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Power Quality Improvement of Grid Connected Wind Energy System using various strategies

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ABSTRACT:
With the increase in demand for Electricity due to increase in population and industrialization, the generation of power is really a challenge now a days. It is necessary to meet the energy needs by utilizing the renewable energy resources like wind, biomass, hydro co-generation, etc. Injection of the wind power into an electric grid affects the power quality. The main power quality issues are voltage sag, swell, flickers, harmonics etc. In this proposed scheme STATic COMpensator (STATCOM) is connected at the point of common coupling with a battery energy storage system (BESS) to mitigate the power quality issues. The battery energy storage is integrated to sustain the real power source under fluctuating wind power. Here two control schemes for STATCOM are compared: Bang-Bang current controller and Fuzzy logic controller. Bang-Bang controller is a hysteresis current controlled technique. The operation of the two STATCOM control schemes for maintaining the power quality of the grid connected wind energy system is investigated using MATLAB/SIMULINK.

Keywords— ***STATCOM, power quality, wind generating system, Battery Energy Storage System (BESS), Bang –Bang current controller, Fuzzy logic controller***

INTRODUCTION:

Both electric utilities and end users of electric power are increasingly concerned about the quality of power. Power quality can be defined as "any power problem manifested in voltage, current and frequency those results in failure or maloperation of the customer equipment" [1]. Injection of the wind power into an electric grid affects the power quality [2]. The group of devices used for mitigation of power quality problems is known by the name of Custom Power Devices (CPDs). The family of compensating devices mainly has the following members: Static Synchronous Compensator (STATCOM), Dynamic Voltage Restorer (DVR) and Unified Power Quality Conditioner (UPQC). The work analyses the performance of STATic COMpensator (STATCOM) with a battery energy storage system (BESS) connected at the point of common coupling of wind energy generating system and the existing power system to mitigate the power quality issues.

During the normal operation, wind turbine produces a continuous variable output power. The main power quality issues are voltage sag, swell, flickers, harmonics.

Existing System:

The STATCOM is a three- phase voltage source inverter having the capacitance on its DC link and connected at the point of common coupling. The STATCOM injects a compensating current of variable magnitude and frequency component at the bus of common coupling [1]. Here the utility source, wind energy system and STATCOM with BESS is connected to the grid. The current controlled voltage source inverter based STATCOM injects the current into the grid in such a way that the source current (grid current) are harmonic free and they are in phase-angle with respect to source voltage. The injected current will cancel out the reactive part and harmonic part of

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the induction generator current and load current, thus it improves the power quality . This injected current generation is by proper closing and opening of the switches of voltage source inverter of STATCOM and is different for the two control schemes proposed. For this the grid voltages are sensed and are synchronized in generating the current command for the inverter.

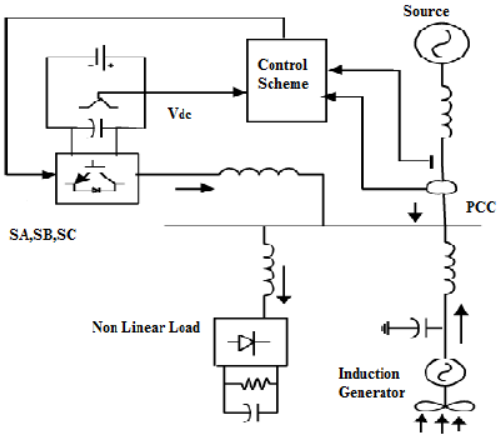

Fig.1. System operational scheme in grid system.

Proposed System:

The three phase injected current into the grid from the STATCOM will cancel out the distortion caused by the nonlinear load and wind generator. The IGBT based threephase inverter is connected to grid through the transformer. The generation of switching signals from reference current is simulated within hysteresis band of 0.08 for Bang-Bang current controller [1]. The choice of narrow hysteresis band switching in the system improves the current quality. The choice of the current band depends on the operating voltage and the interfacing transformer impedance. The compensated current for the nonlinear load and demanded reactive power is provided by the inverter. The real power transfer from the batteries is also supported by the controller of this inverter. The three phase inverter injected current are shown in Fig.

Implementation Using Fuzzy Controller

Inverter current when the output ofThe model of this system is also developed in MATLAB/SIMULINK.

To investigate the performance of the system a load variation is inserted at time T= 0.2 s and the STATCOM is ON from time T=0.05 s. Fig.12 shows the load current, inverter injected current, wind generator current and source current. Whatever changes occurs in the load or induction generator occurs it can't be seen in the source current and it is free from harmonics by the suitable operation of STATCOM by using fuzzy logic controller. Analysis of the system by reducing the output of the wind generating system output is also carried out. Output is reducing at time T=0.5 s and restoring at time T=0.8 s, STATCOM is ON from T=0.0s and OFF at time T=0.7 s and again ON at time T=0.8 **s**. From Fig. 12 we can see that even though the output of wind generating system is varying, the grid current remains constant by the operation of STATCOM. Fig.13 shows the load current, source current, wind generator current.

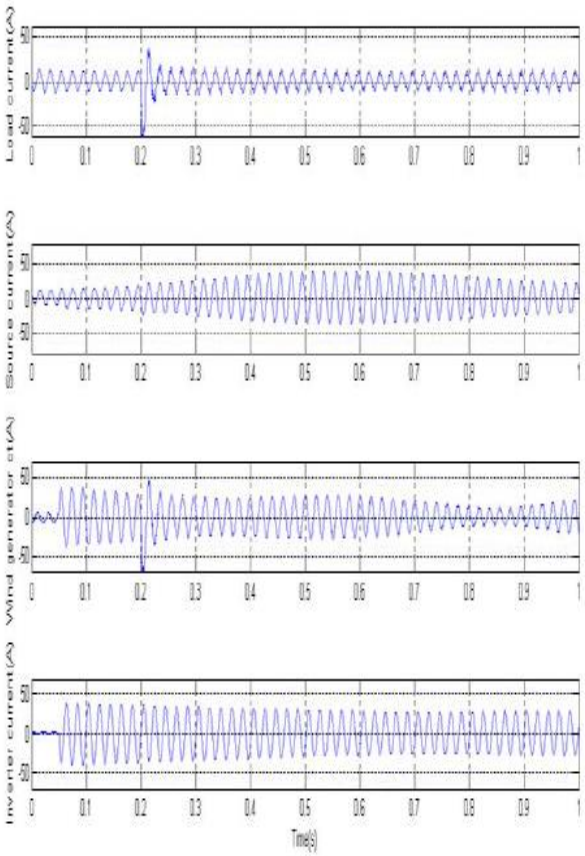

Fig.12. (a) Load Current (b) Source Current(c) Wind generator (Induction generator) current (d) Inverter Injected current

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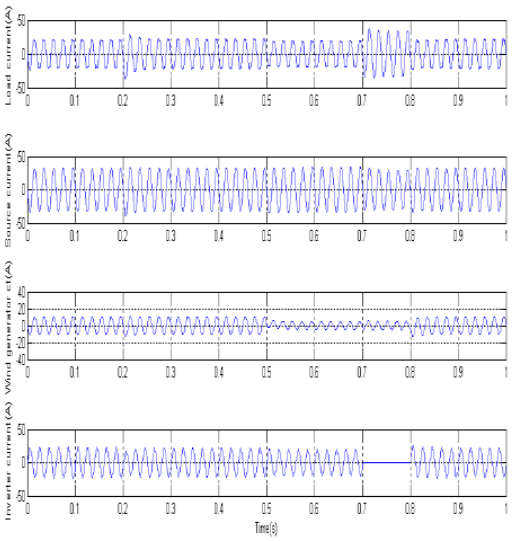

Fig 13 (a) Load current(b)Source current, (c)Inverter current (d) wind generator current

wind generating system is reducing from 0.5 s to 0.8 sand the STATCOM is OFF from 0.7 s to 0.8 s . As shown if Fig 14, the source real and reactive power is increased for providing the necessary power for load when the wind generating system output is varying.

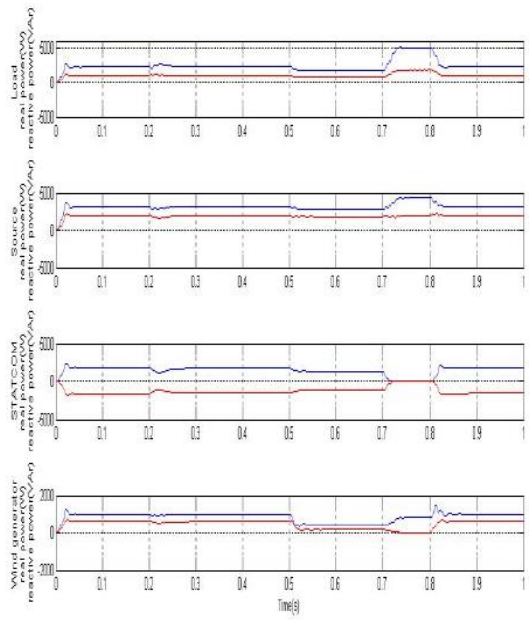

Fig.14. Real and Reactive power for (a) Load (b) Source (c)STATCOM and (d)Wind energy system.

CONCLUSION

The paper presents the STATCOM-based control scheme for power quality improvement in grid connected wind generating system with non linear loads. The operation of the STATCOM is simulated using two controllers: Bang-Bang current controller and Fuzzy controller .STATCOM injects current to the grid and it cancel out the reactive and harmonic parts of the induction generator current and load current .When we are reducing the wind generating system output ,it will not affect the source current magnitude. The THD analysis revealed that the fuzzy logic controller is good compared to bang-bang controller. The fuzzy logic controller is simpler and has faster response. The integrated wind generation and STATCOM with BESS have shown the outstanding performance.

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