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Power Quality Improvement in Grid Connected Wind Energy System

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Abstract: *The wind energy generation, utilization and its grid penetration in electrical grid are increasingworldwide. The wind generated power is always fluctuating due to its time varying nature and causingstability problems. This weak interconnection of wind generating source in the electrical network affects thepower quality and reliability. The influence of the wind turbine in the grid system concerning the powerquality measurements are the active power, reactive power, variation of voltage, flicker, harmonics, andelectrical behavior of switching operation and these are measured according to national internationalguidelines. The paper obviously demonstrates the presence of power quality issue because of establishment of wind turbine with the grid. In this STATCOM is utilized with energy storage system (BESS) to decrease the power quality issues. The STATCOM control scheme for the matrix associated wind vitality era framework to enhance the power quality is simulated utilizing MATLAB/SIMULINK in power system block set.*

Keywords: Power Quality, Wind Generating System (WGS), STATCOM, BESS, IEC standard.

I. INTRODUCTION

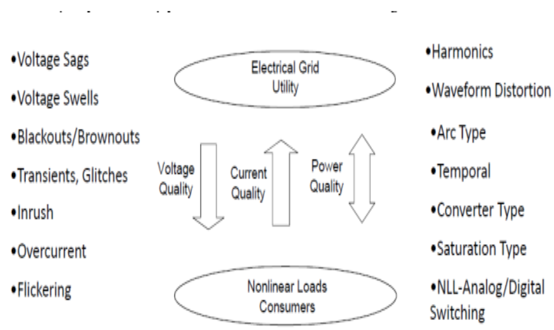
The causes of power quality problems are generally complex and difficult to detect when we integrate a windturbine to the grid. Technically speaking, the ideal AC line supply by the utility system should be a pure sine wave of fundamental frequency (50/60Hz). We can therefore conclude that the lack of quality power can cause loss of production,damage of equipment or appliances or can even be detrimental to human health. It is therefore imperative that a highstandard of power quality is maintained. This project demonstrates that the power electronic based power conditioningusing custom power devices like P-STATCOM can be effectively utilized to improve the quality of power supplied to thecustomers.

Power quality and reliability cost the industry large amounts due to mainly sags and short-term interruptions. Distortedand unwanted voltage wave forms, too. And the main concern for the consumers of electricity was the reliability of supply.Here we define the reliability as the continuity of supply. The problem of distribution lines is divided into two majorcategories. First group is power quality, second is power reliability. First group consists of harmonic distortions, impulsesand swells. Second group consists of voltage sags and outages. Voltage sags is much more serious and can cause a largeamount of damage. If exceeds a few cycle, motors, robots, servo drives and machine tools cannot maintain control ofprocess.

Transmission lines are exposed to the forces of nature. Furthermore, each transmission line has its load abilitylimit that is often determined by either stability constraints or by thermal limits or by the dielectric limits. Even though thepower quality problem is distribution side problem, transmission lines are often having an impact on the quality of thepower supplied. It is however to be noted that while most problems associated with the transmission systems arise due tothe forces of nature or due to the interconnection of power systems, individual customers are responsible for moresubstantial fraction of the problems of power distribution systems.

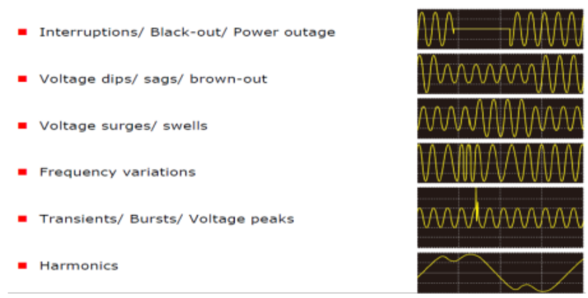
II. POWER QUALITY IMPROVEMENT

Power Quality Issues and Its Consequences: Power quality problem is any power problem manifested in voltage, current, or frequency deviationthat results in failure or malfunctioning of customer equipment.Power quality can be simply defined as shown in the interaction diagram:



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 electricitydifferently than traditional mechanical appliances.Power supply quality issues [5] and resulting problems are consequences of the increasing use of solidstate switching devices, nonlinear and power electronically switched loads, electronic type loads .the advent andwide spread of high power semiconductor switches at utilization, distribution and transmission leaves have non-sinusoidal currents.

Causes and consequences: The causes and consequences of power quality problems can be traced to a specific type of electricaldisturbance. In most of industry, more than 90% of the electric motor with inverter driven application.Poorpower quality causes trouble in receptacle/transmission equipment and electronic equipment malfunctions /Failure. Power quality is a common problem for both electric power suppliers and users. It is not easy to identifywhether the cause of poor power supply quality is at the supplier's system or the user's systemPower disturbances can be classified into the following categories.



Power outages: Power outages are total interruptions of electrical supply. Utilities have installed protection equipmentthat briefly interrupts power to allow time for a disturbance to dissipate.

Causes: Ice storms; lightning; wind; utility equipment failure.

Effects: Complete disruption of operation.

Voltage fluctuations:Voltage fluctuations are changes or swings in the steady-state voltage above or below the designatedinput range for a piece of equipment. Fluctuations include both sags and swells.

Causes: Large equipment start-up or shut down; sudden change in load.

Effects: Data errors; memory loss; equipment shutdown; flickering lights; motors stalling/stopping.

Transients: Transients, commonly called "surges," are sub-cycle disturbances of very short duration that varygreatly in magnitude. When transient occur, thousands of voltage can be generated into the

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electricalsystem, causing problems for equipment down the line.

Causes: Lighting; equipment start-up and shutdown; welding equipment.

Effects: Processing errors; computer lock-up; burned circuit boards; degradation of electricalinsulation; equipment damage.

Harmonics: Harmonics are the periodic steady-state distortions of the sine wave due to equipments generatingfrequency other than the standard 60 cycles per second.

Causes: Electronic ballasts; non-linear loads; variable frequency drives.

Effects: Overheating of electrical equipment; random breakers tripping; hot neutrals.

B. GRID COORDINATION RULE

American Wind Energy Association (AWEA) led the effort to develop its own grid code for stable operation as per IEC-61400-21 for the interconnection of wind plants to the utility systems, after the block out in United State in August 2003. According to these, operator of transmission grid is responsible for the organization and operation of interconnected system.

1) Voltage rise (u)

The voltage rise at the point of common coupling can be approximated as a function of maximum apparent power Smax of the turbine, the grid impedances R and X at the point of common coupling and the phase angle.

2) Voltage dips (d)

The voltage dips is due to startup of wind turbine and it causes a sudden reduction of voltage. It is the relative % voltage change due to switching operation of wind turbine.

3) Flicker

The measurements are made for maximum number of specified switching operation of wind turbine with 10-min period and 2-h period.

4) Harmonics

The harmonic distortion is assessed for variable speed turbine with an electronic power converter at the point of common connection.

III. TOPOLOGY FOR POWER QUALITY IMPROVEMENT

The STATCOM based current control voltage source inverter injects the current into the grid will cancel The STATCOM based current control voltage source inverter infuses the current into the grid will offset the reactive part and harmonic part of the load and induction generator current, in this manner it enhances the power factor and the power quality. To finish these objectives, the grid voltages are detected and are synchronized in producing the current. The proposed grid associated framework is actualized for power quality change at point of common coupling (PCC), for grid associated framework in Fig.1.

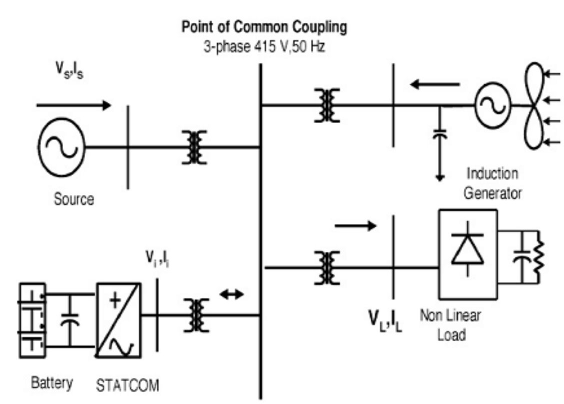

Fig.1. Grid connected system for power quality improvement.

A STATCOM can advance power-system performance in such areas as the following:

a. The power-oscillation damping in power transmission systems.
b. The dynamic voltage control in transmission and distribution systems.
c. The transient stability.
d. The voltage flicker control.

The shunt associated STATCOM with battery energy storage [9] is associated with the interface of the induction generator and non-linear load at the PCC in the grid framework. The STATCOM compensator yield is differed by controlled procedure, in order to keep up the power quality standards in the grid framework. The current control technique is incorporated into the control plot that characterizes the useful operation of the STATCOM compensator in the power framework. A solitary STATCOM utilizing insulated gate bipolar transistor is proposed to have a reactive power backing, to the induction generator and to the nonlinear load in the grid framework. The primary piece outline of the framework operational scheme is appeared in Fig.2.

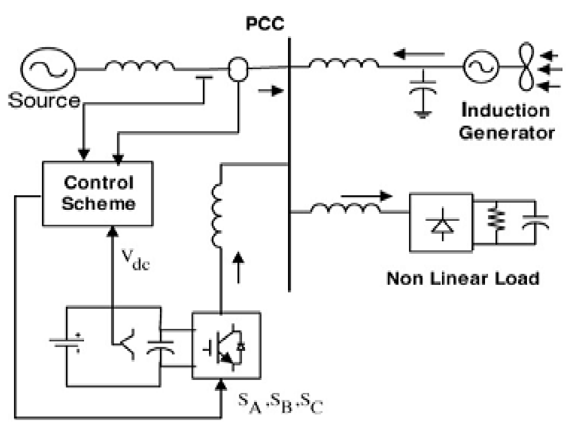

Fig.2. System operational scheme in grid system

The control scheme methodology depends on injecting the streams into the grid utilizing —PID controller. Utilizing such procedure, the controller keeps the control framework variable between limits of hysteresis region and gives right exchanging signals for STATCOM operation. The control framework plan for producing the switching signs to the STATCOM is appeared in Fig.3.

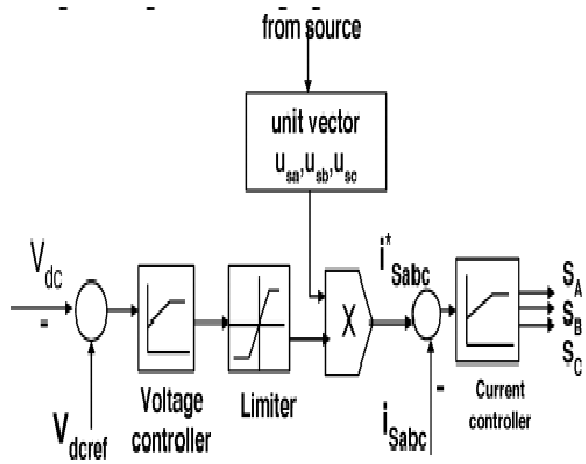

Fig.3 control scheme

IV. SYSTEM PERFORMANCE

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.

Table.1 System parameters

S.no	Parameters	Ratings
1	Grid Voltage	3-phase,415V,50Hz
2	Induction Motor/Generator	3.35 KVA,415 V,50 Hz, P=4, Speed =1440 rpm, R_s=0.01 Ω R_r=0.015 Ω, L_s=0.06 H, L_r=0.06H
3	Line series Inductance	0.05 mH
4	Inverter Parameters	DC Link Voltage =800V DC Link Capacitance = 100μF 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

B. STATCOM—Performance under Load Variations:

The wind vitality producing framework is associated with grid [11] having the nonlinear load.The

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execution of the framework is measured by exchanging the STATCOM at time t=0.7s in the framework and how the STATCOM reacts to the step change command for expansion in extra load at 1.0 s is appeared in the recreation. At the point when STATCOM controller is made ON, without change in some other burden condition parameters, it begins to alleviate for reactive demand and in addition harmonic current. This extra request is satisfy by STATCOM compensator [12].The simulation diagram of proposed control scheme with STATCOM is appeared in Fig.4.

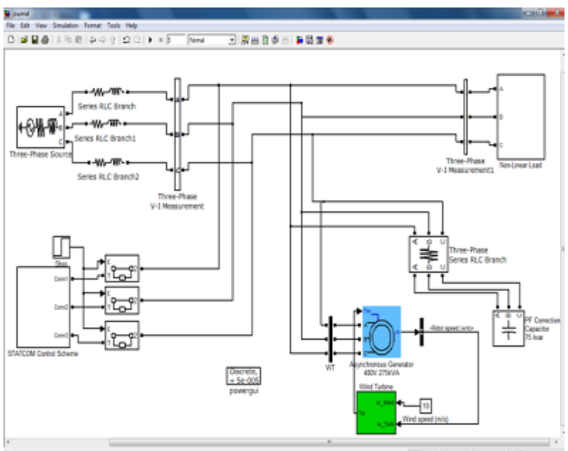

Fig.4 Proposed control scheme with STATCOM

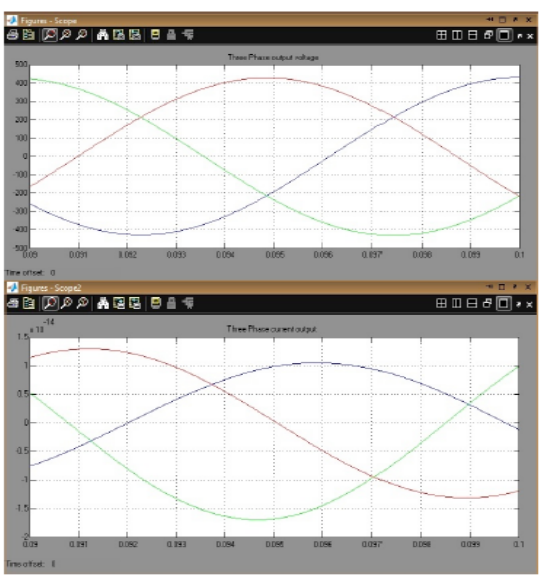

Fig.5. Wind Turbine Model Output

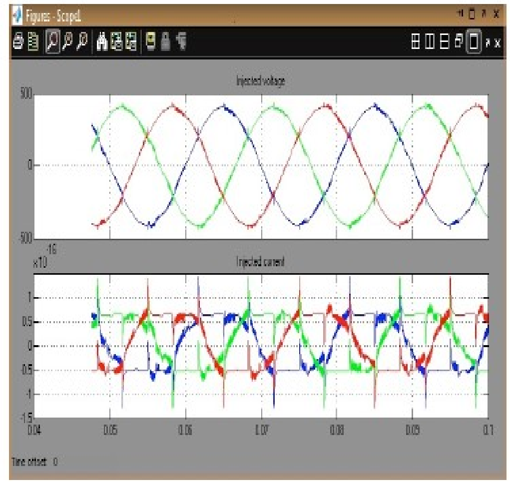

Fig.6 6-Pulse STATCOM OUTPUT

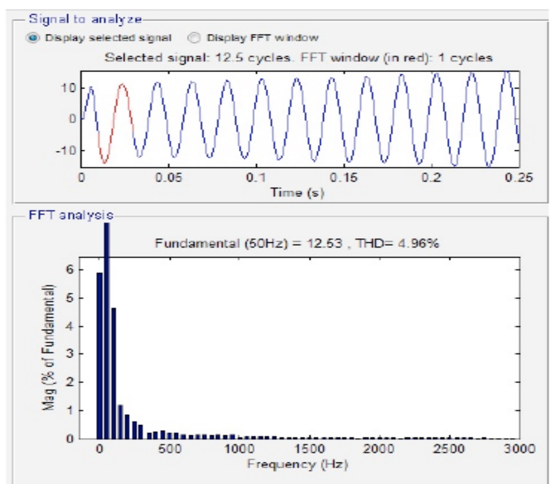

Fig. 7 FFT analysis without Controller (THD=4.96%)

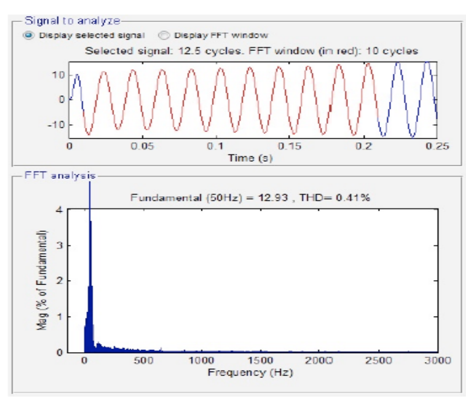

Fig.8 FFT analysis with Controller (THD=0.41%)

V. CONCLUSION

In this paper we present the FACTS device (STATCOM) -based control scheme for power quality improvement in grid connected wind generating system and with nonlinear load. The power quality issues and its consequences on the consumer and electric utility are presented. The operation of the control system developed for the STATCOM in MATLAB/SIMULINK for maintaining the power quality is to be simulated. It 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. The integrated wind generation and FACTS device with BESS have shown the outstanding performance.

In this paper we display the FACTS device (STATCOM) - based control plan for power quality change in grid associated wind producing framework and with nonlinear load. The power quality issues and its results on the buyer and electric utility are exhibited. The operation of the control framework created for the STATCOM in MATLAB/SIMULINK for keeping up the power quality is to be reproduced. It has an ability to counteract the harmonic parts of the load current. It keeps up the source voltage and current in-stage and backing the receptive power interest for the wind generator and burden at PCC in the grid framework, along these lines it gives a chance to improve the utilization factor of transmission line. The incorporated wind generation and FACTS device with BESS have demonstrated the remarkable execution.

REFERENCES

[1] K. S. Hook, Y. Liu, and S. Atcitty, "Mitigation of the wind generation integration related power quality issues by energy storage," EPQU J., vol. XII, no. 2, 2006.

[2] R. Billinton and Y. Gao, "Multistate wind Energy conversion system models for adequacy assessment of generating systems incorporating wind energy," IEEE Trans. on E. Conv., vol. 23, no. 1, pp. 163–169, 2008.

[3] J. Manel Carrasco, "Power electronic system for grid integration of renewable energy source: A survey," IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002–1014, 2006.

[4] M. Tsili and S. Papathanassiou, "A review of grid code technology requirements for wind turbine," Proc. IET Renew. Power gen., vol. 3, pp. 308–332, 2009.

[5] J. J. Gutierrez, J. Ruiz, L. Leturiondo, and A. Lazkano, "Flicker measurement system for wind turbine certification," IEEE Trans. Instrum. Meas., vol. 58, no. 2, pp. 375–382, Feb. 2009.

[6] Indian Wind Grid Code Draft report on, Jul. 2009, pp. 15–18, C-NET.

[7] C. Han, A. Q. Huang, M. Baran, S. Bhattacharya, and W. Lichtenberger, "STATCOM impact study on the integration of a large wind farm into a weak loop power system," IEEE Trans. Energy Conv., vol. 23, no. 1, pp. 226–232, Mar. 2008.

[8] F. Zhou, G. Joos, and C. Abhey, "Voltage stability in weak connection wind farm," in IEEE PES Gen. Meeting, 2005, vol. 2, pp. 1483–1488.

[9] R. S. Bhatia, S. P. Jain, D. K. Jain, and B. Singh, "Battery energy storage system for power conditioning of renewable energy sources," in Proc. Int. Conf. Power Electron Drives System, Jan. 2006, vol. 1, pp. 501–506.

[10] S. W. Mohod and M. V. Aware, "Grid power quality with variable speed wind energy conversion," in Proc. IEEE Int. Conf. Power

Electronic Drives and Energy System (PEDES), Delhi, Dec. 2006.

[11] Fu. S. Pai and S.-I. Hung, “Design and operation of power converter for micro turbine powered distributed generator with capacity expansion capability,” IEEE Trans. Energy Conv., vol. 3, no. 1, pp. 110–116, Mar. 2008.

[12] J. Zeng, C. Yu, Q. Qi, and Z. Yan, “A novel hysteresis current control for active power filter with constant frequency,” Elect. Power Syst. Res., vol. 68, pp. 75–82, 2004.

[13] M. I. Milands, E. R. Cadavai, and F. B. Gonzalez, “Comparison of control strategies for shunt active power filters in three phase four wire system,” IEEE Trans. Power Electron., vol. 22, no. 1, pp. 229–236, Jan. 2007.

[14] 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.

[15] Saeid Eshtehardiha, Mohammad Bayati poodeh and Arash Kiyoumarsi, “Optimized Performance of STATCOM with PID Controller Based on Genetic Algorithm.” In International Conference on Control, Automation and Systems 2007, Oct. 17-20, 2007 in COEX, Seoul, Korea.

BIODATA

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