

GRID INTEGRATION USING STATCOM

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Abstract—Commonly Static Synchronous Compensator (STATCOM) are employed extensively as voltage regulator and reactive power compensators in transmission power system. This research paper deals with the integration of PV system with wind power generating system using STATCOM. Static synchronous compensator is a power electronic device which uses force commutated device like IGBT, GTO etc. to control the reactive power flow in a power system network and stability of power network is increased. STATCOM is a member of Flexible AC Transmission Systems (FACTS) family of devices which is connected in shunt with the line hence it is a shunt device.

Index Terms—STATCOM, PV System, Wind energy system, Power electronic devices.

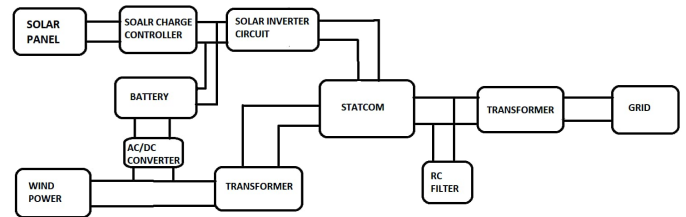
I. INTRODUCTION

With increasing effect of global warming and the reduction of fossil fuel reserves, many are making a decision to switch to sustainable energy solutions to preserve the earth for the future generations. Hydro power generation, wind energy and photovoltaic energy has the potential to meet our energy demands. Wind energy has the capability of supplying large amounts of power to the load but its presence is highly unpredictable [2]. Similarly, PV system has enough capability to use solar energy throughout a day but the solar irradiation levels vary due to sun intensity and unpredictable so power generation is varied. The common drawback of wind and PV systems are their intermittent natures that make them unreliable. However, by combining these two intermittent sources with grid increases the reliability and efficiency of a system. We know that the fixed capacitors are commonly employed for reactive power compensation in distribution networks. But to increase the system performance in large power system network active and reactive power compensating devices are used for example Unified Power Flow Controller (UPFC), Static Synchronous Series Compensator (SSSC), Static Synchronous Compensator (STATCOM) [5]. A STATCOM does the following:

- 1) It occupies less space and replaces passive bank of circuit elements by compact electronic converters.
- 2) It offers specific module, factory built equipment and hence reduce site work and commissioning time.
- 3) It uses highly efficient electronic converters, thereby minimizing its environmental impact.

Because of all these similarities with rotating synchronous generator, they are called as Static Synchronous Generator (SSG). When SSG is operated without a power generating

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Block diagram of Grid Integration Using STATCOM

Fig. 1. Block diagram

source, and with appropriate control to function as a shunt connected reactive compensator, which is analogous to Static Synchronous Condenser. The basic design of a STATCOM involves a voltage source converter (VSC) connected in parallel with the power system. The VSC is usually a three-phase bridge converter that consists of six insulated-gate bipolar transistors (IGBTs) connected in a full-bridge configuration. It also includes a DC link capacitor that provides energy storage for the VSC. DC capacitor voltage will determine the VSC output voltage for STATCOM operation and the phase angle difference of converter as well as system voltages will be determined by dc link voltage for improvement of reactive power in the system. The size of the DC link capacitor is determined by the amount of reactive power compensation required and the response time of the STATCOM.

The reactive power generation or absorption are controlled by increasing or decreasing the capacitor voltage and thereby the amplitude of the output voltage produced by the converter. The magnitude difference between the converter output voltage and ac system voltage determines completely the magnitude and direction of the reactive current flow.

II. LITERATURE SURVEY

A STATCOM (Static Synchronous Compensator) is a power electronics-based device that provides reactive power compensation and voltage regulation to improve the stability, efficiency, and reliability of power systems. Basically it comprises of various sources integrating through a single platform at a Point of Common Coupling (PCC) for voltage control of a grid connected system. PV system are mostly integrated to the power grid via power electronic converter. Theoretically it can be dynamically regulated by controlling the reactive power injection/observed from the power grid and are capable

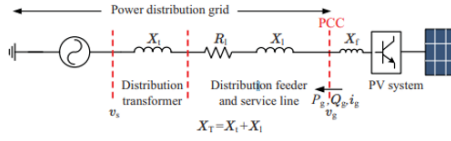


Fig. 1. Simplified model of the distribution grid.

of operating in all four quadrants. So a closed loop controller is required in order to maintain the voltage level at PCC.

Large variation in grid impedance can affect the performance of PCC voltage controllers. The Power Losses in a system causes disintegration, regulation of current and DC voltage balance which is attainable with multi-level STATCOM methodologies. Cascade H-Bridge (CHB) based configuration is a method by which above stated characteristics can be solved[4]. The power quality issues like frequency, voltage sag, active and reactive power, flickering and harmonics are needed to be considered in case of integration with the grid. Various FACTS (Flexible AC transmission system) devices are used for system restoration and power balancing. In this paper, a STATCOM (static compensator) model is proposed in order to improve the power quality for a generated power into the grid. A hybrid model of PV grid connected system with wind energy includes the configuration of active and reactive power imbalance in a system.

Hybrid microgrids mainly comprises of ac and dc sub microgrid, which are linked together through interface converter. Many hybrid systems are stand-alone systems, which operate "off-grid". At different times when neither the wind nor the solar system are producing sufficient amount of power, most hybrid systems provide power through batteries. The integration of these converters not only help to enable the power exchange between the ac and dc sub microgrid but also increase the degrees of freedom regarding the management of the grid. The reliability of the entire system is increased as interconnection of network helps to meet the required increasing demand. Unlike hybrid system, STATCOM perform similar function with grater efficiency, reliability and has large power distribution range.

III. METHODOLOGY

There are separate H-bridge circuits in this system and each consists of 9 H-bridge cells connected in series, forming a "cluster". This clusters are connected to the medium-voltage (MV) grid system via an inductive filter and its resistance. The H-bridge cells utilize conventional IGBTs. These are modeled as ideal switches in power system to achieve high speed and robustness for system-level simulation. The IGBT Full Bridge power module library component is used to help in modelling of converter. This component can be classified into two configurations: Switched configuration where ideal switches represent the semiconductors, and an Averaged configuration which uses controlled voltage and current sources[6]. The

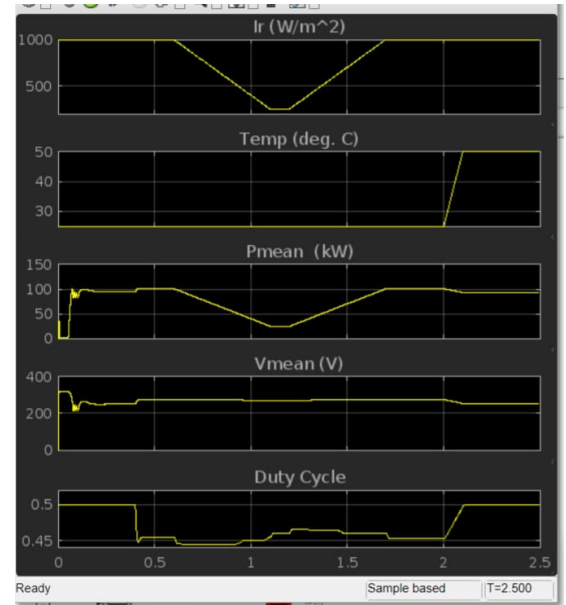


Fig. 2. Input temperature, duty cycle, voltage and current

power module also contain a parameter setting for the number of series-connected cells in a device. The currently implementation of both the power module and the controller is such that the number of cells can be configured at the top level without extending the model with additional component. In Cascade H- Bridge STATCOM which have Master and Slave Control configuration and distributed control is adopted by Hybrid Communication STATCOM that will minimize the maintenance overheads time. The Communication loops are operating in parallel at different layers of three phase modules. Control system de-coupling with cascading H-Bridge Multi level Converter add an advantage to a STATCOM. In traditional STATCOM based cascade H-bridge m-level converters, the dc-link voltage levels are balanced with individual voltage controllers. In this paper a simulation of grid connected system with STATCOM is represented. The input temperature of solar system with heat radiation at different level is observed with generated output voltage along with current and duty cycle is noticed.

A large amount of energy is generated by wind but at different voltage level as compared with solar energy which leads to an flickering and short circuit condition at a common ac bus which is resolved by power electronic devices that uses voltage source converter and various switching device like IGBT, GTO to ensure fast response of a system. Power controllers are implemented in order to ensure smooth performance of a device with maximum power generation. Maximum power point tracking (MPPT) track the power graph generated at the output terminal to ensure healthy battery charging.

By implementing multiple converters with filter an approximate sinusoidal output voltage is obtained that is supplied to a grid. And hence reactive power modulation is successfully performed by STATCOM.

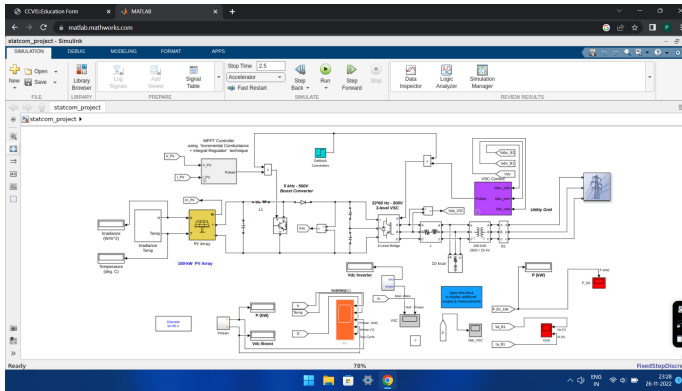


Fig. 3. Simulation model

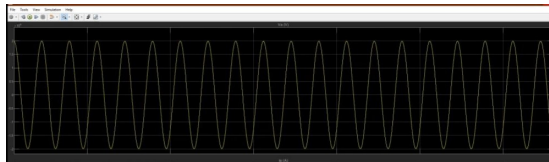


Fig. 4. Output volatge of STATCOM

CONCLUSION

This paper projects the detailed VSC based STATCOM with different power circuits and various control circuits. It gives an overview to integrate a system with different voltage rating device using power electronics circuit. And also it gives an basic idea to obtain maximum power through renewable source in order to meet the increasing demand. It can be concluded that, if the power rating of the transmission lines rises then the switches count will increase. But the power quality of the system will be deteriorating because the power electronic switches loss will increase with switches count so it must be implemented as per the specifications.

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