International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 01 | Jan 2020 www.irjet.net p-ISSN: 2395-0072

Application of Small Wind Turbine in Small Grid using Permanent Magnet Synchronous Generator

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Abstract - *This paper deals with permanent magnet synchronous generator (PMSG) in which the document has studied the feasibility of using small electrical machines (e.g. Automotive alternator, induction motors of domestic applications or electrical motors of some industrial application) as low cost generator for small wind turbine their transformation in permanent magnet synchronous generator PMSG is not difficult. Claw pole Automotive alternators can provide low cost alternative to permanent magnet generators for small wind turbine application. The output of a wind turbine depend on the turbines size and wind speed through the rotor. The wind energy over solar is that the wind can blow at night. The modeling of 2 sets power converter capacity 20 kW, which one has connected with the permanent magnet synchronous generator (PMSG) side and the other one, has connected to the grid side. This system is use for small hydropower (SHP) applications.*

***Key Words*: Permanent Magnet, Smart Grids, Synchronous Generator, Small Wind Turbine**

1. INTRODUCTION

In recent years, the electrical power generation from renewable energy sources, such as wind, is increasingly attraction interest because of environmental problem and shortage of traditional energy source in the near future. Nowadays, the extraction of power from the wind on a large scale became a recognized industry. It holds great potential showing that in the future will become the undisputed number one choice form of renewable source of energy. The force that pushes this technology is the simple economics and clean energy. As a consequence of rising fossil fuel price and advanced technology, more and more homes and businesses have been installing small wind turbines for the purposes of cutting energy bills and carbon dioxide emissions, and are even selling extra electricity back to the national grid.

Power electronics trend in renewable energy industrial was growth up more than 10 years; their applied for wind turbine electrical generators plant, electricity generators from solar energy plant, electricity generators from bio mass plant, electricity generators from hydro power plant etc. This seminar presented wind turbine electricity generation by synchronous generator all of type of excites by direct current or permanent magnet, WRSG (Wound Rotor Synchronous Generator) and PMSG. They can be operated with variable speed control without speed reducer gear. The alternative application is applied to connect with power electronics equipment.

The conventional energy sources are limited and have pollution to the environment. So, more attention and interest have been paid to the utilization of renewable energy sources such as wind energy, fuel cell and solar energy etc. movement of large air masses on the surface of the earth, i.e. the wind. Wind energy conversion systems convert the kinetic energy of the wind into electricity or other forms of energy. Wind power generation has experienced a tremendous growth in the past decade, and has been recognized as an environmentally friendly and economically competitive means of electric power generation. In wind energy conversion system, the wind power is utilized by wind mills or turbines which convert the kinetic energy in wind into mechanical energy or other form of energy, mechanical energy is convert in electricity by using generator.

The variable speed operation of a wind turbine can be achieved with a Doubly Fed Induction Generator (DFIG) or with a PMSG. The PMSG has many advantages over the DFIG. The PMSG does not require DC excitation as the magnetic field is produced by the permanent magnets rather than by the coil. Hence, the PMSG does not require slip rings and brushes, which reduce the weight, cost, losses and maintenance. Another important characteristic of the PMSG is that the pole-slippage can be shorten which allows the use of a major number of poles and to eliminate the use of a gearbox to couple the rotor to the electric generator during the operation.

A control strategy for the generator side converter with output maximization of a PMSG based small scale wind turbine is developed. The generator side switch mode rectifier is controlled to achieve maximum power from the wind. The method requires only one active switching device (IGBT), which is used to control the generator torque to extract maximum power. It is simple and a low cost solution for a small scale wind turbine.

2. RELATED WORK

2.1 Permanent Magnet Synchronous Generator (PMSG)

The PMSG is a regular Synchronous Machine, where the DC excitation circuit is replaced by permanent magnets for eliminating the brushes. Without the brushes and the slip rings, the PMSG has a smaller physical size, a low moment of inertia, which means a higher reliability and power density per volume ratio. Also by having permanent magnets in the rotor circuit, the electrical losses in the rotor are eliminated.

Due to the mentioned advantages, the PMSG are becoming an interesting solution for hydro turbine applications. A permanent magnet synchronous generator is a generator where the excitation field is provided by a permanent magnet instead of a coil.

The term synchronous refers here to the fact the rotor and magnetic field rotate with the same speed, because the magnetic field is generated through a shaft mounted permanent magnet mechanism and current is induced into the stationary armature. Synchronous generators are the majority source of commercial electrical energy. They are commonly used to convert the mechanical power output of steam turbines, gas turbines, reciprocating engines and hydro turbines into electrical Description power for the grid. Some designs of wind turbines also use this generator type. In the majority of designs the rotating assembly in the center of the generator the "rotor" contains the magnet, and the "stator" is the stationary armature that is electrically connected to a load. As showing the diagram 3.1, the perpendicular component of the stator field affects the torque while the parallel component affects the voltage. The load supplied by the generator determines the voltage. If the load is inductive, then the angle between the rotor and stator fields will be greater than 90 degrees which corresponds to an increased generator voltage. This is known as an overexcited generator.

They are known as synchronous generators because the frequency of the induced voltage in the stator (armature conductors) conventionally measured in hertz, is directly proportional to RPM, the rotation rate of the rotor usually given in revolutions per minute (or angular speed). Synchronous If the rotor windings are arranged in such a way as to produce the effect of more than two magnetic poles, then each physical revolution of the rotor results in more magnetic poles moving past the armature windings. Each passing of a north and south pole corresponds to a complete "cycle" of a magnet field oscillation which is shown in fig 1. Therefore, the constant of proportionality is where P is the number of magnetic rotor poles (almost always an even number), and the factor of 120 comes from 60 seconds per minute and two poles in a single magnet. By increasing the torque on the prime mover, a larger electrical power output can be generated. RPM and torque in practice, the typical load is inductive in nature. The voltage of the generator, and are the voltage and the current in the load respectively and is the angle between them. Here, we can see that the resistance, R, and the reactance, play a role in determining the angle. This information can be used to determine the real and reactive power output from the generator.

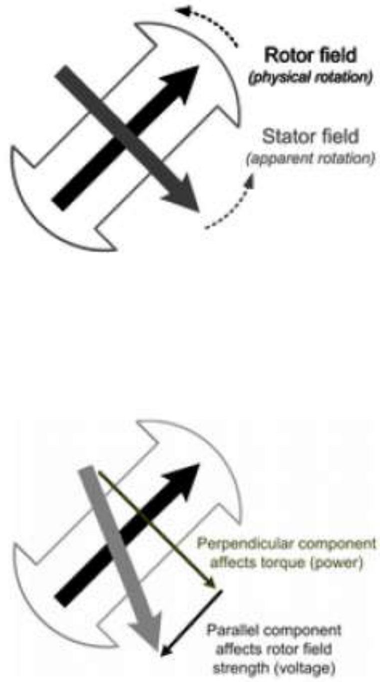

Fig. 1: Permanent Magnet Synchronous Generator

2.2 Voltage Source Converter (VSC)

The DC-link voltage must be boosted to controls level at 650 volts (around 2 time of grid line to line) higher than the grid line-line voltage. The power flow of the grid side converter is controlled in order to maintain the DC-link voltage level to constant during operation time, in the same time the PMSG side is controlled by speed. The both side of power converter is separate by capacitor and separate controls for control system. The capacitor is the DC link storage and DC filter for prepare the good DC voltage quality before convert to AC voltage by grid side converter and fed the power into grid line.

2.3 Low Pass Filter (LPF)

A low pass filter(LPF) is a filter that passes signal with a frequency lower than a selected cut off frequency and attenuates signal with frequencies higher than cut off frequency the exact frequency response of the filter depend on the filter design. A filter is some time as high cut off filter in audio application. A low pass filter is complement of high pass filter. In the optical domain high pass and low pass have the opposite meaning with a high pass filter passing only a longer wavelength and vice-versa for low pass. Low pass filter allow frequencies below their cut off rang they attenuate high frequency noise signal hence use to filter out high frequency noise. Low pass filter are used to filter noise is a high frequency signal when pass through a low pass filter most of the noise is removed and clear sound produced.

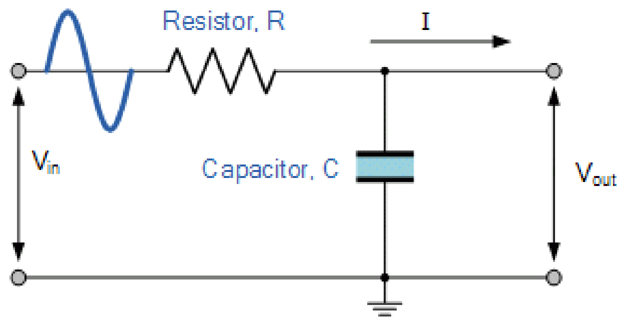

Fig. 2: Low Pass Filter

3. METHODOLOGY

A generator to create electricity. Wind is a form of solar energy and is a result of the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and the rotation of the earth, The terms wind energy or wind power describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity. Shown in fig. 3 Wind (moving air that contains kinetic energy) blows toward the turbine's rotor blades.

The rotors spin around, capturing some of the kinetic energy from the wind, and turning the central drive shaft that supports them. Although the outer edges of the rotor blades move very fast, the central axle (drive shaft) they're connected to turns quite slowly. In most large modern turbines, the rotor blades can swivel on the hub at the front so they meet the wind at the best angle (or "pitch") for harvesting energy. This is called the pitch control mechanism. On big turbines, small electrical motor hydraulic rams swivel the blades back and forth under precise electronic control. On smaller turbines, the pitch control is often completely mechanical.

However, many turbines have fixed rotors and no pitch control at all. Inside the nacelle (the main body of the turbine sitting on top of the tower and behind the blades), the gearbox converts the low-speed rotation of the drive shaft (perhaps, 16 revolutions per minute, rpm) into high-speed (perhaps, 1600 rpm) rotation fast enough to drive the generator efficiently. The generator, immediately behind the gearbox, takes kinetic energy from the spinning drive shaft and turns it into electrical energy. Running at maximum capacity, a typical 2 MW turbine generator will produce 2 million watts of power at about 700 volts. Anemometers (automatic speed measuring devices) and wind vanes on the back of the nacelle provide measurements of the wind speed and direction. Using these measurements, the entire top part of the turbine (the rotors and nacelle) can be rotated by a yaw motor, mounted between the nacelle and the tower, so it faces directly into the oncoming wind and captures the maximum amount of energy. If it's too windy or turbulent, brakes are applied to stop the rotors from turning (for safety reasons). The brakes are also applied during routine maintenance.

The electric current produced by the generator flows through a cable running down through the inside of the turbine tower. A step-up transformer converts the electricity to about 50 times higher voltage so it can be transmitted efficiently to the power grid (or to nearby buildings or communities). If the electricity is flowing to the grid, it's converted to an even higher voltage by a substation nearby, which services many turbines. Homes enjoy clean, green energy: the turbine has produced no greenhouse gas emissions or pollution as it operates. Wind carries on blowing past the turbine, but with less speed and energy.

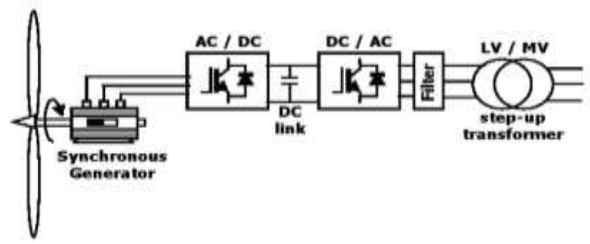

Fig. 3: Permanent Magnet Synchronous Generator Based Wind Turbine

4. CONCLUSION

This paper studied the feasibility of using small electrical machines (e.g. automotive alternator, induction motors of domestic applications or electrical motors of some industrial application) as low cost generator for small wind turbine or small hydro power. The energy conversion systems (wind and hydro turbines) in micro grids and development of small stand-alone systems in rural environment. By comparing the Permanent Magnet Synchronous Generator and Induction Generator based Wind Energy Conversion System, it has great potential and is easy to manage. Blades generates the most power might be useful when trying to build more efficient wind turbines.

REFERENCES

1. Jay Verma, Yogesh , Tiwari, Anup Mishra, Nirbhaya Singh ,"Performance, Analysis and Simulation of Wind Energy Conversion System Connected with grid". IJRTE, ISSN: 2277-3878 Volume-2, Issue-6, January2014.

2. D Mary, Shinosh Mathew, Sreejith K,,"Modeling and Simulation of Grid Connected Wind Energy System.", IJSCE,ISSN: 2231-2307, Volume-3, Issue-1, and March 2013.

3. A.Bharathi sankar, Dr.R.Seyezhai,"MATLAB Simulation of Power Electronic Converter for PMSG Based Wind Energy Conversion System", IJIREEICE, Vol.1, Isuue.8, November 2013

4. Gaurav Singh Bhandari, Dr.M.Kowaslya,"Power Electronics Converter for Grid Intregrated Vriable Speed Wind Turbine", IJDR, Vol.4, Issue.3, March 2014

5. Rajveer Mittal, K.S.Sandhu, D K. Jain,"Grid Voltage Control of Inverter Interfaced Wind Energy Conversion System", IJESD, Vol.2, Issue.5, October 2011.

6. H. Polinder, F. F. A. van der Pijl, G. J. de Vilder, P. J. Tavner, "Comparison of direct-drive and geared generator concepts for wind turbines," IEEE Trans. On energy conversion, vol. 21, no. 3, pp. 725-733, Sept. 2006.

7. T. F. Chan, L. L. Lai, "Permanenet-magnet machines for distributed generation: a review," in proc. 2007 IEEE power engineering annual meeting, pp. 1-6.

8. M. De Broe, S. Drouilhet, and V. Gevorgian, "A peak power tracker for small wind turbines in battery charging applications," IEEE Trans. Energy Convers., vol. 14, no. 4, pp. 1630–1635, Dec. 1999.

9. R. Datta and V. T. Ranganathan, "A method of tracking the peak power points for a variable speed wind energy conversion system," IEEE Trans. Energy Convers., vol. 18, no 1, pp. 163–168, Mar. 1999.

10. K. Tan and S. Islam, "Optimal control strategies in energy conversion of PMSG wind turbine system without mechanical sensors," IEEE Trans. Energy Convers., vol. 19, no. 2, pp. 392–399, Jun. 2004.