



POWER QUALITY IMPROVEMENT BY USING STATCOM CONTROL SCHEME IN WIND ENERGY GENERATION INTERFACE TO GRID

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Abstract – The point of convergence of this paper to improve power quality in wind energy system with the help of STATCOM (Static compensator). The unprejudiced of this interpretation is to examine power quality problem due to installation of wind turbine with the grid. The major power quality measurements are- the active power, reactive power, voltage (sag, swell), flicker, harmonics and electrical behavior of switching operation are measured according to national or international guidelines. The static compensator (STATCOM) is implemented at a distribution level with a battery energy storage system (BESS) to mitigate the power quality issues. The major functional need of the STATCOM in this paper are to provide shunt compensation, operating in capacitive mode only, in terms of the following; voltage stability control in a power system, as to compensate the loss voltage along transmission. Here two control schemes for STATCOM are compared: Bang-Bang current controller and Fuzzy logic controller. 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.

Key Words: PV Grid, Wind Turbine, Total Harmonic Distortion, and Point of Common Coupling

1. INTRODUCTION

Conventionally, the utility grid has prepared to integrate various kinds of traditional generation plants like: wind, hydro nuclear etc. The necessity to include the renewable energy like wind energy into power system is to create its potential to minimize the environmental impact on standard power plant. Due to 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. Power quality is a big interest to the network operators particularly if large wind system is connected to the utility grid. Rated

frequency means maintaining voltage and currents waveforms to be sinusoidal. The unnecessary voltage drop will lead to increase losses in source side and it turns lead to outage in the line due to increased stress on the system for carry the imaginary power. Thus the compensation of reactive power is most need for better transient response. In recent year there has been increased focus on the techniques used for the compensation is FACTS incorporating power-electronics based & other static controllers to enhance controllability and power transfer capability. The main purpose of FACTS devices to supply fast reactive or inductive power that is required. In this event the study the performance of a wind farm with and without STATCOM is examine. We present a simple and efficient model of wind farm consist of wind turbine, induction generator, STATCOM and bus also. We investigate the dynamic behavior of bus voltage. Simulation is carried out by MATLAB/SIMULINK program package to verify validity of model. The proposed STATCOM control scheme for grid connected wind energy generation for power quality improvement has following objectives.

- ❖ The current control scheme is implemented using bang – bang current controller with STATCOM for source current is controlled to be sinusoidal.
- ❖ STATCOM supply reactive power to wind Generator and Load and maintain the load factor.
- ❖ Maintain Unity power factor at the source side.

1.1 Wind Energy

Wind power is one of the fastest growing renewable energy technologies. Usage is on the rise worldwide, because costs are falling. Global installed wind generation capacity onshore and offshore has increased by factor of almost 75 in the past two decades, jumping from 7.5 gig watt (GW) in 1997 to 2018. Wind is used to produce electricity using kinetic energy created by air in motion. That transferred into electrical energy using wind turbine or wind energy conversion system by using generators connected with it.

Today’s new wind power projects have turbine capacities of about 2MW onshore and 3-5 MW offshore.

Figure 1: Conversion of wind energy to electrical energy.

1.2 Wind Generating System

Wind power generation like solar is not consistent thought the year. There are fluctuation in power generation on a regular basis. Even though there are inverters available for power management. The main purpose of a power grid is make electrical available to consumer is a continuous, stable and measurable fashion. Most of the wind turbine even today use induction generators where the rotational speed is directed by the frequency of the grid that is connected to the blades are fixed and there in a passive controlling mechanism during extremely high wind speeds. This design is in widespread use due to its cost – effectiveness and ease of design. However, there are specific major concern regarding such wind turbine designs and grid connectivity.

1.3 System Configuration and Principle of Operation

The shunt connected STATCOM with battery energy storage is connected with the interface of the induction generator and nonlinear load at the PCC in grid system. The STATCOM compensator output is varied according to the controlled strategy, so as to maintain the power quality norms in the grid system. A single STATCOM using insulated gate bipolar transistor is proposed to have a reactive power support to the induction generator and to the nonlinear load in the grid system. The main block diagram of the system operational scheme is shown below in fig.2

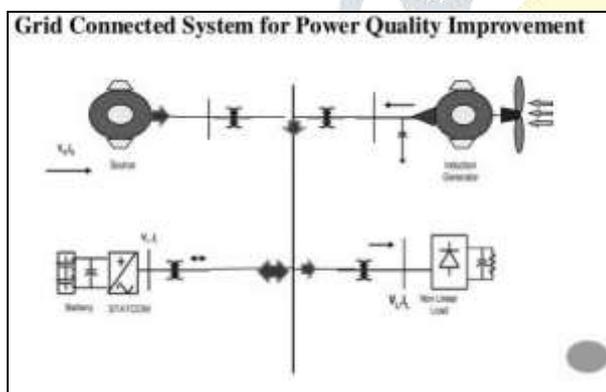


Figure 2: Grid Connected Wind Energy System.

2. LITRATURE SURVEY

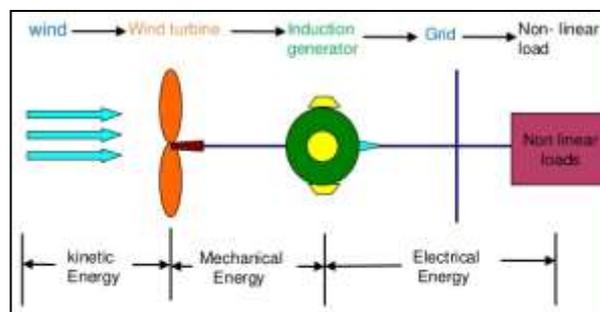
1). A hysteresis current control for active power filter with constant frequency Electric Power Systems Research Oswaldo Lopez- Santos in MULTILEVEL INVERTERS,(2021) “In this paper the review of this method applied to multilevel inverters presented. The main advantages of this method is simple implementation, possibility of this technique to control the output current output voltage of the inverters was also discussed. It also having enhanced system stability, and increased reliability and response speed. In addition it has better control method have. However, this improvement is achieved on the penalty of wide range of variation in the switching frequency. It also possible to improve the hysteresis control in a constant frequency operation”.

2). The Hybrid power system ICICIC, 1-5, 2017 “this system is connected to grid with help of STATCOM. In hybrid power system we use wind power. This source is not constant this cannot connected directly to grid for this purpose STATCOM are used for maintain the constant the output .we improve the power quality of at point of common coupling currently load is continuous variable. Customer want continuous, reliable and quality of power that is customer demand can be increase day by day, load side continuous variable. This condition is effected the source side and power quality problem can be occurs. So hybrid power system minimize this problem at point of common coupling”.

3). Battery Energy Storage System for Power Conditioning of Renewable and Sustainable Energy Sources, 91, Sciencedirect, 2018. “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. This paper provide the comprehensive review of BESS system. Wind energy are strongly dependent on intermittent & fluctuating features. To filter these variability’s BESS system have broadly accepted as one of the potential solution with advantages of such as fast response, capability, sustainable power delivery this has implication for the design process as the renewable energy system will drive the BESS system”.

3. PROBLEM FORMULATION

When the wind power is transfer to the energy Grid the effect of this changes of the energy rating. The performance and power of wind turbine are decided based on measurements and the requirements are according with the global electro-technical commission widespread, IEC-61400. Energy satisfactory measurements related to wind turbine effect inside the grid system - lively electricity, reactive power, variation of voltage, flicker, harmonics and electrical behavior of switching operation and are measured in step with countrywide or worldwide recommendations. In this paper look at indicated power high-quality troubles due to the setup of wind generators along the grid. The STATCOM is are added with the battery electricity storage gadget (BESS) to reduce electricity high-quality troubles in the proposed



scheme.

4. PROPOSED SYSTEM

The proposed fuzzy logic based- based controller for wind turbine system to provide frequency support for a smart grid. The designed controller is aimed to provide a dynamic droop rate depending on the local measurement. The first response of static droop curves is investigated for different scenario of wind turbines connected to smart grid. This

system is integrated into the system, and performance response are evaluated and result are compared with the static droop based controller.

The STATCOM scheme for a grid related wind power era machine is simulated by using MATLAB / Simulink inside the power machine block set to improve electricity fine via the pi controller.

5. OBJECTIVES

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

- ❖ To maintain the power factor of system and the source side is unity.
- ❖ To improve and power quality and at grid side.
- ❖ To investigate the active and reactive power in grid.
- ❖ Removing the Power quality issue at wind generating system
- ❖ Simple bang-bang controller for STATCOM to achieve fast dynamic response.

6. RESEARCH METHODOLOGY/ PLANNING OF WORK

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

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

7. CONCLUSION

The controlled static compensator (STATCOM) is connected to regulate the terminal voltage with certain degree of accuracy. It increase transient stability by maintaining the transmitting voltage at midpoint. The operation of the control system developed in STATCOM- BESS in MATLAB/SIMULINK for maintaining the power quality is simulated. So that power quality is maintained at the point of common coupling. Thus the proposed scheme in the grid connected system fulfill the power quality norms as per the IEC standard 61400-21.

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