International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 03, March-2019

# Controlled Reactive Power in Wind Connected Grid With And Without STATCOM Using MATLAB/SIMULINK

M.PRATHIMA ASST. PROF, A.NAGA JYOTHI, B.NEELAVENI, P.ASHWANTH KUMAR, G.ANUSHA
*Guided by M. PRATHIMA,*

*SSIT, JNTUH*

***Abstract— Voltage Stability and reactive power balance could be a key challenge for the stable operation of grid connected wind farm through-out the faults and grid interruptions. When the wind farm is directly connected to grid, the voltage stability is that the main issue for squirrel cage induction generator (SCIG) because of intermittent nature of wind velocity. Voltage stability drawback is sorted out with the help of flexible AC transmission system (FACTS) devices like static synchronous compensator (STATCOM). A STATCOM is used to counter problems like transient stability support in network including Squirrel Cage wind generator. The wind power system model is implemented using SIMULINK .The STATCOM results are better than static var compensator (SVC) for the stable operation of SCIG. STATCOM improves the stability problem and so help the wind generator system to remain in service throughout grid faults. In order to minimize the lagging nature some compensation techniques has to be implemented such as, Active Power Filter Control (APF), Synchronous Reference Frame and Sensitivity Method***

***Keywords: Wind Farm, STATCOM, Reactive Power, Squirrel Cage Induction Generator, Active Power Filter Control, Synchronous Reference Frame, Sensitivity Method.Matlab/Simulink.***

## I. INTRODUCTION

In recent days, Problem of pollution from fossil fuels during power generation has become severe. Since, their capacity is limited; so that they might not available in future. Consequently, it is become essential to adopt clean energy sources such as wind energy, solar energy for electric power generation. These renewable sources are intermittent in nature. In result of this, these sources create instability in power system. However, renewable sources like wind power being intermittent in nature have proved themselves as a feasible solution to the current problem. As the wind turbine technologies are growing rapidly, many wind power farms are getting synchronized with the traditional systems [1].one of the straight forward techniques of running a wind generating system is to apply the squirrel cage induction generator (SCIG) connected directly to the grid system The SCIG has inherent benefits of cost usefulness and but SCIG need reactive power for magnetization. When the generated active power of SCIG is changed because of the wind and absorbed the reactive power and its terminal voltage of SCIG can be influenced substantially.Capacitors are considered to generate reactive power, whereas inductors consume it. So when both are placed in parallel connection, the current flowing through them cancels out. This is essential when controlling the power factor of a circuit and has become a fundamental mechanism in electric power transmission. Adding both capacitors and inductors in a circuit helps partially compensate for the reactive power consumed by the load.The formatter will need to create these components, incorporating the applicable criteria that follow.

FACTS are described by a group of power electronic devices. This technology was specialized to perform Comparable functions if ancient electrical power grid controllers just like device tap changers, phase shifting transformers, passive reactive compensators, synchronous condensers and many more. A STATCOM is introduced in wind energy which is planned below conventional operating condition to enable the proper control over the active and reactive power output, reaching speed, torque steady state values. A STATCOM is employed the machine speed not to reach below certain safe limit by injecting current based mostly control technology has been projected for improving the power quality

## II.WIND TURBINE INDUCTION GENERATOR (WTIG)

A wind turbine is a device that converts the kinetic energy from the wind into electric power. Wind turbine is use squirrel cage induction generator (SCIG) output power to its nominal value for high wind speeds. so as to generate the power of induction speed should be slightly more than the synchronous speed, so the WTIG is considered to be a fixed-speed wind generator.

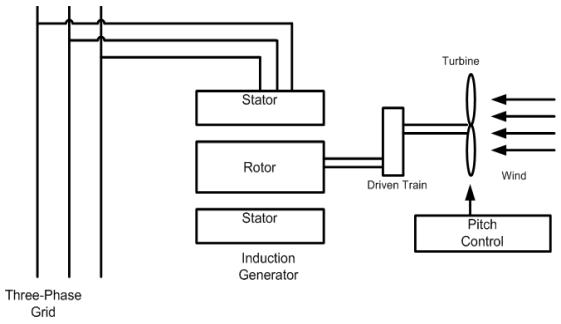



Fig.1 :Wind turbine induction generator

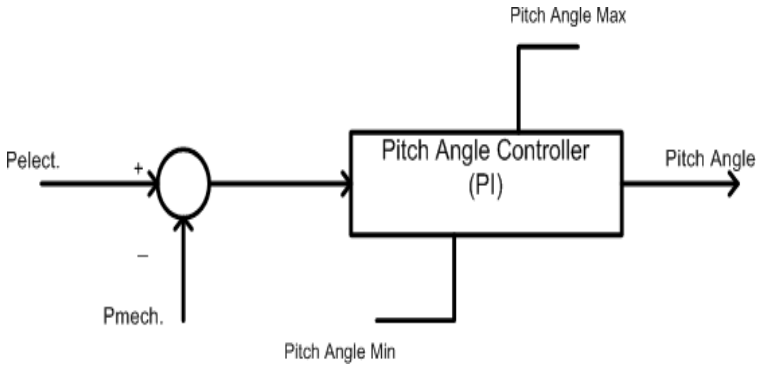



Fig. 2: Control System for Pitch Angle Control

Wind turbine driven rotor and three phase connected stator winding of IG is shown in Fig 1. The blade pitch angle (þ) is controlled to limit the generator output power. In order to generate power the induction speed must be slightly above the synchronous speed but the speed variation is typically so that the WTIG is considered to be affixed speed wind generator.

A Proportional-Integral (PI) controller is used to handle the blade pitch angle which is kept constant at zero degree, limit the electrical output power to the ostensible mechanical power. When it'll increase more than its nominal value then the PI controller will also increase the pitch angle to bring back the measured power to its nominal value. The pitch angle system is illustrated within the Fig 2.

*A. Wind turbine model*

Wind electrical power industry growing rapidly more and more wind farm can be connected into power systems. In the next years, there will be more significant growth in wind energy. Although the great development in the technology of electrical generation from wind energy, there is only one way of generating electricity from wind energy is to use wind turbines that convert the energy contained in flowing air into electricity.

The relation between Cp, þ, L is shown in Fig 3.

*B.Distribution Generators*

The application of distributed generation (DG) has been increasing rapidly in the past decades. Compared to the conventional centralized power generation, DG units have advantages of less pollution, higher efficiency of energy utilization, more flexible installation location, and less power transmission losses. Most of the DG units are connected to the grid via power electronic converters, which introduces system resonance, protection interference, etc. To overcome these problems the microgrid concept was first proposed in the US by the Consortium for Electrical Reliability Technology Solutions [1]. Compared to use a single DG unit, microgrid could offer superior power management within the distribution networks. Moreover, the microgrid can operate in grid-connected mode or Manuscript received February 09, 2014; revised May 03, 2014; accepted for publication June 06, 2014. This work was supported by the National Natural Science Foundation of China under Grant 61174125 and Hunan Provincial Natural Science Foundation of China under Grant 14JJ5035. H. Han, Y. Liu, Y. Sun (corresponding author) and M. Su are with the School of Information Science and Engineering, Central South University, Changsha 410083, China (e-mail: hua_han@126.com,yaoliu@csu.edu.cn,yaosuncsu@gmail.com, sumeicsu@mail.csu.edu.cn). J. M. Guerrero is with the Department of Energy Technology, Aalborg University, 9220 Aalborg East, Denmark (Tel: +45 2037 8262; Fax: +45 9815 1411; e-mail: joz@et.aau.dk). Islanded mode and benefit both the utility and customers in economy.

| State | Load | |
|---|---|---|
| 18.5 Sec Fundamental (Peak) | 16.5 Sec Sec | 18.5 Sec 16.5 |
| 24.2 36.83 THD | 27.39<br>6.42%<br>5.42%<br>4.23% | 32.46 |

| Fundamentals | 100% | 100% | 100% |
|---|---|---|---|
| 3rd 0.78% | 0% | 0% 0.97% | |
| 5th 0.61% | 4.14% | 3.49% | 0.91% |

## III. STATCOM

STATCOM are used for bus voltage regulation by means that of providing or absorbing a reactive power. they are effective for damping mechanical device oscillations. There are different types of shunt compensators are presently used in power systems. the most standard ones are Static Var Compensator (SVC) and STATCOM[4]. During in this work, only the STATCOM, that has a lot of sophisticated topology than SVC is studied. The STATCOM can be a FACTS controller type which is based on voltage source converter (VSC) technology. A VSC generates a synchronous voltage of controllable magnitude and phase angle. STATCOM can be a shunt controller primarily used to regulate voltage by generating/absorbing reactive power and STATCOM can increase reliability and capability of AC transmission system[4]. The Schematic diagram of STATCOM is shown in Fig 4.

Fig. 3: Aerodynamic Power Coefficient Variation Cp against Tip Speed Ratio (TSR) L and Pitch Angle þ

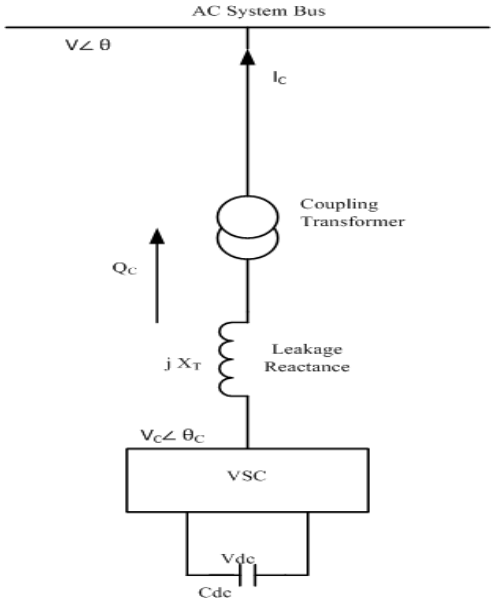



Fig 4:.Schematic diagram of STATCOM

The resulting STATCOM can inject or absorb reactive power to or from the bus which it is connected and thus regulate bus voltage magnitudes [4]. The main advantage of a STATCOM over SVC is its reduced size, which results

from the elimination of ac capacitor banks and reactors; moreover, STATCOM response is about 10 times faster than that of SVC due to its turn-on and turn-off capabilities. The active and reactive power exchange between the VSC and the system is shown in Fig 4

When it is perform a steady state operation, the voltage V2 generated by the VSC is in phase with V1 (=0), so that only reactive power is flowing (P=0). If V2 is lower than V1, Q is flowing from V1 to V2 (STATCOM is absorbing reactive power). On the reverse, if V2 is higher than V1, Q is flowing from V2 to V1 (STATCOM is generating reactive power) [11].As long because the reactive current stays within the minimum and minimum current values (-Imax, Imax) imposed by the converter rating, the voltage is regulated at the reference voltage Vref. However, a voltage droop is generally used (usually between 1% and 4% at maximum reactive power output.

## IV. MODELING AND SIMULATION RESULTS

The Simulink Model of wind farm in MATLAB as shown in Fig 6, 6(a) and 6(b) to check the stability behavior with or without STATCOM. First, fault occurs and ends between duration 12 to 12.1 sec and again, starts and ends between duration 16 to 16.1 sec of the simulation. During the event of fault, this simulation verifies dynamic reactive power compensation capability of STATCOM. The network having 120kV, 50Hz, grid supply, feeds a 30kV distribution system through120/30kV, 62.5KVA step down transformer. There are two loads within the system 30MW and 8MW at 20km from the transformer

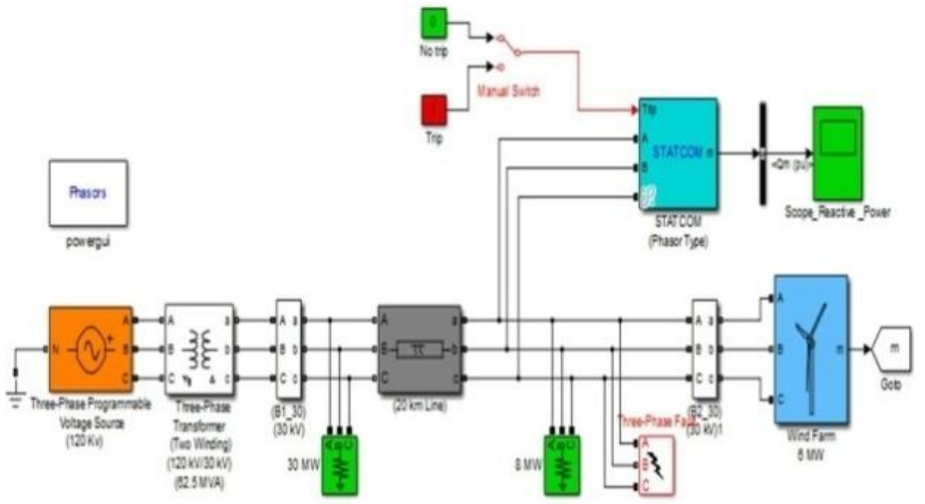



Fig. 5: Simulink Model of Wind Farm with STATCOM

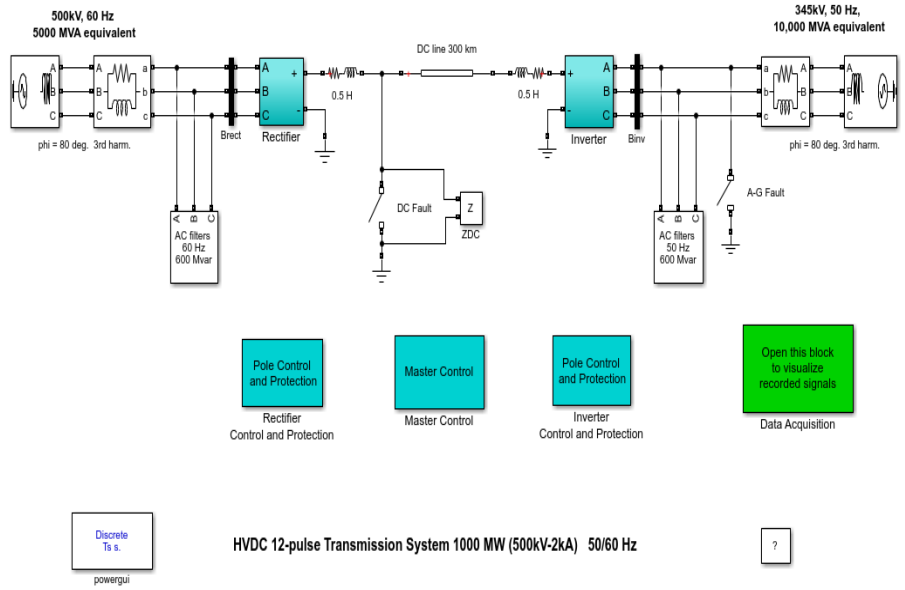



Fig 6(a): Detailed Model of Wind Farm When fault is at Generator 1

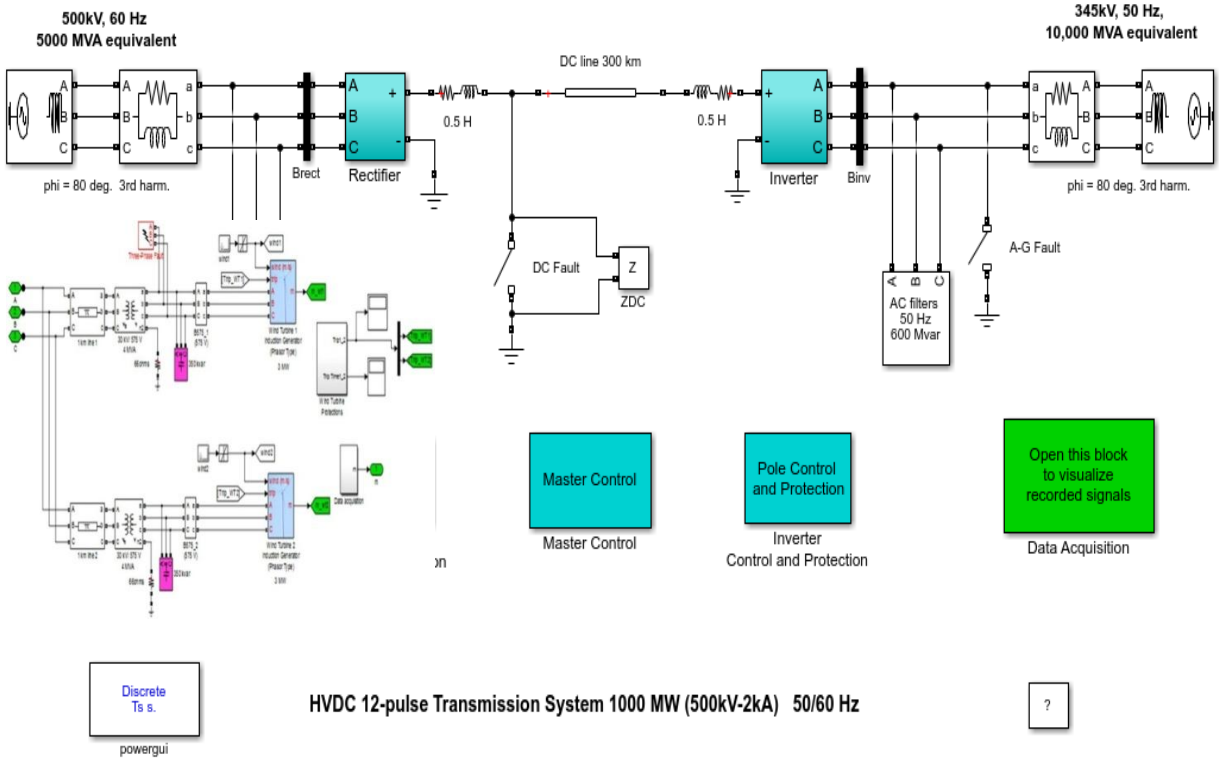



Fig 6(b): Detailed Model of STATCOM [10].

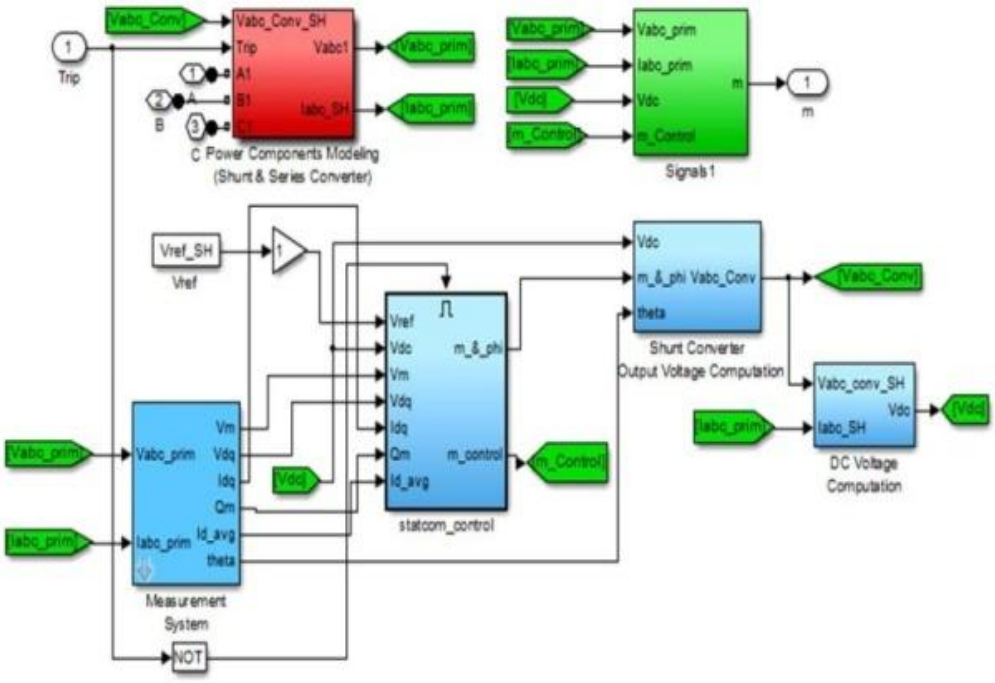



Fig 7:Staic Power Control by using Hvdc Controlled Facts devices

Every wind turbine includes a protection system monitoring voltage, current and machine speed. The system is simulated in MATLAB/Simulink. Fig 6 and Fig 6(a) and Fig 6(b).The simulation time is 20 sec.

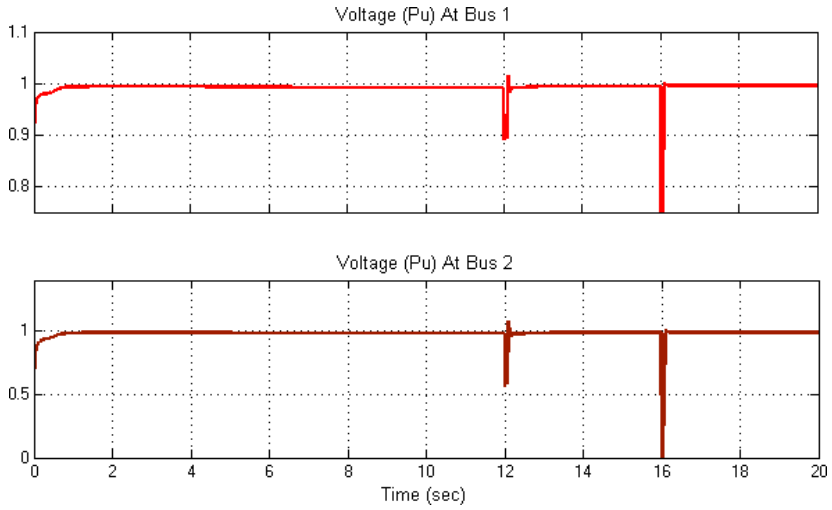



Fig. 8: Voltage (Pu) At Bus 1 and Bus 2 with STATCOM with Fault.

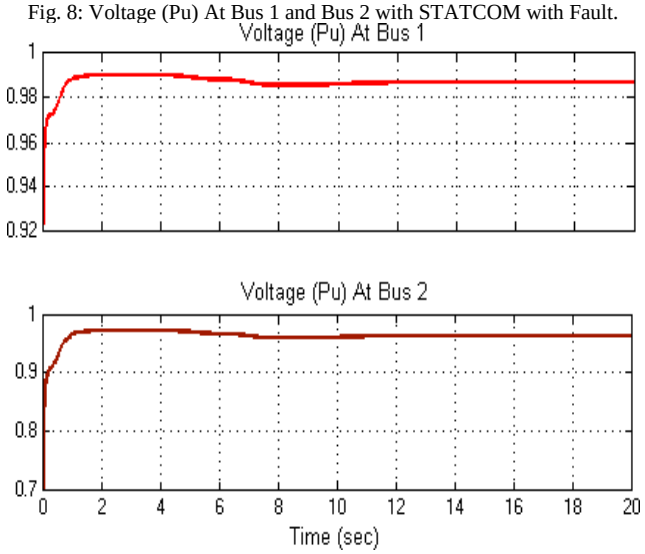



Fig 9: Voltage (Pu) At Bus 1 and Bus 2 with STATCOM and without Fault.

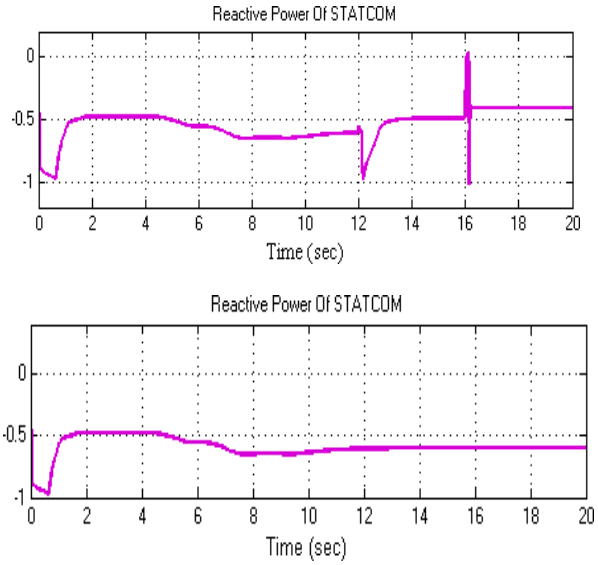
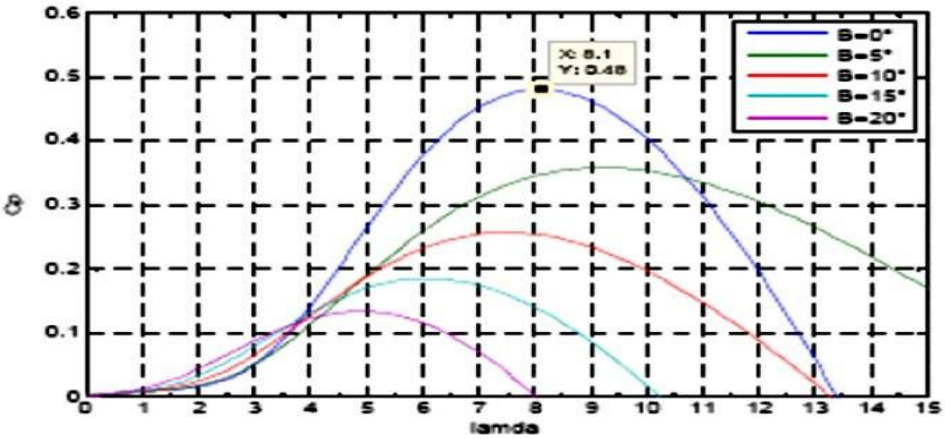



Fig. 10: Voltage (Pu) At Bus 1 and Bus 2 without STATCOM and without Fault.




. Fig. 11: Reactive Power of STATCOM with Fault.

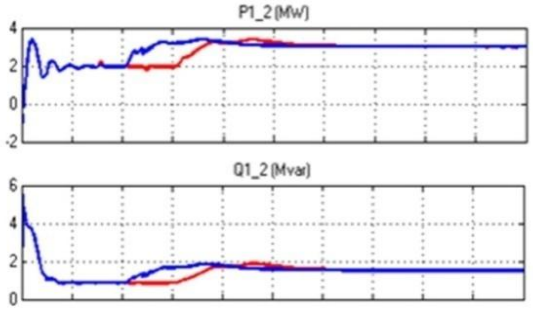



Fig. 12: Active Power, Reactive Power without STATCOM Without fault at bus.

.

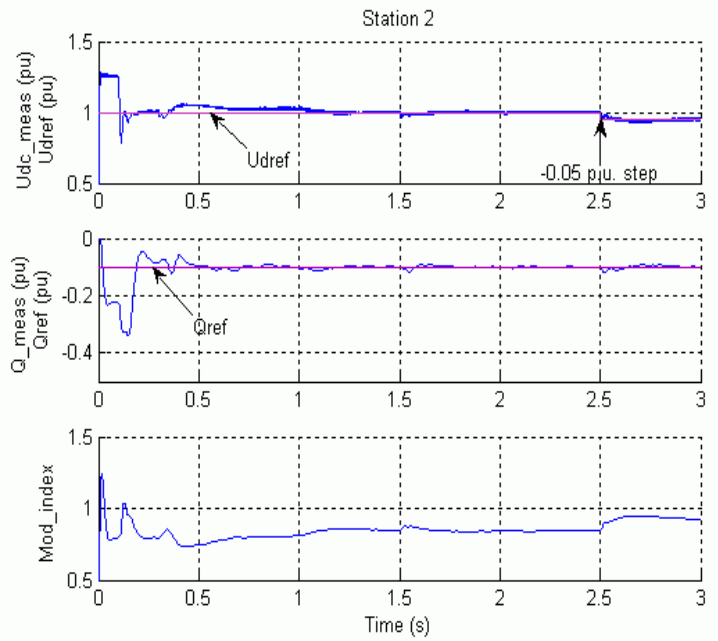



Fig:13 Voltage Source Converter HVDC Based for Reactive power Measurment.

## V. CONCULSION

For the planned work stability improvement of wind farm power plant system using induction generators is investigated. The wind farm provides the active power to the grid when the wind turbines are connected to the grid. The reactive power is absorbed from grid. Induction machine are largely used as generators in wind power primarily based generations. Without reactive power compensation, the combination of wind power in a network causes voltage collapse within the system and under-voltage tripping of wind farm generators. Therefore, it's necessary to compensate the reactive power for grid connected wind farm to eliminate the results of voltage fluctuations that is caused by reactive power loss in grid.

## REFERENCES

[1] Rajiv Singh, "Transient Stability Improvement of a FSIG Based Grid Connected wind Farm with the help of a SVC and a STATCOM:A Comparison", International Journal of Computer and Electrical Engineering, Vol.4, No.1, February 2012.

[2] CH.Appala Narayana, "Application of STATCOM for Transient Stability Improvement and Performance Enhancement for a Wind Turbine Based Induction Generator" , International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue- 6, January 2013.

[3] Sharmila,Pardeep Nain, "Analysis of IG Based Wind Farm with STATCOM and SVC in MATLAB/SIMULINK",IJESRT,4.(7):July,2015,pp.1163 -1169.

[4] Mahmoud Ebadian, Mohsen Noruzin Azghandi, "Harmonic Analysis of Voltage in Different Wind Speeds For Wind Farms" , International Journal of Advanced Research in Computer Science and Software Engineering, Vol.4, Issue-11,November 2014,pp.30-35.

[5] K.B. Mohd. Umar Ansari, " Use of STATCOM for Improving Dynamic Performance of Wind Farms Connected in Power Grid", International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering,Vol. 3, Issue-9 September 2014,pp.11738-11748.

[6] Naimul Hasan , " Dynamic Performance Analysis Of DFIG Based Wind Farm with Statcom and SVC" ,International Journal of Emerging Technology and Advanced Engineering, Vol. 2, Issue-7, July 2012, pp.461-469.

[7] Pradeep Kumar, "Dynamic Performance of STATCOM on the Induction Generator based Wind Farm", International Conference on Global Scenario in Environment and Energy ICGSEE-2013[14th – 16th March 2013],Vol.5, pp.2462-2470, July-Sept 2013.

[8] Bouhadouza Boubekeur, "Application of STATCOM to Increase Transient Stability of Wind Farm", American Journal of Electrical Power and Energy Systems. Vol. 2, No. 2, 2013.

[9] Deshveer, Sudhir Malik, "Simulation and Modeling of STATCOM and WINDFARM in transmission line using MATLAB and analysis of bus voltage", International Journal of Enhanced Research in Science, Technology &Engineering, ISSN: 2319-7463, Vol. 5, Issue 6, June- 2016.

[10] www.mathworks.co.in

[11] Sravanthi, P., Rani, K. R., Amarnath, J., & Kamakshaiah, S. (2014, September). Critical clearing time and transient stability analysis of SCIG based wind farm with STATCOM. In Smart Electric Grid (ISEG), 2014 International Conference on (pp. 1-8). IEEE.