

Electrical and Mechanical Assemblies in Wind Turbines

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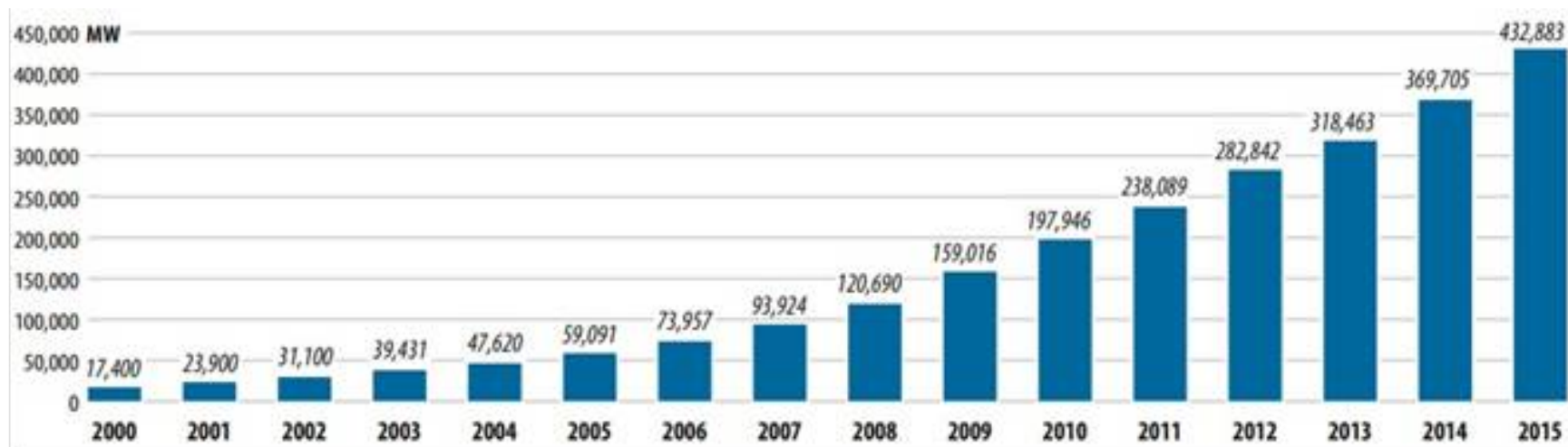
Abstract

Wind energetics is a modern branch of energetics, which is based on the conversing of the kinetic energy of wind into the other forms of energy – electrical or mechanical energy. Besides the fact that wind energy is consumed from the early start of the human civilization, this, ecologically clean and renewable source of energy is still considered as a new, under-exploited one. Constant enlargement of the exhaust gas emission in atmosphere represent a big threat to the climate changes, with potentially catastrophic consequences on humanity. The usage of the renewable sources of energy, together with the improvement of the energy efficiency, influences positively the decreasing of the primary energy consumption, as well as prevention of the dangerous climate changes. The main types, work principles and basic characteristics of the wind turbines, together with the review of their good and bad sides are represented in this work. The special attention is devoted to the constructive characteristics, work principles and monitoring and maintaining of the main electrical and mechanical assemblies of the wind turbines, as well as the commonly used materials for their manufacturing.

Global cumulative installed wind capacity

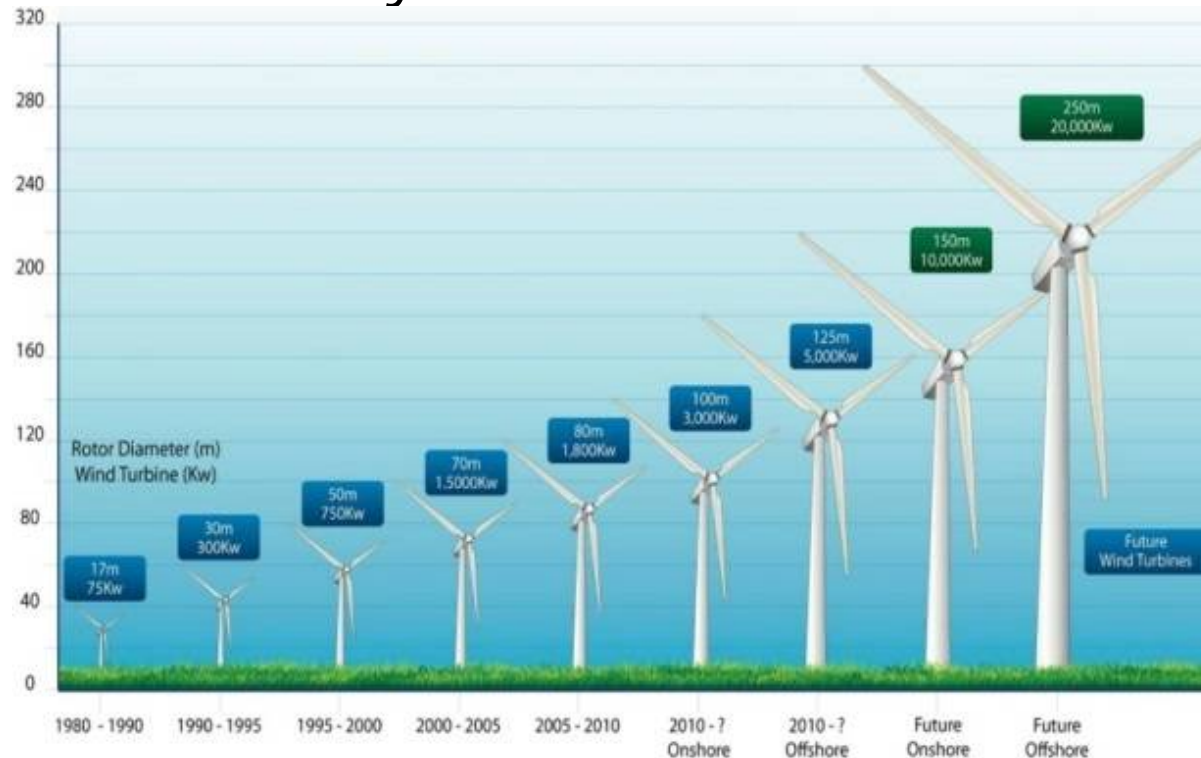
Wind power is very consistent from year to year but it has significant variation over shorter time scales. In order to give a reliable supply it is used in conjunction with other electric power sources.

As of the end of 2015, worldwide, total cumulative installed capacity from wind power amounted to 432,9 GW and increased by 17% compared to the previous year.

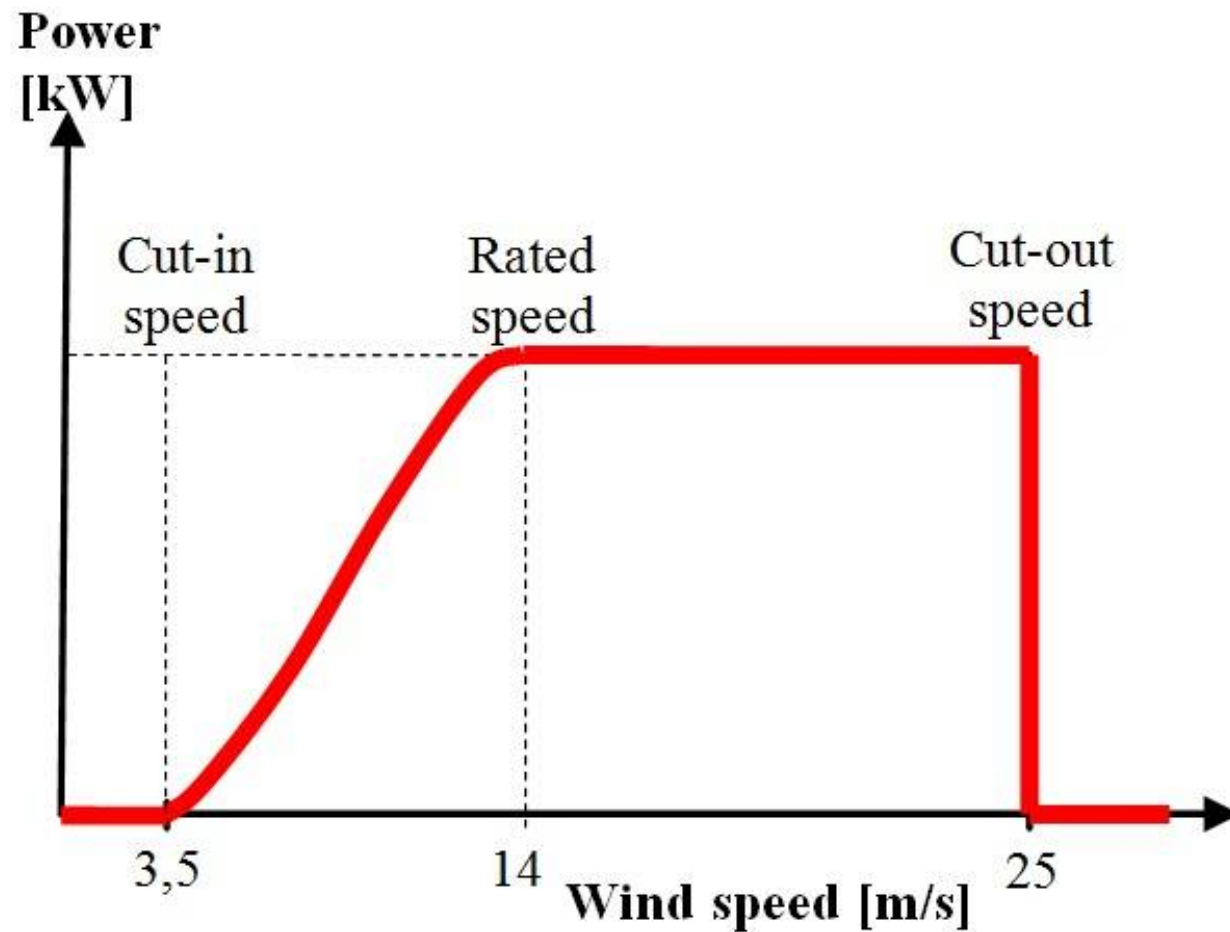


Past and present wind turbines

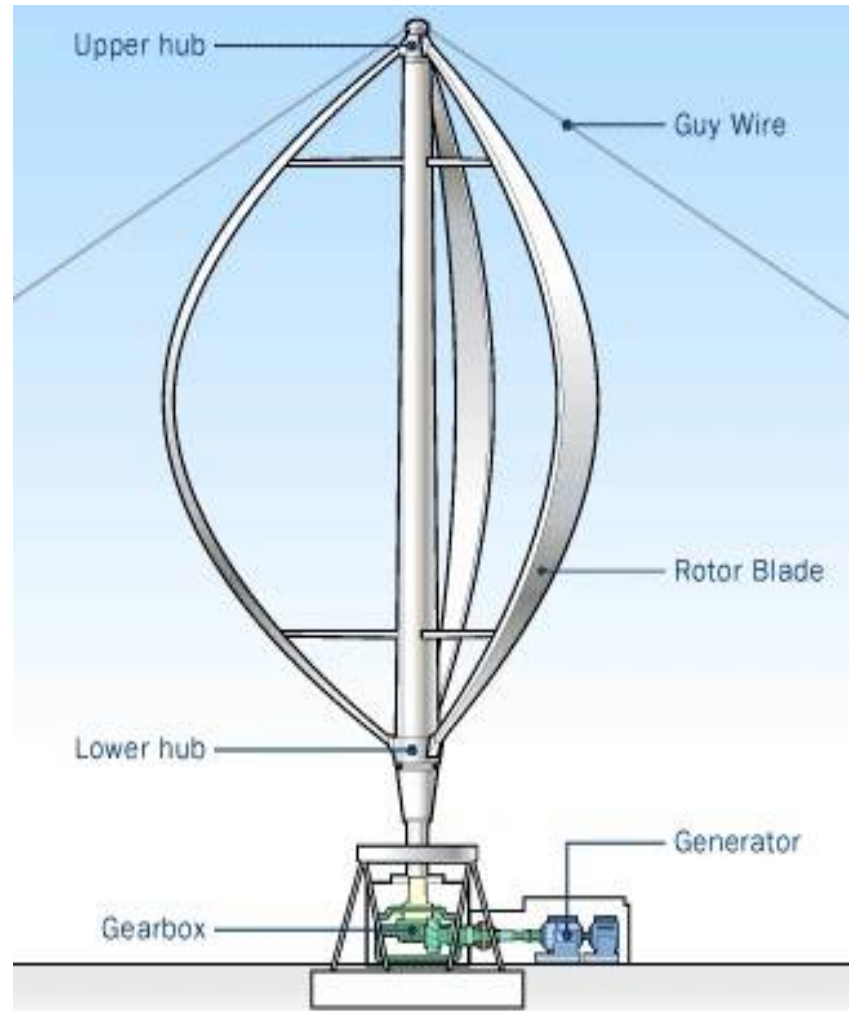
The size of WTs has grown significantly in the past 15 to 20 years. WT capacity has grown too, from several tenths kW a few decades ago, to several MW today.



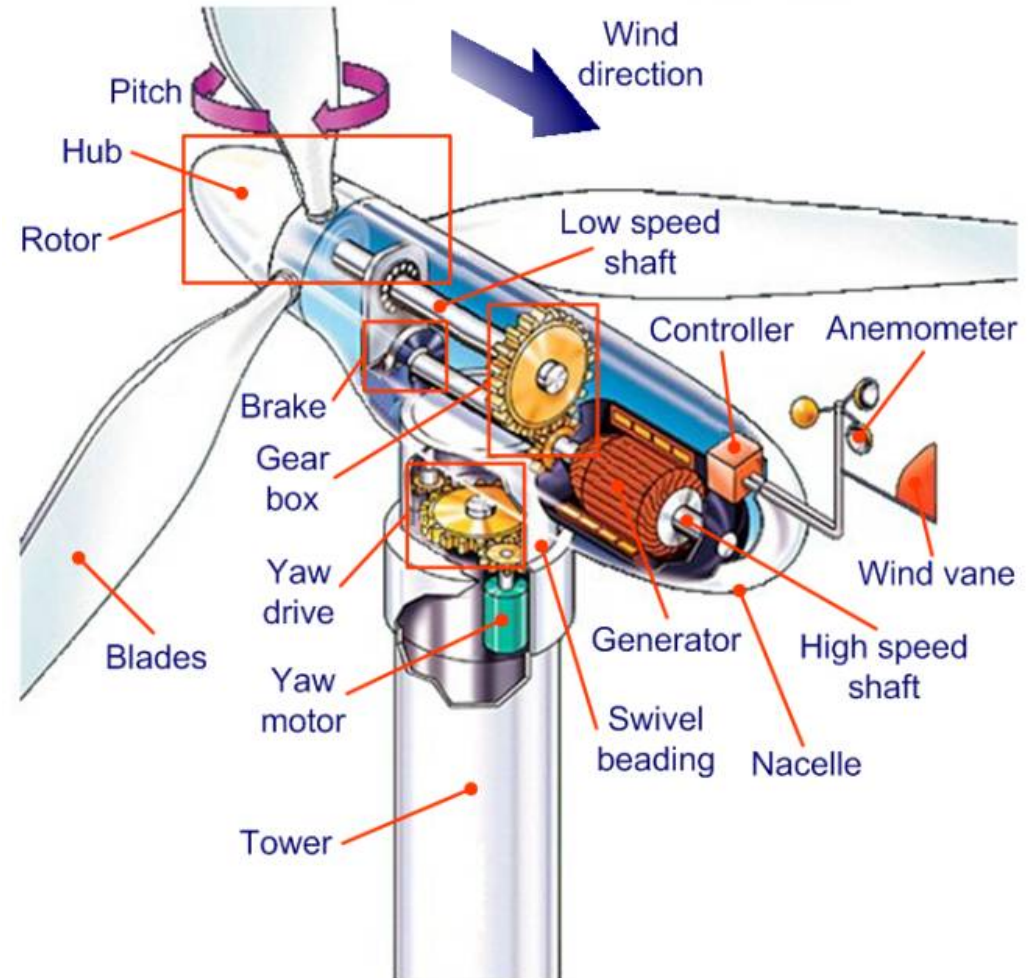
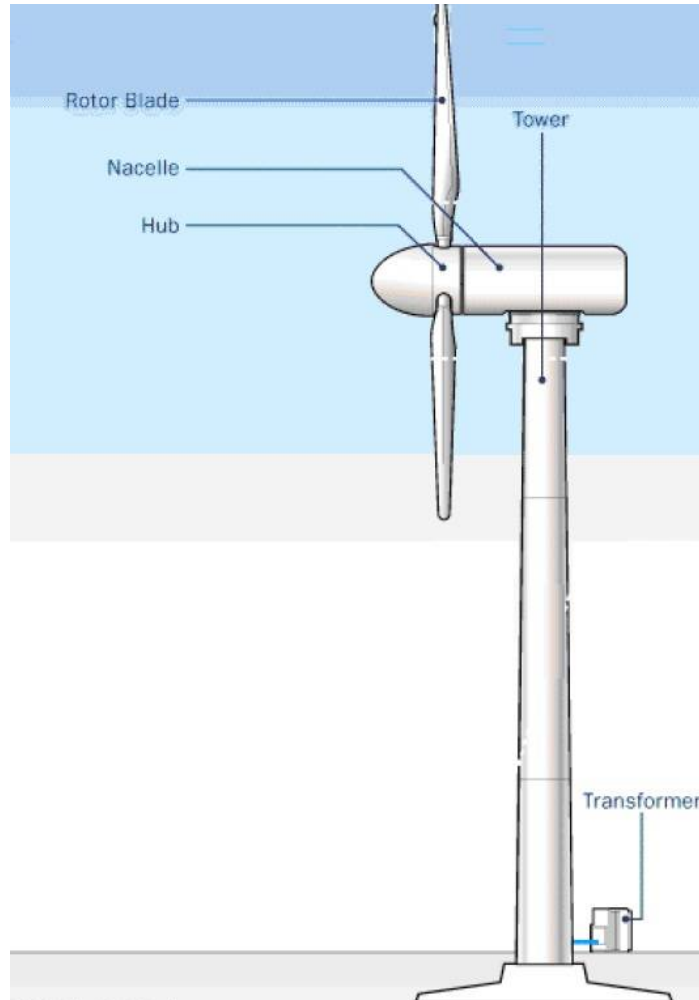
Wind speeds for the wind turbine



Vertical axis wind turbine – VAWT



Horizontal axis wind turbine – HAWT





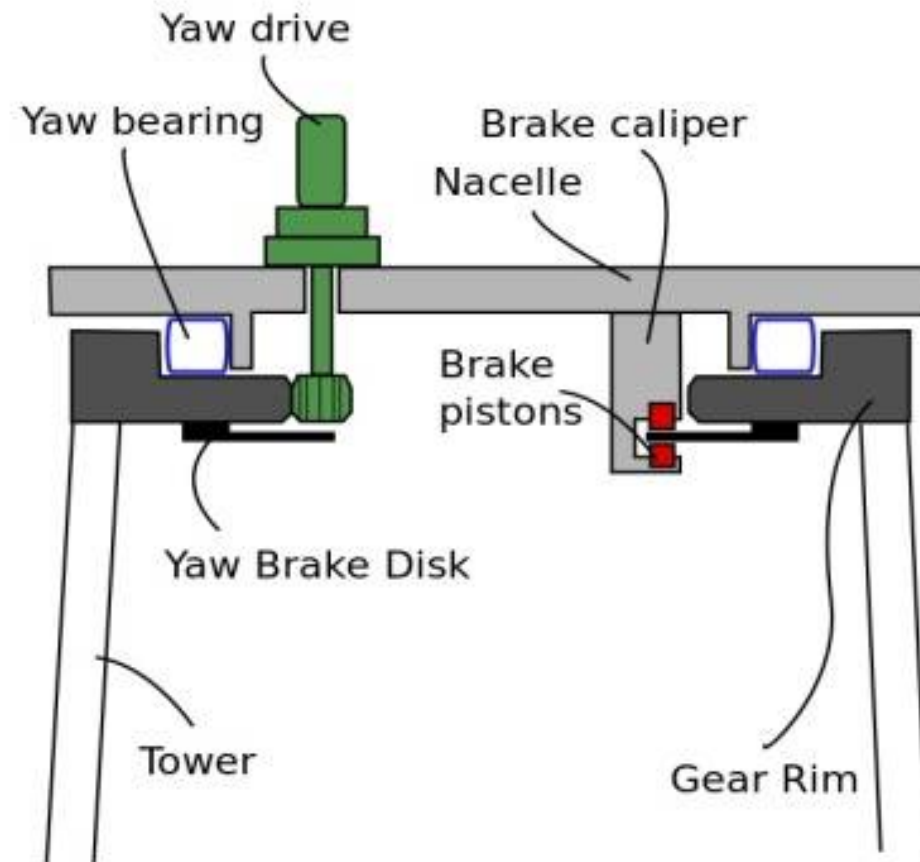
The main components of the wind turbines

- › *The rotor blades* “capture” the wind and convert its energy into the rotation of the hub. The blades are produced from polyester or epoxy reinforced with mainly glass fibres and to some extent carbon fibres in combination with polymer foam or balsa wood for the sandwich parts. The blades are mostly produced in two halves, the upper and lower part, and are joined using adhesive bonding. The blades are bolted via a pitch bearing to the hub.
- › *The rotor hub, the main shaft, the gearbox, the bedplate and the tower* are basically produced from different types of low-alloy steels and cast irons.

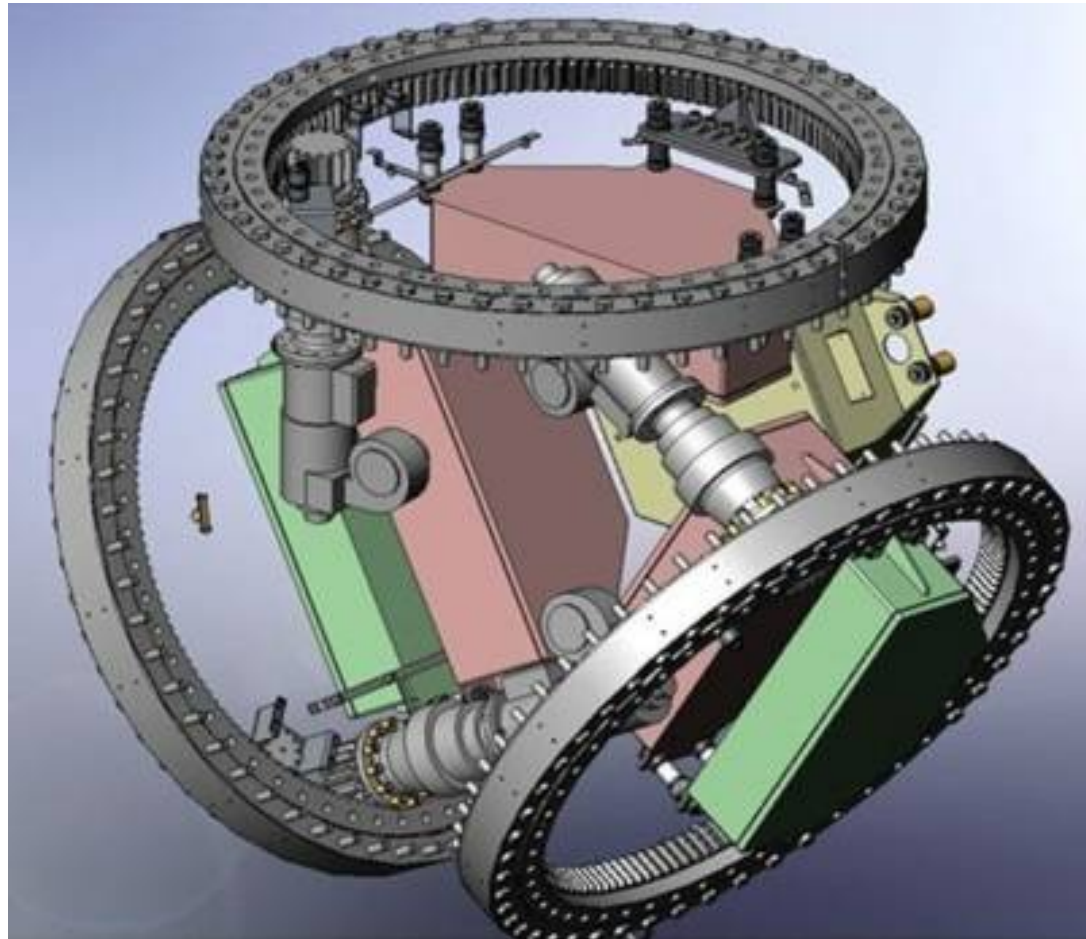


- › *The generator* is assembled of magnets and a conductor (typically a coiled wire). Generator uses the properties of electromagnetic induction to produce electrical voltage. The materials used for generators include magnetic steels and copper for wirings in electromagnet generators, or steels, copper, boron, neodymium and dysprosium in permanent magnet generators.
- › *The power electronics* (PE) converter ensures that the output electrical signal complies with the power quality of modern grid codes. They are the part of the control system which helps in achieving safe control and the maximum power output.

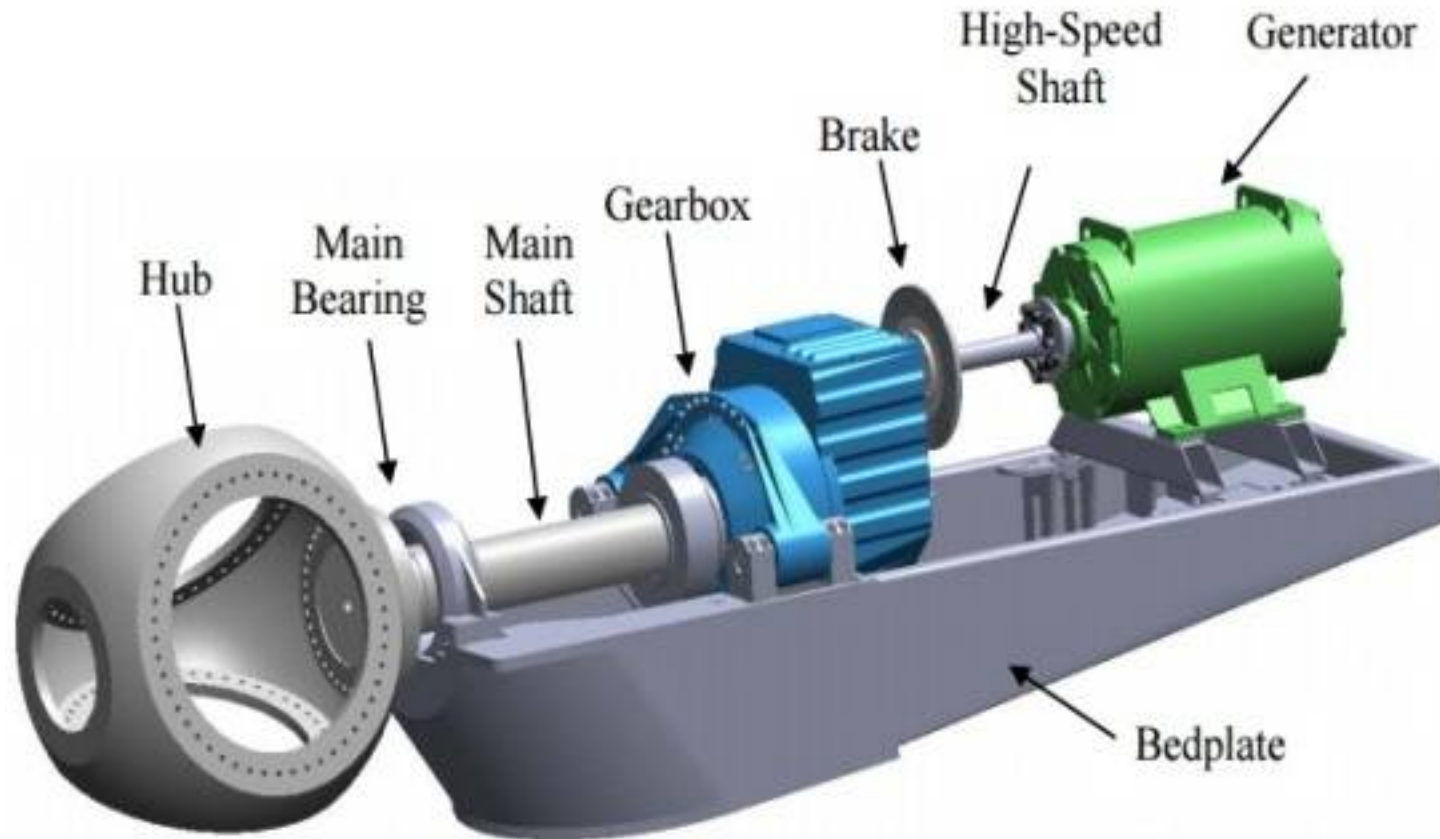
Yaw system of the wind turbines



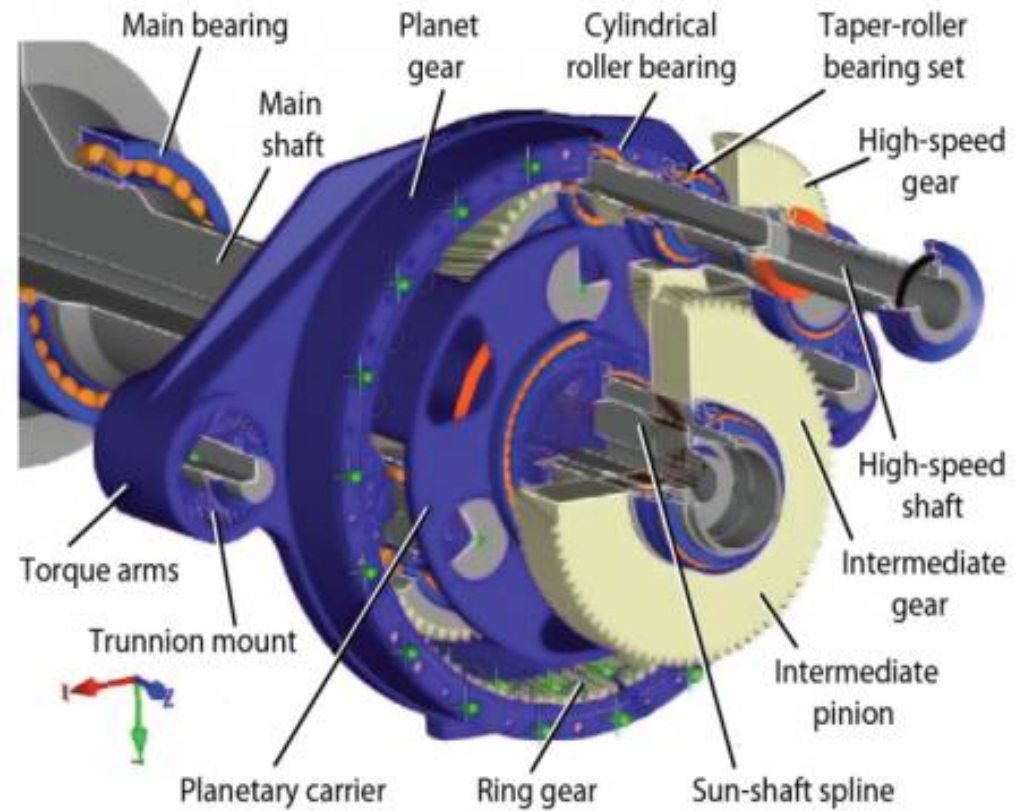
Variable pitch control system



A typical WT drivetrain configuration



A typical WT gearbox





Wind turbine generators

These devices convert mechanical to electrical energy. WT generator has to work with a power source (the wind turbine rotor) which supplies very fluctuating mechanical power (torque).

Their magnetic field can be provided by either electromagnets, which need electrical excitation and consume reactive power, or permanent magnets (PM) which do not need electrical excitation.

Electromagnet generators are less efficient below their rated power than PM generators, and turbines naturally generate below rated power for most of the time.

PM generators are the choice for the majority of new offshore wind turbine designs and therefore they will be increasingly present in future offshore wind farms. Main materials in PM generators include magnetic steel, boron, rare earth elements, insulation and copper.



Conclusions

Over 200 000 operating wind turbines, with a total capacity of about 433 GW operates nowadays worldwide. Bearing in mind the fact that wind energy is a relatively new, green and renewable source of energy, mentioned numbers shows that it is the promising one. This fact puts the construction of the wind turbines in the focus of interest of scientist and engineers around the world. The characteristics of the wind technology, the main electrical and mechanical parts and basic assemblies of the wind turbines are presented in this paper.