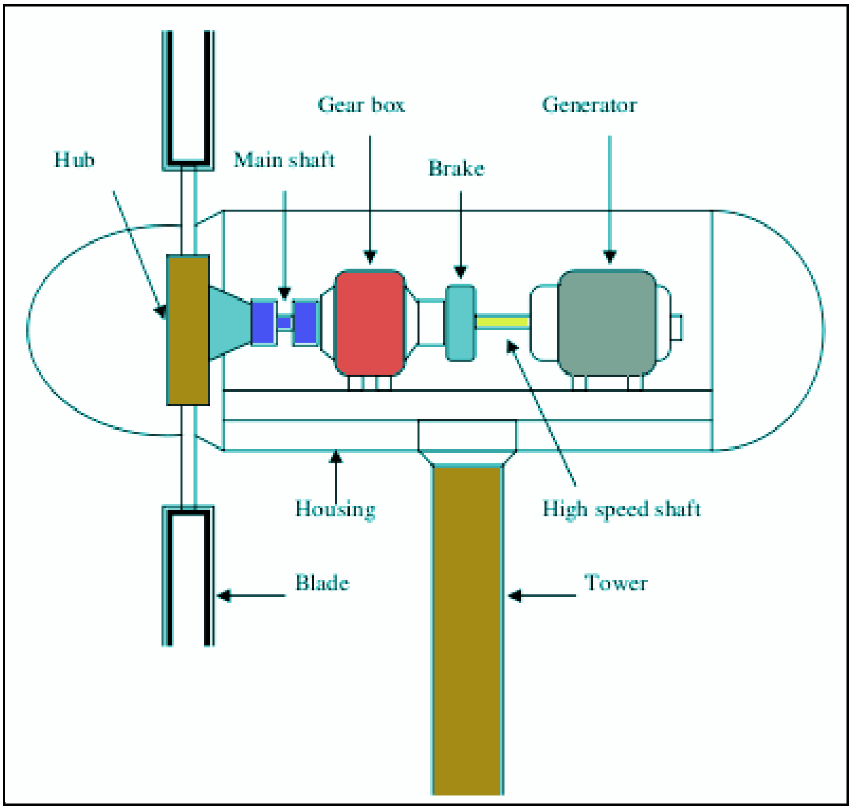


Fig 10 Internal nacelle structure
Hub A rotor hub is provided for coupling a wind turbine rotor blade and a shaft. The hub assembly consists of hub, bolts, blade bearings, pitch system and internals . Rotor hubs are made with welded sheet steel, cast iron, forged steel. The types of rotor hubs are

- Hinge-less hub
- Teetering hub

Fig 11 Rotor hub

Drive shaft Drive shafts are a hollow or solid steel hardened shaft under very high stresses and considerable torque. Drive shafts are used to transfer rotational mechanical energy from blade hub to the generator to produce electricity. A wind turbine normally consists two shafts .

Main shaft: It is connected between blade hub and input to the gear box. It rotates at low speeds. So It is also called as 'low speed shaft'.

Generator shaft: It connects the gear box output to the generator input. It rotates at very high speed equals to the rating of the generator. It is also called 'high speed shaft'.

Fig 12 Shaft system
Gear box Gear box used in wind energy systems to change low speed high toque power coming from a rotor blade to high speed low torque power which is used for generator. It is connected in between main shaft and generator shaft to increase rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1000 to 1800 rpm. Gearboxes used for wind turbine are made from superior quality aluminum alloys, stainless steel, cast iron etc.

The various gear boxes used in wind turbines are

1. Planetary Gearbox
2. Helical Gearbox
3. Worm Gearbox

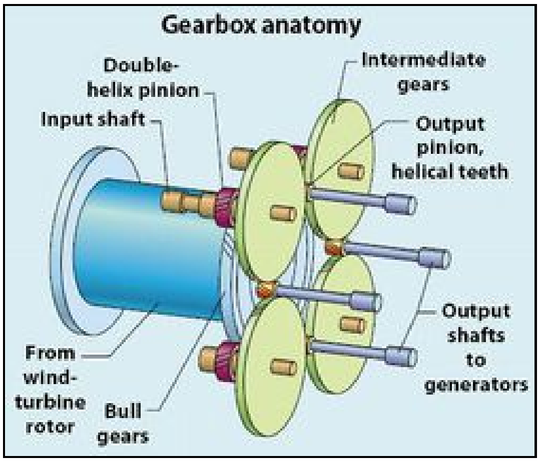


Fig13 Gear box
Generator

The output rotational mechanical energy of the gear box is connected to the generator through generator shaft. It works on the principle of 'Faraday's law of electromagnetic induction". It converts mechanical energy into electrical energy.

Sources:Wind Power Turbines, Rotor Hub Assembly,Gearbox for Wind Turbines, A Wind Turbine,The Wind Turbine Yaw Mechanism

Anemometers

Wind speed is the most important factor for determining the power content in the wind. The power content in the wind is directly proportional to cube of the wind velocity. Measuring wind speed is important for site selection. The device which is used for measuring wind speed is called anemometer. These are usually located on top of the nacelle.

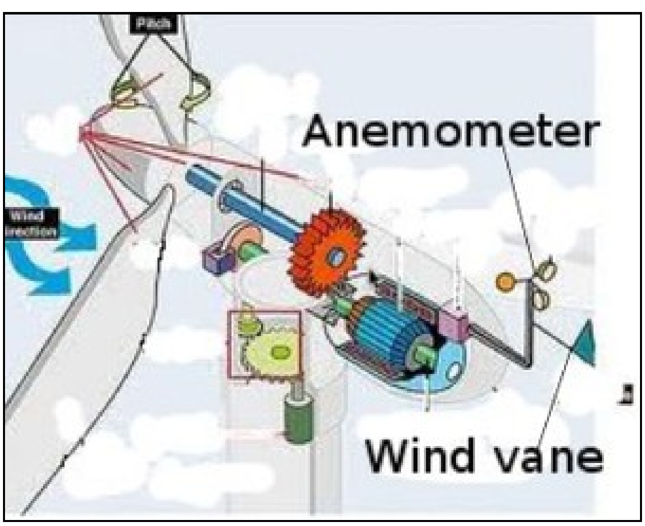
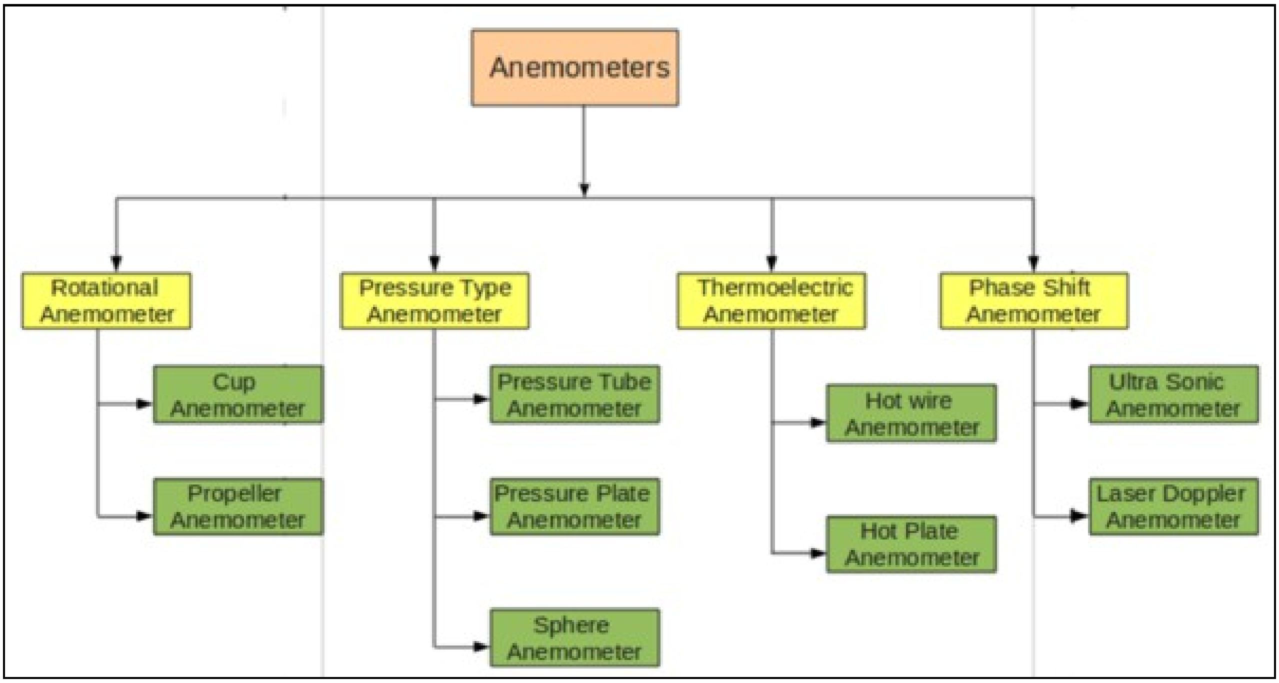


Fig 14 Anemometer & Wind vane
Source:Anemometer

Types of anemometers The various types of anemometers are used in measuring wind speed is shown in flow chart below.



Source: Wind Power Energy

Wind vane Wind vanes are used to measure the wind directions and communicates with the yaw system to orient the turbine properly with respective to wind directions, to extract maximum amount of power from wind. Wind turbines are oriented to upstream wind or down stream wind.

Source:A Wind Turbine

Yaw Mechanism

yaw mechanism turns the rotor into the upwind direction as the wind direction changes. Electric motors and gear boxes are used to keep the turbine yawed against wind. This can be also used as controlling mechanism during high wind speeds.

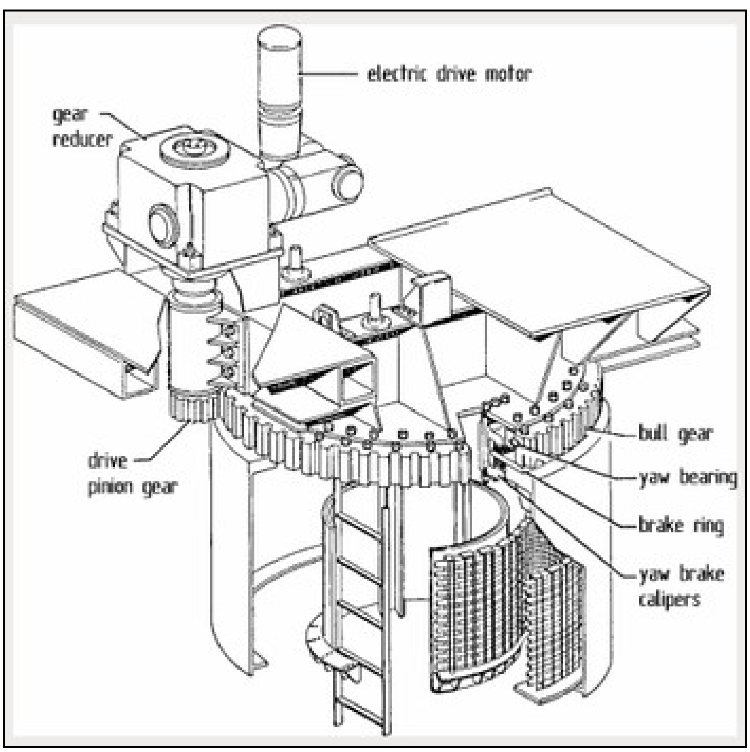


Fig 15 Yaw structure
Source:The Wind Turbine Yaw Mechanism

[<<Back to main page](#)