Wind Turbine Generator Tied to Grid using Inverter Techniques and Its Designs

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Abstract— This paper proposes a method of using small sizes WTG of 300W low capacity turbine in small grid channel with inverter techniques. Power can be fed directly to grid by improving durability and eliminating battery usage, using WTG inverter technique. The proposed wind tied with grid by PMG includes boost converter and three phase inverter. For tracking wind speed with variations of wind power MPPT method is used. Interleaving technique is adopted for different frequency variables to improve power capacity. Final result proves WTG helps in improving wind power application as shown in simulation result.
Key words: Wind turbine generator (WTG), MPPT, PMG, Boost converter

I. Introduction

One of the energy production methods to fulfill basic demand is changing energy form. By using wind power, efficiency can be increased with adaptive methods. The aim of this work is to design and implement the hybrid energy conversion system under simple inverter and MPPT techniques. Coupling generators tied with the grid by using converters to convert power in wind turbine which shows variation in availability of power that can be contributed to grid stability. This stability of grid depends on different strategy of availability, compatibility, capability, functionality and system reliability.

It has become attend to install WTG in larger size in order to produce Mega Watt Power (3, 5). In smaller areas, size of WTG is reduced purposely. It shows even for 300W WTG installation space availability is important. Charging systems should be included when the size is reduced (7). IT may also produce problem such as battery maintenance, due to overheating, discharging which may reduce battery life. By considering all such problems battery systems can be eliminated for small sized WTG which also reduces system cost.

A. Wind Turbine Generator

InFig1. WTG accompanied with PMSG including inverter model is shown. In Fig 1a[5] shows conversation WTG power by using single phase or three phase grid tied inverter for feeding power to grid. It has certain advantage and disadvantage like producing current sinusoidal and lowering torque pulse this may result in increasing device cost which includes cost of power switches.

If the voltage has tostep up, boost converters can be used by reducing complexity of WTG as shown in Fig 1b. Production of vibration and noise is also a demerit but cost may reduce significantly, this may be due to distortion current.

Techniques like DCM (Discontinuous Conduction Mode) operation can be employed to reduce distortion current [9,10]. These techniques will not suit for WTG below 300W flyback based inverter is used to step up voltage level higher to supply for rear inverter. This flyback inverter is shown in Fig 2. This inverter uses both boost converter and rectifier for converting WTG power.

Now the power to the grid is feed by flyback inverter containing flyback converter with polarity inversion circuits. Owing to the transformer the size can be minimized and switch current can be reduced by operating flyback converter in boundary conduction mode (BCM). In order to maintain generator voltage level at step up voltage level and also for reducing cost flyback inverter is proposed as shown in Fig 2. Energy production by the wind turbine depends upon the wind velocity acting on the turbine. Hence it only converts the mechanical energy into electrical energy. But they do not create or produce electrical energy; it only depends upon mechanical force turn the rotor and electrical demand that is load placed on generator. This proves why generator comes in different sizes and producing various amount of electricity.

Linear motion is converted into rotatory motion which directly pushes against blades of turbines.
When it pushes harder generations of electricity is increased by WTG.

According to Faraday's law of magnetic induction whenever a electron flows on electric coil magnetic field is produced around it, in same way when a magnetic field moves past a wire coil, voltage is induced in it. This shows all electrical turbine worksbecause of this effect.

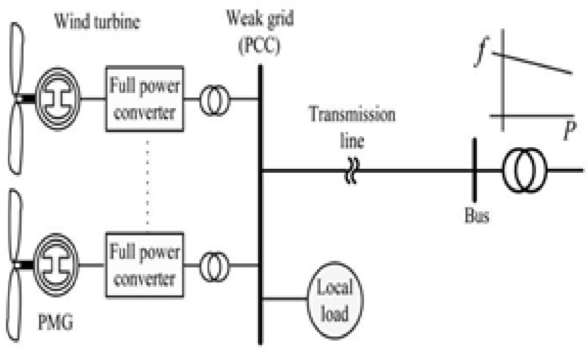

Fig. 1: WTG with Inverter

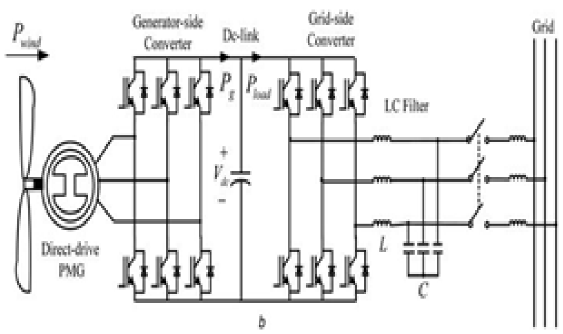

Fig. 2: WTG with PMSG.

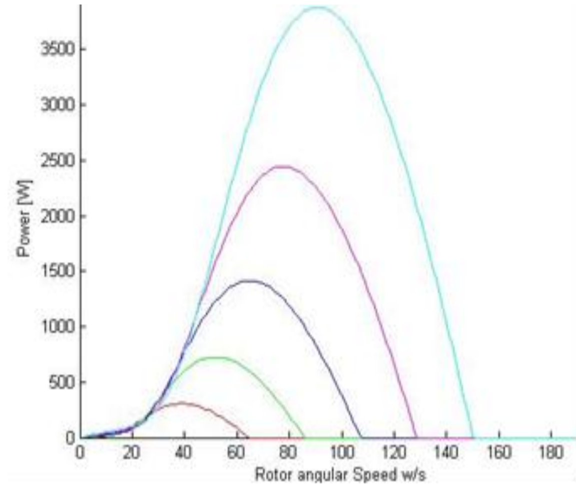

Fig. 3: Power speed characteristics of WTG

II. MPPT CONTROLLER

Based on environmental condition, wind speed and its direction are considered power cannot be tracked and it's varied gradually, In order to avoid this criteria, rectified dc power can be tracked using maximum power tracker.

Using this, electric power can be calculated by both dc booster sides of varying current and voltage level.

$$P = V \times I \qquad (1)$$

$$P_w = \frac{\rho}{2} C_p(\lambda, \theta) A_r V_w^3 \qquad (2)$$

Where P_w=Mechanical Power, =Air Density,
= Power coefficient, A= Area swept by rotor, V= wind speed.

$$T = \frac{P}{\ } \qquad (3)$$

T=Torque Power, Pw=Mechanical Power, =Angular Velocity.

Value is calculated by using the following.
formula,

$$C_{p\{\lambda|\gamma\}} = (C_2 \frac{1}{\beta} - C_3\, \lambda - C_4^{\gamma} - C_5) \qquad (4)$$

By rectifying dc power maximum power can be traced rather than environmental condition such as wind speed and direction.

A. *Mppt Search Process Steps*

1. If P(k) >=P(k-1) and V_{dc}(k) >= V_{dc} (k-1), the dc side voltage reference need to be increased by ΔV_{dc}.
2. If P(k) >=P(k-1) and V_{dc}(k) < V_{dc}(k-1), the dc reference voltage needs to be decreased by ΔVdc.
3. When P (k) < P(k-1) and V_{dc}(k) >= V_{dc}(k-1), the decreasing the reference voltage by ΔVdc.
4. When P (k) < P(k-1) and V_{dc}(k) < V_{dc}(k-1), the increasing the reference voltage by ΔV_{dc}.

III. BOOST CONVERTER

Using Boost converter output voltage level can be maintained. Switching device like MOSFET duty cycle can be varied from 0-1 or vice versa, level by changing boost output voltage with reference voltage.

Component	Value
Switching Frequency Fs	20 kHz
Inductance	120 H
Capacitance C1 and C2	330 µF
Resistance R	100 Ω

Table I: Ranges Of Boost Converter.

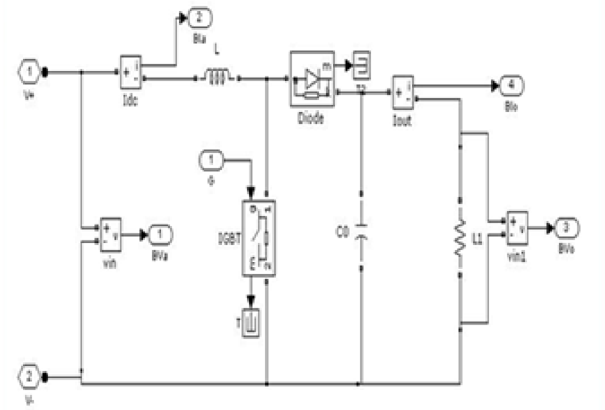

Fig. 4: Simulink diagram of Boost converter.

IV. PULSE WIDTH MODULATED INVERTER

In this three phase ac output will be discussed from functioning of system inverter.DC voltage sources are given as input. Output of the inverter will be sinusoidal with respective voltage and frequency. Therefore inverter switching frequency is determined by signals like sinusoidal control signal which modulates the switch duty ratio and frequency.

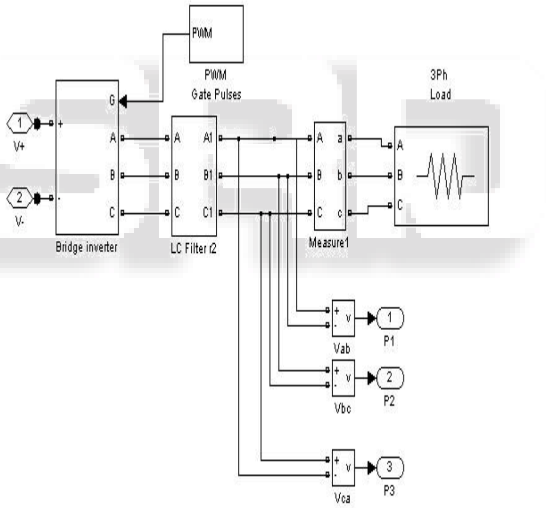

Fig. 5: Simulink model of Inverter.

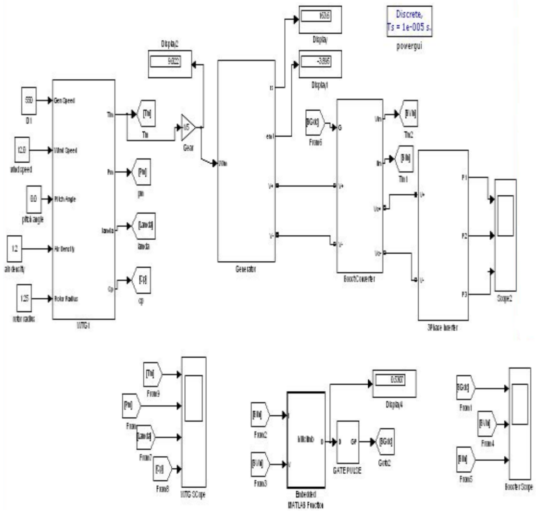

Fig. 6: Simulink model of Wind turbine generator.

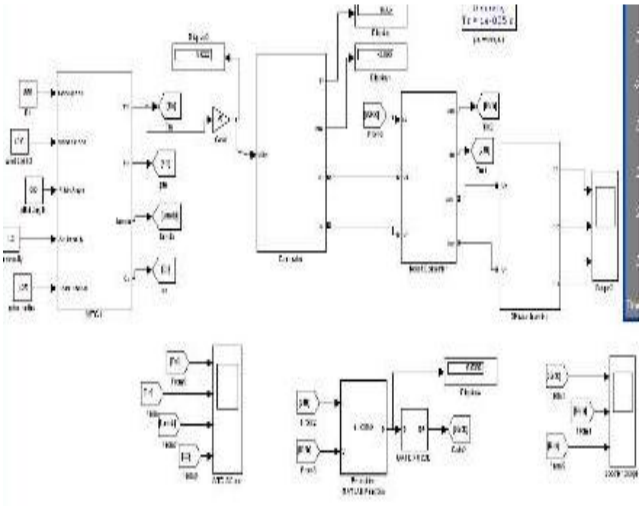

Fig. 7: Simulink model of proposed work.

V. SIMULATION RESULTS

Grid tied wind turbine is constructed with effectiveness based on MPPT techniques with PWM inverter implementation circuit simulation is also performed using MATLAB Simulink software. Simulationsresult shows that proposed system will maintain weak grid voltage and also power the load grid in standalone mode operations. This proposed scheme can also be used for active power control application. Hence it is noticed from fig.(9)Maximum power can be searched and controlled in order to maintain power coefficient to its maximum point in wind turbine.

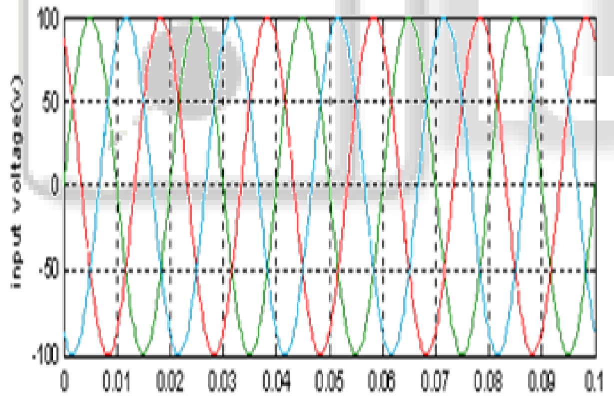

Fig. 8: Input waveform from wind turbine.

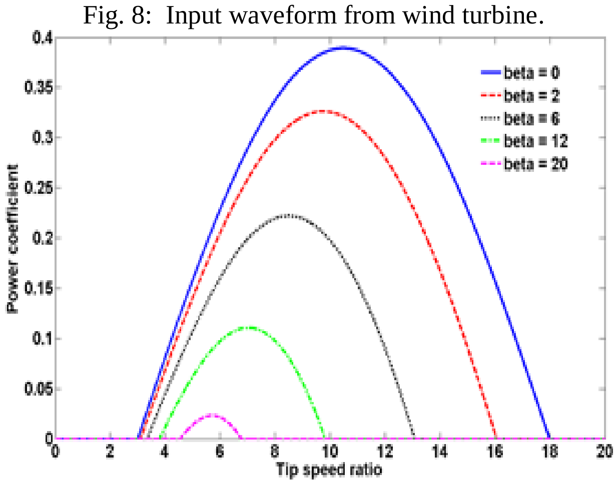

Fig. 9: Maximum Power output.

VI. CONCLUSION

Thus the design and implementation of grid tied with wind power using inverter techniques are done by using MPPT technique. The pitch control is coordinated with the generator speed control and is used for limiting the generator speed range. A well-designed dc-link voltage controller can maintain the active power flow balance between the source and load. The droop control is adopted for power sharing between multiple winds converters and also for regulating the grid voltage amplitude and frequency via reactive power and active power control. Simulation results have shown that the proposed system can help maintain the weak grid voltage and also power the local grid in stand-alone mode operation. The proposed scheme with active power control can also be used for wind power smoothing and other active power control applications.

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