



# Power Stability Improvement in Grid Connected Wind Turbine Using PID

Mahdi Mozaffari Legha<sup>1</sup>, Mohammadashraf Keshavarzi<sup>2</sup>

<sup>1</sup>Department of Power Engineering, Institute of Higher Education Javid, Jiroft, Iran.

Email: [mozaffarilegha.m@gmail.com](mailto:mozaffarilegha.m@gmail.com)

<sup>2</sup>Education Teacher, Iranshahr, Iran. Email: [Keshavarzi\\_1357@yahoo.com](mailto:Keshavarzi_1357@yahoo.com)

**Abstract:** In this paper interconnection of wind generating source in the electrical network affects the power quality and reliability. The influence of the wind turbine in the grid system concerning the power quality measurements are the active power, reactive power, variation of voltage, flicker, harmonics, and electrical behavior of switching operation and these are measured according to national international guidelines. The paper study demonstrates the power quality problem due to installation of wind turbine with the grid. The proposed control scheme to mitigate the power quality issues for power quality improvement in the grid connected wind energy generation is simulated using MATLAB/ SIMULINK in power system block set.

**Key words:** Energy System, Stability, PID controller, STATCOM, THD.

## INTRODUCTION

In recent years, wind energy has become one of the most important and promising sources of renewable energy, which demands additional transmission capacity and better means of maintaining system reliability. To have sustainable growth and social progress, it is necessary to meet the energy need by utilizing the renewable energy resources like wind. The need to integrate the renewable energy like wind energy into power system is to make it possible to minimize the environmental impacts. Wind energy conversion systems are the fastest growing renewable source of electrical energy having tremendous environmental, social, and economic benefits [1]. Power Quality is defined as power that enables the equipment to work properly. A power quality problem can be defined as any deviation of magnitude, frequency, or purity from the ideal sinusoidal voltage waveform. Good power quality [2] is benefit to the operation of electrical equipment, but poor power quality will produce great harm to the power system. However, the generated power from wind energy conversion system is always fluctuating due to the fluctuation nature of the wind. Therefore injection of the wind power into an electric grid affects the power quality. The important factors to be considered in power quality measurement are the active power, reactive power, variation of voltage, flicker, harmonics, and electrical behavior of switching operation [3]. In this proposed scheme Static Synchronous Compensator (STATCOM) is connected at a point of common coupling with a battery energy storage system (BESS) to mitigate the power quality issues. Therefore STATCOM [4] provides Reactive Power support to wind

generator and load. The battery energy storage is integrated to sustain the real power source under fluctuating wind power. The STATCOM control scheme for the grid connected wind energy generation system for power quality improvement is simulated using MATLAB/SIMULINK in power system block set. In this paper there will be the analysis of factors which are responsible for the power quality problems in the wind energy conversion system and implementation of proper control scheme for power quality improvement in the wind energy conversion system connected to the grid. The paper is organized as follows. The section II introduces the power quality standards, issues and its consequences of wind turbine. The section III introduces the grid coordination rule for grid quality limits. The section IV describes the topology for power quality improvement. The section V describes the control scheme. The section VI and VII describes the control system performance and conclusion respectively. This paper proposes an interconnection of wind generating source in the electrical network affects the power quality and reliability.

## II. SYSTEM PRESENTATION

Power quality problem is any power problem manifested in voltage, current, or frequency deviation that results in failure or malfunctioning of customer equipment.

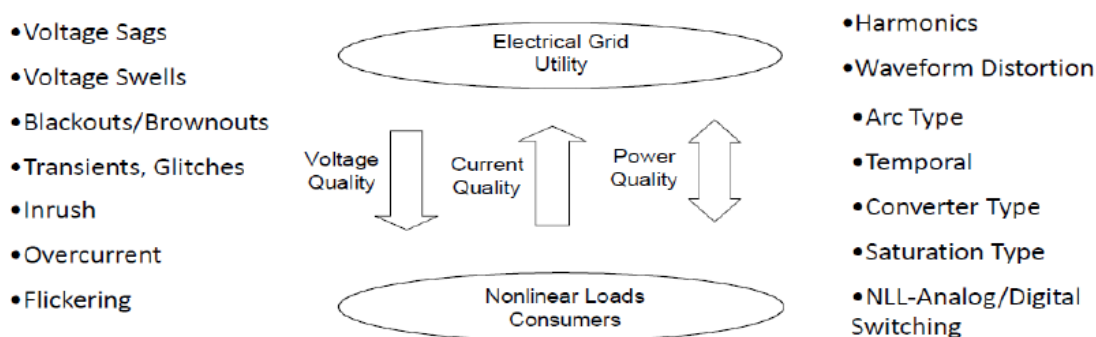


Fig.1. defined Power quality

Power quality is a two-pronged issue, with electronic equipment playing both villain and victim. Most new electronic equipment, while more efficient than its mechanical predecessors, consumes electricity differently than traditional mechanical appliances. Power supply quality issues [5] and resulting problems are consequences of the increasing use of solid state switching devices, nonlinear and power electronically switched loads, electronic type loads .the advent and wide spread of high power semiconductor switches at utilization, distribution and transmission leaves have non sinusoidal currents.

### III. Topology

The STATCOM [8] based current control voltage source inverter injects the current into the grid in such a way that the source current are harmonic free and their phase-angle with respect to source voltage has a desired value. The injected current will cancel out the reactive part and harmonic part of the load and induction generator current, thus it improves the power factor and the power quality. To accomplish these goals, the grid voltages are sensed and are synchronized in generating the current command for the inverter. The proposed grid connected system is implemented for power quality improvement at point of common coupling as shown in Fig. 2. The grid connected system in Fig. 2, consists of wind energy generation system and battery energy storage system with STATCOM.

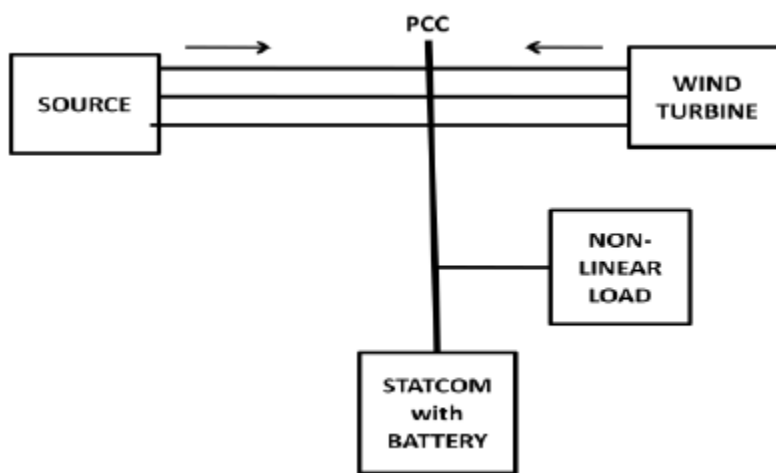


Fig.2. Line diagram of Grid connected system

### III. SIMULATION RESULTS AND DISCUSSION

The proposed control scheme is simulated using SIMULINK in power system block set. The system parameter for given system is given Table I. The system performance of proposed system under dynamic condition is also presented. The three phase injected current into the grid from STATCOM will cancel out the distortion caused by the nonlinear load and wind generator. The IGBT based three-phase inverter is connected to grid through the transformer. The generation of switching signals from reference current is simulated within hysteresis band of 0.08. The choice of narrow hysteresis band switching in the system improves the current quality and control signal of switching frequency within its operating band.

TABLE – I SYSTEM PARAMETERS

1	Grid Voltage	3-phase,415V,50Hz
2	Induction Motor/Generator	.35 KVA,415 V,50 Hz, P=4, Speed =1440 rpm, Rs=0.01 $\dot{U}$ Rr=0.015 $\dot{U}$ , Ls=0.06 H, Lr=0.06H
3	Line series Inductance	0.05 mH
4	Inverter Parameters	DC Link Voltage =800V DC Link Capacitance = 100iF Switching Frequency =2 kHz
5	IGBT Rating	Collector Voltage = 1200V, Forward Current =50 A, Gate voltage = 20 V, Power dissipation =310 W
6	Load Parameter	Non-Linear Load 25 KW

When STATCOM controller is made ON, without change in any other load condition parameters, it starts to mitigate for reactive demand as well as harmonic current. This additional demand is fulfill by STATCOM compensator [12].The simulation diagram of proposed control scheme with STATCOM is shown in Fig. 3 and Fig. 4.

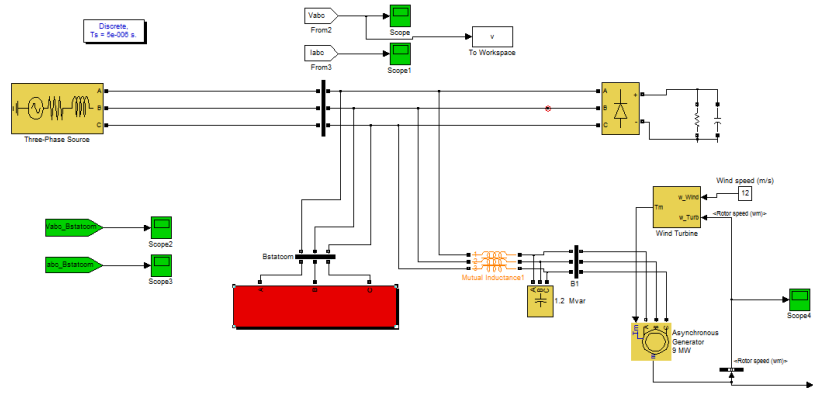


Fig. 3. Proposed system model

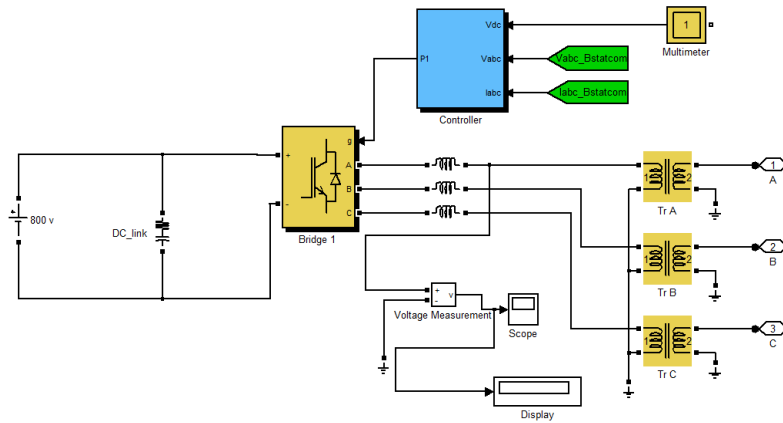


Fig. 4. Proposed control scheme with STATCOM

The DC link voltage and Current through capacitor are shown in Fig.6. The source voltage and source current at PCC is shown in Fig.5. The outputs of source current, load current, inverter injected current and wind generator current are shown in Fig.6.

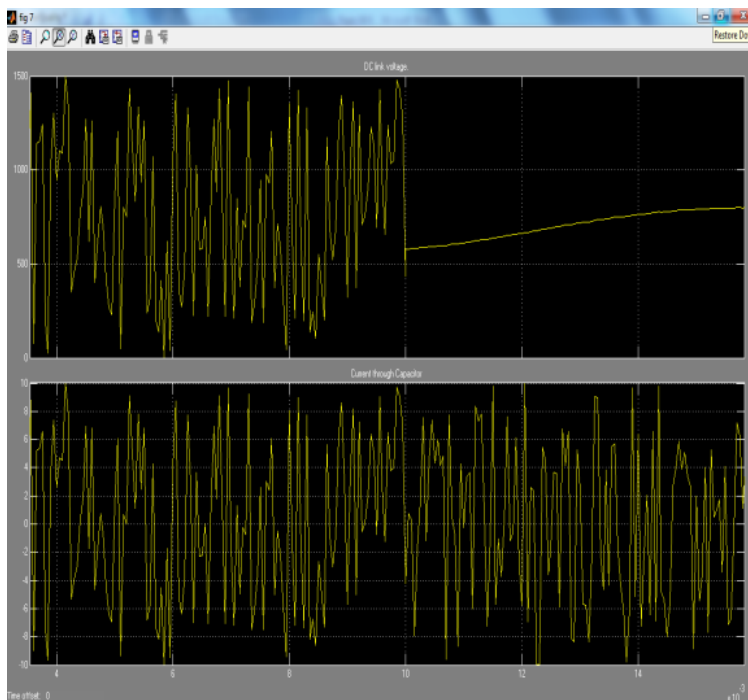


Fig. 5. DC link voltage and Current through capacitor

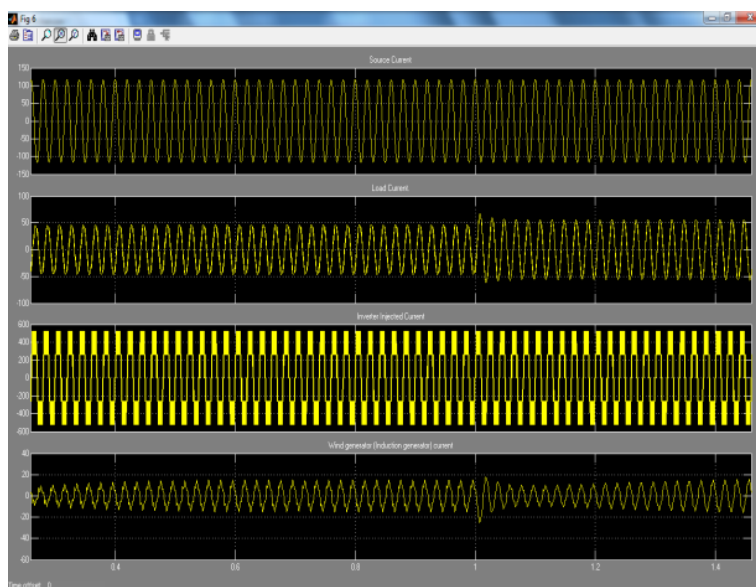


Fig. 6. (a) source current, (b) load current, (c) Inverter injected current and (d) wind generator current.

#### IV. CONCLUSION

The paper analyses the factors which are responsible for the power quality problems [16] in the wind energy conversion system and implementation of proper control scheme for power quality improvement in the wind energy conversion system connected to the grid. The proposed control scheme for the grid connected Wind

energy generation system for power quality improvement is simulated using MATLAB/SIMULINK. The control scheme has a capability to cancel out the harmonic parts of the load current. It maintains the source voltage and current in-phase and support the reactive power demand for the wind generator and load at PCC in the grid system, thus it gives an opportunity to enhance the utilization factor of transmission line.

## REFERENCES

- [1]. S.W Mohod, M.V Aware, —A STATCOM control scheme for grid connected wind energy system for power quality improvement,|| IEEE System Journal, Vol.2, issue 3, pp.346-352, Sept.2010
- [2]. E. Muljadi and C.P. Butterfield —Power quality aspects in a wind power plant,|| in IEEE Power engineering June 18-20, 2006.
- [3]. Sun, Tao, Chen, Z., Blaabjerg, F.:-Flicker Study on Variable Speed Wind Turbines with Doubly Fed Induction Generators||, Accepted for IEEE Transactions on Energy Conversion.
- [4]. A.P. Jayam, B.H. Chowdhury, —Improving the dynamic performance of wind farms with STATCOM||, IEEE, 2009
- [5]. S. W. Mohod and M. V. Aware,|| Power quality issues & its mitigation technique in wind energy conversion,|| in Proc. of IEEE Int. Conf. Quality Power & Harmonic, Wollongong, Australia, 2008
- [6]. Larsson A. Flicker emission of wind turbines caused by switching operations IEEE Trans on Energy Conversion, 2002, 17(1): 119-123.
- [7]. English version of Technical Regulations TF 3.2.6, —Wind turbines connected to grids with voltage below 100 kV —Technical regulations for the properties and the control of wind turbines||, Eltra and Ekraft systems, 2004.
- [8]. N. G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, New York: IEEE, 2000.
- [9]. A.Arulampalam, J.B.Ekanayake & N.Jenkins, Application study of a STATCOM with energy storage, Proc. IEE Generation, Transmission & Distribution, Vol. 150, No. 3, 2003, 373–384.
- [10]. S. Heier —Grid Integration of Wind Energy Conversions,|| Hoboken, NJ: Wiley, 2007.
- [11]. Indian Wind Grid Code Draft report on, Jul.2009, C-NET.
- [12]. M.E. Baran, S. Teleke, L. Anderson, S. Bhattacharya, A. Huang, S.Atcitty, —STATCOM with Energy Storage for Smoothing Intermittent
- [13]. Wind Farm Power||, IEEE/PES, 2008.
- [14]. B. Behzad Jazi, H. A. Abyaneh, M. Abedi — Power quality improvement using active filter capability in back to back convertor installed for variable speed DFIG wind energy system,|| 2001.
- [15]. Z. Yang, L. Zhang —Integration of statcom and battery energy storage,|| IEEE Trans. on Power Systems, vol. 16, no. 2, pp. 254–260, May 2001.
- [16]. A. Morales and J.C. Maun: —Power quality responsibilities by grid impedance assessment at a wind power production||, CIRED, Barcelona, Spain, 12-15 May 2003.