A Study of Power Quality Improvement for Solar Source using D Statcom Method

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***Abstract*— This paper presents the design of a DSTATCOM (Distribution Static Compensator) and its control function approach for power quality improvement under linear/ nonlinear loads in distribution system. The Distribution Static Compensator (DSTATCOM) is a compensating device which is used to control the flow of reactive power in the distribution systems. Photovoltaic systems have been increasingly used in the generation of electrical energy because of the cost of energy produced from fossil fuels is rising day to-day and there by photovoltaic energy becomes a promising alternative source for fossil fuels. Power quality is the major problem that occurs between grid to end user transmission lines. DSTATCOM is the one of the power quality compensating device which will rectifies the power quality problems such as voltage sag and swell which occurs in high voltage power transmission lines. It is high economically effective in transmission lines and more safe to end-user equipments.**

Keywords-DSTATCOM, power, voltage, transmission lines, PV system, sag, swell.

I. INTRODUCTION

PV system is design to give the electric supply to load and load can be ac type or dc type. The general block diagram of grid connected PV system is shown in Fig.1 and the system can be a single phase or three phase depending on the grid connection requirements. The efficiency and proper operation of photovoltaic systems depends on a number of factors. Environmental conditions as well as system design constitute the most important factors in the operation of the PV systems and these can have a significant impact on the efficiency and power quality response of the whole system. The variable power flow due to the fluctuation of solar irradiance, temperature and choice of power semiconductor devices are some of the parameters that affect the power quality of photovoltaic systems

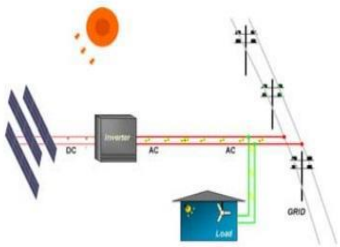

Fig.1. Solar Power System

Utility and customer-side disturbances result in terminal voltage fluctuation, transients, and waveform distortions on the distribution system. In recent years, the non-linear loads and complexity of control systems in industrial processes have triggered the power quality problems in distribution network. Power quality issues are gaining significant attention due to the increase in number o FACTS devices offer a fast and reliable control over the transmission parameters, i.e. Voltage, line impedance, and phase angle between the sending end voltage and receiving end voltage of sensitive loads. In this paper, among the different custom power devices, the role of DSTATCOM has been investigated to improve the quality of power.

II. DSTATCOM

DSTATCOM is a voltage source converter (VSC) based custom power technology which can perform as a reactive power source in power systems. The D-STATCOM can regulate magnitude of voltage at a particular AC bus, at the point where it is connected, via generating or absorbing reactive power from the system.

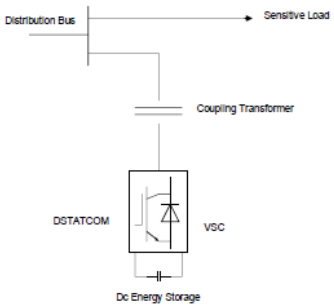

Fig. 2 DSTATCOM

1.1 Basic Structure

The schematic diagram of a D-STATCOM is as shown in fig .it contains

1. DC Capacitor
2. Voltage Source Inverter (VSI)
3. Coupling Transformer
4. Reactor

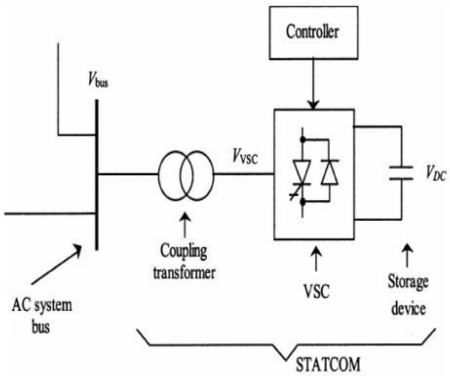

Fig.3 Block Diagram of the voltage source converter based DSTATCOM

The AC voltage control is achieved by firing angle control. Ideally the output voltage of the VSI is in phase with the bus(where the DSTATCOM is connected.) voltage. In steady state, the dc side capacitance is maintained at a fixed voltage and there is no real power exchange, except for losses. The DSTATCOM differs from other reactive power generating devices (such as shunt Capacitors, Static Var Compensators etc.) in the sense that the ability for energy storage is not a rigid necessity but is only required for System unbalance or harmonic absorption.

1.2 Operating Principle

A D-STATCOM is capable of compensating either bus voltage or line current. It can operate in two modes based on the parameter which it regulates. They are-

- **Voltage Mode Operation:** In this mode, it can make the bus voltage to which it is connected a sinusoid. This can be achieved irrespective of the unbalance or distortion in the supply voltage.
- **Current Mode Operation:** In this mode of operation, the D-STATCOM forces the source current to be a balanced sinusoid irrespective of the load current harmonics. The basic operating principle of a D-STATCOM in voltage sag mitigation is to regulate the bus voltage by generating or absorbing the reactive power. Therefore, the DSTATCOM operates either as an inductor or as a capacitor based on the magnitude of the bus voltage.

1.3 Control Block

The basic functions of Control block are the detection of fault, voltage sag and voltage swell in the system; computation of voltage, generation of trigger pulses to the sinusoidal PWM based DC-AC inverter and termination of the trigger pulses when the event has passed. They can control external devices such as mechanically switched capacitor banks too.

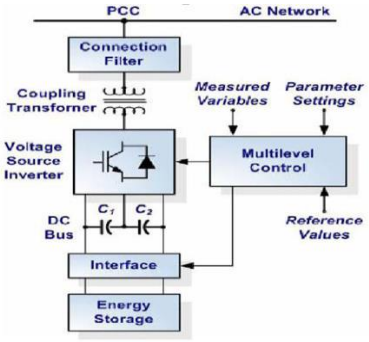

Fig.4. Schematic Representation of the DSTATCOM

1.4 Location of DSTATCOM

The DSTATCOM is connected in shunt with distribution system as shown in fig.5.Here in this figure three distribution feeders are considered. These feeders are feeding different sensitive loads. DSTATCOM is connected at the point of common coupling to inject current into the system when any non-linearity occurs due to these loads.

2. Photo Voltaic Energy Storage System

Recent research shows that the PV inverter has the capability of acting as DSTATCOM – a Flexible AC Transmission System (FACTS) device and is pronounced as PV-STATCOM. With the use of this STATCOM capability, the PV inverter is demonstrated to improve the connectivity of neighboring wind farms, improve the power transfer capacity over long transmission line. In these control strategies, the PV-STATCOM utilize the entire solar inverter capacity during night time and the remnant inverter capacity after real power generation during daytime and exchange reactive power with the grid to accomplish different objectives such as voltage control, reactive power control etc.

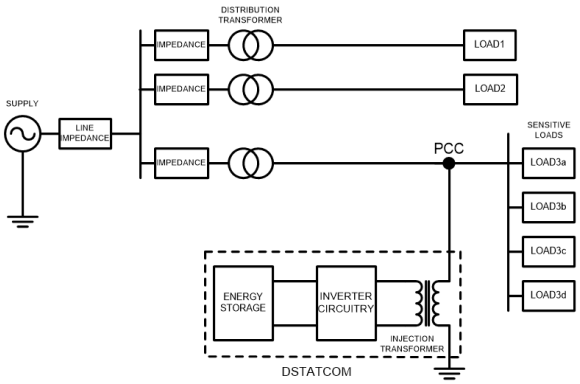

Fig.5 Dstatcom

III. RELATED WORK

Many survey and literature have been studied and found that the Dstatcom methods are most suitable for improving power quality of solar source. Some of the related works are to improve the quality of power using different facts devices are:

i **Molina, M.G.** discusses the dynamic performance of a distribution static compensator (DSTATCOM) coupled with an energy storage system (ESS) for improving the power quality of distribution systems. The presented

integrated DSTATCOM/ESS compensator is analyzed as a voltage controller, a power factor controller and an active power controller. Modeling and control approaches are proposed, including a detailed modeling of the DSTATCOM/ESS.

ii **B. Singh** discuss Solid-state controllers are widely used to convert AC power for feeding number of electrical loads such as adjustable speed drives, furnaces, power supplies etc. Some of these controllers behave as nonlinear loads because they draw nonsinusoidal current from the AC mains. Filter technology for improving power quality of such loads has matured to a reasonable level. Moreover, hybrid filters are considered one of best options for improving power quality for a number of considerations. A comprehensive review of hybrid filters configurations is given: their control approaches, state of art, design considerations, selection criteria, potential applications, latest trends, future developments and their comparative features. A broad review of the status of hybrid filters to researchers, design and practice engineers dealing with power quality improvements are presented.
The performance of DSTATCOM has been analyzed for varying linear loads, non-linear loads and DTC induction motor drive, using dqo transformation technique. DSTATCOM has been found to regulate PCC current under varying load condition and load unbalancing. It is clear from comparison of THD analysis for different types of loads under normal and various faults conditions that DSTATCOM reduces harmonics from load current very effectively and makes it smooth

iii **Static VAR Compensator:** According to IEEE definitions and standards, a shunt connected static VAR generator or absorber whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific parameters of the electrical power system.

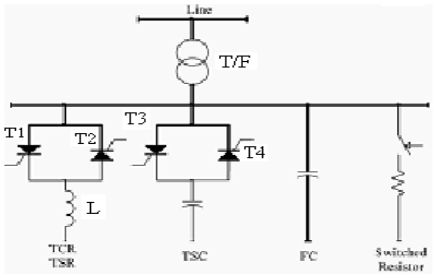

Fig.6 Static VAR Compensator

iv **Static Synchronous Series Compensator:** According to IEEE definitions and standards, a static synchronous generator or dynamic voltage restorer operated without an external electrical energy source or a series compensator where o/p voltage is in quadrature and controllable independently of the line current for the purpose of increasing or decreasing the overall reactive voltage drop across the line and there by controlling the transmitted electric power. SSSC is also known as dynamic voltage restorer. The DVR was first installed in 1996 and is shown in Fig. 7. DVR is useful for compensating voltage quality problems that are due to voltage sag.

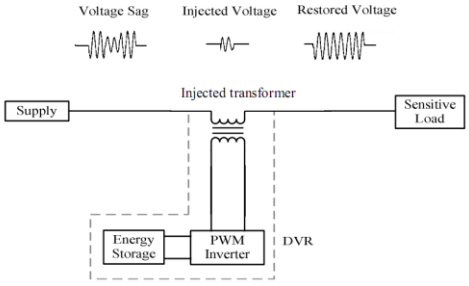

Fig.7 Static Synchronous Series Compensator

v **Thyristor Controlled Series Capacitor:** According to IEEE definitions and standards, a capacitive reactance compensator which consists of series capacitor bank shunted by thyristor controlled reactor in order to provide a smoothly variable series capacitive reactance. Fig. 8 shows a Thyristor Controlled Series Capacitor.

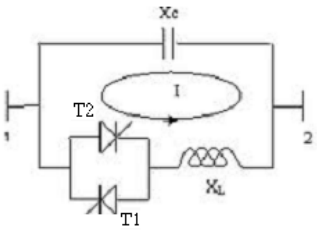

Fig. 8. Thyristor Controlled Series Capacitor

vi **Thyristor Controlled Series Capacitor (TCSC)** has been modeled in a simple two bus system with distributed parameter line.

IV. PROPOSED WORK

After reviewing various papers, finally came to know that the dstatcom method are most suitable for compensating the voltage sag and swell. Now my proposed work is based on Other advanced controllers like fuzzy controller, artificial intelligence based adaptive fuzzy controller and state space vector technique can be employed with DSTATCOM to increase the effectiveness of DSTATCOM i The effectiveness of DSTATCOM can be established for distribution networks .with other types of non-active loads like arc furnace, and active loads like FOC induction motor drive using dqo transformation technique and wind turbine system n distribution networks.

V. CONCLUSION

In this study various techniques of power quality improvement are viewed. Different paper are followed up and finally came into conclusion with one method i.e. dststacom to improve the quality of distribution level.

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