



Power Electronics in Wind Energy System

Dhiraj Nilkanth Ladhe
B.E. Electrical
University of Pune
Pune, Maharashtra, India

Abstract: In the today's world there is a unbalance between demand and supply of electricity in all country which leads to focus on Renewable energy sources. Although the carbon emission is the important factor in generation of electricity. So the renewable energy is better option to maintain the balance between chains of electricity. But there is a good interfacing is required between the grid and energy source. If it is not maintain then there will be a power quality issues in the system. Here power electronics plays an important role in interfacing between grid and source. This paper will discuss wind energy with power electronics interfacing and some disadvantages also discussed here regarding power electronics used in the renewable energy system basically in wind power..

Keywords: Renewable energy, Wind power, Power electronics.

I. Introduction

The energy demand is rapidly increasing and the deregulation of electricity has caused that the generation unit can't follow the requirement. A way to fill this gap is to look for the renewable energy sources like wind, solar, and fuel cells. Here we are dealing with the wind energy

The function of wind turbine is to convert the linear motion of wind into electricity with help of generator setup. The blades are design according to aerodynamic which helps to rotate the generator and generate electricity. There are two main types of wind turbine HAWT and VAWT. The most efficient is the HAWT type which is used in most of the wind plant.

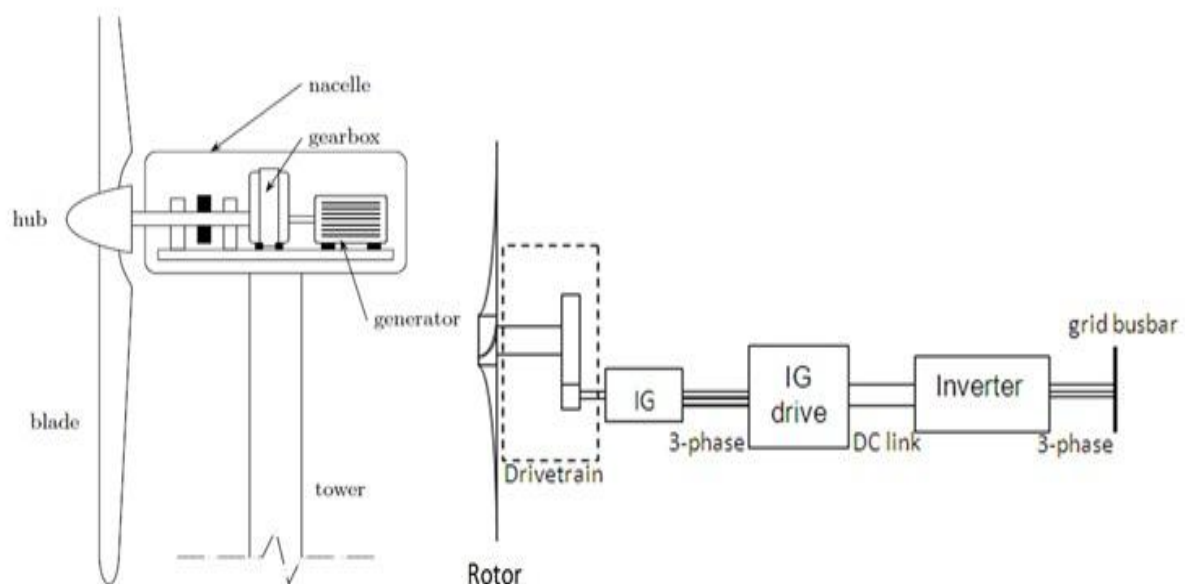


Fig.1 Function of wind turbine plant

The aerodynamic power is given by the equation (1)

$$P = 0.5 \rho \pi R^2 v^3 C_p \quad (1)$$

Where, ρ = Air density

R = Turbine radius

V = Wind speed

C_p = Turbine power coefficient

The rotor efficiency is given by the equation (2)

$$\text{Rotor efficiency} = CP = 0.5(1 + \lambda)(1 - \lambda^2) \quad (2)$$

From these equations the aerodynamic power and rotor efficiency is estimated.

II. Basics of Power Electronics

On the conversion side the power electronics plays an important role. the basic component of power electronics system are shown in the form of block diagram. Main power source may be an ac supply system or dc supply system. The output from the power electronic circuit may be variable dc or ac voltage or it may be a variable voltage and frequency in general the output of a power electronic converter circuit depends upon the type of load. The feedback component measures the parameter of load, says speed in case of rotating machine and compares it with the command. The components, controls the instant of turn on of semiconductor devices forming solid state power converter system.

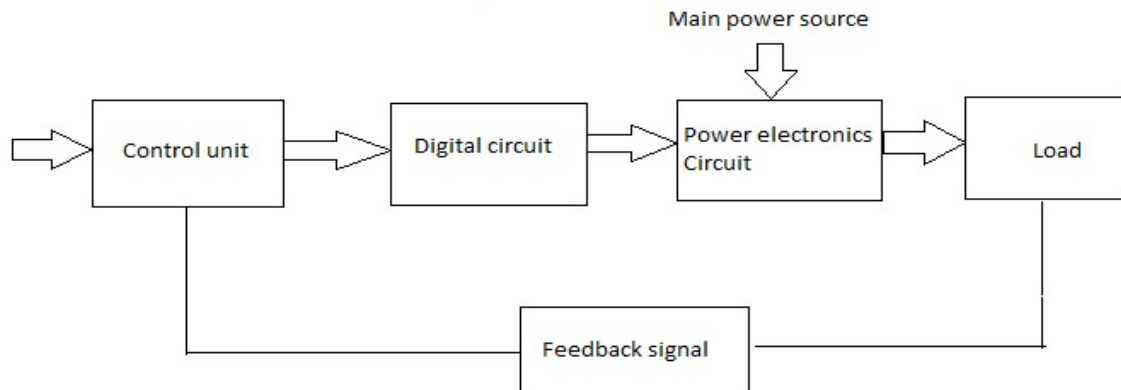


Fig. 2 Block diagram of typical PE system

III. Wind Energy

All Prior to the development of coal in the mid-19th century, nearly all energy used was renewable. Almost without a doubt the oldest known use of renewable energy, in the form of traditional biomass to fuel fires, dates from 790,000 years ago. Use of biomass for fire did not become common place until many hundreds of thousands of years later, sometime between 200,000 and 400,000 years ago.

Probably the second oldest usage of renewable energy is harnessing the wind in order to drive ships over water. This practice can be traced back some 7000 years, to ships on the Nile.

Moving into the time of recorded history, the primary sources of traditional renewable energy were human labour, animal power, water power, wind, in grain crushing windmills, and firewood, a traditional biomass. A graph of energy use in the United States up until 1900 shows oil and natural gas with about the same importance in 1900 as wind and solar played in 2010.

By 1873, concerns of running out of coal prompted experiments with using solar energy. Development of solar engines continued until the outbreak of World War I. The importance of solar energy was recognized in a 1911 Scientific American article: "in the far distant future, natural fuels having been exhausted [solar power] will remain as the only means of existence of the human race".

The theory of peak oil was published in 1956. In the 1970s environmentalists promoted the development of renewable energy both as a replacement for the eventual depletion of oil, as well as for an escape from dependence on oil, and the first electricity generating wind turbines appeared. Solar had long been used for heating and cooling, but solar panels were too costly to build solar farms until 1980.

The IEA 2014 World Energy Outlook projects a growth of renewable energy supply from 1700 gig watts in 2014 to 4550 gig watts in 2040. Fossil fuels received about \$550 billion in subsidies in 2013, compared to \$120 billion for all renewable energies. Paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

IV. Wind Power Conversion

Wind has been utilized as a source of power for thousands of years for such tasks as propelling sailing ships, grinding grain, pumping water, and powering factory machinery. The world's first wind turbine used to generate electricity was built by a Dane, Poul la Cour, in 1891. In this approach, the wind turbine is allowed to spin at whatever speed that is needed to deliver the maximum amount of power. When attached to a synchronous or induction generator, the electrical output will have variable frequency depending on whatever speed the wind turbine happens to have at the moment.

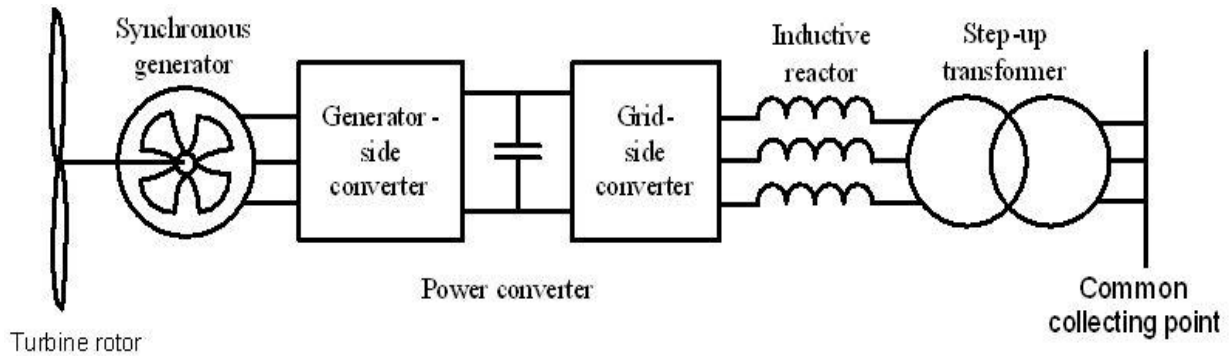


Fig.3 Basic concept of indirect system of PE in wind energy

This means that the generator cannot be directly connected to the utility grid, which of course requires fixed 50- or 60-Hz current. Figure 3 shows the basic concept of these indirect systems. Variable frequency ac from the generator is rectified and converted into dc using high power transistors. This dc is then sent to an inverter that converts it back to ac, but this time with a steady 50- or 60-Hz frequency. The raw output of an inverter is pretty choppy and needs to be filtered to smooth it. Any time ac is converted to dc and back again, there is the potential for harmonics to be created, so one of the challenges associated with these variable-speed, indirect wind turbine systems is maintaining acceptable power quality. In addition to higher annual energy production, variable-speed wind turbines have an advantage of greatly minimizing the wear and tear on the whole system caused by rapidly changing wind speeds. When gusts of wind hit the turbine, rather than having a burst of torque hit the blades, drive shaft, and gearbox, the blades merely speed up, thereby reducing those system stresses. In addition, some of that extra energy in those gusts can be captured and delivered.

V. Advantages of Power Electronics Interface

- a) High efficiency due to low power loss in semiconductor devices.
- b) High reliability due to power electronics converter system.
- c) Small size and less weight results in lower floor space so less installation cost.
- d) Mass production cost of this type of converter is low.

VI. Dis-advantages of Power Electronics Interface

- a) Power electronics converter circuits have tendency to generate harmonics in the supply system as well as in load system.
- b) AC to DC and AC to AC converters operate at low input power factor under certain operating conditions.
- c) Regeneration of power in power electronics converter system is difficult.
- d) Power electronic controllers have low overload capacity.
- e)

VII. Conclusion

As we find here power electronics is the key in wind energy but some disadvantages also there by using this system. The most important one power quality issues are generating with this converters. So we want to look forward to minimize this power quality issues in wind energy system.

References

- [1] Dr. P. S. Bimbhra Power Electronics, Khanna publishers
- [2] Gilbert M. Masters Renewable and efficient electric power system, wiley publication.