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# Solar Photo Voltaic System Power Enhancement Control Strategies for Inverter- A Survey

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**ABSTRACT**

Photovoltaic (PV) energy has a fast growing annual rate and is quickly becoming an important part of the energy balance in most regions and power systems. This paper aims to study the effects of connecting a PV system to the grid through simulation of the system. The Effect of variation of power factor of loads, variation of PV penetration, introduction of harmonics into the system by the PV inverter and anti-islanding effect of the PV system are studied. Finally, the Performance Ratio of a typical grid connected PV system is evaluated to determine the reliability and grid connectivity of the PV system.

**Keywords:** PV; reactive power; solar, grid; inverter

## I. INTRODUCTION

Renewable and sustainable sources such as SPV systems, WT energy conversion systems are now considered as a promising and growing alternative source of energy considering the fact of global emission and degraded PQ. These problems due to non-renewable sources can be diminished to a great extent by enhancing the use of renewable sources in DERs and MGs. These renewable sources possess several features such as emission-free power generation, they are everlasting and most importantly fuel used in generating power from solar and the wind is solar irradiation and moving air masses, which are abundant in amount and also available at free of cost. It is also proven in past studies that the stability of the traditional electric power network can also be augmented by integrating renewable sources to the utility grid through MGs and DERs. In traditional power systems, a power is generated at the far end from the load and further this power is being evacuated from source to load through a long transmission network which will lead to increased transmission and distribution losses. These losses can be alleviated up to a great extent by generating a power at the load end and serving the load requirement of nearby localities. DERs and MGs are considered to be local power systems which possess the above mentioned functionalities which have been looked by power system engineers since past many years.

## II. LITERATURE REVIEW

**Hossein Dehghani Tafti et al. [1]** this paper reviews various strategies which are proposed in the reported literature for calculating the reference current as well as selecting the reference active/reactive power based on the grid voltage. The performances of these control strategies are investigated on the 150 kW NPC grid-connected multi-string PVPP, which is considered as the state of the art for medium power PVPPs. The PVPP is connected to the 12.47 kV medium voltage distribution system where different fault situations is simulated. The controller of the grid-connected inverter consists mainly of two parts: the selection of the reference active/reactive power and the calculation of the reference currents under faults.

**Jundi Jia et al. [2]** In this paper, current control strategies of VSC under unbalanced faults for short circuit power provision are reviewed in two groups, namely power-characteristic-oriented and voltage-support-oriented control strategy respectively. As the fault current provided by converters should be restricted within secure operation limits considering semiconductor capabilities, converter current limit issue is also discussed. Converter-based generation can behave significantly different from the traditional alternators under grid faults. In order to evaluate the potential impact of future converter-based power systems on protective relays, it is necessary to consider diverse current control strategies of voltage source converters (VSC) under unbalanced faults as the performance of converters primarily depends on their control objectives.

**Karthik Kandasamy et al. [3]** this paper proposes and investigates a control strategy for the neutral-point-clamped (NPC) inverter in order to inject proper unbalanced reactive currents to the grid during unbalanced grid faults. The proper unbalanced current injection reduces negative sequence of grid voltages and currents. The current references are scaled up/down individually, based on the grid phase rms voltages and inverter nominal current. The performance of the implemented control algorithm is investigated on a 150-kVA PVPP connected to12.47-kV medium-voltage grid simulation model under various voltage sag conditions. Results from an experimental setup of grid-tied NPC inverter are presented in order to demonstrate the effectiveness of the proposed unbalanced current injection algorithm.

**J. Pou et al. [4]** this paper studies the low-voltage ride-through (LVRT) capability of the full-row HB inverter in a grid-connected photovoltaic power plant (GCPVPP). A control algorithm is implemented for the isolated dc/dc converters which balances the capacitor voltages during voltage sags and reduces the second-harmonic voltage ripple of the dc-link capacitors. The performance of the grid-connected full-row HB inverter with LVRT capability is investigated on a 3-MVA single-row, three-level CHB topology for the GCPVPP connected to a 6.6 kV grid. In each stage, rather than individual strings per phase, all photovoltaic strings are connected to all phases through isolated dc/dc converters. The per-phase power imbalance issue and second-harmonic voltage of the dc-link capacitors are alleviated by using this topology.

## III. IMPACTS OF CONNECTING PV SYSTEM TO THE GRID

If the PV penetration is really high Photovoltaic systems can subject the grid to several negative impacts. They are

i) Reverse power flow,
ii) Overvoltage along Distribution feeders,
iii) Voltage control difficulty,
iv) Phase unbalance,
v) Power Quality problems,
vi) Increased Reactive power and
vii) Islanding detection difficulty.

This paper considers the following three impacts.

### 1] Power quality problems/Harmonics

The inverter forms the core of the grid connected PV system and is responsible for the quality of power injected into the grid. Inverters also introduce harmonics into the system in the presence of non-linear loads, during DC to AC conversion. Harmonic currents introduce voltage drop and result in distortion of supply voltage. Harmonics can also cause resonance in the supply system, resulting in malfunction, reduction in lifetime or permanent damage of electrical equipment [3].

### 2] Increased Reactive

Power Photovoltaic inverters usually operate at unity power factor. The owners of small residential PV systems in an incentive based program are levied based on their kilowatt-hour yield and not on their kilovolt-ampere hour yield. Hence they prefer to operate PV inverters at unity power factor, maximizing the active power generation, and accordingly their returns. As a result the reactive power demand met by the PV system is minimal. Hence, the grid is responsible for supplying majority of reactive power, and it makes the distribution transformer operate at a low power factor.

### 3] Islanding Detection

The condition when the solar system continues to supply to the load even though grid power from the utility is not present is called islanding. Islanding can be dangerous to utility workers, who may not realize that a circuit is still energized while working on repairs or maintenance. Hence, the solar inverter must detect islanding and disconnect the PV system when the grid is down. This function of the PV system is known as ‘anti-islanding’. These impacts are dependent on the size and location of the PV system. According to the Solar America Board for Codes and Standards (Solar ABCs) PV systems are classified into three categories, based on the ratings of the system.

### Control Strategies

The structure of the PV grid connected system with the proposed control scheme. A two stage transformer-less solar-grid integrated system, with the two stages being DC to DC converter and three-phase DC to AC inverter, is considered. The DC voltage obtained at the output of PV panels is boosted up to required voltage with the help of a boost converter which also ensures that maximum power is extracted from the source. Sudden change in voltage at the output of boost converter is prevented by DC link capacitors, which also provides low impedance path for the ripple current, isolation between the converter and inverter, and freedom for independent control of voltage across it, and is followed by a three-phase three-level NPC inverter and LCL filter. Three-level VSI is preferred over two-level due to its advantages of reduced switching frequency, voltage ratings and power loss, better dynamic response and good harmonic spectrum, at the expense of increased number of switches and input voltage level. the efficiency of two-level and three-level PV grid-tie inverters are compared and the calculated as well as experimental efficiencies of three-level inverters are shown to be comparatively high at increased DC voltage levels.

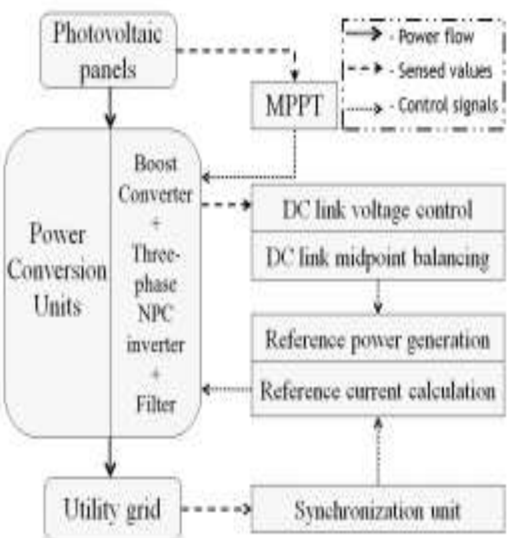


Figure 1 Basic structure of grid connected PV system

## IV.CONCLUSION

Photovoltaic Systems have developed into a mature technology used for mainstream electricity generation. However, they introduce numerous negative impacts into the electrical networks. Studies on three such impacts have been provided. Reactive power support with regards to varying load power factor and varying PV penetration levels was studied. Further, the Performance Ratio of the typical grid-connected system in India was calculated in order to compare the performance of the PV system with other systems throughout the world. The studies carried out will help PV power generators and utilities the issues to be studied for a grid-connected PV system.

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