Design, Control, And Fault Analysis of Multi-Array Photovoltaic Battery-Integrated Bidirectional Converters for Grid-Connected Systems with Implementation of Facts Devices

Tulja Jyoti Bhuarya[1], Neha dewangan[2], Poonam Sahu[3], Shalini Singh[4], Mithilesh Singh[5]
[1,2,3,4,5]Shri Rawatpura Sarkar University Raipur

***Abstract*—The security of a power system is regarded as the ability of the system to withstand disturbances without causing a breakdown of the power system. For wind power generators to contribute to the security of a power system, they must have the ability to contribute to both the voltage and frequency control in stabilizing the power system following a disturbance, they must be able to ramp up or down to avoid insecure power system operation, they must be able to ride through disturbances emanating from the power system, they must be able to avoid excess fault levels while still contributing to fault identification and clearance, and they should be able to operate in island mode when the supply from the grid is lost. In this paper suppression of harmonics with FACTS devices with implementation of multi array PV battery-based system will be capable to draw the energy.**

***Index Terms*—FACTS devices, PV battery, harmonics.**

I. INTRODUCTION

FACTS known as Flexible AC Transmission system is a power electronics new devices used in power system to compensate harmonics, Power factor improvement, etc. It is flexible in the sense that it has suppress excessive reactive power and when needed supplies reactive power to the system. It has consisted of many Capacitors bank with inductance in parallel to supply inductive reactance or capacitive reactance when needed to system. devices consist of SVC consists of conventional thyristors, which have brisk control over the machine voltage and have more sophisticated regulators compared to the mechanically switched conventional bias. SVCs are shunt-connected devices bias able of generating or absorbing reactive power. By having a controlled amount of capacitive or inductive current, they can maintain voltage stability at the connected machine. The Thyristor Controlled Reactor (TCR), the Thyristor Switched Reactor (TSR), and the Thyristor Switched Capacitor (TSC), or a combination of all three in resembling configurations. The TCR uses firing angle control to continuously increase or drop the inductive current, whereas in the TSR, the inductors connected are switched in and out stepwise, therefore with no nonstop control of firing angle. Generally, SVCs are connected to the transmission lines, therefore having high voltage conditions. Thus, the SVC systems have a modular design with further thyristor faucets connected in series or parallel for extended voltage position capability.

To meet the demand for reactive power generation and consumption in the network, SVCs acclimate the conduction ages of each thyristor stopcock. For an SVC consisting of one TCR and one TSC, assuming that both reactor and capacitor have same power conditions, the following scripts can be used: Reactive power is absorbed when the thyristor stopcock on the reactor leg is incompletely or completely conducting and the capacitor leg switch is out [1-9]. Reactive power is generated when the thyristor stopcock on the reactor leg is in partial or no conduction mode and the capacitor leg switch is on. No reactive power is generated or absorbed if both the thyristor stopcock and the capacitor switch are out. The voltage-current(V-I) specificity of an SVC with the two operating zones A pitch around the nominal voltage is also indicated on the V-I characteristic, showing a voltage division during normal operation, which can be balanced with maximum capacitive or inductive

currents. As the machine voltage drops, so does the current injection capability. This direct dependence is a significant debit in the case of grid faults, when a large quantum of capacitive current is demanded to bring back the machine's nominal voltage. The technology of SVC with thyristor faucets is getting substantially outdated due to the slow time responses, fitted current dependence on machine voltage, and low dynamic performance [9-18].

II. PROBLEM IDENTIFICATION:

1. Now these studies by using hybrid system such as PV array and wind energy system have not been much more explored.
2. The study has been mostly in closed the PV battery based on single input transformer.
3. For any one renewable energy sources, continuous power supply is complicated.

III. METHODOLOGY

The aims of the proposed systems are following:

1. To detect surplus power and decrement environmental pollution and energy dependency.
2. To give the output power with high efficiency.
3. Easy to step of power conversion.

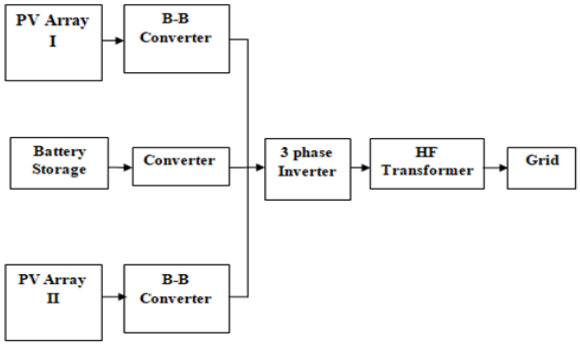

Fig 3.1 Grid connected PV battery-based system

The planned converter system has been decreasing the power conversion step as shown in fig 3.1 and less component count compare to existing grid connected structures. the maximum power extract from PV array by MPPT technique and connect with B – B converter and battery connect with bidirectional converter. The grid needs AC output so dc output invert to AC by VSC. That can work independent. The proposed system is capable for 3 phase operation of domestic purpose.

Photovoltaic Cell:

PV devices are converted sunlight into electrical energy. A single PV device is known as a cell. An individual PV cell is usually small and producing about 1 or 2 watts of power. The PV cells are made of different semiconductor material and their thickness is less than of four human hairs. These cell devices are often the block of electrical building of PV modules known as solar panel. The PV system completely consists of batteries, charging controller, inverter, wiring, load controller also.

The specification of solar cell has following –
Efficiency: 15 to 17.3%
Open circuit voltage (V_{oc}): 0.5V to 0.6V
Short circuit current (I_{sc}): 7.96A to 8.49A
Maximum power (P_{max}): 3.64W to 4.18W
Maximum power voltage (V_{MP}): 0.49V to 0.52V
Maximum power current (I_{mp}): 7.35A to 8.05A

Temperature coefficient:
Current: +2.79A/k
Voltage: 2.11mv/k
Power: -0.45%/k

The solar cell temperature increases, power and voltage drop across down. When 10 solar cells are connected in series, they could get module voltage 4.95V to 5.21V and current 7.34A to 8.04A with maximum power 36.5W to 41.86W.

PV arrays and module are just a part of a PV system. When 6 solar modules are connected in series, that we could get solar panel voltage 29.7V to 31.26V and there is no change in current and the power equal to 219W to 251.16W.

Irradiation (G) is the amount of sunlight that is effect of electromagnetic radiation. It is the measure of solar energy incident the area over a period of time. It is measured in W/m^2. Solar modules go through a variation of light intensity due to factors such as sun change the position that presence of clouds. This can affect the performance of the solar module. The figure 3.2 & 3.3 show the effect of changing irradiation on the P-V and I-V characteristics of a module:

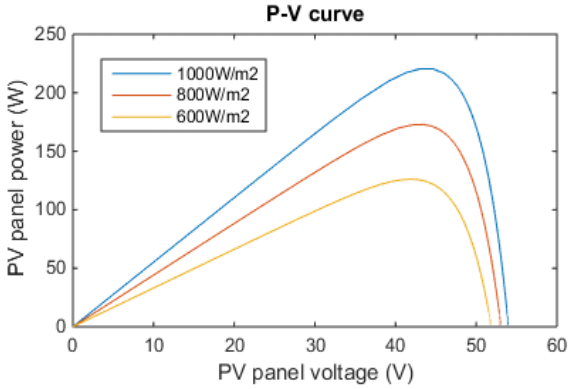

Fig 3.2.: Effect of Varying Irradiation on the P-V Characteristic of a Module

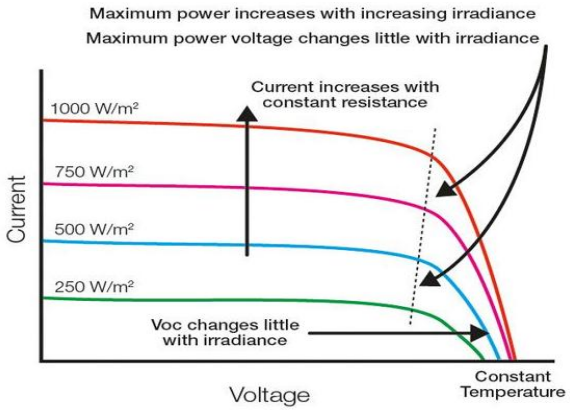

Figure 3.3: Effect of Varying Irradiation on the I-V Characteristic of a Module

The PV cells and modules are made up on semiconductor materials; they are connected to be some sort of resistance in the circuit. Maximum Power Point resistance of the Solar Cell is called the Characteristic Resistance (R_{CH}):

$$R_{CH} = \frac{V_{MPP}}{I_{MPP}}$$

The concept of MPPT is simple - to automatically vary a PV array's operating system so it can produce its maximum output power. This is necessary for PV cell because it has non-linear current-voltage qualities. The power delivered by an array increase, to a point, as the current draw rises.

The maximum power point (MPP) is at the knee shape of the curve. Any additional current drawn from the array results in a rapid drop-off of cell voltage, thus reducing the array power output. The objective of an MPPT subsystem is to determine just where that point is, and to regulate current accordingly.

Traditionally, electricity is generated in large power stations, located near resources or at logistical optima; it is transported through a high-voltage transmission grid and is locally distributed through medium-voltage distribution grids. DG aims to add versatility of energy sources and reliability of supply and reduce emissions and dependence on fossil fuels (Fig.3.4) The goals of DG include the minimization of the environmental impacts of energy production. In addition, DG can contribute to the reduction of transmission losses and help introduce new developments such as fuel cells and super-conducting devices as shown in Fig. 3.15.

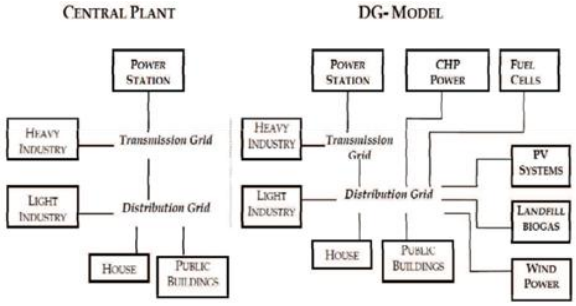

Fig.3.15 Distributed generation system.

Above DG technologies are not new (e.g., internal combustion engines, gas turbines, etc.). On the other hand, due to the changes in the utility industry, several new technologies are being developed or advanced toward commercialization (e.g., fuel cells, photovoltaic's, etc.). different distributed generation technologies [20]

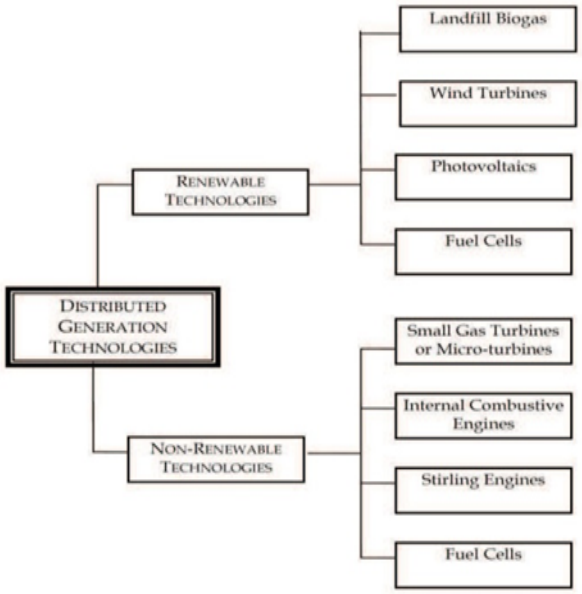

Fig. 3.4 Distributed Generation technologies for power generation

IV. RESULT:

PV Array

Fig 5.1 show below is time vs PV array (pv1 & pv2) reference current based on MPPT. In fig main line is for pv1 and dot line shows pv2 input.

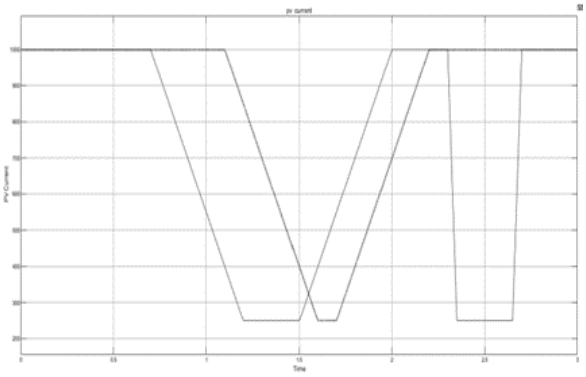

Fig.5.1 MPPT PV Current

Figure 5.2 shows the PV array input reference voltage based on MPPT. In fig. shows time vs power, voltage, and duty cycle graph in PV1 and PV2.

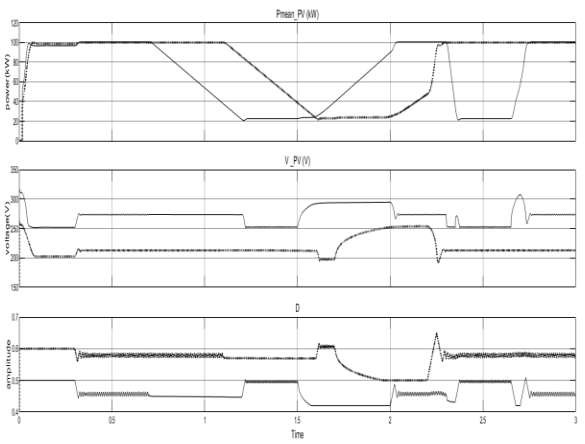

Fig. 5.2 PV Array power, voltage, and duty cycle (VSC) Voltage and modulation index

A voltage source converter is converting DC in to AC having one polarity of DC and through reversal of current polarity power reversal take place.

Figure 5.3 shows time vs VSC voltage and figure 5.4 shows time vs VSC modulation index

VSC reference voltage is obtaining peak of the voltage 500V DC the resulting wave shows in below figure.

Figure 5.4 shows the time vs amplitude graph that shows the modulation index shows with help of scope value of MI is lie between 0.82 to 0.84.

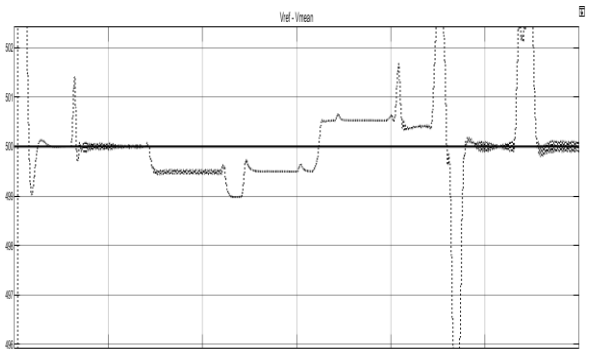

Fig 5.3 VSC Voltage

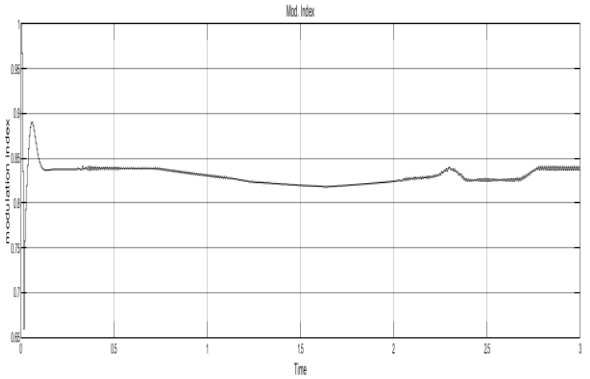

Fig 5.4 VSC Modulation Index

V. CONCLUSION

Renewable energy system is growing and gradually, solar power has been entering the residential place. As stated in since the 1970s, when the first PV system for residential area was installed, there have been 150,000 PV installations as per industry expert. Also, federal and state rebates help to promote the use of solar power. It is acknowledged by a novel multi array bi directional dc-dc converter with fault analysis gives a rich mix of PV and twist source to extract most extreme vitality from the multi sources. An adaptable control methodology which achieves a superior use of solar PV, battery capacity without affecting existence of battery and power system management in a grid connected multi array PV battery-based system.

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