Vol. 03, No. 01 (2021)
25 DECEMBER 2021

E-ISSN: 2582-7502
JS International Journal of Multidisciplinary Research (JSIJMR)
www.jconsortium.com/index.php/JSIJMR
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PERFORMANCE EVALUATION OF IRRADIANCE AND TEMPERATURE ON Z-SOURCE INTEGRATED SOLAR PV SYSTEM CONNECTED TO PUBLIC GRID

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ABSTRACT

Renewable energy sources (RES) such as solar, wind, tidal provide pollution-free and green energy. As per growing the population and dependency on the advance technology the energy consumption is also rapidly increased, conventional sources are depleting very fast and not enough to accomplish all the demands. Due to the high demand of energy power failure issue also increasing, to overcome all these problems researchers move to the Renewable (non-conventional) energy sources, that's are used to provide the power for constant load and fulfill the demand continuously. PV is the most easiest and efficient source to generate power. In this paper, a study was done on describes the comparison of DC output voltage between boost converters with the Z- source converter.The working of grid-tied solar PV array with the effect of irradiance and temperature change by using Z-source paper components used in the system and analysis of the result of the grid station or load are performed.

Keywords: *PV array, Z-source converter, DC-DC converter,Utility grid*

I.INTRODUCTION

Most of the world's energy is gathered from fossil fuels mainly by burning coal or nuclear power station. But this traditional way of electricity generation is a challenging issue as it contributes to greenhouse gas emanations. Besides, Fossil fuels and all the non-renewable resources to generate electricity are also depleting with time. Population is increasing and in the current scenario, there is a shortage of conventional energy sources to accomplish all the demand for energy.

At the present, Renewable or Non-conventional energy resources such as PV and wind farms, are recognized as pollution-free or green resources of generating energy. In the past few decades, solar photovoltaic energy becomes one of the important sources of renewable energy as it requires less maintenance and is noise and pollution-free. Power converters devices are used with the solar PV system for deliver efficient power. There are various configurations of PV systems. Among these standalone and grid-connected system configurations are the most important ones [1].

A grid-connected solar system has more advantages over to the standalone PV system as in it electricity can be taken or send to the electric grid dependent upon the load demand. It reduces bill costs as net electricity consumption can be reduced by sending extra electricity to the grid. It can also be installed without battery backup.

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Any photovoltaic system installed without battery backups produces more power, because there are no storage losses occurs in the system [2]. In this PV generation system, the conversion efficiency of electric power generation is low. The electric power generation of the solar arrays changes continuously with the change in climate and their generated power output is always change with environmental conditions [3].

Power generation through PV supplied to the grid gaining is more and more visibility, while the world's power demand is rising [4]. A grid is an interconnected network for delivering electricity from producers to end-users. The grid connected system consisting of generating stations produces electrical power, distribution lines that are connected to individual end-users, and high-voltage transmission lines which are connected to a grid. The main advantage of the grid-connected system is the more effective utilization of generated power [5]. Grid integration of solar PV systems is popular compares to standalone. This trend is increased due to many benefits of distributed power generation including the incentives in many countries that motivates the commercial acceptance of grid-connected PV system. The output voltage and power of the PV system are low and need to be increased for a grid-tied system. For this purpose Z source converter plays an important role in boosting the PV array voltage. The main objective of this paper, boost output voltage by using the Z source converter as compare to the boost converter and study variation in the output power of the grid which connects by the solar PV array.

II. MODEL FORMATION & STRUCTURE

The schematic diagram for a grid integrated system feeding on a solar photovoltaic has been shown in Figure 1. By using a Z-source converter, improve solar panel output voltage so it has to match with DC-link voltage, which has to be controlled appropriately to produce a smooth voltage waveform at grid level by the inverter. The performance of this system will be regulated by how the inverter is get connected. There is a lot of inverter configuration available which has to be connected between solar PV and Grid, and it is strongly recommended to select a suitable configuration for getting optimum results from the system.

As in the block diagram, it shows the energy conservation from one source to another source by using converter, inverter, and transformer. It shows how energy is transfer and convert in different forms. By using solar PV arrays to generate the DC voltage the generating voltage is not enough for the heavy electric devices so boost the output voltage by using a Z-source converter after it, the inverter is used to change the DC to AC and after that increase the voltage to match with the grid voltage by using the transformer.

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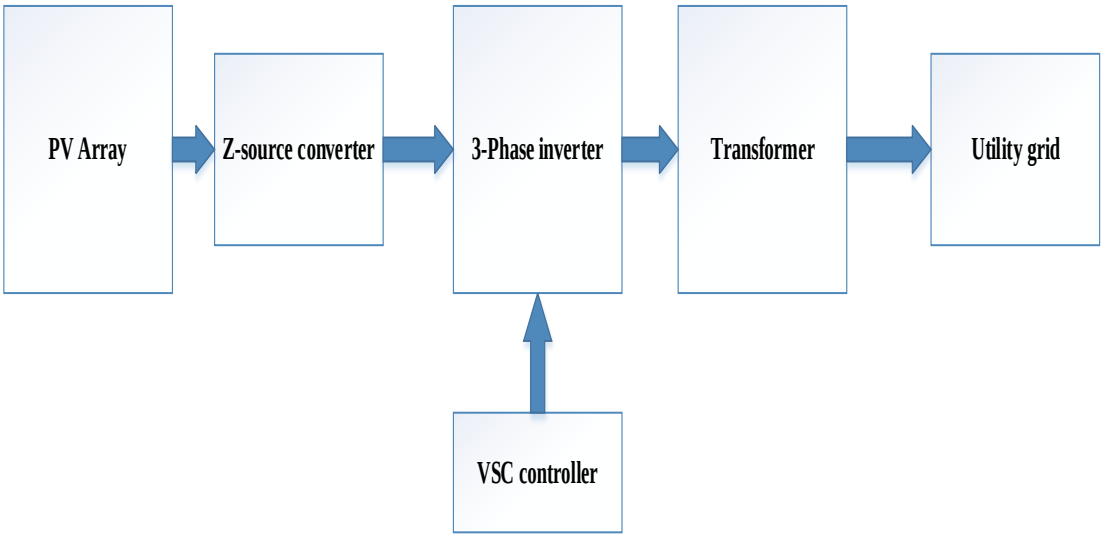

Fig1. Block diagram

2.1 PHOTOVOLTAIC SOLAR ENERGY

The function of Solar PV is to generate electric power from sunlight. PV is made by semiconductor material that is silicon which converts sunlight to electric power. These systems have a long life and good efficiency with little maintenance. Researchers are currently focusing on developing more efficient semiconductor materials and designs to surge power production. A PV technology is evolving to generate electricity by using the energy of heat, and ultraviolet radiation is known as thermos photovoltaic, through which power can be generated for longer periods. Photovoltaic systems can be classified into two main systems namely stand-alone and grid-tied systems. Standalone systems are cost-effective applications of photovoltaic that are mainly used in the areas where it is not easy to connect with the grid and at that palace where transmission of power by the grid is not possible. The difference between a stand-alone system and a grid-tied system is that the solar energy output in stand-alone systems is matched with load demand. These stand-alone systems are included of solar modules, control units as well as storage elements and loads. Grid tied photovoltaic systems help provide energy for both industrial and household loads. The use of grid tied systems is fast growing. There are significant economic and technical issues when these systems are connected to the power grids.

The PV source includes of PV cell, so it is essential to model a PV cell to make a PV module and then a PV array to get wanted power and voltage levels. Fig.2 shows the equivalent circuit of PV cell consisting of a current source.

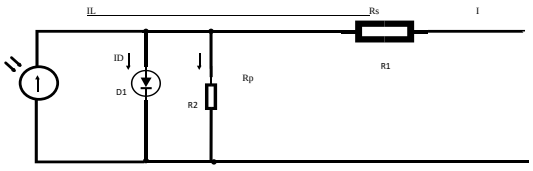

Fig2. Equivalent circuit of solar PV cell

Solar PV cell shows a non-linear current and voltage characteristics and the output always depends on the radiation and temperature.

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$$I = I_L - I_S\left(e^{\frac{V}{n \cdot V_T}} - 1\right)$$

I_L is photo current, Is = Id is saturation current of diode, n is diode ideality factor

2.2 Z-SOURCE CONVERTER

The Z-source converter (ZSC) is an alternating power conversion topology that can both buck or boost the input voltage using passive components. It uses a unique LC impedance network for coupling the converter main circuit to the power sources, which provides a way of boosting the input voltage, a conditional that can be obtained in the traditional inverters. Z-shaped inductors and capacitors can couple the system. When it does that, it uses a unique inductor capacitor network that has an impedance. Thus, the harmonic distortion and inrush current have been reduced to minimal value [6]. Z-source inductors and capacitors have been chosen the same value. So, they can be used symmetrically. The inductor voltages and capacitor voltages will be equalized due to symmetrical properties. So, the voltages will be the following equation.

$$VL_1 = VL_2 = VL \text{ and } VC_1 = VC_2 = VC$$

The Z-source network is included of two inductors and capacitors which are connected in X-shape, which eliminates the shoot through and limited voltage gain problem from traditional DC-DC converter [7].

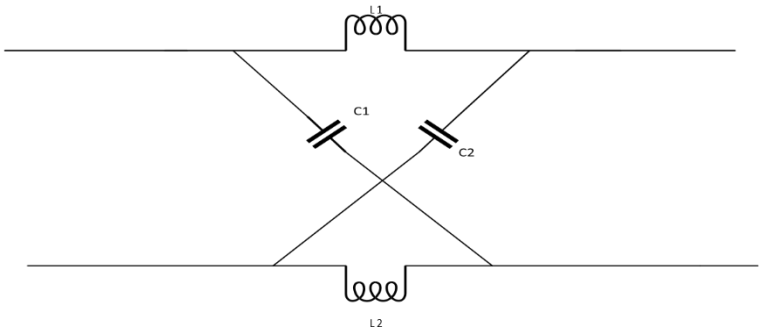

Fig 3. Z-source converter

2.3 INVERTER

The inverter is an electronic device that has to be used to convert direct current (DC) to alternating current (AC). An inverter is a type of converter which changes or convert the power from DC to AC. The input voltage, output voltage and frequency, and overall power handling depend on the circuitry or specific device design. The inverter does not generate any power, the power is providing by the DC source. A power inverter is completely electronic or maybe a combination of mechanical effects and electronic circuitry. The static inverter does not utilize moving parts in the conversion process.

We provide boosted voltage to the inverter from the Z-source converter, which changes the output DC voltage in the AC voltage. And after that, it goes to the transformer to step up the output voltage [8].

2.4 TRANSFORMER

To connect high voltage with the PV system, a transformer is connected with the system. The transformer is connected to step up the voltage to connect with the grid. The primary coil of the transformer received energy

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from the AC source or by the inverter, secondary coil delivers step-up voltage or energy to the load or the grid and core to make a path for magnetic flux.

Transformers are either step-up or step-down according to the ratio of the number of turns of secondary to the primary. In the system, the inverter delivers 260 voltage to the transformer, which step-up the voltage to 25 KV and transfers it from the secondary side of the transformer.

III. MODEL

To connect high voltage with the PV system, a transformer is connected with the system. The transformer is connected to step up the voltage to connect with the grid. The primary coil of the transformer received energy from the AC source or by the inverter, secondary coil delivers step-up voltage or energy to the load or the grid and core to make a path for magnetic flux.

Transformers are either step-up or step-down according to the ratio of the number of turns of secondary to the primary. In the system, the inverter delivers 260 voltage to the transformer, which step-up the voltage to 25 KV and transfers from the secondary side of the transformer.

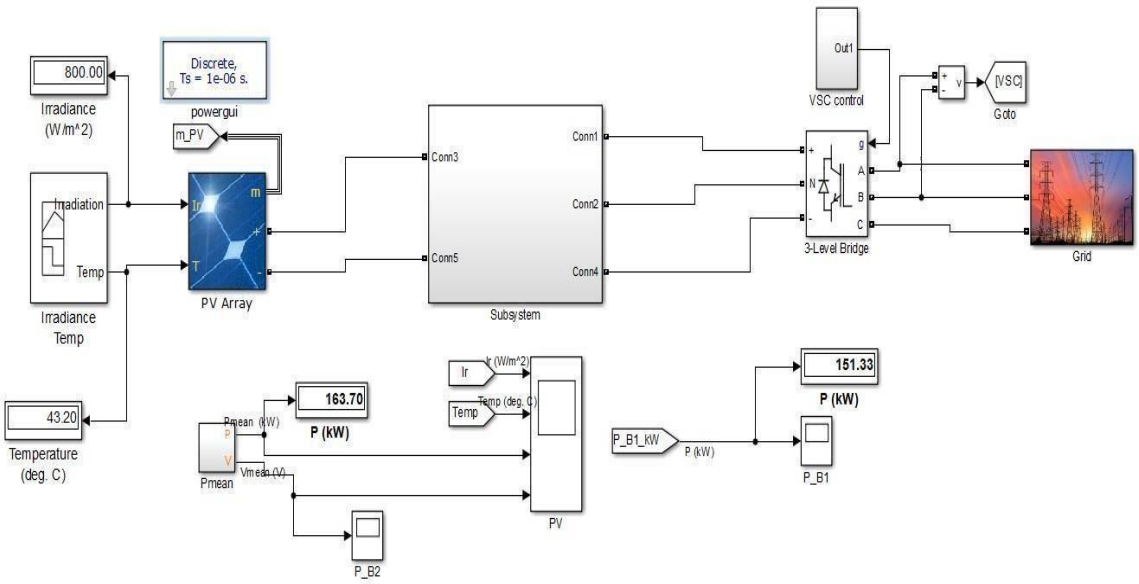

Fig 4. Simulation model of grid connected PV array by using Z-source converter

IV. RESULTS

This model shows the performance of the grid-tied solar PV system and the effect on output power with the change in irradiance and temperature. Fig.5 shows the output of the Z-source converter, where the maximum mean voltage is 500 V, VSC converters the 500 V DC link voltage to the 260 V AC and keeps unity power factor. The effect of change in the irradiance from 800 to 400 W/m2 at the time of 2.0 to 2.25 sec is considered and observed the changes in the output power from 150 KW to 95 KW for the same time. After that change in irradiance when it increases from 400 to 800 W/m2 at the time 2.25 sec to 2.5 sec and observed that power increases from 95 KW to 150 KW according to irradiance.

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Fig 6 shows the power output of PV connected grid by using Z-source converter. Fig 7 shows the comparison of output voltage through converters, between the boost converter and the Z-source converter. In fig 7 the output of output voltage by using the boost converter is about 390 V maximum values, but besides it when compare with the output voltage by using Z-source converter is gives about 500 V maximum output voltage which helps to improve or increase the output power of the PV connected grid system. These results show the advantages of using Z-source converter over the Boost converter and size of Z-source converter is also low as compare to the boost converter which is help to decrease the size of grid. The output voltage from the Z-source converter is more stable as compare to the basic boost converter.

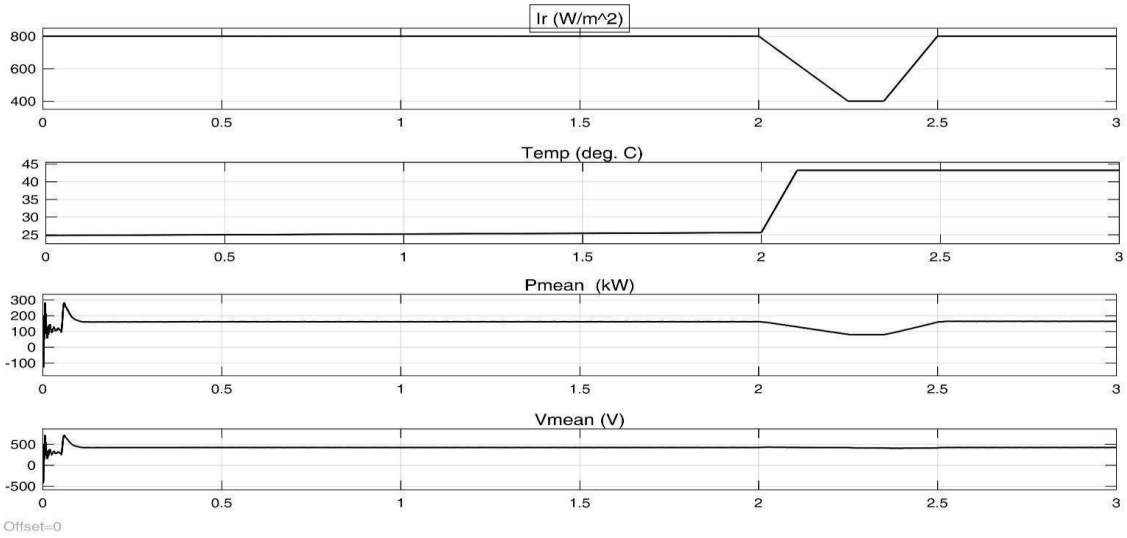

Fig 5: effect of irradiance and temperature to the power of grid

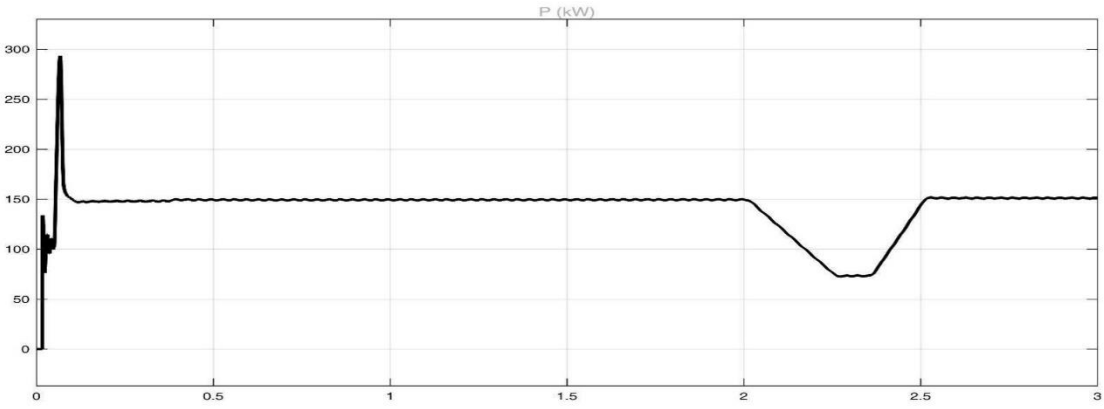

Fig 6: Output power of the grid by using Z-source converter

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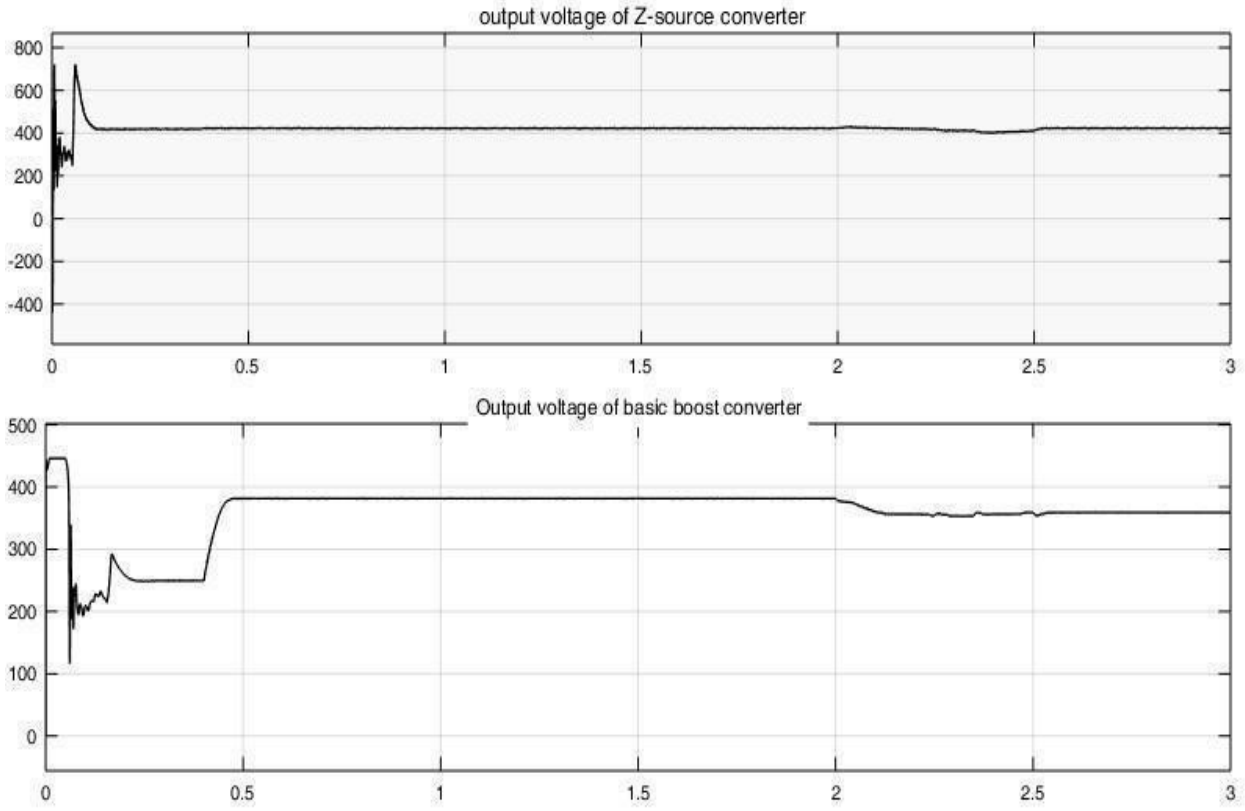

Fig 7:- PV mean output voltage by using Z-source and boost converter

V. CONCLUSION

This paper proposed the installation of a simple PV-connected grid system by using a Z-source converter. This model simulates two scenarios: local grid-tied system or national grid-tied system. There are economic savings when the system is connected to the grid system because of the two-way system. Therefore, to encourage private and governmental agencies to expand on solar energy production electricity Distribution Company has to be truly committed to a "feed-in-tariff" billing system.

In the model, we used a Z-source converter which enhances the output power as compared to the boost converter, and due to fewer components used in the Z-source converter the size of the converter becomes small as compared to the basic boost converter, and the power output also high.

We study the effect of irradiance and temperature on the grid-connected solar PV array.

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