Simulation of a Power-Control Strategy for a DCmicrogrid Hybrid Generation System in Islanding Mode

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Abstract - The planned system presents power-control ways of a grid-connected hybrid generation system with versatile power transfer. This hybrid system permits most utilization of freely on the market renewable energy sources like wind and electrical phenomenon energies . For this, associate degree accommodative MPPT algorithmic rule alongside commonplace perturbs and observes technique are going to be used for the system. Also, this configuration permits the 2 sources to provide the load severally or at the same time reckoning on the provision of the energy sources. The rotary engine rotor speed is that the main determinant of mechanical output from wind energy and cell operational voltage within the case of output power from alternative energy. magnet Synchronous Generator is not to mention turbine for attaining wind energy conversion system . The electrical converter converts the DC output from non-conventional energy into helpful AC power for the connected load . This hybrid system operates underneath traditional conditions that embrace traditional temperature within the case of alternative energy and traditional wind speed at plain space within the case of wind energy. The simulation results square measure bestowed maybe the operational principle, practicableness and responsibleness of this planned system.

Keywords: Dc microgrid, Solar, Wind, Hybrid generation.

I. INTRODUCTION

This paper describes the integration of wind power and solar power by interconnecting it to the microgrid that stores and transforms DC power. Nowadays, renewable energy is frequently used. distributed energy sources such as wind power, solar power and so on that can be operated in parallel with a wider utility. Nowadays, most of peoples interested to use renewable energy sources such as tidal energy, solar energy, wind energy, geothermal energy, wave energy, and so on. Generation of DC power is done by a micro grid. This project illustrates the storage and utilization of DC power by using a micro grid. These all renewable energy source generates DC power. By generating these DC power we are utilizing by microgrid.

A Microgrid is a discrete energy system that consists of distributed energy sources and loads capable of operating in parallel. Thus, the generation, storage and demand management of power becomes easy. The primary purpose is to ensure local, reliable and flexible power for urban and rural communities, at the same time, providing solutions for commercial, industrial and federal government consumers. A microgrid also consists of distributed energy resources like solar PV systems and wind energy systems that have several electrical loads.

II. MICROGRID ARCHITECTURE

A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode. Microgrid can be configured as Consumer Microgrid, Community Microgrid and Utility Microgrid.[1] In Consumer Microgrid, single consumer with demand resources on consumer side of the point of delivery.(e.g. sports stadium). Community Microgrid consists of multiple consumers with demand resources on consumer side of the point of delivery, local objectives, consumer owned, (e.g., campus, etc.) and Utility Microgrid consists of supply resources on utility side with consumer interactions, utility objectives. Based on the connection of distributed energy sources, the microgrids are classified as AC Microgrid and DC Microgrid.

As traditional power system is based on AC, microgrids are considered to be naturally AC based at early stage. A three-phase AC bus is commonly employed as the point of common coupling (PCC) [2]. PCC is normally set as the only power interface between a utility grid and the microgrid. The schematic structure is shown in Figure.1. A microgrid can be either operated in grid-connected condition or in the stage of isolation.

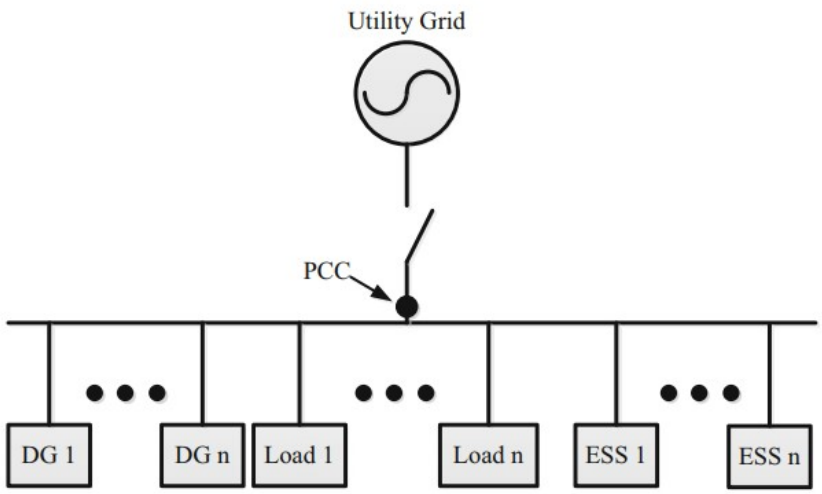

Figure 1 . AC Grid Structure

The idea of DC microgrid emerged soon after the concept of microgrid was proposed[3]. It is commonly designed for a distributed DC power source connecting intermittent renewable power sources, energy storages, and DC loads. This is due to the fact that many renewable power sources, e.g., directly driven wind generation and photovoltaic system, and energy storage systems, e.g., battery and super-capacitor, normally have DC links at their interface converter stages[4]. By connecting all the DC links of the sources and loads, a DC microgrid is formed, as is demonstrated in Figure. 2. Unlike the idea of AC microgrids, a DC microgrid does not directly connect to the prevalent three-phase AC utility grid but via a bidirectional DC/AC converter for common integration.

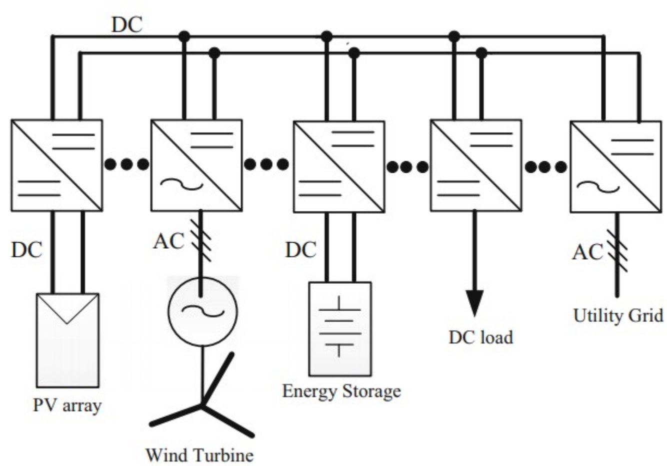

Figure 2 . Structure of DC Microgrid

In this paper we have developed a DC Microgrid system which includes solar PV system, Wind system , Battery storage system along with a grid connected inverter. The block diagram of the proposed system is as shown below.

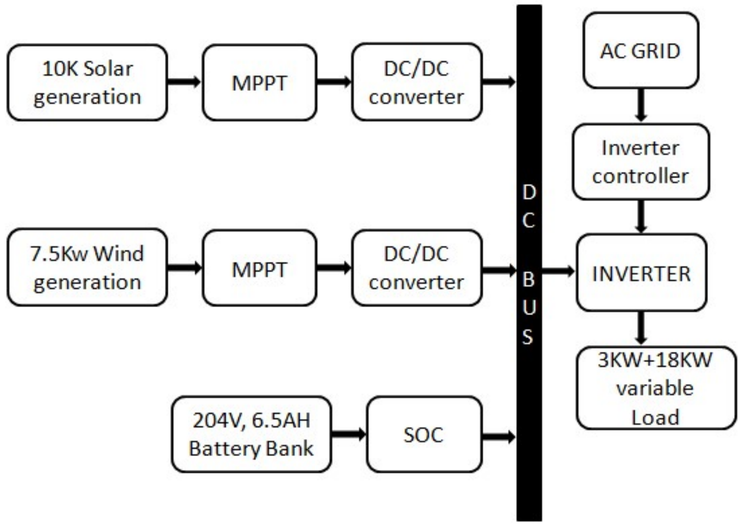

Figure 3 . structure of Proposed System

III. SOLAR SYSTEM

In this paper, solar panel was designed using a diode modelling. A 10Kilo Watt solar panel were designed by connection two 5KW solar panel arrays in parallel. Each 5Kilo Watt solar panel array is simulated using two 2.5Kilo Watt solar panels in series with each panel rating of 340Voc and 3.75 Isc rating. The block diagrams of solar system given below.

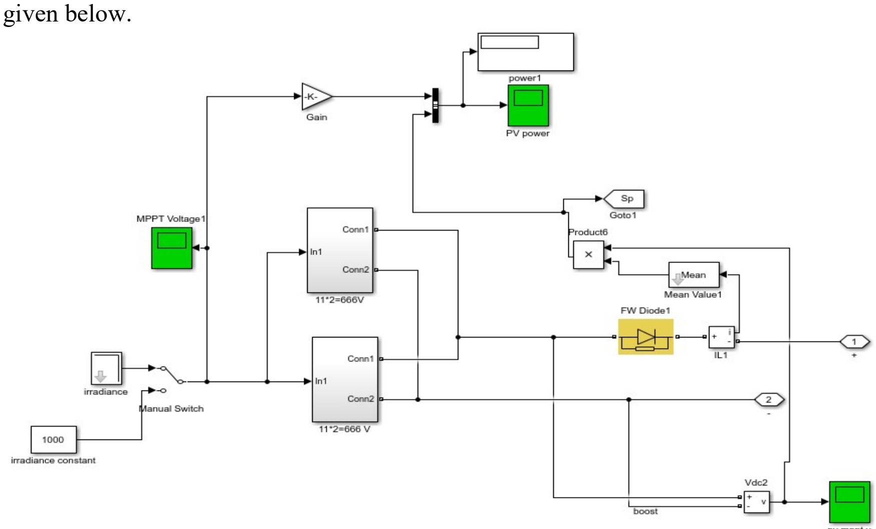

Figure 4 MATLAB simulation model of Solar system

IV. WIND ENERGY SYSTEM

In this paper wind energy system is designed by coupling wind turbine with permanant magnet synchronous machine for generation of Three phase supply. The wind is based on the steady-state power characteristics of the turbine. This generated volatge is fed to a uncontrolled rectifier to convert the three phase supply to DC. The converted DC is fed to DC/DC converter at 100V level.

The model of wind turbine is based on the steady-state power characteristics of the turbine. The stiffness of the drive train is infinite and the friction factor and the inertia of the turbine must be combined with those of the generator coupled to the turbine. The output power of the turbine is given by the following equation in per unit system.

$$P_{m\_pu}=k_p c_{p\_pu} v^3{}_{wind\_pu},$$

where

P_{m_pu}	Power in pu of nominal power for particular values of ρ and *A*
c_{p_pu}	Performance coefficient in pu of the maximum value of c_p
v_{wind_pu}	Wind speed in pu of the base wind speed. The base wind speed is the mean value of the expected wind speed in m/s.
k_p	Power gain for c_{p_pu}=1 pu and v_{wind_pu}=1 pu, k_p is less than or equal to 1

The Simulink® model of the turbine is illustrated in the following figure. The three inputs are the generator speed (ωr_pu) in pu of the nominal speed of the generator, the pitch angle in degrees and the wind speed in m/s. The tip speed ratio λ in pu of λ_nom is obtained by the division of the rational speed in pu of the base rotational speed (defined below) and the wind speed in pu of the base wind speed. The output is the torque applied to the generator shaft.

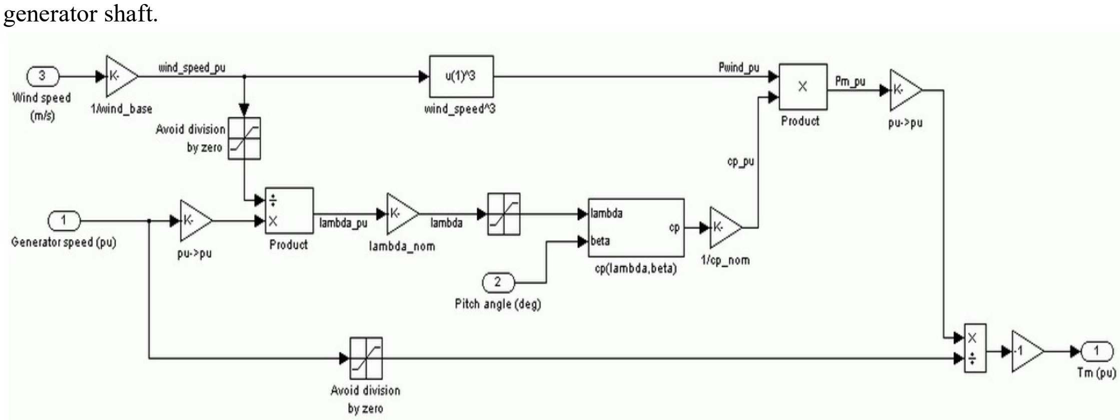

Figure 5 . Simulink model of wind turbine

The Permanent Magnet Synchronous Machine block operates in either generator or motor mode. The mode of operation is dictated by the sign of the mechanical torque (positive for motor mode, negative for generator mode). The electrical and mechanical parts of the machine are each represented by a second-order state-space model. The sinusoidal model assumes that the flux established by the permanent magnets in the stator is sinusoidal, which implies that the electromotive forces are sinusoidal. The block implements the following equations. These equations are expressed in the rotor reference frame (q_d frame). All quantities in the rotor reference frame are referred to the stator.

$$d/dt(i_d)=1L_d v_d-RL_d i_d+L_q L_d p\omega_m i_q$$

$$d/dt(i_q)=1L_q v_q-RL_q i_q-L_d L_q p\omega_m i_d-\lambda_p\omega_m L_q$$

$$T_e=1.5p[\lambda i_q+(L_d-L_q)i_d i_q]$$

L_q, L_d	q and d axis inductances
R	Resistance of the stator windings
i_q, i_d	q and d axis currents
v_q, v_d	q and d axis voltages
ω_m	Angular velocity of the rotor
λ	Amplitude of the flux induced by the permanent magnets of the rotor in the stator phases
p	Number of pole pairs
T_e	Electromagnetic torque

The L_q and L_d inductances represent the relation between the phase inductance and the rotor position due to the saliency of the rotor. For example, the inductance measured between phase a and b (phase c is left open) is given by:

$$L_{ab}=L_d+L_q+(L_q-L_d)\cos(2\theta_e+\pi/3)$$

Θ_e represents the electrical angle.

V. PROPOSED SYSTEM

The proposed model shown in figure 3 is modeled using the MATLAB with solar, wind and battery simulation in synchronized with ac grid is shown in figure 6.

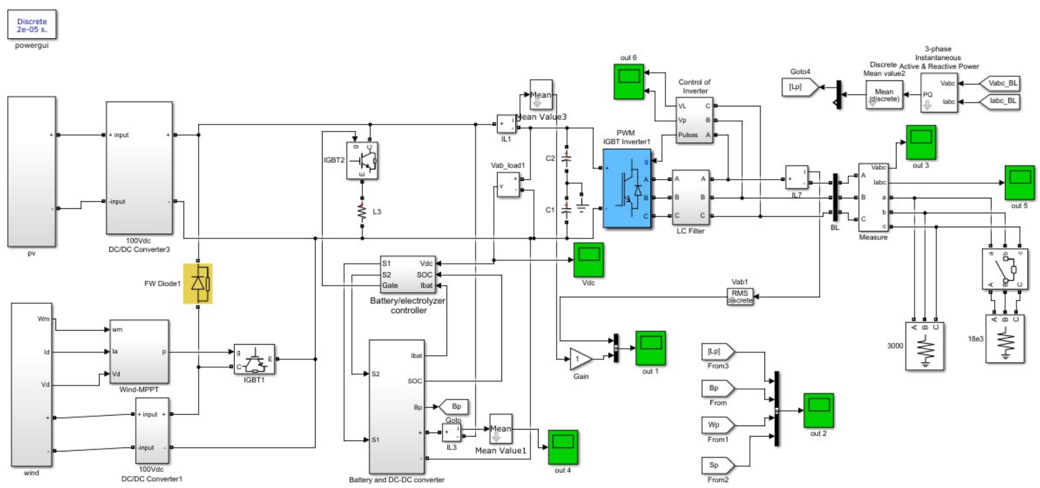

Figure 6 . MATLAB Model of proposed system

VI. RESULTS

The waveforms of power generation from each source is shown in below figures.

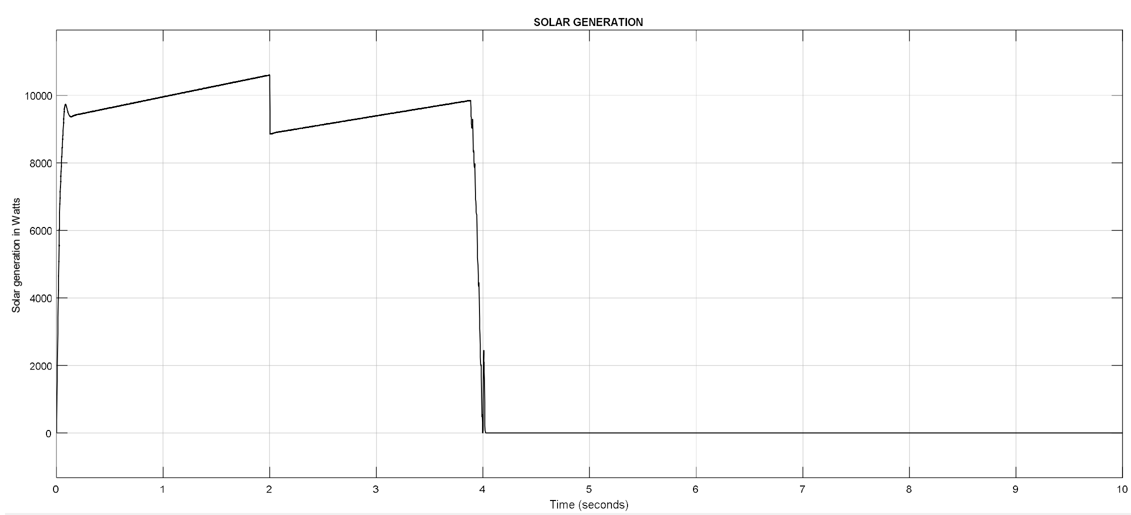

Figure 7. SOLAR PANEL GENERATION

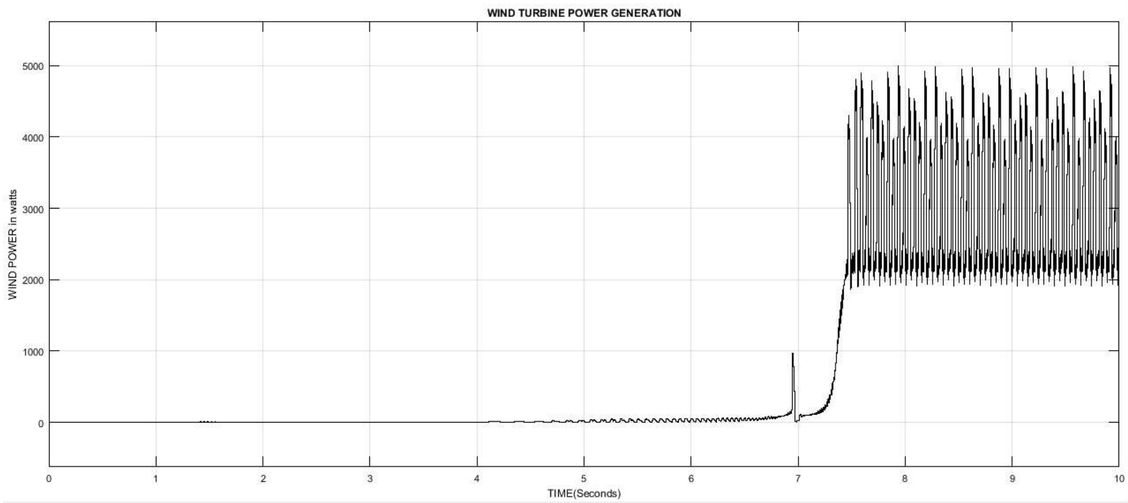

Figure 8. Wind Power generation

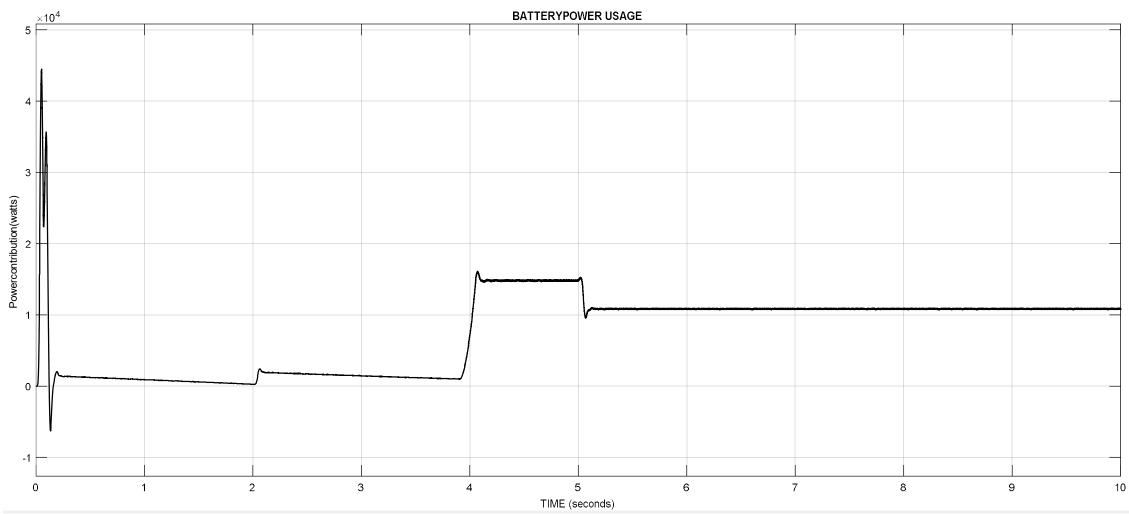

Figure 9. Battery discharge power

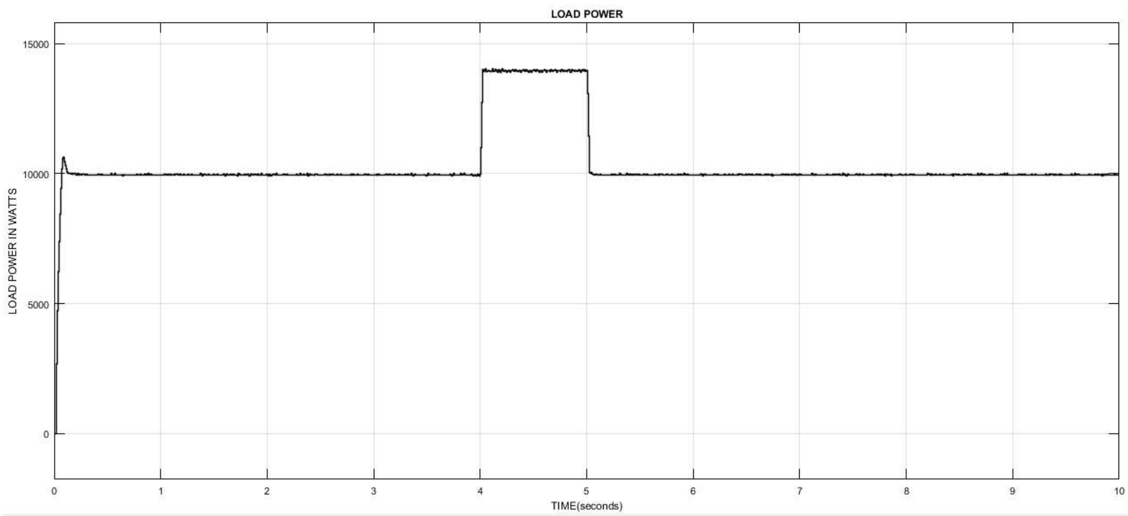

Figure 10. Load Power

VII CONCLUSIONS

In this paper, a renewable energy based hybrid power system, its energy management and control system is proposed. It is modelled for an isolated load/grid connected load using static converters. This proposed system facilitates improvement in power quality which ensures continuous and reliable supply to loads. Therefore, this system can tolerate the rapid changes in load and environmental conditions and suppress the effects of these fluctuations and provides optimum utilization of available resources. In this paper a new model was proposed by the integration of wind power and solar power by interconnecting it to the microgrid that stores and transforms DC power.

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