© 2016 IJSRST | Volume 2 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Engineering and Technology

Integration of Wind Energy Based Microgrid with Utility Grid

Patel Tejal
Electrical Department, MGITER Engineering Collage, Navsari, Gujarat, India

ABSTRACT

This with the growing development of renewable energy sources, wind energy is becoming more useful due to its advantages i.e easily available, free of cost, ecofriendly etc. This paper represents the modeling of permanent magnet synchronous generator based wind system integration with utility grid. The wind system generates the ac power through PMSG. We can boost up this ac voltage through different converters. Rectifier which convert the ac power in to dc power which is fed to the dc to dc converter so that we can obtain our desire voltage level. The dc power obtained from boost converter , can be convert in ac power through Inverter.

Keywords: Wind energy, microgrid, PMSG, Boost converter

I. INTRODUCTION

Wind energy is one of the most important renewable sources. Wind energy is capable to supply large amount of power. Different types of generator can be used for wind based microgrid system i.e induction generator, synchronous generator.[1] PMSG is broadly used in now days because of it can generate high torque at low revolving speed. Also PMSG can connect to turbine without gear box so that complication and losses could be minimizes.[3]

In 12th and 13th centuries use of wind power become useful for sailing ships , pumping water and grinding grains. The starting period of wind energy based electricity generation in 1890's. Denmark was the first country to use the wind energy for generation of electricity.[5] The advance scenario shows that wind power could reach 2,000 GW by 2030 and reducing co_2 emission by more than 3 billion tonnes per year.[6]

This paper mainly represents the wind energy conversion system integration with utility grid using boost converter. Main function of boost converter to increases the voltage level.[6] Mathematically Modelling of wind turbine and PMSG can be obtained through dq rotating reference frame theory. In the modelling of wind turbine and PMSG different parameters should be consider.[3] mathematically modelling of wind turbine can be obtain through following equation.

$$P_w = \frac{1}{2}\rho A V_u^3 C_p \qquad (1.1)$$

Where , P = Power produce by wind turbine**.** A=Area through which wind is pass **,** ρ = Air Density , V =Velocity of wind , C_p = tip speed ratio.

In this paper, Pulse Width Modulation control strategy is implemented for boost converter. Obtained value is compared with reference value to extract maximum power from boost converter. In this paper 700 v is taken as reference value. Different control strategy can be implemented in Inverter.

II. BOOST CONVERTER AND INVERTER

A. Boost Converter

Figure 1 illustrates a boost converter, which consists of a voltage source Vs, an inductor L, which is used for energy storage and connected to the voltage source in series, a switching device M, a diode D, a filter capacitor C and a load.

Energy from the voltage source is stored in the inductor *L* when the switching device *M* is conducting. The current through the inductor increases linearly, the diode *D* is reverse biased and the capacitor provides voltage for the load during that time. When the switching device

M is opened, the diode *D* conducting the current through the inductor *L*, and diode *D* offers power for the load and the charging of the capacitor *C*. [7]

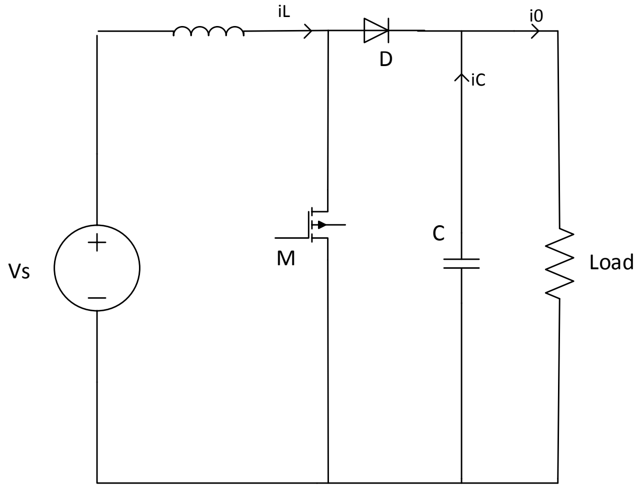

Figure 1. Boost Converter

Output equation of boost converter,

$$\frac{Vo}{Vs} = \frac{1}{1-D} \tag{1.2}$$

Equation 1.2 shows that the gain of the boost circuit is always greater than 1, which means that the output voltage of the boost circuit is always higher than the input voltage.[7]

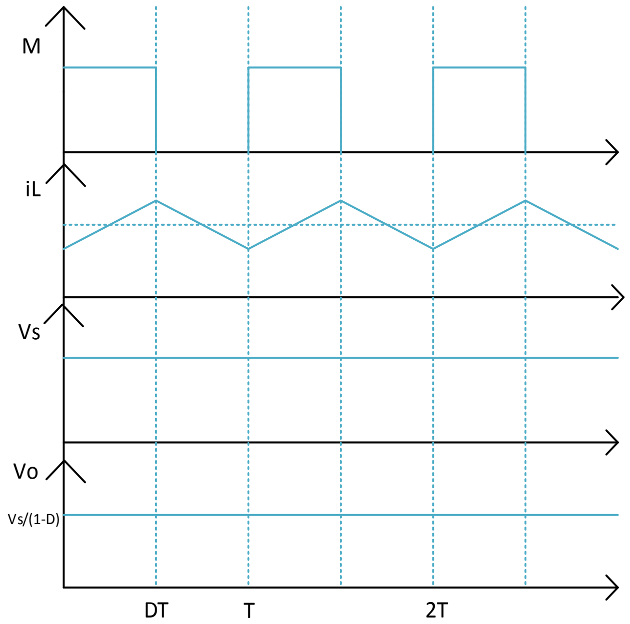

Figure 2. output waveform of boost converter

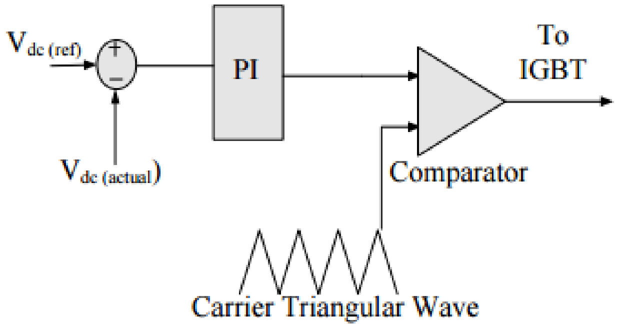

Figure 3. pwm technique

Pulse Width Modulation (PWM) control method is used to extract maximum power from the available wind power. For this system, the reference voltage of 700 V is used to control the DC voltage at the rectifier DC side terminals.

B . Inverter

Power MOSFET and IGBT switches are largely used power semiconductor devices for inverters.

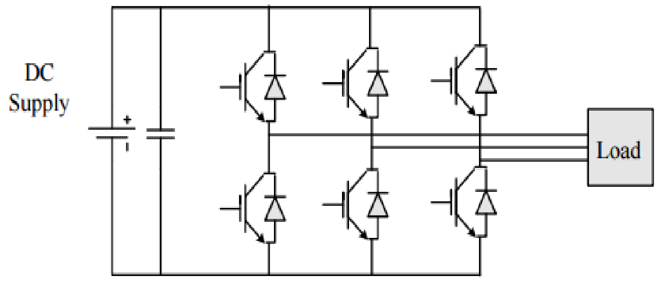

Figure 4. Inverter Circuit

As the IGBT combines low on-state voltage drop and high off-state voltage characteristics of BJT and high input impedance of the MOSFET, IGBT is chosen as power semiconductor switch The circuit diagram of the three phase VSI is shown in Figure 4.[7]

III. SIMULATION AND RESULTS

A. Boost converter

Figure 5 represent the implementation of boost converter in Matlab Simulink. The output waveform of the boost waveform is shown in figure 5.

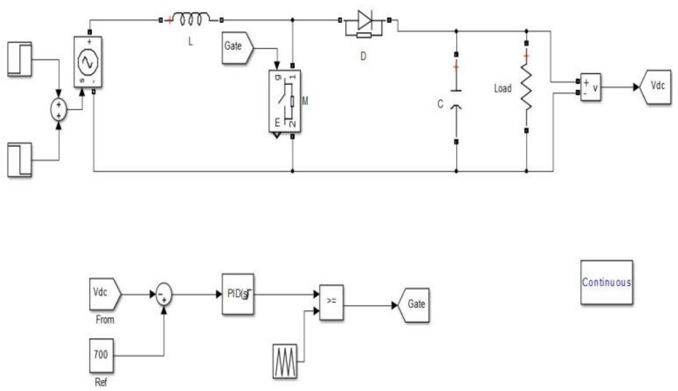

Figure 5. Boost Converter

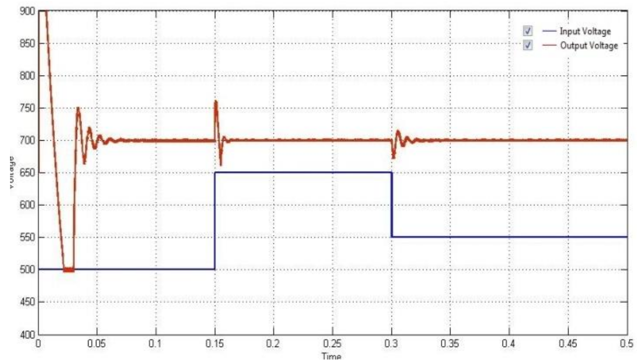

Figure 6. output waveform of boost converter

Figure 5 represent the input and output voltage of the boost converter. From the figure it is clear that output voltage is increases from 500 voltages to 700 voltages which is almost constant.

B. WECS with Utility Grid

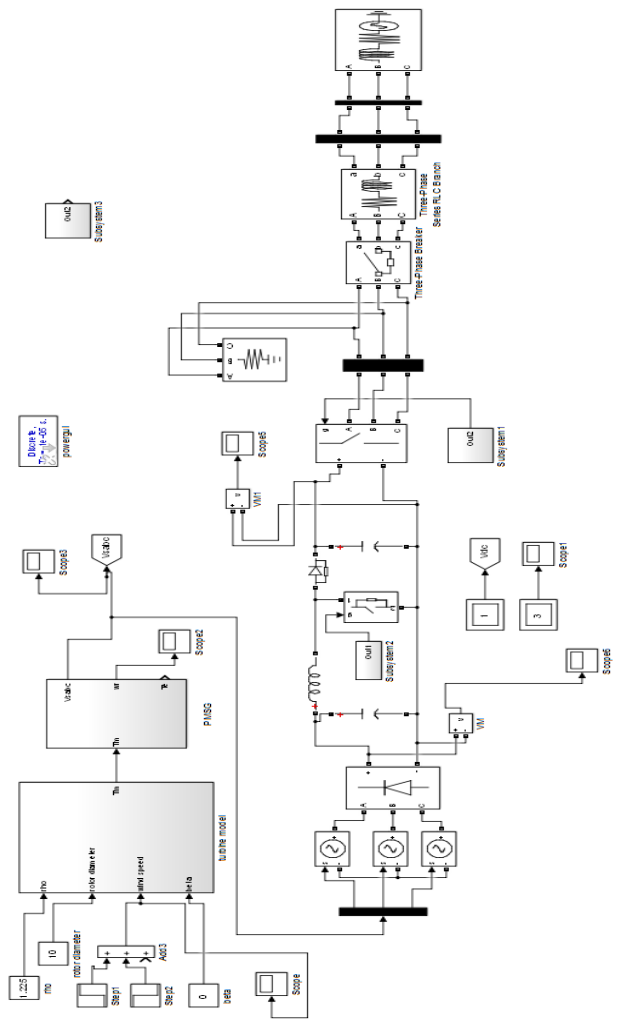

Figure 7. Wecs with Utility Grid

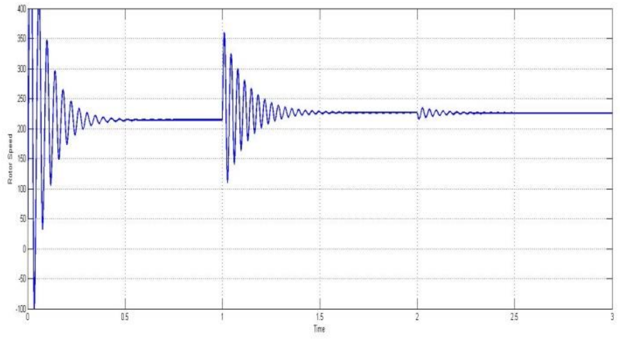

Figure 8. Rotor Speed after Integration

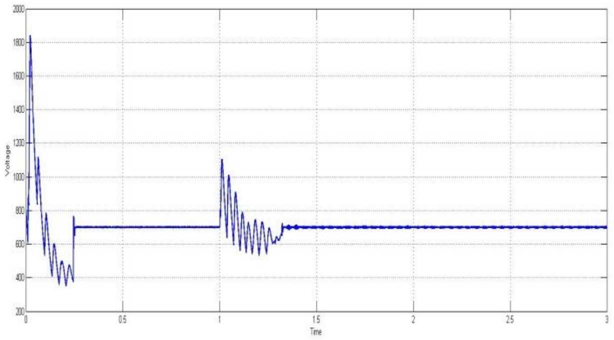

Figure 9. output waveform of boost converter after integration

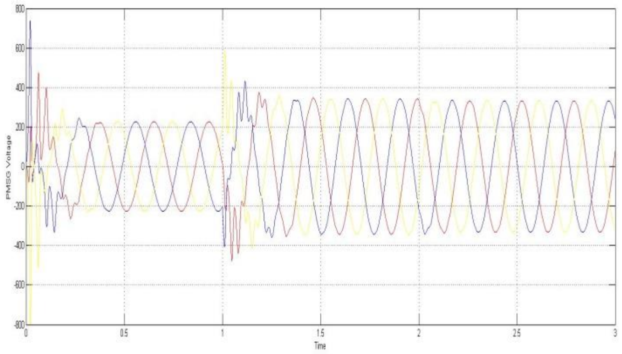

Figure 10. three phase output voltage after integration

Figure 7 shows the complete simulation model of WECS integration with utility grid. Figure 8, Figure 9, Figure 10, represent the rotor speed after integration, output waveform of boost converter after integration and three phase output voltage after integration respectively. We can see that when the grid is integrated with the system some disturbance is appear in the system at 1 sec. After that it will try to stable and will continue in few sec.

IV. CONCLUSION

This paper analyze the wind system integrate with utility grid with different converters. When the grid is connect to the system at 1 sec some disturbance is appear and after that it will minimize and it will stable after few seconds. pwm technique can be implemented for boost converter to extract maximum value.

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