Harmonics Reduction of Grid Integrated PV-Wind System with Hybrid Controller

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***Abstract*—While interconnecting renewable energy conversion systems to the power grid, which leads to generation of power quality problems and the system stability may deviate due to generation of harmonics. the main important power quality problem is that harmonic distortion. Deviation of system response from its fundamental frequency component is called harmonic distortion. If order of the harmonic distortion increases the system becomes unstable. This paper demonstrates that the modelling of grid connected hybrid system and, in this work, two energy systems such as photo voltaic and wind energy system are connected as hybrid mode to the power system grid. However, the proposed hybrid system has been subjected to frequent disturbances due to continuous variations in the renewable powers. therefore, in this paper, as certain novel method has been proposed to improve power quality for grid incorporated renewable sources is a STATCOM based controller. Therefore, the hybrid system has been designed and investigated on MATLAB/ Simulink environment. As per the simulation results, grid integrated mode with STATCOM controller shows a better dynamic and transient behavior. Moreover, the effectiveness of harmonic distortion can be reduced with proposed controller**

***Index Terms*— Total Harmonics Distortion (THD), STATCOM, Hybrid System, Dissipated Generation (DG), Solar Photo Voltaic (SPV).**

I. INTRODUCTION

With the increasing in population corresponding increase in the electrical energy requirements so it needs to increase the generation according to the load requirements. For this conventional energy sources are not sufficient to meet load as the fossil fuels as degraded as times go on. so it is necessary to integrate or penetrate the renewable energy resources like solar, wing, tidal, geo thermal, bio gas etc. A hybrid energy system is a photovoltaic array coupled with a wind turbine. This would create more output from the wind turbine during the winter, whereas during the summer, the solar panels would produce their peak output. Hybrid energy systems often yield greater economic and environmental returns than wind, solar, geothermal or trigeneration stand-alone systems by themselves. with the major power system in order to get the continuous power supply with high power quality and A combine use of wind-solar systems results, in many places, to a smoother power output since the resources are anti-correlated. Therefore, the combined use of wind and solar systems is crucial for a large-scale grid integration. But the practical power system is getting power quality problems like harmonics distortion, voltage or current distortion, voltages sags or voltage swells, due to interconnection of the renewable resources. Harmonic distortion is nothing but the distortion or deviation of the system voltage or current response from its fundamental frequency component.it means other than fundamental frequency component is called as harmonics which creates power quality problems.

A Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a disoperation of end user equipment's. Utility distribution networks, sensitive industrial loads and critical commercial operations suffer from various types of outages and service interruptions which can cost significant financial losses. With the restructuring of power systems and with shifting trend towards distributed and dispersed generation, the issue of power quality is going to take newer dimensions.

In developing countries like India, where the variation of power frequency and many such other determinants of power quality are themselves a serious question, it is very vital to take positive steps in this direction. the present work is to identify the prominent concerns in this area and hence the measures that can enhance the quality of the power are recommended.

This work describes the techniques of correcting the supply voltage harmonics, and interruption in a distributed system. At present, a wide range of very flexible controllers, which capitalize on newly available power electronics components, are emerging for custom power applications. Among these, the distribution static synchronous compensator is one of the most effective devices, works based on the Voltage Source Converter (VSC) principle. a STATCOM injects a current into the system to correct the voltage sag, swell and interruption and harmonics. Comprehensive results are presented to assess the performance of the device as a potential custom power solution.

II. EQUIVALENT CIRCUIT MODEL FOR HYBRID SYSTEM

Figure 1. shows the block diagram modelling of the system which consists of both wind energy system and photo voltaic systems are integrated and are interconnected to the power system main grid having three phase bus system connected with three phase loads. Individual systems are connected to grid through boost topology that is buck-converter(step-down) for wind energy system and boost- converter(step-up) for solar PV- system. MPPT algorithm is used for extracting maximum power that can be generated from both the wind and PV systems.

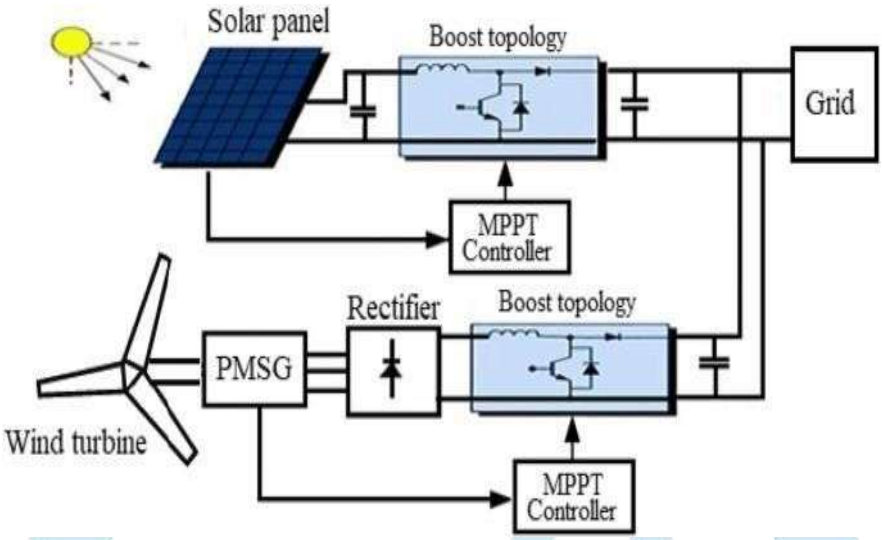

Figure.1. system model integrated with PV& WECS

III. SIMULATION

Simulation Without Controller

Simulation and analysis of the hybrid power system consisting of solar PV and wind system which are connected to the common inductive load. In general, the low irradiation of PV array system inverter gives the lower voltage than the rated voltage which effects the quality of power. So, it is overcome by using STATCOM. In stand-alone mode the converter needs to maintain the constant voltage and frequency irrespective of unbalanced load or current quality, which can be highly destroyed, if the load is non-linear. The modelling and simulation of hybrid system along with STATCOM are done using MATLAB/SIMULINK Figure 40. shows the matlab simulation model for hybrid system which consists of individual load fed from three phase voltage source of 25kv phase to phase voltage 0.13223 phase angle of phase A and 63510.4 base voltage connected through the transmission lines and three phase transformers. transmission line parameters are RLC with 50Hz operating frequency and 0.1273 ohm/km resistance, 0.933mH/km inductance and 12.74nF/km capacitance and the line were designed for 100km.and the output of transmission line are connected to transformer with the rating of 25kv/440v and the output of transformer is connected to three phase load through circuit breaker.

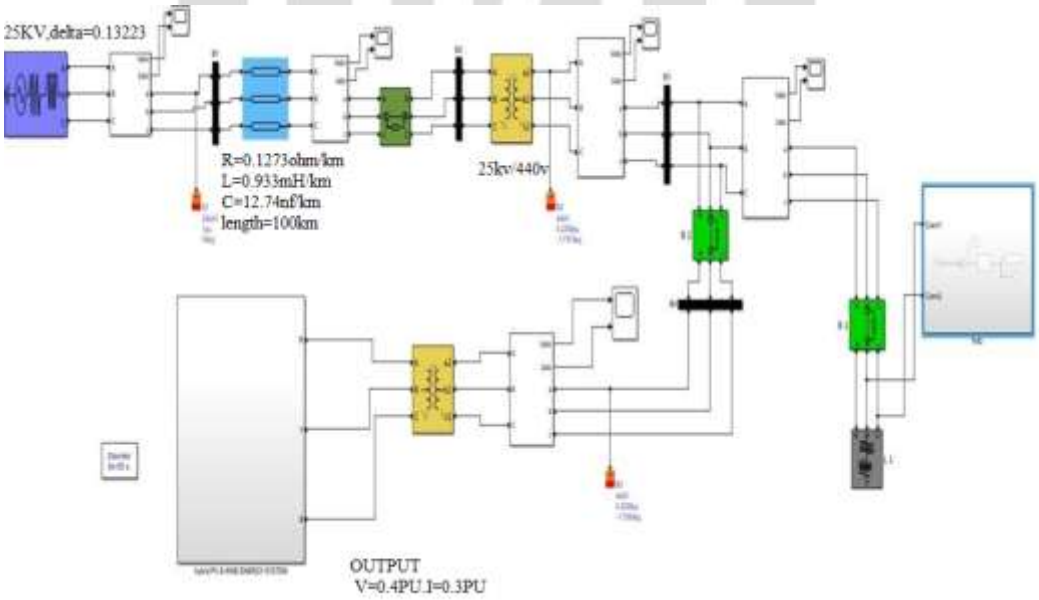

Figure 2. Matlab simulation model for hybrid system without controller

Figure 2. shows that internal simulation model for PV and wind system which consists of PV system connected to the grid through boost converter to step up output and LC filter to reduce. harmonics and the duty cycle for the boost converter can control by the MPPT controller which will generates duty pulses according to the maximum power point tracking. and wind energy system is connected to grid through buck converter to step down its output where the buck converter duty cycle can determine by voltage source controller.

Results Without Controller

Figure 3. shows the individual power system source voltage and current without interconnection of hybrid system. Figure 5. load voltage and current without interconnection having harmonic content in its output. Figure 6. Shows the individual PV &Wind system output voltage and current

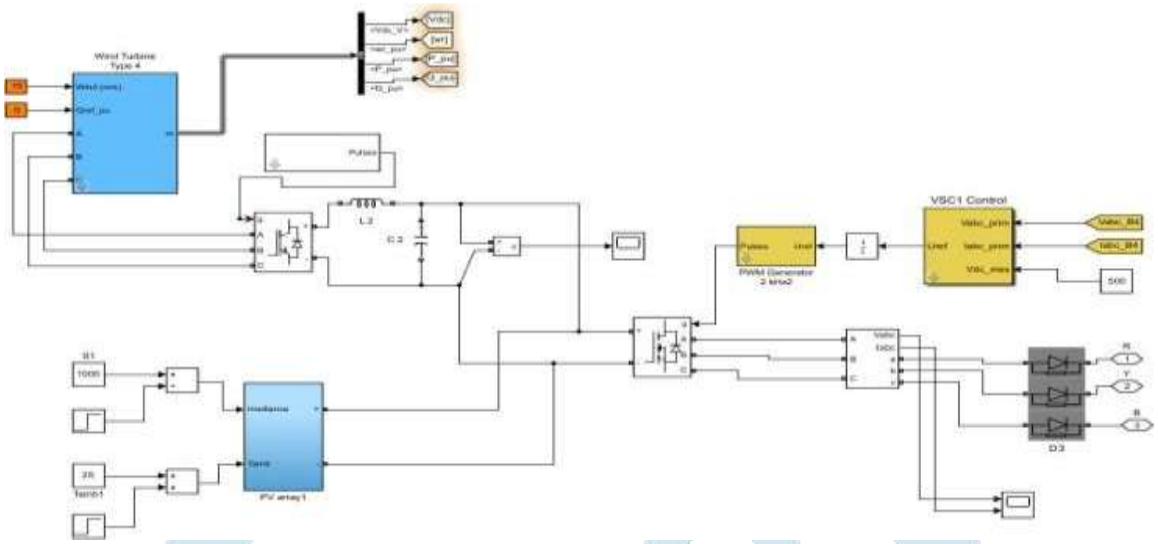

Figure 3. internal simulation model for PV and wind system

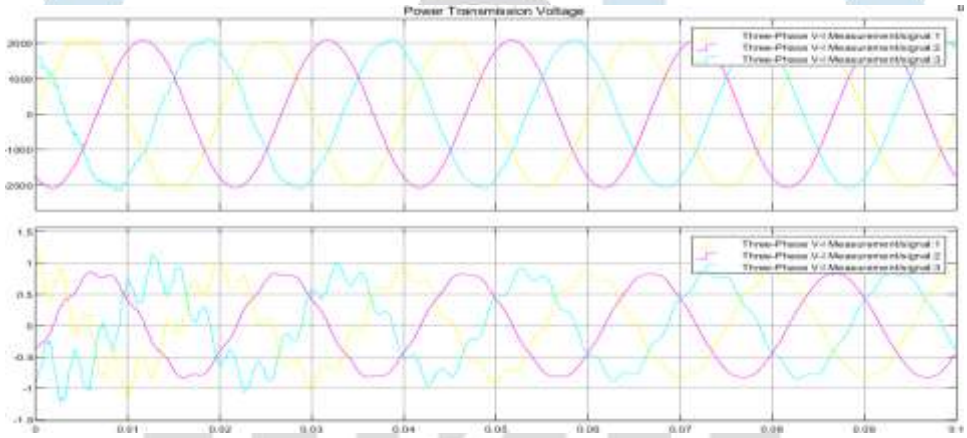

Figure 4. individual power system source voltage and current

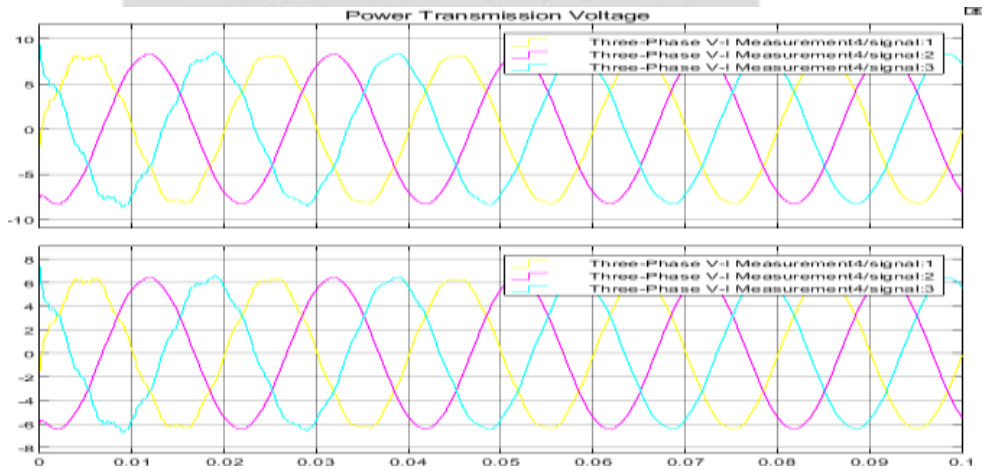

Figure 5. load voltage and current without interconnection

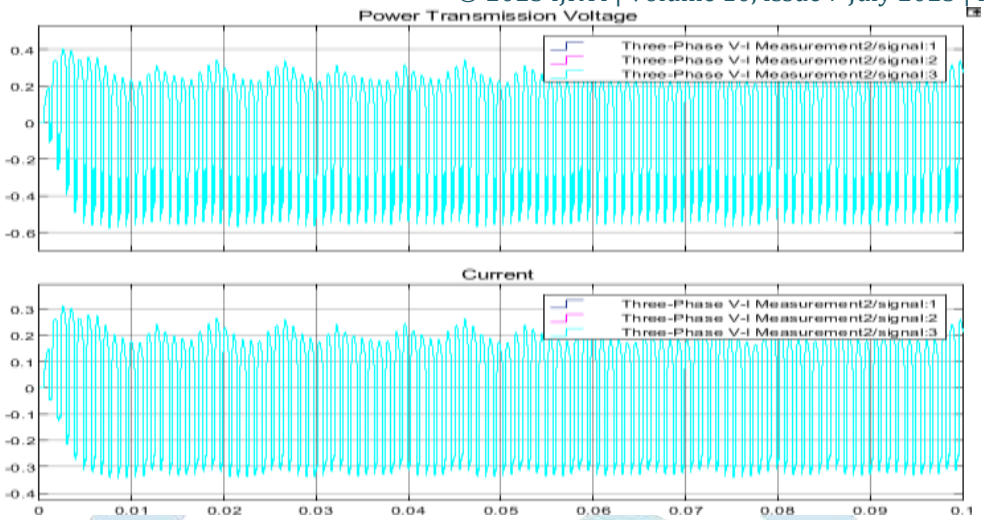

Figure 6. individual PV &Wind system source voltage and current

When PV and wind energy systems are interconnected to the main grid, due to continuous changes in solar irradiation and continuous variation in wind speed the system output is not constant having harmonic content in its output. Figure 7. Shows hybrid power system output voltage and current with fundamental frequency of 50Hz and the harmonic frequency order of 14.25Hz with harmonic order of 7.89%.

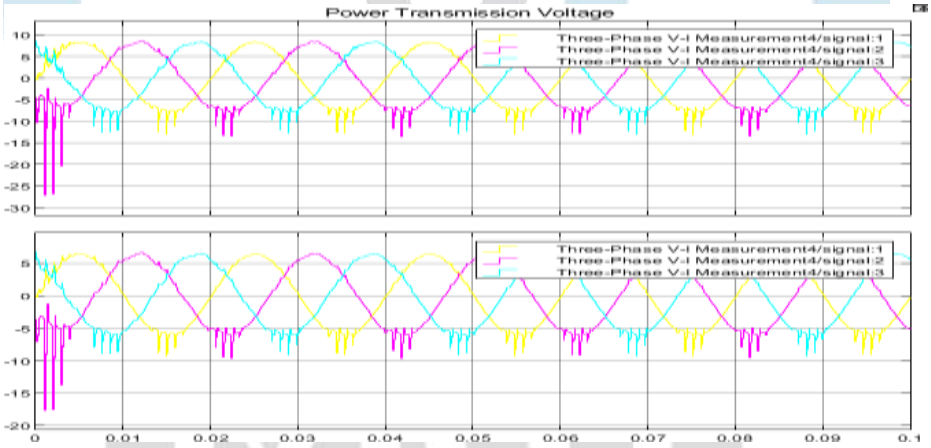

Figure 7. hybrid power system output voltage and current

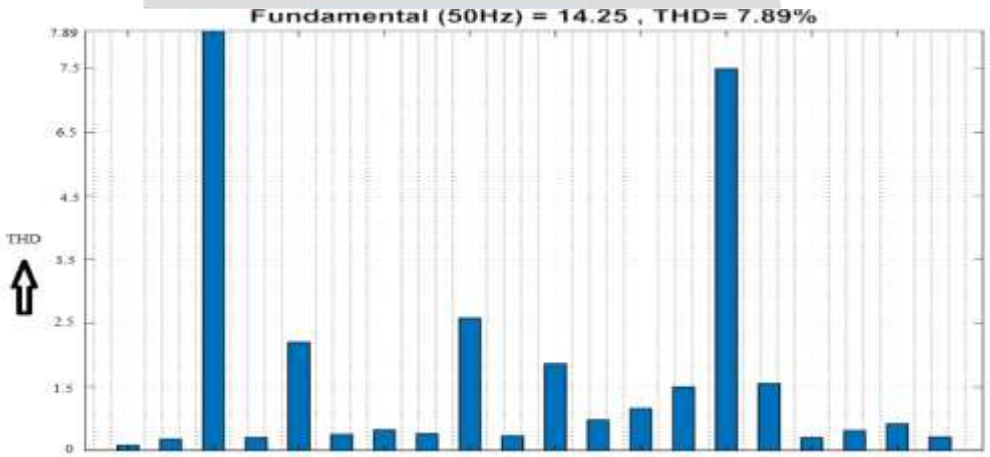

Figure 8. shows the line-to-line voltage of the interconnected system with harmonic content and Figure 9. shows THD graph for hybrid system line to line voltage having the THD value of 0.07289

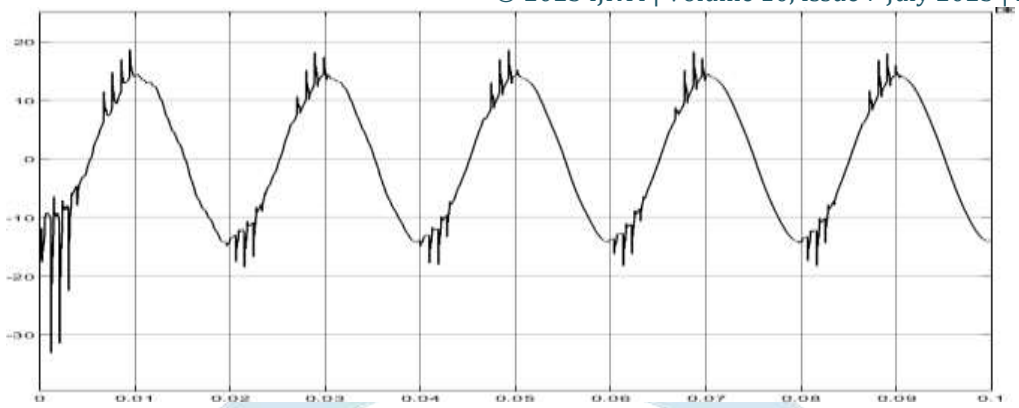

Figure 9. Harmonic content in line-to-line voltage

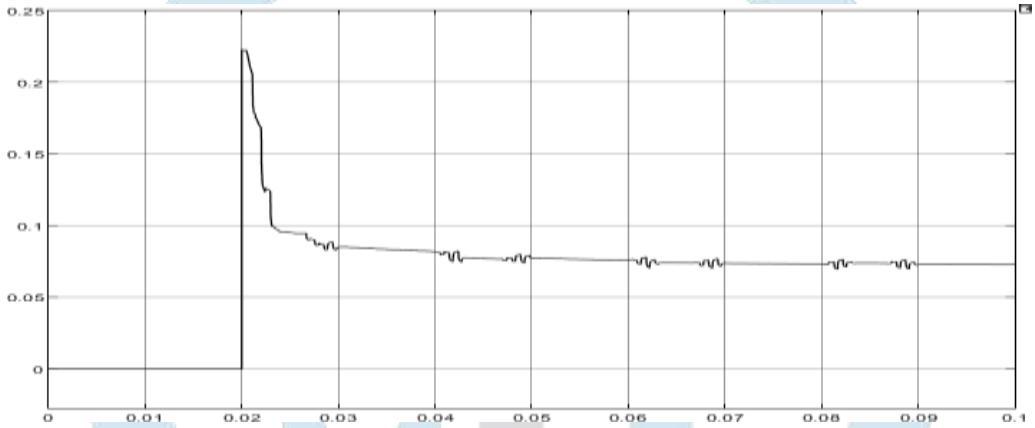

Figure 10. THD graph for hybrid system line to line voltage

Simulation With Controller

Figure 11. shows that simulation model for hybrid system with STATCOM controller that is connected in shunt to the load which will reduce the harmonics generated in the hybrid system and also provide voltage support which means improves the voltage profile and also improves the transient stability. Figure 12. Shows the output voltage and current of hybrid system with STATCOM controller with reduced harmonics shown in figure 13 . Line to line voltage of hybrid system with STATCOM controller. And the Figure 14. shows harmonic order with controller reduced to the value 0.00443

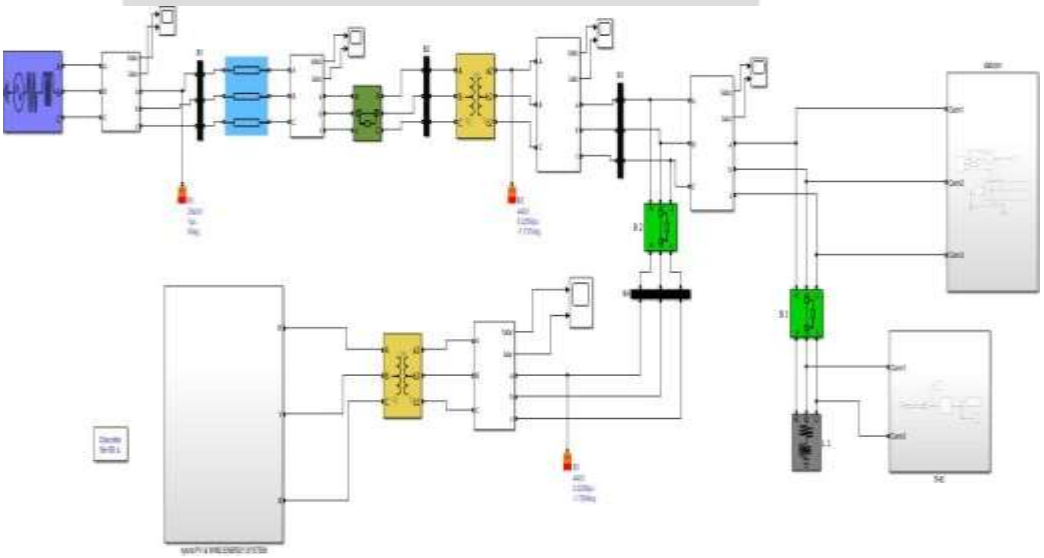

Figure 11. Simulation model for hybrid system with STATCOM controller

IV. Results With Controller

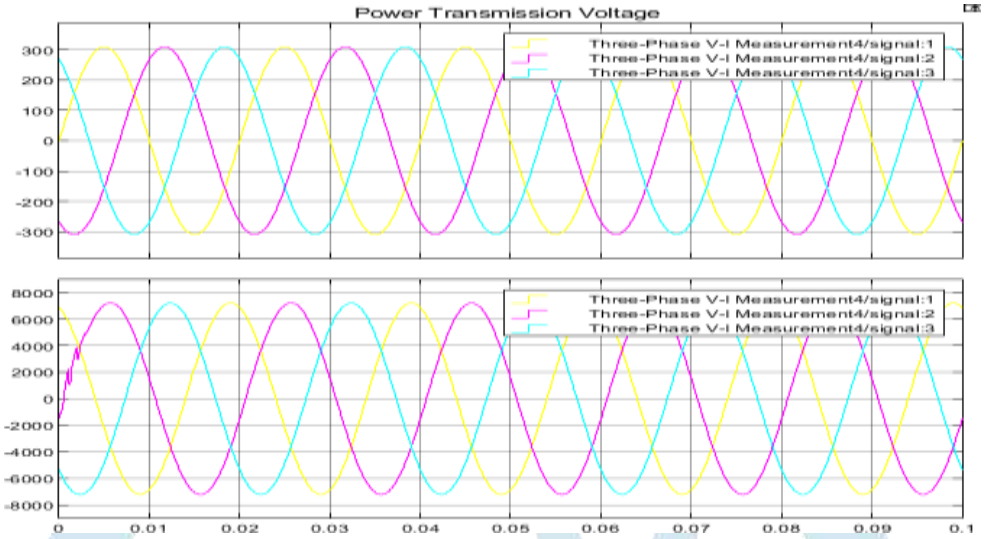

Figure 12. output voltage and current of hybrid system with STATCOM controller

V.

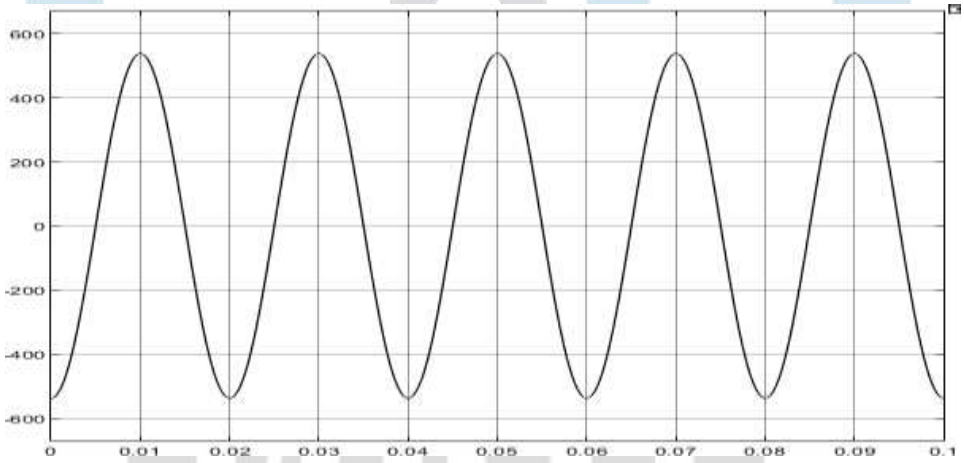

Figure 13. Line to line voltage of hybrid system with STATCOM controller

Figure 14. harmonic order with controller

VI. Conclusion

Generation due conventional energy resources are unable to meet the increased load demand, so PV and Wind energy generation systems are interconnected with grid to form a hybrid power system. due to continuous variation in the solar irradiation and wind velocity, harmonics will be generated in the system output. So, in order to mitigate the harmonic content an advanced controllers are used such as STATCOM, which will reduce the harmonic order from 7.89% to 0.4%.

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