

“A STATCOM-Control Scheme for Grid Connected Wind Energy System for Power Quality Improvement”

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Abstract :-The renewable energy resources like wind, solar, hydro, biomass etc. are required for sustainable growth and social progress, it is essential to meet the energy need by utilizing the renewable energy resources. The necessity of integrated renewable energy like wind energy into the power system is to make it minimize the environmental impacts. This project proposes the STATCOM control scheme for grid connected wind energy system for power quality improvement. This paper discusses about the improvement of grid power quality with aid FACTS devices on integration of wind energy system. The generated power from renewable energy source is always fluctuating due to the environmental conditions. In this proposed scheme a STATCOM (Static Synchronous Compensator) is connected at a Point Of Common Coupling (PCC) with battery energy storage system (BESS) to mitigate the power quality problems is simulated using MATLAB/SIMULINK in Sim Power System block set. Fuzzy based controller is designed to improve the profile of source current in STATCOM. The intended result of proposed scheme relieves the main supply source from the reactive power demand of the load and the induction generator, and the reduction in the THD (Total Harmonic Distortion) in the source current of the system.

Key Words:- FACTS devices, Power quality issues, STATCOM, Wind turbine, Point of Common Coupling.

I INTRODUCTION

multiplied power demand and environmental concern, wind power generation is immediately growing and wind plants are being integrated to power networks worldwide in massive numbers. Injection of alternative energy into a utility grid results in violation of power quality because of

the fluctuating nature of the wind. According to the IEC standard, determination of the power quality is from the performance of wind generators. During this work power quality problem such as voltage variations, flickers, harmonics are demonstrated because of installation of wind turbine with the grid. FACTS devices will be used to overcome these power quality issues. This project proposes the STATCOM control scheme for wind energy system for power quality improvement. The simulation has been done in MATLAB/Simulink block set. A STATCOM based control technology has been proposed for improving the power quality which can technically manage the power level associate with the commercial wind turbines. The proposed STATCOM control scheme for grid connected wind energy generation for power quality improvement has following objectives.

- Unity power factor at the source side.
- Reactive power support from STATCOM to wind Generator and Load.
- Simple bang-bang controller for STATCOM to reduce the total harmonic distortion.

Today in wind turbine generating system pulse controlled inverters are used. Due to the improvement in switching techniques, the voltage and current at the point of common connection can be made more sinusoidal and unity power factor so as to improve the power quality at PCC. However the wind generator introduces disturbances into the distribution network. One of the simple methods of running a wind generating system is to use the induction generator connected directly to the grid system. The induction generator has inherent advantages of cost effectiveness and robustness.

A proper control scheme in wind energy generation system

is required under normal operating condition to allow the proper control over the active power production. In the event of increasing grid disturbance, a battery energy storage system along with wind energy generating system is generally required to minimize the fluctuation generated by wind turbine.

Wind generating system:- There are plenty of wind generating turbines are successfully operating all over the world. Into the operation of fixed-speed wind turbine, all fluctuations into the wind speed are transmitted as fluctuations into the mechanical torque, power on the grid side and accelerate large voltage fluctuations. The power quality problems can be observed with concern to the wind generation, transmission and distribution network, like voltage sag, swells, flickers, harmonics etc. but the wind generator introduces disturbances into the distribution network. One among the simple way of running a wind generating system is to use the induction generator (IG) connected directly to the grid system.

SYSTEM CONFIGURATION AND PRINCIPLE OF OPERATION

The Static Synchronous Compensator is principally based current control voltage source inverter (VSI) injects the current into the grid in such the simplest way that the supply current are harmonic free and their phase-angle with respect to supply voltage includes a desired value. The injected current from inverter can eliminate the reactive part and harmonic a part of the non-linear load and induction generator current, so it improves the power factor and therefore the power quality. To accomplish these goals, the grid voltages are perceived and are synchronized in generating the current command for the electrical converter. The projected grid connected system is implemented for power quality improvement at point of common coupling (PCC). The grid connected system

Grid connected system for power quality improvement.

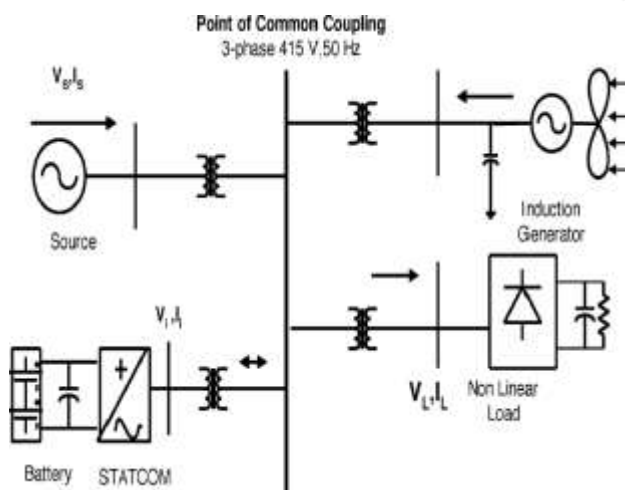
**Facilities required for proposed work:
Software – MATLAB2019**

PRINCIPLE OF STATCOM

The Static Synchronous Compensator (STATCOM) could be a shunt device of the flexible AC Transmission Systems (FACTS) family using power electronics to control power flow and improve transient stability on power grids. The STATCOM is regulates voltage at its terminal by controlling the amount of reactive power injected into or absorbed from the power system. Once system voltage is low, then STATCOM generates reactive power (STATCOM capacitive). Once system voltage is high, it absorbs reactive power (STATCOM inductive). Usually a STATCOM is installed to support electrical networks that have a poor power issue and sometimes poor voltage regulation. The most common use of this device is for voltage stability. Essentially it is a voltage source converter (VSC) based device, with the voltage source behind a reactor. The voltage source is formed from a DC capacitor and therefore the device has little active power capability. However, its active power capability may be increased if a suitable energy storage device is connected across the DC capacitor.

II LITERATURE REVIEW

1. A novel hysteresis current control for active power filter with constant frequency Electric Power Systems Research 68 (2004) 75_ 82, In this paper a novel hysteresis current control for active power filter (APF) is suggested which is based on optimal voltage vector and in the meantime with constant switching frequency. In the method the location region of the reference voltage vector is detected quickly by a set of hysteresis comparators through one try-and-error process. Two appropriate switches are then selected to control the corresponding two line-to-line currents independently with constant switching frequency. The new method has the advantages of fast allocation of reference voltage space vector, good current tracking accuracy, and constant switching frequency. Therefore, it is efficient and safe in operation. Computer simulation results show that the new current control method can improve APF performance noticeably.
2. A Statistical Approach to the Design of a



Dispatchable Wind Power-Battery Energy Storage System IEEE TRANSACTIONS ON ENERGY CONVERSION, VOL. 24, NO. 4, DECEMBER 2009, A scheme that allows the dispatch of steady and controllable level of power from a wind power generating station is proposed in this paper. The scheme utilizes two battery energy storage systems (BESSs) in which the generated wind power is used to charge one BESS, while the second BESS is used to discharge constant power into grid. The role of the two BESS interchanges when the discharging BESS reaches specified operating limit. With this scheme in mind and based on given wind speed statistics, charging characteristics of the BESS are studied, and a method to determine the expected charging time of the BESS to reach stipulated battery state of charge is developed. The expected BESS charging time, in turn, dictates the constant power level that can be dispatched to the grid through the discharging BESS. The corresponding discharge time is also determined using the developed method, the accuracy of which is validated experimentally. The proposed design procedure is then used to determine the minimum BESS capacity based on the expected wind power. Statistical likelihood of dispatchable power delivery achievable from the scheme is also obtained.

3. Battery Energy Storage System for Power Conditioning of Renewable Energy Sources IEEE PEDS 2005, Renewable energy sources such as wind, hydro, etc. are intermittent in nature. Generators connected to the local grid may lead to severe power quality problems. These issues are voltage dip while connection/disconnection of the generator, uncertainty of supply, unbalanced and distorted power supply. In this paper, the power conditioning of micro hydro driven induction generator connected to the local grid using battery energy storage system (BESS) is simulated for voltage regulation, load leveling, harmonics elimination and power factor improvement.

4. Comparison of Control Strategies for Shunt Active Power Filters in Three-Phase Four-Wire Systems EEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 22, NO. 1, JANUARY 2007, Strategies for extracting the three-phase reference currents for shunt active power filters are compared, evaluating their performance under different source and load conditions with the new IEEE Standard 1459 power definitions. The study was applied to a three-phase four-wire system in order to include imbalance. Under balanced and sinusoidal voltages, harmonic cancellation and reactive power compensation can be attained in all the methods. However, when the voltages are distorted and/or unbalanced, the

compensation capabilities are not equivalent, with some strategies unable to yield an adequate solution when the mains voltages are not ideal. Simulation and experimental results are included.

5. Design and Operation of Power Converter for Microturbine Powered Distributed Generator with Capacity Expansion Capability IEEE TRANSACTIONS ON ENERGY CONVERSION, VOL. 23, NO. 1, MARCH 2008, In this paper, a novel approach for the design of power converter for a microturbine is proposed. In the method, a unified control scheme as well as a novel modular arrangement has been developed such that the inverter circuit is capable of parallel operation of different modules in anticipation of reaching high-capacity requirements. To validate the effectiveness of this proposed approach, scenarios including the loss of grid and grid-connected operation were both tested through the software simulation and experimental validation. From the test results, they have consolidated the feasibility and practicability of the approach for the applications considered.

III PROBLEM FORMULATION

Injection of the wind power into an electric grid affects the power quality. The performance of the wind turbine and thereby power quality are determined on the basis of measurements and the norms followed according to the guideline specified in International Electro-technical Commission standard, IEC-61400. 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. In this proposed scheme STATic COMPensator (STATCOM) is connected at a 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.

IV EXISTING SYSTEM

The STATCOM control scheme for the grid connected wind energy generation system for power quality improvement by PI controller is simulated using MATLAB/SIMULINK in power system block set. The effectiveness of the conventional scheme relieves the main supply source from the reactive power demand of the load and the induction generator.

IX REFERENCES

V PROPOSED SYSTEM

Fuzzy Logic Controller is designed to improve the profile of source current in STATCOM. The intended result of proposed scheme relieves the main supply source from the reactive power demand of the load and the induction generator, and the reduction in the THD (Total Harmonic Distortion) in the source current of the system.

VI OBJECTIVES

The proposed STATCOM control scheme for grid connected wind energy generation for power quality improvement has following objectives.

- Unity power factor at the source side.
- Reactive power support only from STATCOM to wind Generator and Load.
- Simple bang-bang controller for STATCOM to achieve fast dynamic response.

VII RESEARCH METHODOLOGY/PLANNING OF WORK

The proposed work is planned to be carried out in the following manner:

- 1) Study of basic concepts of Battery
- 2) Finding the problems from conventional system by surveying literature.
- 3) Design and study of battery topologies as three topology have incorporated Centralized, Distributed, Modular
- 4) Analysis of the proposed topology.
- 5) Study of the control strategies.

VIII CONCLUSION

The paper presents the STATCOM-based control scheme for power quality improvement in grid connected wind generating system and with non linear 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-BESS in MATLAB/SIMULINK for maintaining the power quality is 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 STATCOM with BESS have shown the outstanding performance. Thus the proposed scheme in the grid connected system fulfills the power quality norms as per the IEC standard 61400-21.

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