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Grid Connected Maximum Power Utilization Using Isolated Ac-Dc Converter

Ballabh Chaudhary , Professor Arun Pachori

Department Of Electrical Engineering, Jabalpur Engineering College, Jabalpur, (M.P.) India.

Abstract
Grid-connected photovoltaic (PV) systems are increasingly attracting the attention of industry and academia as a means of providing an alternative to conventional fossil-fuel generation. In grid-connected PV systems, a key consideration is the design and operation of power converters and how to achieve high efficiency for different power configurations. The requirements for converter connection include: maximum power point, high efficiency, control power injected into the grid, and low total harmonic distortion of the currents injected into the grid. Consequently, the performance of the inverters connected to the grid depends largely on the control strategy applied.

Keywords: photovoltaic (PV); DC/DC converter; high voltage direct current (HVDC); input parallel output series (IPOS); high voltage; large capacity; high step-up ratio.

I. INTRODUCTION

By the increasing growth in the population of the world, the demand for new energy sources is significantly increasing. Today, fossil fuel resources are the major energy sources used for generating electricity. These resources include petroleum, natural gas, coal, etc. [1], which also result in serious environmental pollution and contribute to global warming by releasing the harmful carbon dioxide into the atmosphere. In addition, such resources are non-renewable limited energy sources that cannot fulfill the ever increasing demand for energy.

Renewable sources of energy such as biomass, wave energy, wind power, hydroelectricity, and solar power could be alternative sources to replace fossil energy resources. Renewable resources provided for about 18% of global energy consumption in 2006 [2]. Wind power is currently widely used in the United States and Europe. It is installed capacity of over 100 GW and growing rate of over the 30% per annum. Photovoltaic industry could produce more than 2000 MW of electricity power in 2006 [2]. Because of their reliability and easy access to the energy source, photovoltaic systems have attracted much more attention than other technologies that use renewable energy sources. Advantages of photovoltaic (PV) systems outweigh their drawbacks. Some of these advantages are long life, low maintenance needs, ease of installation and no need for fuel; drawbacks are low output in cloudy days and high costs of initial setup [3]. The voltage generated by a PV cell is low (about 0.5 to 0.7 V); thus, it is necessary to connect a series of cells in a PV panel. In addition, the panels can be linked in parallel or in series to produce higher voltage with a greater current with same voltage, or the same current, respectively [4]. Generally, grid connected PV inverters can be divided into two groups: single stage inverters and two stage inverters. Previous studies were mainly centered on single stage inverters, while present and future studies mainly focus on two stage inverters. In two stage inverters, a DC/DC converter connects the PV panel and the DC/AC inverter. The PV panel converts sunlight to DC electricity (for a PV panel with low output voltage, a DC/DC boost converter is used [5]); DC voltage can then be converted to AC voltage with a power electronics system (inverter).

II. LOSSES AND VOLTAGE STEP UP TECHNIQUES

Reference [7] proposed a converter of robust and simple solutions, without using transformers and by using cascading boost converters there are possibilities of getting higher voltage ratio and obtain overall good efficiency. For a line voltage of steep step-up, a circuit was suggested. Within a boost converter, switched-capacitor (SC) is integrated in the circuit. High voltage ratio can be achieved by SC with an increase of the supply voltage to higher voltage values. One advantage of the suggested circuit is its flexibility. Any higher voltage ratio could be obtained by increasing the capacitors. A thorough review, introduction and framework which is systematic for high-step-up coupled inductor boost converters category wise was carried out. Boost converters with high-step-up coupled inductor represents an ideal converter for various applications with several advantages of high voltage gain, simple structure and low switch voltage stress. High-step-up coupled- inductor boost converters were categorized in to five categories and were reviewed, which were derived from conventional boost converter. Reduction of the input current ripples, recycle leakage energy, and improving the step-up voltage gain are the future challenges that needs to be considered and the techniques to be used were discussed in [8].

III. PHOTOVOLTAIC DEVICE

Several energy sources are available for energy conversion systems, including batteries, PV devices, fuel cells and wind generators. Each energy source is connected to its inverter through a specific integration technique; sometimes, additional devices and extra steps may also be needed. For instance, a wind turbine generator needs an extra AC/DC converter (e.g. rectifier) to connect to an inverter [6], since it generates an AC instead of a DC current. On the contrary, a PV panel creates DC power; thus, it can be linked to the inverter directly or through a DC/DC converter. Favorably, this will decrease the total cost [7]. Essentially, a PV cell has a semiconductor P-N junction diode cell that directly transforms light into electricity [8]. When sunlight hits common junctions of a p-n diode, comprising of photons, the electron system of the material absorbs the energy and produces electron-hole pairs (charge carriers). These are detached by the potential wall, generating a voltage that uses an external circuit to drive a current through, known as the photovoltaic effect [9]. Different cell arrangements, such as series-parallel, parallel and series create a PV module that has a specific power capacity [10].

Likewise, modules are linked in series-parallel arrangement to gain higher power capacity and make a panel or array [11]. The solar cell's output voltage is a function of the photocurrent that is contingent on the level of solar irradiation throughout the process [12].

Shortcomings of a PV device include low energy conversion efficiency and high cost of initial-installation [13]. The control system has an important role in a PV system that uses power converters, such as DC/DC converters and DC/AC inverters to safeguard the system's overall operation [14].

IV. GRID CONNECTED SYSTEM

The discusses, still-open research issues and current state of art in the communications of smart grid like GSM, GPRS, 3G, WiMAX, PLC, ZigBee along with well considerate of the technologies, challenges and potential benefits in the research. The discussion of pilot projects, grid characteristics, architectures, key players, challenges in research and applications on information and communication technology issues, to give a complete summary on the topics are all the future works to be carried out. The QoS (Quality of Service) mechanism was introduced and standards are presented. A control method was recommended for PV systems of 3 phase grid connected system with dc-dc converter. In order to supply alternating current of high quality in the grid, a 3 phase–2 level voltage source inverter was used and total efficiency increased as the transformer primary voltage increased. The PV arrays are interconnected to the grid by using power electronic devices like inverter and converter to analyze grid designed for 800 W photovoltaic system connected with 3 phase inverter systems [7]. Limitation is that, PV developers and simulation computer programmers should design more efficient PV systems to rise the output voltage of PV array and improvise the performance of MPPT. To meet the high-power requirement and reduce the ripple at the supply current and hence a hybrid combination of three coupling inductors and three-phase interleaved boost converter was chosen. In realtime micro grid, before interfacing the converter, proper protection arrangements with proper isolation and standard safety precautions must be provided. Proposed converter uses gain extension technique for voltage stress on the switches to be reduced. In the micro grids, the striking choice of this converter were the modular structure, very low supply current ripple, low switch current and voltage stresses and at higher power level, higher voltage conversion ratio were very attractive features [8].

V. PROPOSED METHODOLOGY GRID-CONNECTED PV SYSTEMS

While sizing the grid-connected PV system, Step 1 and Step 3 are chosen initially to understand the location suitability for PV plant installation and to assess the solar resource potential. After the clearance of these two steps, the sizing of the PV system and its components is considered. In grid-connected PV systems, the array capacity is generally a chosen value depending upon the area availability. Once the PV array capacity is chosen, the next major step is sizing the inverter. In grid-connected PV systems, the inverter power sizing is a very delicate problem, where many installers would recommend having an inverter with a PV array power ratio of 1.0–1.1. However, the inverter sizing should be made by considering the overload condition where the energy loss is high during the operation phase of the PV plant. Hence, while sizing the grid-connected PV system's inverter, two main conditions are considered [9]:

Overload behavior: In PV systems, overload behavior is commonly seen and it is the issue of improper system component sizing. At present, with all existing modern inverters, this behavior can be avoided by ensuring that the Pmpp of the array overcomes its Pnom DC limit. This condition allow the inverter to operate as expected at its nominal power condition. This condition ensures that there won't be any overheating of the system component.

Loss evaluation: It is a method that gives clear understanding on inverter sizing for a grid-connected PV. In this condition, power distribution diagrams are plotted considering the operating conditions, which are then used for energy loss evaluation. The difference of the point where maximum power potential is obtained to the nominal DC power results in energy loss. While sizing an inverter, low power or energy losses are ensured in the PV system [9].

System Diagram of Grid-Connected PV Systems

A general system diagram of grid-connected PV systems is shown in Fig. 2 and consists of three main components: PV panels (or arrays), power converters (PV inverters), and ac grid. As the power generated by the PV arrays is dc power, the power converter, which is a power electronic-based technology, is required to convert the dc power from the PV arrays to the ac power [7]. In other words, power converter plays an important role in controlling the power delivery and at the same time ensuring a proper integration between the PV and the grid. Additionally, other specifications are imposed by the grid requirements to make grid-connected PV systems more resilient and grid-friendly: (1) reliable or secure the power supply; (2) flexible control of active and reactive power; (3) dynamic grid support per demands; (4) system condition monitoring, protection, and communication; and (5) high efficiency and reliability, low cost, and small volume [38–40].

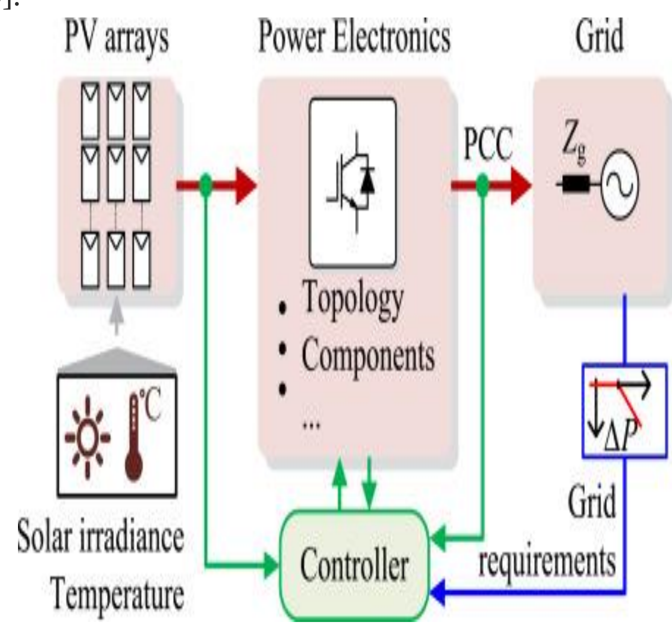

Fig 1. PV array.

VI. RESULT AND SIMULATION

One of the most important advantages of solar hybrid systems is a complementary factor for PV panels whose output characteristics change depending on the weather conditions. With the energy storage unit in

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the system the ripple effects are prevented in the DC bus. Thanks to the battery group, quality energy is provided and the continuity of energy is maintained. Solar hybrid systems occupy the grid as little as possible regarding energy use. In contrast, solar hybrid systems support the grid structure.

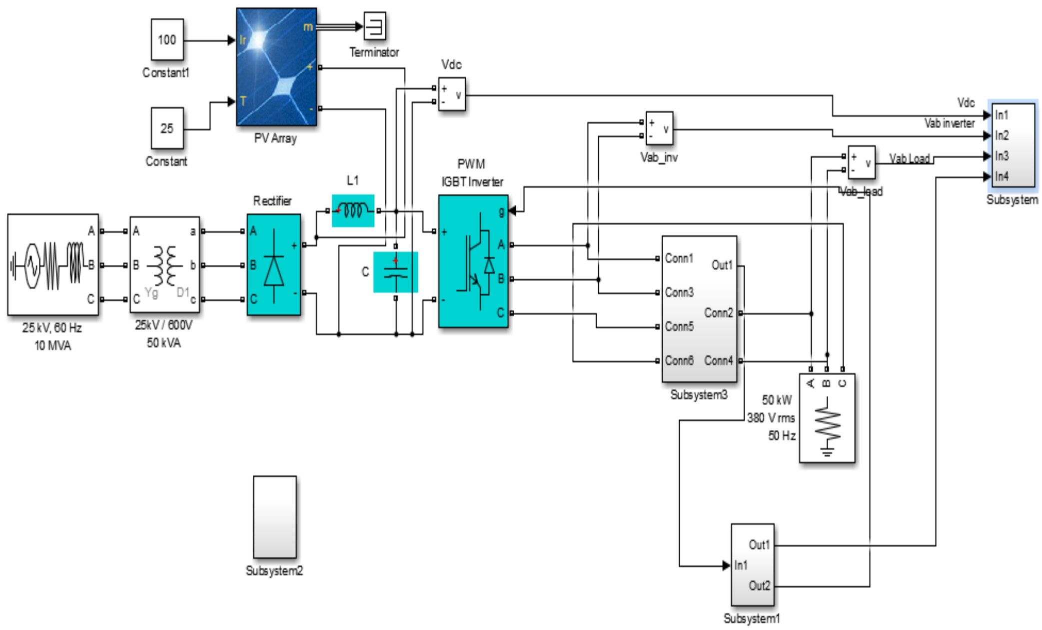

Fig 2. Model.

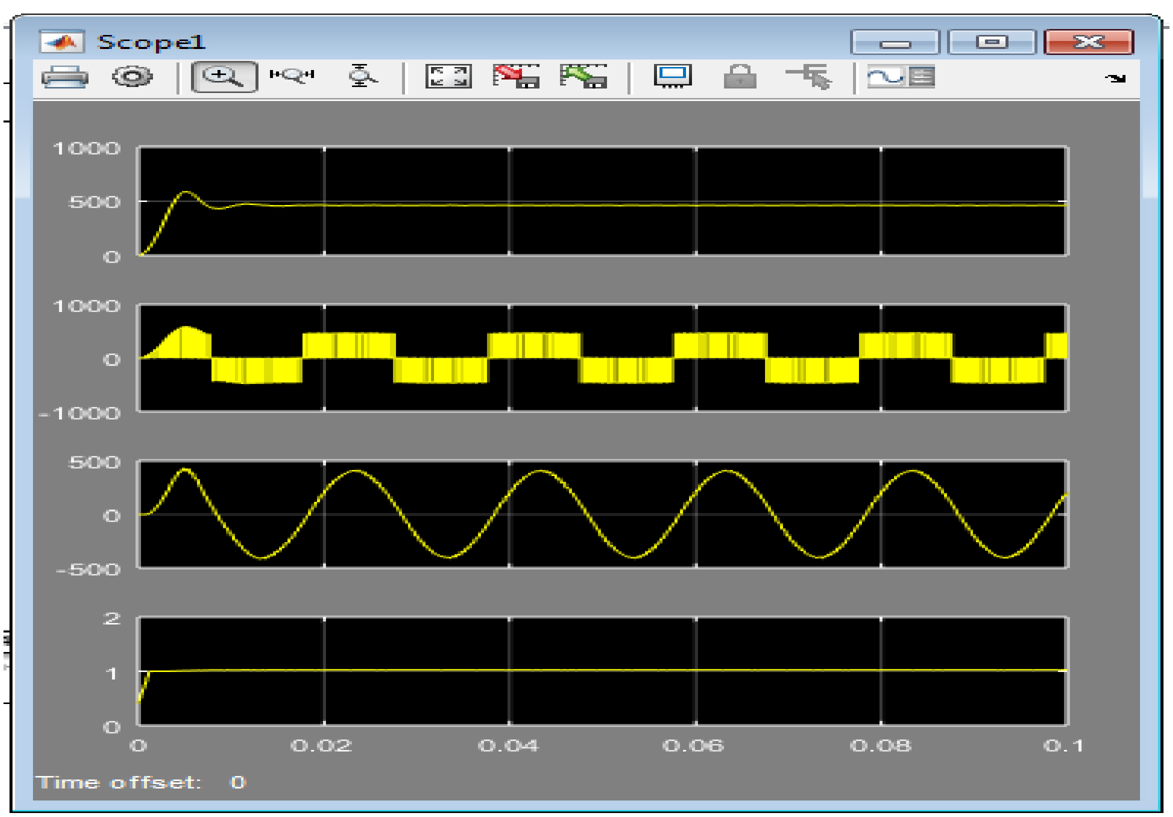

Fig 3. Output waveform.

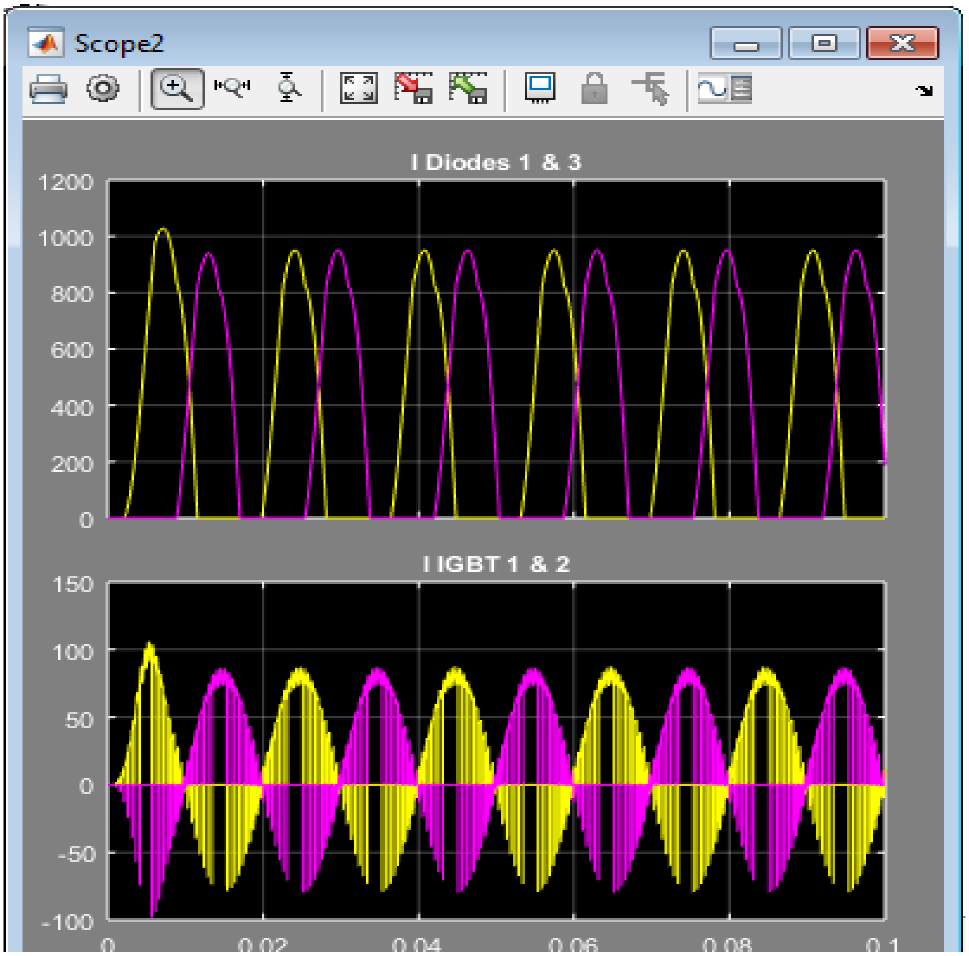

Fig 4. Diode Switch.

V. CONCLUSION

PV-systems offer a wide range of possibilities and configurations for the use of power electronic converters. An overview technologies and transformerless topologies is given and the technology is presented as promising for the future. In addition some problems from the application side are given. Future work will be to compare the transformerless topologies with special respect to the induced ground-leakage currents by simulation and measurements on an experimental setup. Experimental measurements are important, because parasitic effects, which are difficult to understand only by simulation, play a role for the paths of the leakage currents at higher frequencies.

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