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Grid Synchronization of Wind Based Microgrid

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***Abstract –** This paper is on the synchronization of a wind based microgrid with main grid. The wind power is generated using the permanent magnet brush less DC generator (PMBLDCG) and the MPT (Maximum Power Point Tracking) is executed with P&O (perturb & Observe) approach to extract the maximum power from the wind generation. This power is fed to the AC load using a voltage source inverter (VSI) through the battery bank (BSS) at DC link. The control algorithm operates in standalone mode and grid connected mode. I can switch in* islanded and grid connected modes seamlessly *according to the wind conditions. In standalone mode, this wind power is fed to the load through a VSI, during low wind conditions, the battery discharges itself to fulfill the load demand. After that, the grid is connected to give power to the load during low wind conditions, and for this, control algorithm operates in grid connected mode. Therefore, the control algorithm switches from voltage control to current control mode to provide smooth synchronization and vise versa at de-synchronization. A MA TLABI Simulink model is developed to simulate the system performance during wind variations ,and during synchronization and resynchronization.*

***Keywords**- Microgrd;*

I- INTRODUCTION

Modern advanced civilization is standing on the feet of electrical engineering . This energy is generated mainly from the conventional resources based on fossil feels. However, in this world of technical advancement and development only conventional energy resources are not sufficient. Therefore, renewable resources have also been explored and research on these fields is also getting maturity [1-2]. The local demand of energy is fulfilled with distributed energy generation, and micro grid is one of such ways that consists of resources like wind, solar, hydro, and biogas etc. [3-5]. These sources increase energy efficiency, reduce losses, enhance the robustness of such sources [6]. They can also feed the extra power to the utility grid through power electronics converters. Therefore, the converters of these microgrid systems have to work in both standalone and grid connected modes. Various control algorithms for standalone system have been used in previous literature to improve the power quality, stability and performance of such systems [7-9]. The control algorithms of grid connected system are also defined in [10- 1 1]. These control algorithms geeate the PWM pulses for the switching of the converter according to the operating mode. These converters are being used for smooth transition between gid connected and standalone modes to transfer the energy coming from the distributed generation or micogrids. I must be transients fee during transfer. Some work in this field is reported in the literature [12- 15].

These control algorithms are based on voltage control and current control approach. In [12], a thorough control description is given on gid connected, standalone and rectifier modes for multifunctional PWM converter. It is

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given with the PLL (Phase Lock Loop) approach to extract grid angle. A indirect current control method is used for seamless transfer of distributed generation system for intentional islanding in [13]. It is also provided LCL filter design. Karimi [14] has introduced universal integrated synchronization and control (UISC) for single phase converter operation in both modes of operation and also reduced the requirement of PLL. In [15], a control strategy is explained with single control structure including both the modes of operation and smooth transition without PLL approach.

In this work, the control algorithm switches in two modes in voltage and current control modes according to the availability of wind. The microgrid works in standalone mode when sufficient wind power is available and excess power is stored in battery during high winds. When wind generation is small and demand is increased the battery starts exhausting and if the gid is available the synchronization process takes place seamlessly. Now the converter starts operating in current control mode form the voltage control mode. Here SOG! (Second Orde Generalized Integrator) based PLL (Phase Lock Loop) is used to extract the gid angle.

II- WORKING PRINCIPLE

The proposed microgid consists of PMBLDC (Permanent Maget Brushless DC) generator based wind system, connected to the DC link through DC-DC boost converter to provide MPPT to the wind power as shown in Fig.l. A diode bridge rectifier is used at generator terminals to convert wind power into DC power. This boosted power comes to the battery bank at DC link. A VSI is used to transfer the DC power to AC load during islanding mode. This system is connected with the utility grid when grid is available through STS (Static Transfer Switch). Linear/ nonlinear loads, interfacing inductor (Lf) and filter capacitor (C) are connected at point of common coupling (PCC).

Non-conventional means of energy has become an alternative and or an additive for the conventional source of energy. With endless potential of wind energy and environmental-merits, it has become the most popular source of renewable energy. The WECS based on the wind- turbine (WT) is categorized as fixed and variable speed system. Initially fixed-speed WECS was popular one. Nowadays, variable speed generators are more effective. PMSG is more effective and efficient as compared to other generators and are best suited for WECS due to its high torque to size ratio, less maintenance required, omission of slip-rings, reduced overall-cos. Permanent magnets(PM) instead of electromagnets makes the stator direct-flux constant [65]. The modelling of wind based power generation system is discussed below.

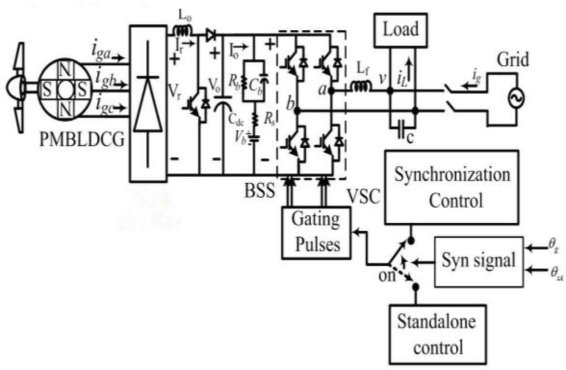

Fig 1 - Schematic diagram of wind based microgrid with utility grid

The rotor-blades of WT converts the kinetic-energy of the wind into mechanical-energy. Then generator as an electrical-sytem transform mechanical-power into the electrical-power. WTs generally used for WECS are vertical-axis-wind-turbine (VAWT) and horizontal-axis-wind-turbine (HAWT). HAWT shows listed below advantages than VAWT.

- it offers flexible blade-pitch so that blades can operate at optimum-angle of attack, for extracting more wind-energy.
- it always captures efficient wind-energy from during the whole rotation as blade’s rotation is perpendicular to the wind.
- it is self-starting, but VAWT needs initial starting-torque.

The kinetic energy, which is extracted from the wind, is penetrated on to the turbine blade area.
The three-phase brushless DC permanent-magnet (BLDCPM) generator with surface-mounted PM outer rotor and concentrated stator-phase windings producing trapezoidal EMFs is considered for this study as the electrical generator suited for micro-wind turbine applications. The BLDCPM generator consists in a simple construction, based on armature windings on the stator and permanent magnets on the rotor. The lack of

brushes in its configuration yields several benefits for this topology as improved efficiency, better reliability, longer life with less maintenance, higher power density and higher torque to weight ratio [18]. The operation principle of the BLDCPM is based on the attraction and repulsion between the stator and rotor magnetic poles. As the rotor shaft of the BLDCPM generator is driven in motion by the micro-wind turbine, the constant excitation field, provided by the permanent magnets on the rotor, induces dynamic back-EMFs in stator-armature phase windings. This stator-phase back-EMF voltage is proportional to the magnetic field strength and has quasi-trapezoidal shape due to the non-sinusoidal distribution of the air-gap magnetic flux density in respect of the rotor position. In practice this waveform is not quite trapezoidal as several factors intervene, such as manufacturing, leakage flux, material saturation, etc.

III - CONCLUSION

A wind based microgid has been modeled and its performance is simulated in MATLABI Simulink using Sims Power System. The micogrid has worked in standalone environment with wind availability. When the grid fault is recovered and wind speed reduces the micogrid synchronizes with the utility grid and when fault appears the grid abnormal condition is detected and the control transfers from voltage control to current control mode. The synchronization and resynchronization process are achieved seamlessly. The obtained results have been depicted to state and transient responses are observed satisfactory.

FUTURE SCOPE

Multiple renewable source can be connected in parallel for more renewable power sharing like solar panels, fuel cells etc. The controllers can be further updated with fuzzy adaptive control structure and the conventional MPPT modules can be changed to new faster response MPPT techniques. The wind farm unit can also be connected 3-ph AC grid with synchronization controller for sharing the power to load or injecting excess power to grid in synchronization.

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