CONTROL AND ENERGY MANAGEMENT OF SINGLE-STAGE GRID-CONNECTED PV SYSTEM USING BES SYSTEM

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ABSTRACT - The goal of this article is to develop a DC-DC bidirectional converter to manage the battery charge, hold, and discharge operations based on the load requirements. For genuine power injection. The regulation of single-stage conversion is becoming more common, accomplished solely by VSC. However, coordination between the DC-DC converter and the VSC is necessary to accomplish concurrent MPPT and actual power injection operation. A coordinated control of single stage grid linked SPV and BES systems, as well as energy management, is suggested in this study. The method coordinates the VSC and bidirectional DC-DC converter depending on the battery's State of Charge (SoC) to achieve both MPPT and power injection at the same time. Not only does the suggested technique inject actual power, but it also compensates for load reactive power and minimises imbalanced neutral current. Fur Then, for better usage of VSC capacity. Simulation studies are used to explain the proposed method's multi-functional characteristics.

Keywords- Bidirectional DC/DC Converter, solar photo-voltaic, battery storage system, energy management.

I. INTRODUCTION

Non-renewable energy sources are depleted on a daily basis. As a result, it is necessary to concentrate and focus on renewable energy sources such as solar, tidal, wind, and geothermal. Solar energy is clean and abundant; significant emphasis is placed on the PV cell, which offers benefits such as low maintenance, extended life, and convenience of installation. Electric power is created when a photovoltaic cell is irradiated by sunshine or artificial light. Because there is no transfer to thermal energy, a photovoltaic transforms solar energy directly into electrical energy; it is a direct conversion process. Maximum available power is provided to system by activating the SPV system Maximum Power Point. Due to its availability, the traditional.

The standard approach in PV systems, particularly in GCPVSs, is to use two stages, one with to keep the inverter's output voltage within grid compatibility limits. The maximum power point tracking (MPPT) approach with two stages is easy to implement since the maximum power may be tracked easily by controlling the boost converter switching. lowering the system's overall efficiency. As a result, it is simple to build a single-stage power conversion unit (PCU) that can be linked to the grid and supplied by a string of PV modules. The, and it also encourages the development of a plug-and-play grid interface.

Although the conversion stage efficiency in grid-connected SPV systems has increased, it still faces the issue of intermittent energy generation in the face of is integrated into the grid-connected SPV system. which is explored in the literature. Despite the fact that done in two stages. The system is addressed in a Overcome the suggested hybrid storage system for varied operating modes in energy management.

II. BLOCK DIAGRAM

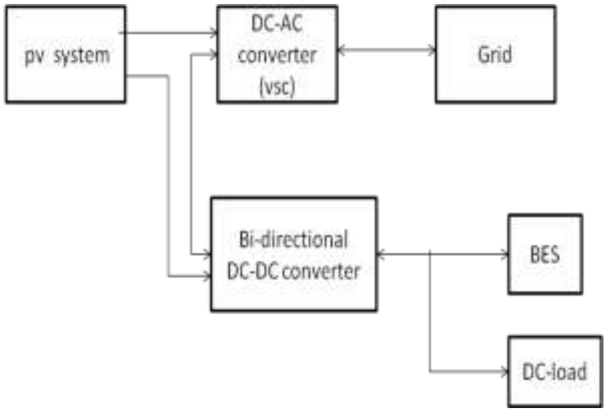

Fig.1. With the BES System, a single-stage PV system was proposed.

A Solar Converter RSC with single-stage conversion is implemented for photovoltaic PV and battery applications. In which the MPP is only reached when the battery is charged or when electricity is injected into the grid, but it is not feasible to charge the battery and pump power into the grid at the same time. The inverter is also isolated from the grid when charging the battery.

As illustrated in Fig. 1, this article proposes a single-stage SPV-DSTATCOM and battery storage with coordinated control. The qualities include real power injection, reactive power adjustment, and active rectification, to name a few. The recommended control operation is divided into three modes, each of which is dependent on the amount of SPV power available.

III. Equivalent representation for the above block diagram

In a three-phase network, Figure 1 illustrates All of the components are included, including the Solar modules are linked in series and parallel to match the needed voltage and power ratings in the SPV strings. The VSC is primarily utilised for SPV MPP tracking and real-time power injection. VSC provides auxiliary services such as reactive power compensation, grid current balancing, and active rectification to enhance power factor.

This proposed solution connects battery energy storage to VSC's dc-link.

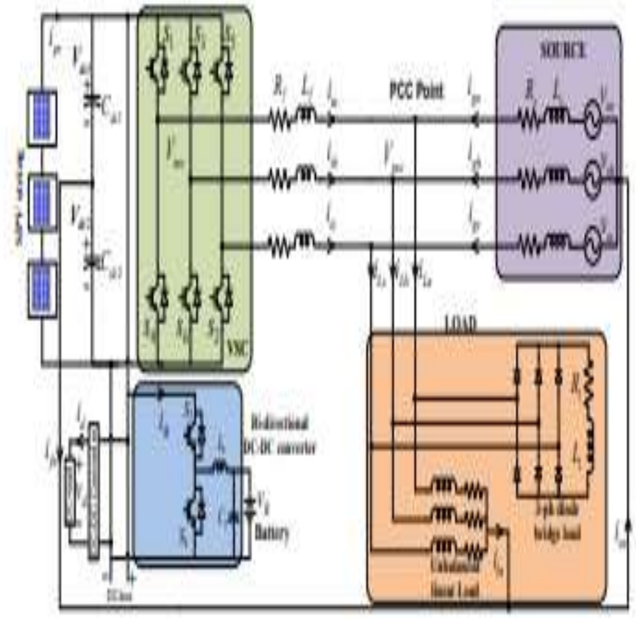

Fig.2. Equivalent representation for the above block diagram

SPV with Storage and Grid Connection:
The MPPT is achieved in a grid-connected SPV system without a storage device via the VSC's DC-link voltage control loop, which ensures power balance.

SPV with Battery Storage and Grid Connection:
In a grid-connected SPV system with battery storage backed by a DC-DC converter on the dc-side of the VSC, the MPPT is achieved by synchronising the operation of the VSC and the DC-DC converter.

IV CUREENT CONTROL SCHEMES

4.1. PI Controller:

The Proportional Integral (PI) is a common current controller that keeps output current sinusoidal, maintains a tight power factor, and is simple to use. These advantages are proportional and integral, and their magnitude is determined by the system's features. It takes a long time and a lot of effort to manually modify PI controller parameters to achieve steady state. A fuzzy controller can be used to get around this constraint.

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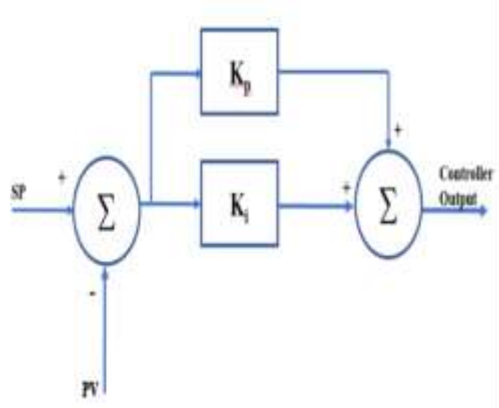

Fig. 3. PI controller block diagram.

4.2. Fuzzy Logic Controller:

They are the four primary components of an FLC. Conventional controllers may not work effectively in most nonlinear applications. As a result, the fuzzy logic controller has shown to be an effective solution for a variety of nonlinear applications. Membership functions (input/output) make up a fuzzy logic controller. The knowledge base's input response is divided into two categories: errord and change in error de.

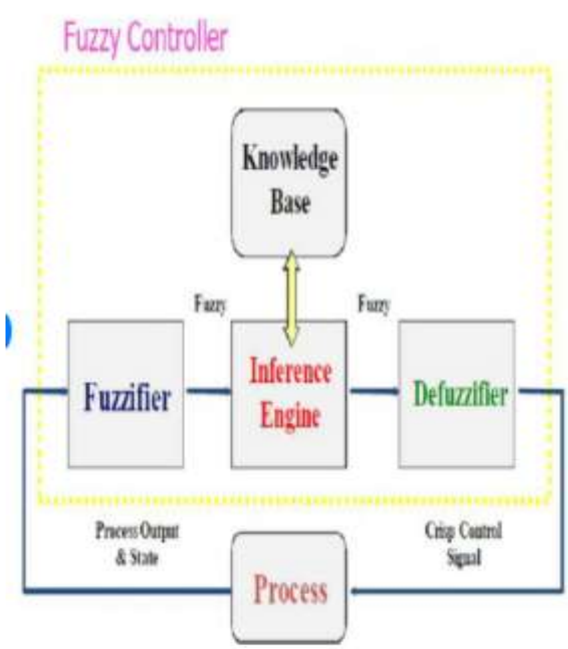

Fig . 4 Block of diagram of FLC

4.2.1Variables:

The Linguistic variables considered in the control are

- ZE- zero
- PS-positive small
- NS-negative small
- PM-positive medium
- NM-negative medium
- PB-positive big
- NS-negative big

4.2.2 Membership functions:

Error:

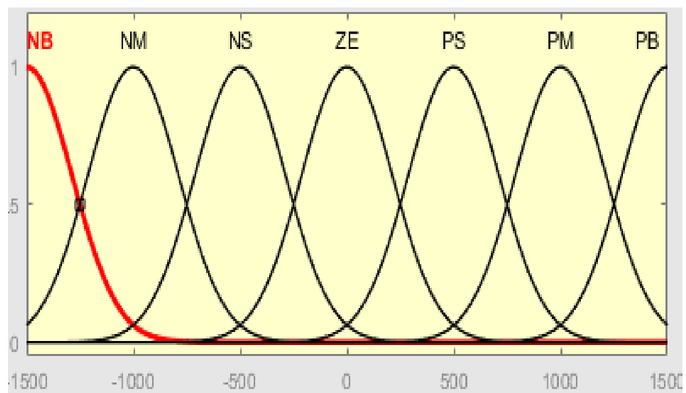

Fig .5. Membership function for error signals.

Change in error:

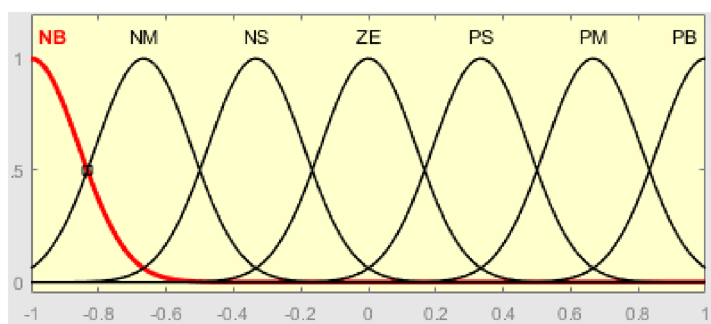

Fig .6. a change in the membership function of the error signal.

Control signal:

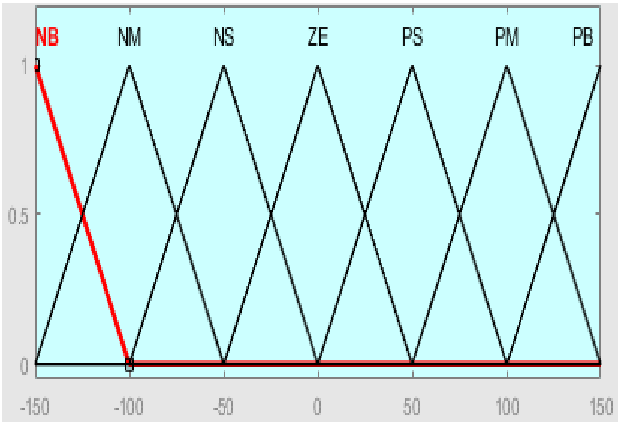

fig .7. Control the signal's membership.

4.2.3. RULE base for fuzzy control:

The following is a general interpretation of the control principles that should be applied to the Fuzzy control:

• Leave the current value alone if Error = 0 and Change in Error = 0.

• Don't change the current setting if Error is non-zero but approaching zero at an acceptable rate.

de/e	NB	NM	NS	ZE	PS	PM	PB
PB	Z	PS	PM	PB	PB	PB	PB
PM	NS	Z	PS	PM	PB	PB	PB
PS	NM	NS	Z	PS	PM	PB	PB
ZE	NB	NM	NS	Z	PS	PM	PB
NS	NB	NB	NM	NS	Z	PS	PM
NM	NB	NB	NB	NM	NS	Z	PS
NB	NB	NB	NB	NB	NM	NS	Z

Table1: Fuzzy control rule base

V. SIMULATION MODEL AND RESULTS

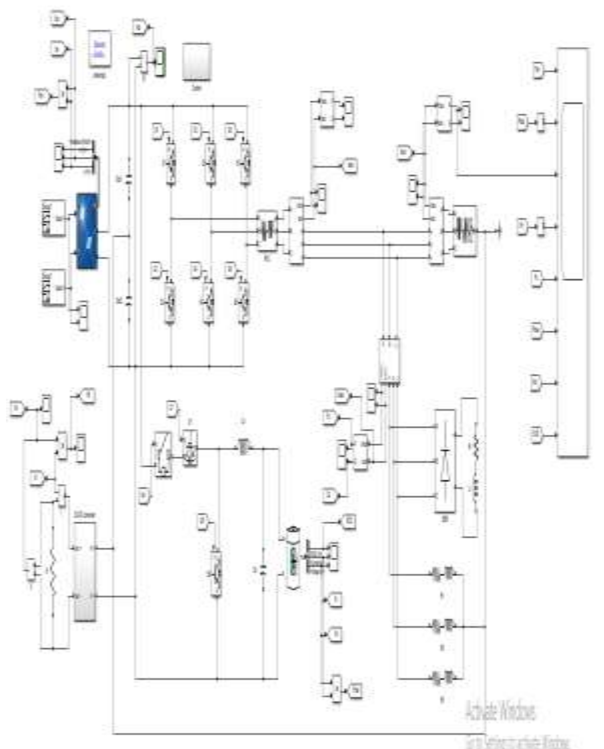

Fig.8. Integration of an SPV DC-DC converter with a VSC

Simulation model of Controller

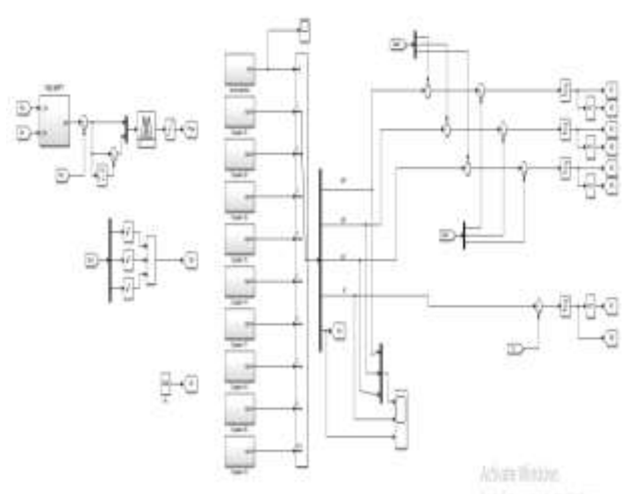

Fig 9.simulation model of controller

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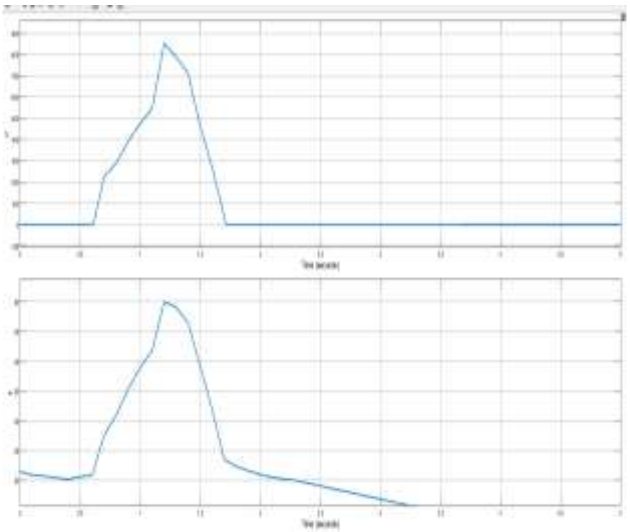
Fig 10.Temperature &Irradiance output waveform

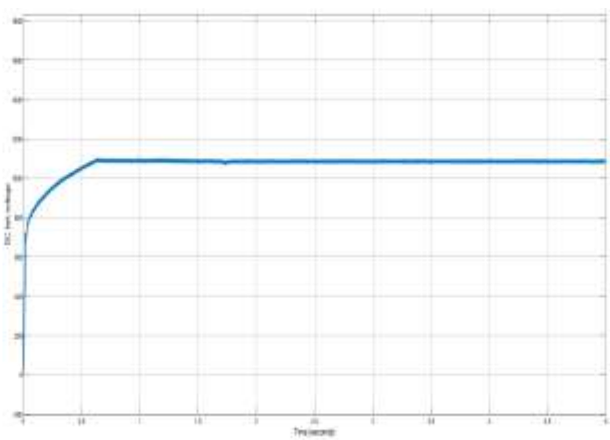
Fig11. DC- link voltage output waveform

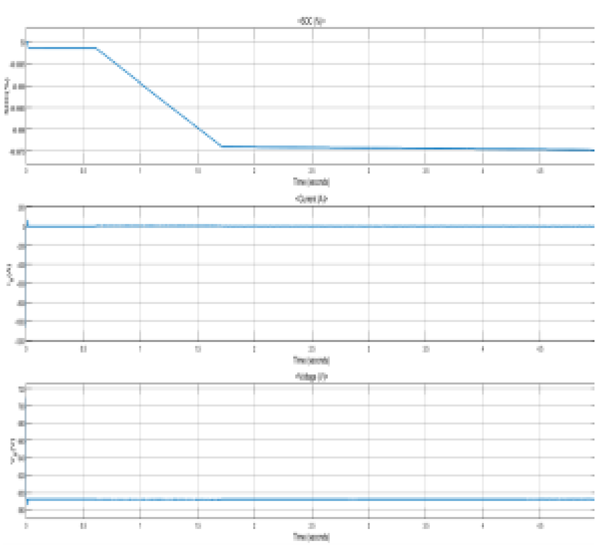
Fig12 Battery output wavef

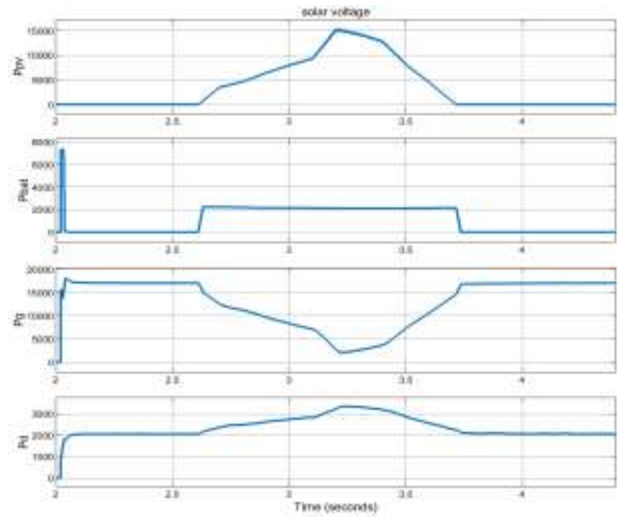

Fig13. DYNAMIC POWER FLOW (a) solar voltage (b) battery power (c) grid power (d) dc-load power

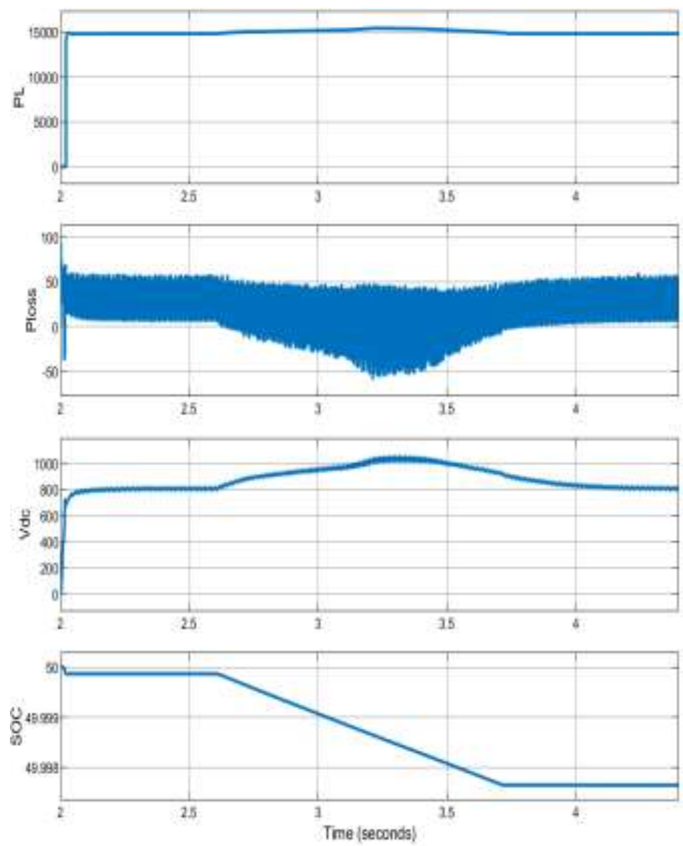

Fig.14. ac-load power (b) power losses (c) dc-link voltage (d) state of charge

VI. CONCLUSION

This paper proposes a single-stage SPV-DSTATCOM with coordinate control technique for The performance of the suggested technique is shown through simulation

studies in which it is operated in various modes, revealing the benefits of the proposed approach.
1)During SPV hours, actual power injection to the grid, as well as battery charging and discharging, is feasible in addition to reactive power correction.
2) With an energy storage device, the system's reliability improves .

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