# EFFICIENT DESIGN AND EVALUTION OF LARGESACLE SOLAR PV FARMS WITH DC BATTERY SYSTEMS

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**ABSTRACT:**

Typically, solar inverters curtail or "clip" the available power from the photovoltaic (PV) system when it exceeds the maximum ac capacity. This article discusses a battery system connected to the dc link of an inverter to recuperate this PV energy. Contrary to conventional approaches, which employ two dc-dc converters, one each for the battery and solar PV system, the proposed configuration utilizes a single dc-dc converter capable of simultaneously operating as a charge controller and a maximum power point tracking (MPPT) device. In addition to improving the overall system capacity factor, increasing the conversion efficiencies, and ensuring MPPT stability, the proposed configuration offers a simple solution for adding energy storage to existing PV installations. With this configuration, the excess power that will otherwise be curtailed due to inverter rating limitations is stored in the battery and supplied to the grid during periods of reduced irradiance.

**Keywords: PV, MPPT, DC-DC converter, High efficiency.**

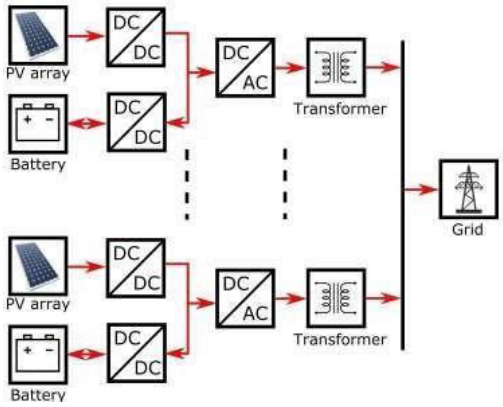
## INTRODUCTION

Due to the consideration towards depletion of conventional energy sources and environmental impacts, the role of renewable sources for energy generation has become prior choice nowadays. Due to the ease of availability, environment friendly nature and the reducing trends in the cost of solar photovoltaic (PV) panels, solar based energy generation has become popular as compared to other energy sources [1]. The main drawback of the solar energy, is its intermittent nature. So the solar PV array alone, is not possible to meet the load demand at every time. This causes poor reliability of the system. This problem is overcome by using the battery energy storage (BES) along with the PV array [2]. There are several configurations, which are available for integrating the PV array and BES into the utility grid. A single stage grid interfaced solar PV- BES system is reported in the literature with maximum power extracting capability [3]. A grid integrated PV-BES system involving two stage conversion is also reported in the literature [4]. Where the extraction of maximum power from the PV array is done by using maximum power point tracking (MPPT) control, which generates duty cycle for the DC- DC converter. For extracting the PV array maximum power, there are several

algorithms, which are available and these are discussed in the literature [5]. The power quality aspects are met by controlling the voltage source converter (VSC) with proper control algorithms. Most of the loads connected at the point of common coupling (PCC), are highly inductive and nonlinear loads. Due to the highly inductive loads, the power factor of grid side is poor and the nonlinear loads cause high distortion to the grid currents and that reflect to grid voltages also. So the power quality improvement plays a vital role in the grid connected PV system.

**Objectives**

A technique for integrating battery storage into multi-MW grid-connected PV systems using a dc-dc converter that can serve as both an MPPT and charge controller at the same time. The PV system's overall energy output is raised with such a setup, the PV system's dc-link voltage is better controlled during power outages, and the system efficiency is higher than with other frequently employed methods using numerous power converters. Also, the suggested method offers battery integrated PV systems a relatively low cost without the requirement of a separate dc-dc converter for MPPT optimal control. A 20% increase in the yearly capacity factor of PV systems is feasible in regions with abundant clear days and adequate solar PV resources.




## LITERATURE SURVEY

Samuel et.al (2019): "Awareness and use of solar energy as alternative power sources for ICT facilities in Nigerian university libraries and information centers". This paper reports a survey carried out to investigate the awareness and use of solar energy as alternative power source for ICT facilities in Nigerian library and information centers. Descriptive research design using survey method was adopted for this study. Questionnaire was designed and used as survey instrument. The population for this study includes the staff of three Nigerian university libraries. Finally, this study concludes that all the respondents have good knowledge of what solar energy is as they all responded in affirmative.

Ehsanul Kabir et.al (2018): "Solar energy: potential and future prospects". In this article the merits and demerits of solar energy technologies are both discussed. A number of technical problems affecting renewable energy research are also highlighted, along with beneficial interactions between regulation policy frame works and their future prospects. For that they

provide a global scenario with regard to solar energy technologies in terms of their potential, present capacity, prospects, limitations and policies. This was help them to expand their understanding on how much further they can count on solar energy to meet the future energy demand. Finally, they concluded that despite a few drawbacks solar energy technology is of the most promising renewable energy sources to meet the future global energy demand

Suhas bannur (2018): "Concentrated solar power in India: current status, challenges and future outlook". In this article, some of the challenges that have inhibited the growth concentrated solar power are identified and possible solutions suggested. The critical challenges for CSP are related to the lack of reliable direct normal irradiance database, indigenous manufacturing and competition from PV. The results of this study carried out to assess the impact of indigenous manufacturing and economics of scale on capital costs and normalized cost of electricity are presented and this study also shows that even with indigenous manufacturing and considering economics of scale, the capital cost per megawatt of installed capacity is higher than the central electricity regulatory commission benchmark costs

Jean Baptiste et.al (2018): "A review of the solar energy situation in Rwanda and Uganda". In this paper authors review the solar energy development and future in Rwanda and Uganda. In these two countries, solar energy sector plays an important role in supporting socio-economic development. The paper examines the development of solar energy market in both countries since their beginnings in the 1980s. This peer review paper also identified that supports from donors, investors and government to promote development of solar energy in these two countries. Finally, the challenges and opportunities facing Rwanda and Uganda in development of solar energy are presented in this study.

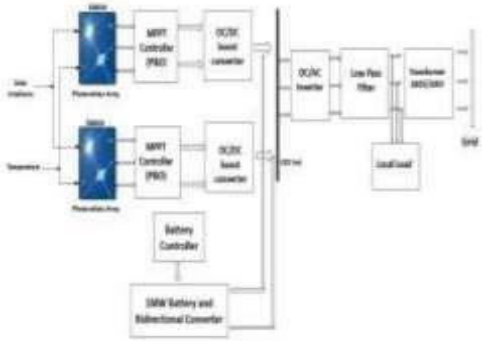
Farhard Taghizadeh-Hesary (2018): "Empirical analysis of factors influencing price of solar modules". In this paper authors examined the influence of wage, interest rate, exchange rate and oil price on the price of solar modules for five major solar module producing countries. For that they focused mainly on the consideration of potential economic factors would give us new insights into the mechanism surrounding the recent cost reduction in solar modules. And they concluded using corporate R&D expenditure as an independent variable may give us a better understanding of the role of solar R&D in reducing technology cost.

## METHODOLOGY

Using Posits software center, it's a computational research. PVsyst is software for simulating stand-alone and grid-connected PV systems. System location is in Karad near area. On the grounds of prior inquiry, validation will be carried out. GRID CONNECTED SOLAR PV SYSTEM – A grid-connected solar PV power plant is being

installed using PVsyst Software to power generation, economic feasibility of some of the locations in INDIA. Proposed model shown in figure of the grid-connected PV system. The validation location of Rethae Bk at the eastern of Kasegaon is used. It is a computational study using Posits software facility. PVsyst is simulation software able to simulate both stand alone and grid connected PV systems.. Validation will conduct on the basis of previous investigation.

The PV-Batteries grid connected system design is based on type of the system, location, required area, solar irradiance etc. The basic components of PV system are PV modules, maximum power point tracking (MPPT), DC- DC converters inverter and batteries [8].To design a grid connected solar PV system for the commercial use, the following steps are required.



Many literatures have been published related to drive PV power plants with energy storage (ES) to manage and stabilize the production of PV power plants. However, a large and growing body of literature is related to the investigation of the possible use of ESSs to reduce the significant impact of PV generation on distribution networks (residential) and standalone (off grid) small scale KW photovoltaic systems.

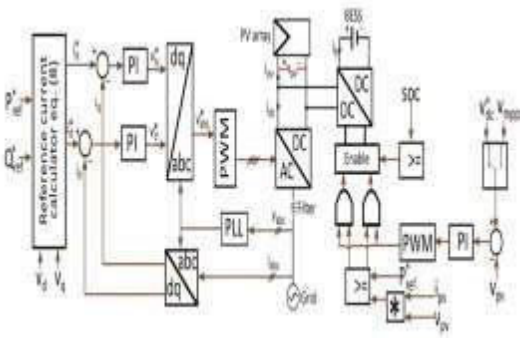
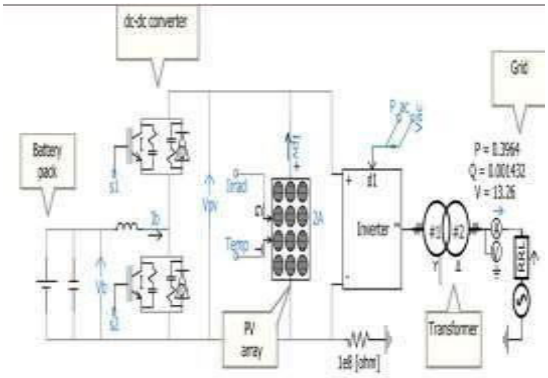



**Fig.1. Controller circuit.**

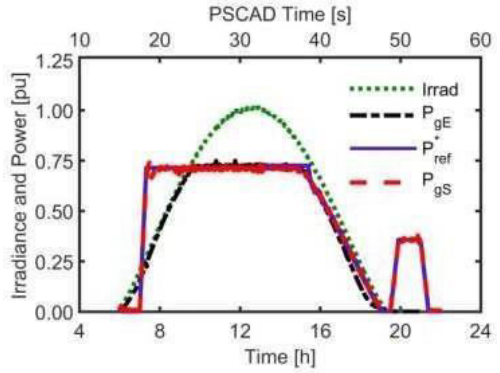
The main objective of this paper is to present energy control strategy using lithium ion batteries for large scale of PV system connected to grid. The batteries act as energy buffer and inject electricity into the grid based on requirement to manage the production of the PV system. In this paper, the concept of energy storage management used is an extension of the approach implemented for low voltage and low energy storage system applied in [8]. The proposed model consist of 1MW of System along with 1MW batteries and the grid which are connected by DC-DC boost converters and three phase DC-AC inverters as shown in Fig.1.

Maximum power pointtracking (MPPT) perturb and observe (P&O) method is used as known of its ability to significantly increase the efficiency of the PV system during the rapid change in irradiance [ 9]. The batteries manage the power flow through grid using bidirectional converter and controller. The results of simulation confirm

the effectiveness of the strategy of energy storage management.

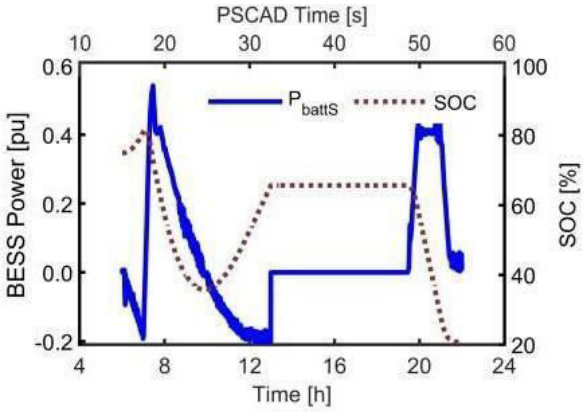



In order to assess the anticipated transients during transitions and validate the model's performance, a single portion of the multi-MW PV system is simulated in PSAD/EMTDC under various operation modes for the same example day. The was estimated to show the proposed system's many operational modes. Moreover, the BESS was scheduled to be unavailable between 13 and 19.5 hours to verify system functionality and transient stability. The PSCAD/EMTDC simulation was speeded up so that a 1 second period of PSCAD time corresponds to 24 minutes of real-time active reference.




## CONCLUSION

The strategy for integrating battery storage into multi-MW grid-connected PV systems is presented in this study. It involves the usage of a dc-dc converter that can serve as both a charge controller and an MPPT device. The PV system's overall energy output is raised with such a setup, the PV system's dc-link voltage is better controlled during power outages, and the system efficiency is higher than with other frequently employed methods using numerous power converters. Also, the suggested method offers battery integrated PV systems a relatively low cost without the requirement of a separate dc-dc converter for MPPT optimal control. In order to decrease the annual curtailed energy from utility- scale PV farms, a generic strategy for sizing dc-bus connected batteries is devised. This method assesses the smallest battery size.




Three phase voltage Source Inverters (VSI) is used to convert the DC bus voltage regulated by the capacitor into three-phase AC voltages with variable magnitude and frequency. The inverter circuit is represented in Fig.4, it contains insulated gate bipolar transistors (IGBTs) which rely on the reference voltage and the switching method to

provide variable frequency. VSI is efficient, cost effective, require small space, and faster dynamic response. Two control loops used in VSC: internal control loop to regulate Id (direct axis current) and external loop Iq (quadrature axis current) to control the active and reactive power flow of three phase inverters connected to grid. Phase locked loop (PLL) is applied to control the grid voltage and current to maintain the

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