Impact of SVC on Power Quality Issue in Photovoltaic Solar Power System

Amit Agarwal[1], Shanti Rathore[2], Nagendra Tripathi[3]

[1]Research Scholar, Dept. of Electrical Engineering, Dr. C V Raman Institute of Science and Technology, Bilaspur (C.G.) India.

[2]Associate Professor, Dept. of Electronics and Communication Engineering, Dr. C V Raman University, Bilaspur (C.G.) India.

[3]Associate Professor, Dept. of Electrical Engineering, Bhilai Institute of Technology, Durg (C.G.) India.

ABSTRACT

The limited fossil fuels and continuously increasing energy demand are the main reason for use of Renewable Energy sources. Renewable energy systems are plays vital role in sustainable development. In this paper we discuss about power quality issue in solar PV power plant which comprises PV array, power quality improvement of harmonics distortion, correcting power factor and protection of solar PV plant by over voltage and over current using ETAP. In this paper, different analysis of grid connected PV plant on the power quality is reviewed.

Keywords: Photovoltaic Cell, Harmonic distortion, Power factor, ETAP.

I INTRODUCTION

In today's life, energy-related aspects are becoming extremely important as they involve, for instance, a rational use of resources, the environmental impact related to the pollutant's emission and the consumption of non-renewable resources.

These are the reasons behind an increasing worldwide interest in sustainable energy production and energy saving. Among all the technologies and research work done on the generation of sustainable and widespread energy, interesting solutions are represented by photovoltaic (PV) cell.

The research activity and development process in photovoltaic field have usually been focused on solar radiation analysis, efficient operating strategies, design, improvement and sizing of these systems. Solar cell efficiency plays important input parameter in PV-powered product design. Often, limited space is available for the solar cells to be integrated.

When considering only modern renewable, Solar Photovoltaic technology is getting the most attention, due to its feasibility in most parts of the world unlike the wind and tidal projects which are practically feasible only at certain geographical locations in the world.

II GRID CONNECTED PV SOLAR POWER SYSTEM

As we know that solar demand is increasing day by day. It is widely used in generation of electricity by capturing the sunlight via the solar panels. These panels convert light energy into electrical energy (DC).

Now in grid connected PV solar power system, the power is being transferred to the grid. This power should be synchronized as that of the Power available in the grid.

The grid connected system has two important tasks to perform:

(a) Tracking of maximum power from the solar panels with the help of suitable MPPT method.

(b) The voltage at the PCC must be sinusoidal and at the same level of grid voltage.

III POWER QUALITY IMPROVEMENT OF SOLAR PV PLANT

Renukadevi V and Dr. B Jayanand have proposed two parts of the circuits; one of the circuits is detecting harmonic and reactive component, and other circuit generating the compensation current of grid-connected PV system. Here the load current is having three components – active, reactive and harmonic. It tracks the actual compensation current that the command current aroused, and compensate Harmonic and reactive component of the grid current, and offset harmonics and reactive component of load current and compensate active component of grid current to provide the active power to the load and power grid. Block diagram representation of the proposed system Albert Alexander S has explained a detailed analysis of employing different switching techniques and observing its performance. ETAP is used to perform the simulation studies in which a separate model is developed for In addition; the past works by the author including intelligent control strategy and switches reduction topology are also included. This ensures the consumers to make an optimal choice of the photovoltaic inverter which upholds the better improvement in performance parameter [4].

(a) Load Flow Analysis:

The ETAP Load Flow Analysis module calculates the bus voltages, branch power factors, currents, and power flows throughout the electrical system. ETAP allows for swing, voltage regulated, and unregulated power sources with multiple power grids and generator connections. It is capable of performing analysis on both radial and loop systems. ETAP allows you to select from several different methods in order to achieve the best calculation efficiency.

This chapter defines definitions and explains the usage of different tools you will need to run load flow studies. Theoretical background for different load flow calculation methods is also provided.

The Load Flow Toolbar section explains how you can launch a load flow calculation, open and view an output report, or select display options. The Load Flow Study Case Editor section explains how you can create a new study case, what parameters are required to specify a study case, and how to set them. The Display Options section explains what options are available for displaying some key system parameters and the output results on the one-line diagram, and how to set them. The Load Flow Calculation Methods section shows formulations of different load flow calculation methods. Comparisons on their rate of convergence, improving convergence based on different system parameters and configurations, and some tips on selecting an appropriate calculation method are also found in this section. The Required Data for Calculations section describes what data is necessary to perform load flow calculations and where to enter them. The Load Flow Study Output Report section illustrates and explains output reports and their format. Finally, the Load Flow Result Analyzer allows you to view the results of various studies in one screen so you can analyze and compare the different results.

(b) Static VAR Compensator:

A static VAR compensator is a parallel combination of controlled reactor and fixed shunt capacitor shown in the figure below. The thyristor switch assembly in the SVC controls the reactor. The firing angle of the thyristor controls the voltage across the inductor and thus the current flowing through the inductor. In this way, the reactive power draw by the inductor can be controlled.

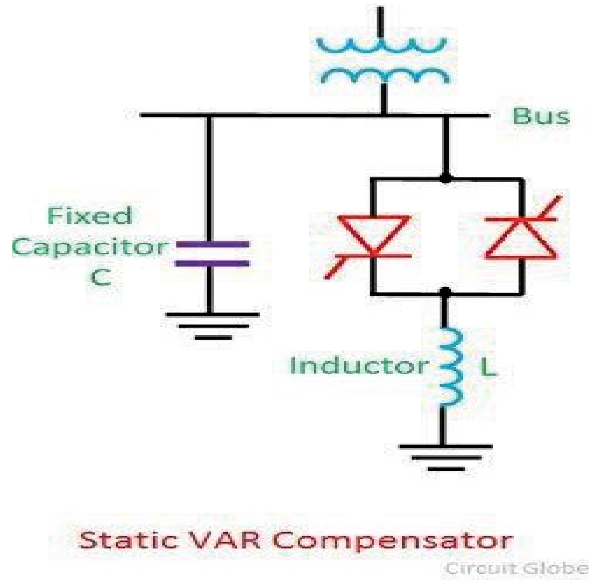

Fig. 1 SVC (Static VAR Compensator)

The SVC is capable of step less adjustment of reactive power over an unlimited range without any time delay. It improves the system stability and system power factor. Most commonly used SVC scheme are as follows.

(i) Thyristor controlled reactor (TCR)
(ii) Thyristor-switched capacitor (TSC)
(iii) Self Reactor (SR)
(iv) Thyristor controlled reactor – Fixed capacitor (TCR-FC)

Thyristor-switched capacitor – Thyristor controlled reactor (TSC-TCR)

IV METHODOLOGY

Single line diagram of PV connected distribution system of Dr. C.V. Raman University is shown in figure 1. At present distribution system is supplied from 315kVA, 11000/415V Grid connected Transformer, 100kW solar panel is also grid connected through 415 V system at Bus 5. Also a SVC is connected to the system at bus 3 to enhance the voltage quality of the system. Simulation is done by using ETAP software.

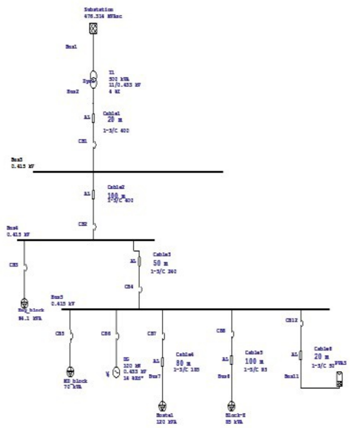

Fig. 2 Model of PV Solar panel connected to grid power system

V DESIGN IMPLEMENTATION

ETAP software provides a platform to set parameter and check the system operation in a wide range. According to set parameter, input and output property of the sub-systems the sub- systems are connected to form an integrated system which fulfill our demand in this project.

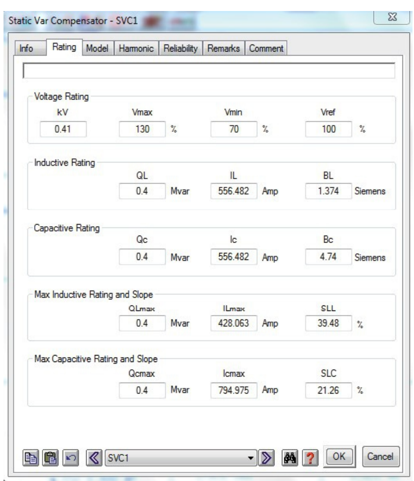

Fig. 3 SVC Rating

VI RESULT AND DISCUSSION

This section deals with the results of the project with or without Static VAR Compensator that was used to mitigate power quality issue present in grid connected PV solar power system.

(a) When SVC is not connected to the System:

In this dissertation, the basic structure of an SVC operating under typical bus voltage control and its model are described. This shows, the effectiveness of shunt FACTS devices such as SVC has been studied in improving the system stability of an IEEE 9 bus system.

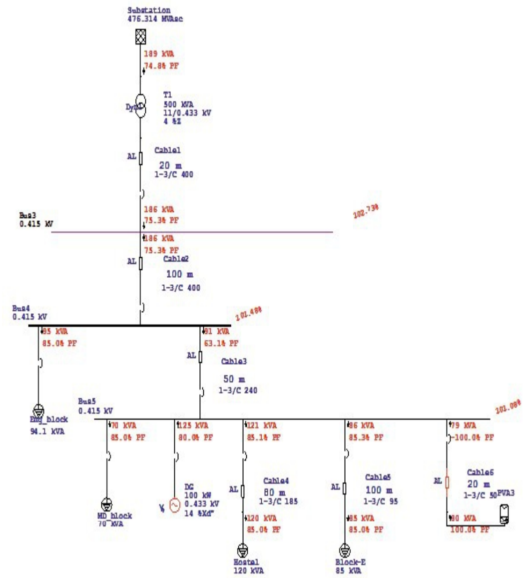

Fig. 4 Load Flow Analysis of grid connected PV system with SVC

(b) When SVC is connected to the System:

By adding SVC to the secondary of the transformer, reactive power is compensated in the bus 3 hence increasing the power quality of the system.

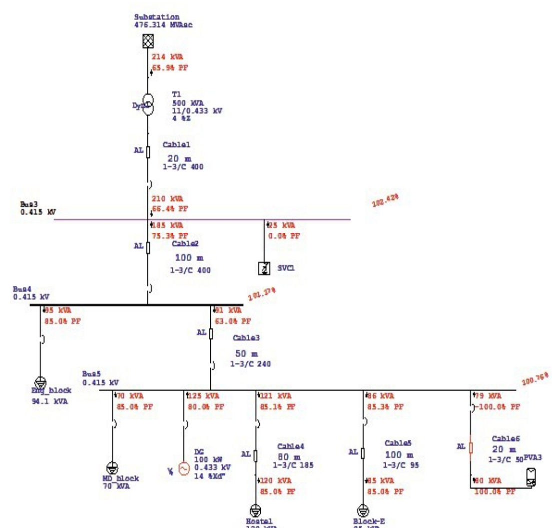

Fig. 5 Load Flow Analysis of grid connected PV system with SVC.

Table 1

Reactive power compensation with and without SVC

Reactive Power	At Bus 3
Without SVC	186
With SVC	210

VII CONCLUSION

This review has provided brief information on power quality issues for the solar power plant and its improvement using SVC. Most of these authors considered the grid connected issue of three phase system like power stability, phase balancing, voltage stability, harmonics and power factor. Most of the techniques focus on the developing ETAP simulation of the power quality of the solar plant. Considering the different existing methods of the solar off grid connected power plant for power quality improvement as above and advantages and limitations. Also, it is low cost and can be indigenously developed. However, the total power quality improvement for harmonics distortion, power factor correction, over voltage and current protection, economics, durability, reliability, etc. of its components is required to be tested.

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