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MODELING AND CONTROL OF A BATTERY BASED PHOTOVOLTAIC GRID CONNECTED SYSTEM

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Abstract— currently, due to the less usage of conventional electricity resources and growing problems of environmental pollution, renewable energy resources are playing a large function in generating energy. The solar and wind are popular renewable energy sources among all of them, solar energy has grown to be a promising, famous and alternative supply due to its advantages consisting of abundance, no pollution, renewability and maintenance loose. Here three independent control loops are used to control the entire system. Those are battery control for bidirectional power flow between battery and DC-link through bidirectional buck-boost converter, MPPT control for extracting maximum power and inverter control for maintaining stable voltage and current at local load. The complete system is simulated and analyzed in MATLAB/SIMULINK.

Keywords— battery energy storage system, Solar Photovoltaic, point of common coupling.

I. INTRODUCTION

With technology advancement in the world, the need for energy is felt to grow very fast. And also the main portion of the energy requirement is derived from the conventional sources of energy, and then scientists moved towards the renewable energy resources. Despite the benefits, PV system also have a few risks as well. PV system can be discussed as useless during night, without the usage of BESS as the requirement in grid connected system. Nickel Metal Hydride battery considered for usage of PV system in this paper. The predicted life of Ni-MH battery under proper care is almost 5 years. The considered system in this paper consists of a PV based DG system, synchronized with the grid and supplying power to the load as well to the grid. The voltage level is equal between the load and the grid. The Battery is defined as a backup source that can be used during the emergency times. The capacity of the Batteries can be measured as 'Ah' (Ampere Hour), it simplifies how much amperes of current flows per an hour. So batteries play a critical position whenever it comes to storage purpose. This paper proceeds with the modelling of the PV generator, voltage source converter (VSC), control algorithm, BESS, Bidirectional converter for battery.[1][2][3]

II. SYSTEM MODELLING AND DISCRIPTON

PV cell is a primary unit of a solar PV system followed by PV module and PV array system [6]. A module is formed by the Group of PV cells joint together and a group of module in series and parallel forms an array to get the necessary voltage. A PV cell converts the solar energy into the electrical energy. The electrical characteristics of a PV cell resemble a p-n junction diode therefore the output current can be shown in the form of equation.

$$I_{pv} = N_p I_{ph} - N_p I_{rs}\left[\exp\left(\frac{qV_{dc}}{KT_cAN_s}\right) - 1\right] \quad (1)$$

Where Tc: working temperature of the cell,

Vdc: output voltage

Ipv: output current of PV array

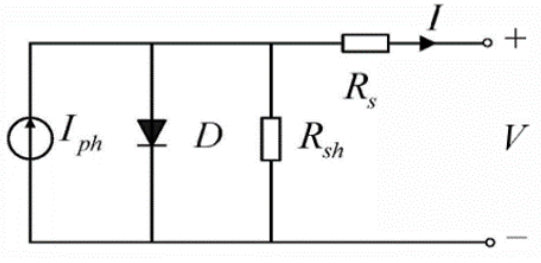

Fig.1 circuit diagram of solar cell

III. MODELLING OF BOOST CONVERTER

The Boost converter includes of a switch (IGBT/ MOSFET), a diode, inductor, capacitor and a load (may be R/ RL/ RLC-load). The MATLAB/Simulink of the boost converter is shown in Fig.2.

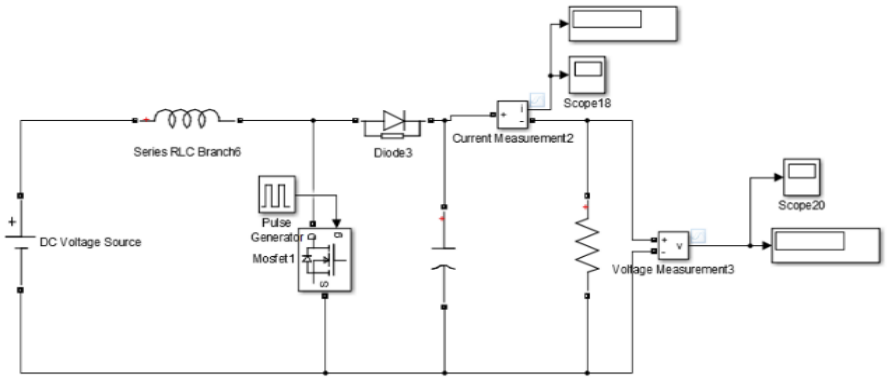

Fig.2 Modelling of boost converter

Boost converter converts a lower uncontrolled DC input voltage into highly

Controlled DC output voltage [7], [8].

Mathematically,

$$V_o = \frac{V_s}{1-D} \ldots (2)$$

Where, Vo: Output voltage

Vs: input/source voltage

D: duty cycle

Modelling of BESS

A battery can be used as a controlled voltage source (CVS) which is in series with a constant resistance (R). The equation for battery modelling is given in equation (3).

$$E = E_0 - K\frac{Q}{Q - \int idt} + A\exp(-B)\int idt) \quad (3)$$

Where, 'E': no load voltage,

'Eo': constant battery voltage,

'K': polarization voltage,

'Q': battery capacity,

'A': exponential voltage,

'B': exponential capacity

'i': current of the battery

Modelling of Bi-directional Converter

The bidirectional buck-boost DC-DC converter is used to maintain continuous power flow between the DC bus and battery energy storage system. A constant voltage across the dc link is maintained by the charging or discharging of the battery depending upon the change in solar irradiance or change in the load. So voltage across the dc link should be

stable through the operation of the system when the battery is Charging or discharging.

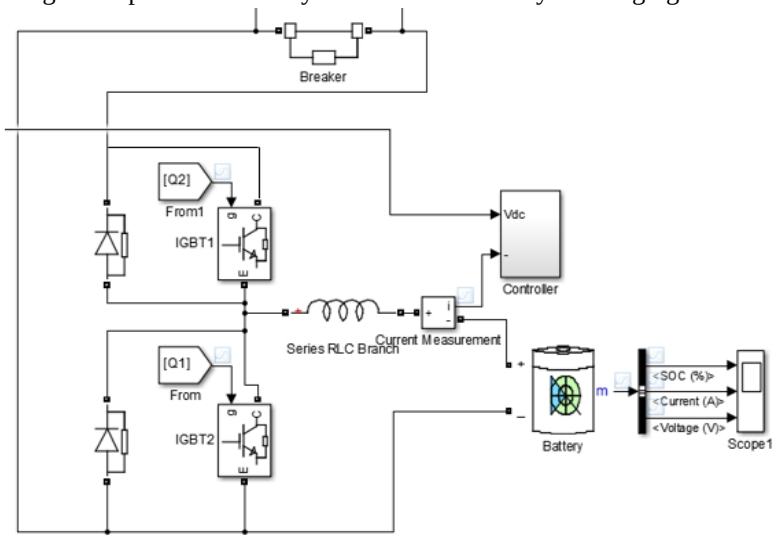

Fig.3 Modelling of bi-directional converter

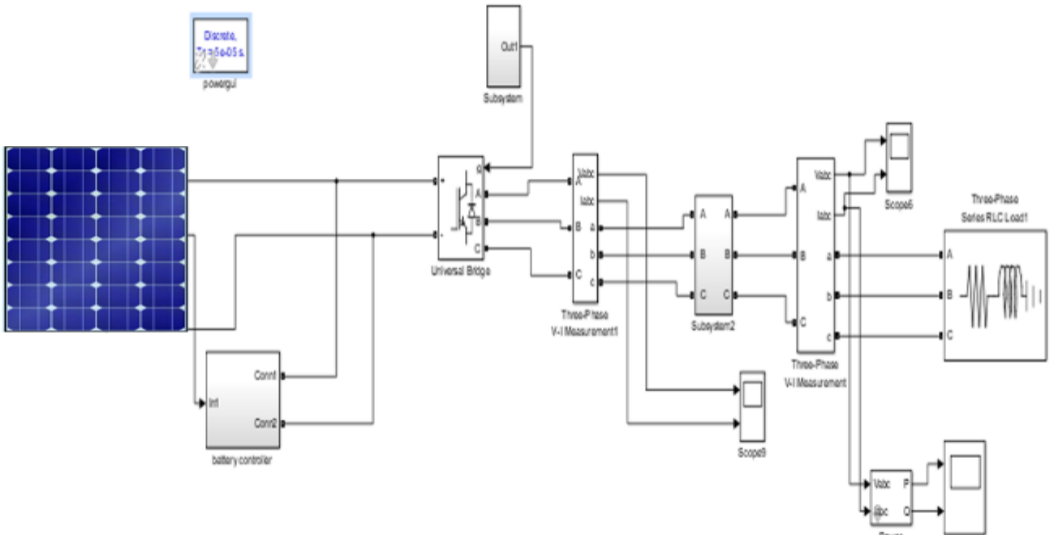

Fig.4 PV based battery grid connected system

IV. SIMULATION RESULTS

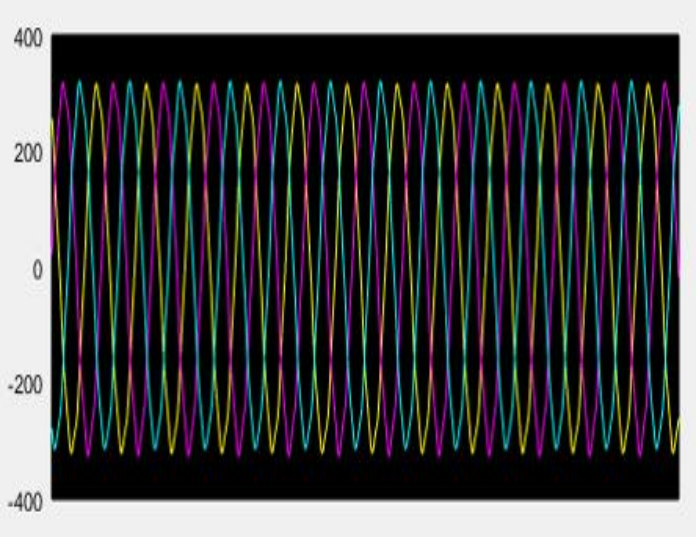

Fig.5 Output voltage in grid side

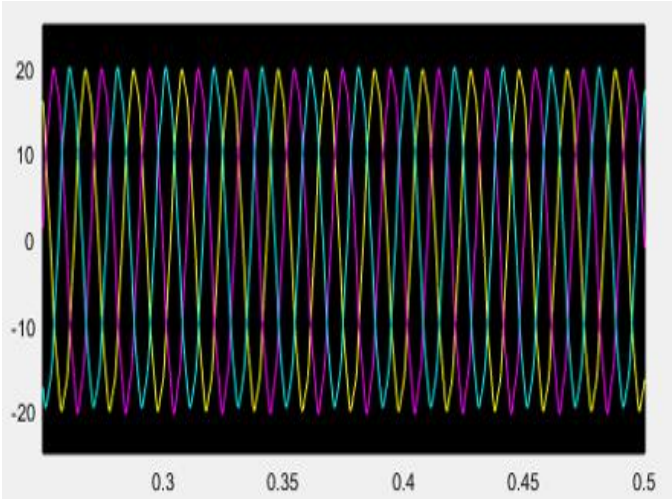

Fig.6 Output current in grid side

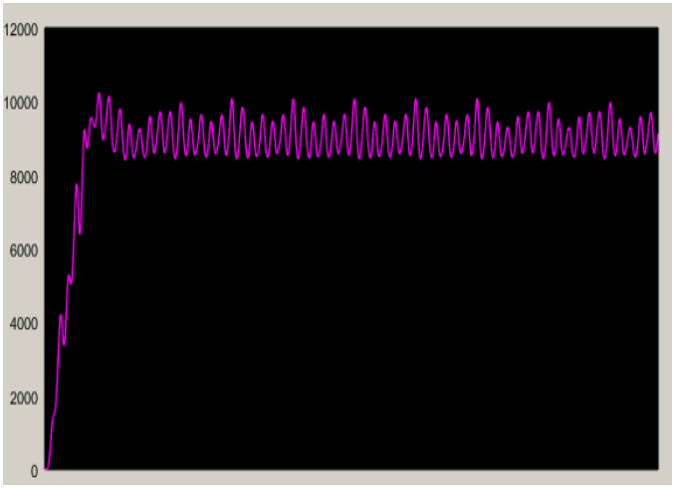

Fig.7 Active power in grid side

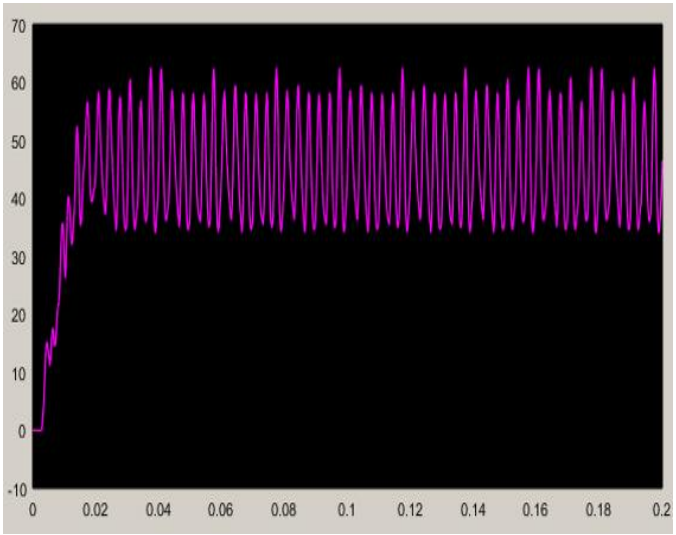

Fig.8 Reactive power in grid side

V. CONCLUSION

The proposed system is clarified over integrated with battery based grid connected PV system. The active power during healthy conditions is shown. The battery connected PV system as a backup works superior to the no battery based PV system and it can be used during emergency times and faulty conditions.

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