PV System Powered BLDC Motor with Energy Storage

M.V. Ramesh, P. Sowjanya, V.S.G.Lakshmi

Abstract*: PV energy is a plentiful renewable source and is expected to play a vital role for distributed generation. In this paper, photovoltaic system includes a battery solution that is prepared in PSCAD. A simple control method able to work the solar PV moduleatmax power utilising a common 3- phase VSC is suggestedfor motor control.BLDC motor is powered by PV energy. The power shared by each source is controlled by power factor corrected boost converter. Battery is connecting to the system in order to prevent voltage fluctuations, and to eliminate the power mismatch between PV power generation and motor. The performance of the system is developed and implemented using the PSCAD/EMTDC Software.

***Keywords* : Photovoltaic (PV) array; Maximum power point tracking (MPPT); energy storage; BLDC motor.**

I. INTRODUCTION

Due to rapidly growing population, sudden climate change, global warming, depletion of conventional fossil fuels the demand of renewable energy is increasing day by day. Solar power turns into comparatively cheap in the coming years and rising as better technology. The essential advantage of sun strength is that the sunlight can be at once converted in to solar energy by using least photovoltaic (PV) solar cells [1].

Power electronic converters are utilized in the system, since the tradition control matrix is an AC system, but the PV output is DC. The amount of power produced by the PV module is function of inputs i.e. irradiance and temperature [6]. PV module has nonlinear behavior and so it is required to model for Maximum Power Point Tracking (MPPT). PV module generates small amount of power, the MPPT need to continuously adjust the system and attracts maximum energy from the sun regardless of climate or load conditions [5]. Photovoltaic structures can exist as standalone system also. However, electricity swings may occur because of varying irradiance. To have constant power even at during shading, energy storage devices such as batteries may be incorporated into the PV system [7].

In this paper, solar PV system powered brushless dc motor with energy storage using PSCAD/EMTDC model is presented along with the solar panel modeling at different values of irradiance as input parameters, and MPPT modeling based on the perturb &observe algorithm. Different power electronic converters can be utilized to promise that PV systems are managed for maximum outputs with changes in both ecological and electrical parameters. The major contribution of this paper is to power the BLDC motor and energy management control of PV system in PSCAD/EMTDC software.

Section2 defines the system configuration. Section3represents thecontrol of system. Section4 presents simulation results for voltage output of the PV powered BLDC motor under various operating conditions. Section V finally concludes the paper.

II. SYSTEM ARRANGEMENT

Block diagram demonstrationof PV powered motor with energy storage is presented in figure-1. Solar PVsystem with MPPTcan be acquired by P&O algorithm which is fed toboost converter. Depending upon the reference power generated by the MPPT, the dc link current is adjusted by the boost converter. Buck-boost topology is used for energy management control. The 3-phase VSC controls the DC voltage keeping reference value. DC link capacitor is connected to VSC which is responsiblefor high-quality powerflow to the load.

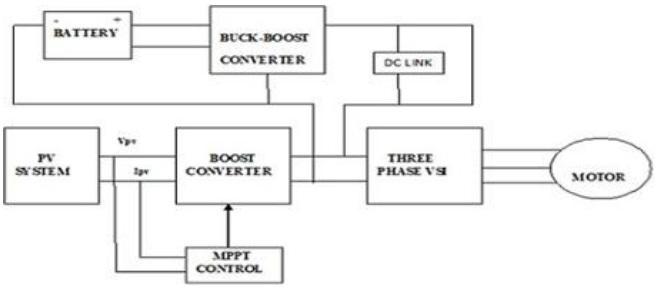

Figure 1: Block diagram of the system

Fig-1 Block diagram of the system

The system is operatedprimarily based on 2 situations. First one is while a battery is feeding the load. During night time, battery feeds the load. Other one is while both the battery and PV system are feeding the load. If radiation isnot sufficient to power load at rated speed, remaining load is fed from battery. During these 2 conditions, battery acts as source. Speed is proportional to the depth of solar radiation

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PVArray:

Different combination ofcells and quantity of PV modulesis to be described according to strength andenergy necessities.

Characteristics curves are shown in fig-2. The irradiance has fast drops during cloudy times. The maximum irradiance is 1000W/m2.The ambient temperature is to be as 250C, which turned into the standard value for the area of the given irradiance.

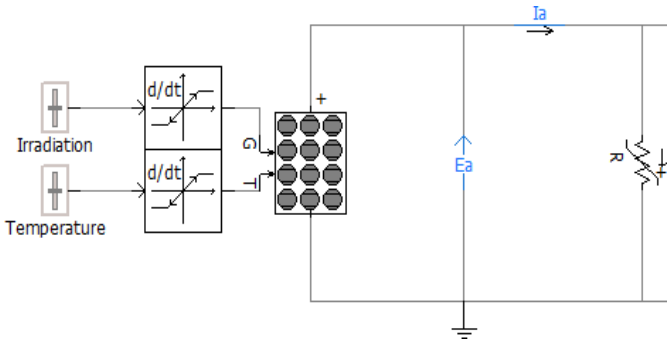


Fig 2a): PV array connected to resistance

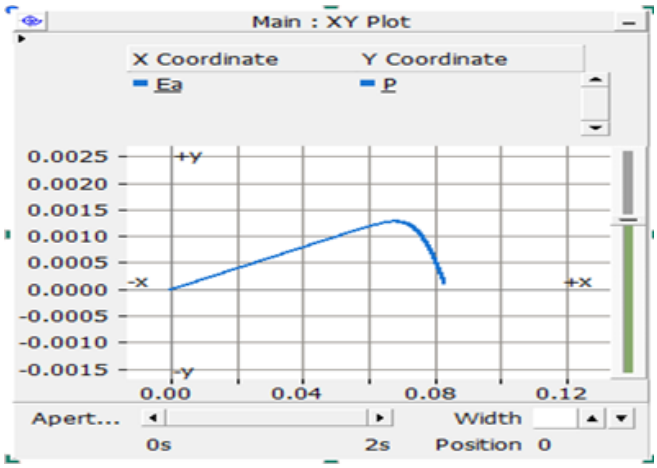


Fig 2b): Power Vs Voltage characteristics of PV array

Irradiation	At 1000 w/m^2	At 800 w/m^2	At 500w/m^2
Voltage(kV)	0.659	0.652	0.63
Current(kA)	0.62	0.50	0.31
Power(MW)	0.31	0.25	0.15

Fig2c) Table for different irradiance values

Battery:

The battery library version in PSCAD is as the Shepherd model. Theotheroption isto identify rate of charge and discharge curves. The model is used to observe the battery nominal voltage at 48V. This voltage is taken by arranging a bank with series and parallel.

III. CONTROL OF PROPOSED SYSTEM

This system control is classified into three parts; manage PV array through an MPPT approach, switching pulse generation for VSI.

Maximum Power PointTracking:

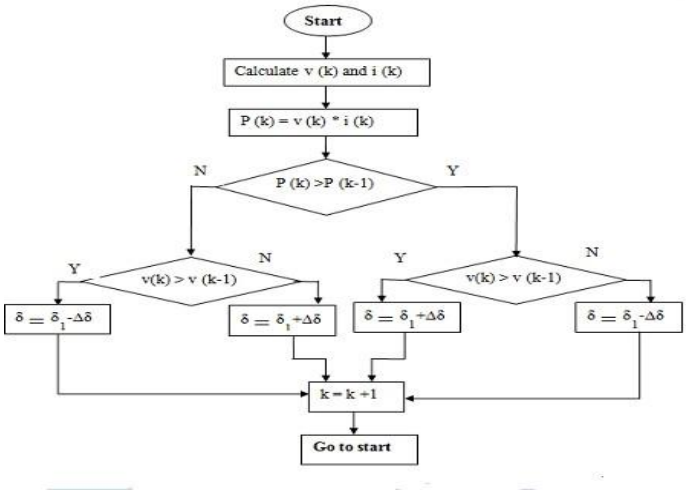


Fig-3: P&O MPP AlgorithmFlow Chart

Perturb & Observe is simplest technique of MPPT to put into effect. In this technique voltage is only sensed & easy to apply. In this method output power is checked through various supplied voltage. P&O flow chart is shown in Figure-3.

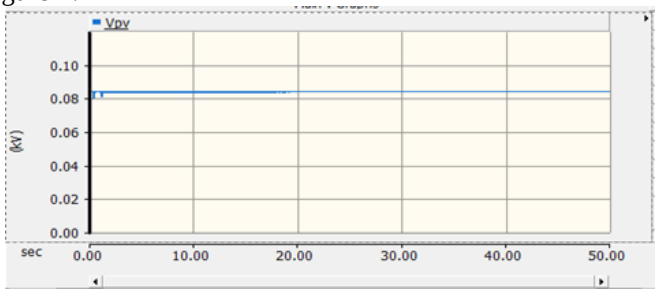
According to MPP theorem, output power is maximized by varying supply impedance identical to the load impedance. The MPPT algorithm is equal to the trouble of matching impedance. In present paper, Boost Converter is utilized as impedance coordinating circuit among I/Oby changing its duty cycle.

Switching Pulses forVSI:

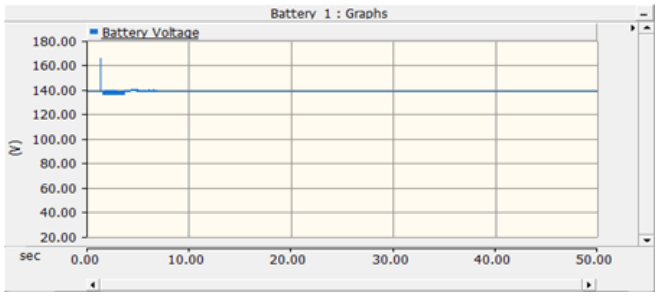
The pulses for 3-phase VSI are produced by using PWM technique. It is the sine-triangle PWM, where, a sinusoid of the desired frequency is compared with a high frequency ramp and its output is used to drive the switches. It is vital to note that adjoining switches cannot be turned on simultaneously since this could typically result in the short circuit of the DC link.

IV. SIMULATION RESULTS

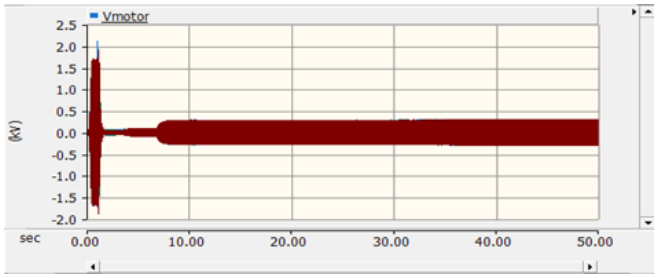
The proposed model issimulated in PSCAD instable-state and transient conditions at 1000 W/m2. The performance of BLDC motor, Battery and PV system aredisplayed in Figure-4.



4a) PV array voltage



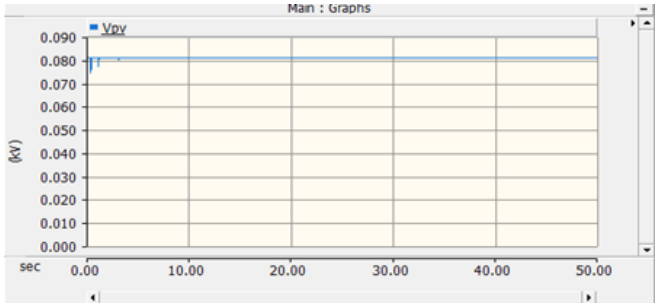
4b) Battery voltage



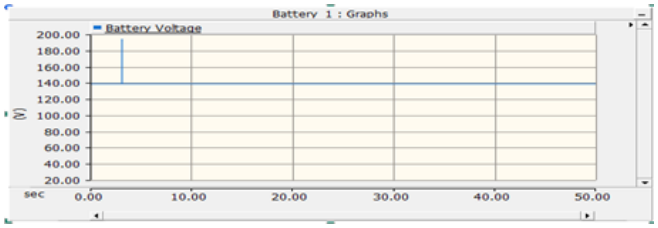
4c) BLDC motor voltage

B) Dynamic performances at 500W/m²

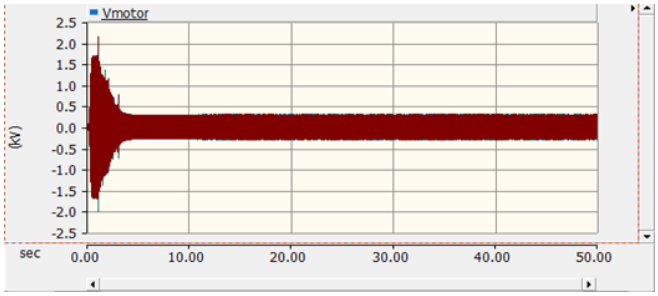
The dynamic responses of BLDC motor, Battery and PV cell are exposed in Figure-5.



5a) PV array voltage



5b) Battery voltage



5c) BLDC motor voltage

V. CONCLUSIONS

The projected BLDC motor drive powered by solar PV system is demonstrated through steady-state and transient performances. This model is modeled in PSCAD software. Implementation of PV system and battery converters are considered. The consequences show that the energy control and management work as predicted.

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