Reliability Evaluation of Wind Farms Integrated with Statcom

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ABSTRACT:

Renewable wind energy has been expanding quickly on a global scale lately, taking the place of polluting and finite fossil fuels as a significant source of green electricity. Still, The nature of dispersed wind induction generators and the unpredictability of wind present issues for integrating a large-scale wind farm into a power system, especially in a weak power grid. The impact of STATCOM in facilitating the integration of a sizable wind farm into a weak power grid is examined in this research. First, there is the introduction of a real weak power system with two sizable wind farms close by. The power quality problems are identified and a centralized STATCOM is suggested to address them, especially the short-term (seconds to minutes) voltage swings, based on the field SCADA data analysis.

I. INTRODUCTION:

The demand for electricity has grown, and coupled with the depletion of natural resources, there is a greater need to produce energy from renewable sources, including wind power. current years have seen a rise in the production of wind power due to the most current technological developments in wind energy conversion and the increased assistance from public and commercial entities. The fastestgrowing renewable energy source for electricity is wind power. In 2006, there were 11,603 MW of installed wind power in the US; by 2007, that amount is predicted to rise by 26% [1]. Given the recent multiplication of wind power penetration, it is now essential to address the issues related to preserving a stable electric power system with a variety of energy sources including. The prerequisites for higher penetration include voltage stability and an effective fault ride through capability. The windmills need to

Secondly, a model be able to keep running. Power electronic converters such as the Unified Power Flow and the Static Synchronous Compensator (STATCOM) are based on Flexible AC Transmission Systems (FACTS). This research illustrates how well a STATCOM works to make it easier to integrate a large WF into a poor power supply. To begin with, a real poor power system with there are two enormous WFs introduced nearby. The problems are identified by the study of the field SCADA data, and the solutions require both steady state and dynamic voltage regulation. For dynamic voltage control, a STATCOM is suggested, specifically to reduce the shortterm (seconds to minutes) voltage swings. Second, in the PSCAD/ETMDC simulation environment, a model of the system, WF, and STATCOM is constructed for steadystate and dynamic impact studies. The field data is used to validate the created model. Additionally, using the PV and VQ curves that the simulation produced, the system voltage control Controller (UPFC) are widely utilized in power systems due to their capacity to offer adaptable power flow management [3]. The primary driving force behind the selection of STATCOM in wind farms is its capacity to deliver and/or absorb reactive power into the system in order to support the busbar system voltage. continuous operation under erratic voltage circumstances in compliance with grid norms. Grid codes are specifications established by regulatory bodies, and in order for wind power installations to be connected to the grid, they must fulfill these criteria.

II. DFIG BASED WIND TURBINE:

The DFIG is an induction machine with a wrapped rotor that has slip rings fastened to it. The rotor side and grid side are the two halves of the AC/DC/AC converter. The rotor is to maintain a steady DC link voltage, electricity is generated or absorbed by the grid side power converter and fed by the rotor side power converter. DFIG can be used to generate electricity at varying speeds that range from below synchronous speed to above synchronous speed.

III. STATCOM:

A static variable generator, the STATCOM's output can be adjusted to maintain or regulate particular electric power system parameters. Reactive result the compensator's power is adjusted to regulate the voltage at certain transmission network terminals, preserving the intended power flow in the event of potential disruptions and emergencies. Compared to a Static Voltage Compensator (SVC), STATCOMs can handle transient events more quickly and more effectively at lower voltages. A STATCOM's maximum compensation current is not affected by the system voltage. All told, a STATCOM offers dynamic voltage control, dampening of power oscillation; this enhances the system's momentary stability. The angle Φ can be adjusted to regulate the current flow from the converter to the ac system or the other way around.

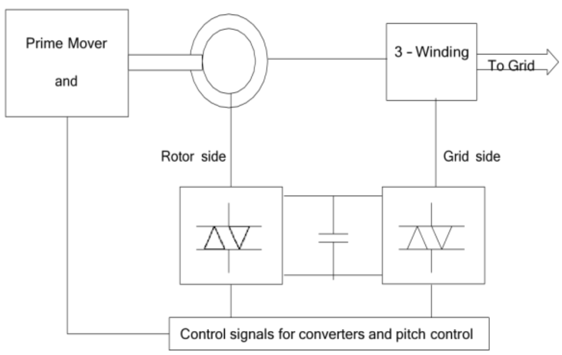

Fig.1. Block diagram of a variable pitch/speed wind turbine with DFIG

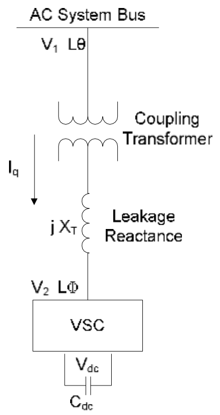

Fig.2. Basic model of a STATCOM

IV. SYSTEM OF TESTING:

The system depicted in Fig. 4, which depicts a typical power system load being provided by the nearby synchronous generators, has been the subject of the simulation study. By the wind turbine that was erected (DFIG). A diagram of the power system, shown in Fig. 4, has been examined to assess the system's performance in various transient scenarios, such as a quick load change or a three-phase fault.

The wind turbine is more difficult to operate and respond to new issues in the power system because of its many limitations. Therefore, more system hardware is needed to assist in keeping the electrical grid stable both during and after a breakdown occurs. Two generators are used in the proposed test system: a synchronous generator and a wind turbine that functions as a doubly fed induction generator (DFIG). A typical load is connected to bus 3 of the entire system. The load bus is coupled to STATCOM, the active voltage supporter. The term "grid" refers to an external system that is linked to the system of interest by a weak connection. The primary motivation is to compel the generator and STATCOM to react to malfunctions within the designated region. The electrical short The connected electric power grid has a 10 MVA power output. Due to the extremely poor grid, a higher rated compensating device is needed. Examining the particular requirements for the system to return to its initial condition after the problem has been fixed is one of the paper's goals. For this test system, a three phase short circuit fault requires around ±150 MVA of STATCOM capacity to be restored. This is the highest capacity needed to repair the wind turbine and keep it from tripping during or after the problem, and it is extremely high. has been started. The primary reason for connecting the STATCOM and the load to the same bus is that the reactive power supply is always connected as close to the point where it is needed. This is specifically done to prevent excessive contact with the associated power system and to assist the efficient operation of the STATCOM. Appendix I contains the ratings for all major circuit data used to model the system in DIgSILENT PowerFactory version 13.2.

V. RESULTS OF SIMULATIONS:

This test system's many situations include line outages, small-duration three-phase high-impedance failures, and abrupt shift in the load. The corresponding sections provide the results and comments of the findings. Three phase ground fault: The load bus is where the three phase high impedance (Xf=5Ω) short circuit fault is examined. This ground fault has an impedance.It has a ground impedance of Xf = j5 Ohms and is started at t=0.5 sec and cleared at t=0.7 sec. This system does not meet grid code requirements because it is noticed that the voltage of the wind turbine and the load bus does not recover even after the fault is removed. The voltage loss during the fault has been reduced with the use of a

STATCOM, and even after the fault has been cleared, the wind turbine voltage stability has been restored. Utilizing a STATCOM with a higher grade enhances the simulation results for the fault bus and wind turbine voltages for the system instances without and with the STATCOM, respectively, are displayed in Figs. 5 and 6. It might be found that the system oscillates at a voltage of roughly 0.8p.u. after the fault has been removed, and that the voltage drop at the fault bus during the fault period is to 0.4p.u. Similar to how the load bus reacts, the wind turbine voltage likewise has a high chance of tripping and going offline. When a STATCOM is added to the load bus, the voltage rises to roughly 0.9 p.u. during the fault and returns to 1.0 p.u. when the fault is resolved in 0.7 seconds. Voltage is promptly restored because there aren't many oscillations following the system's fault being cleared via a STATCOM

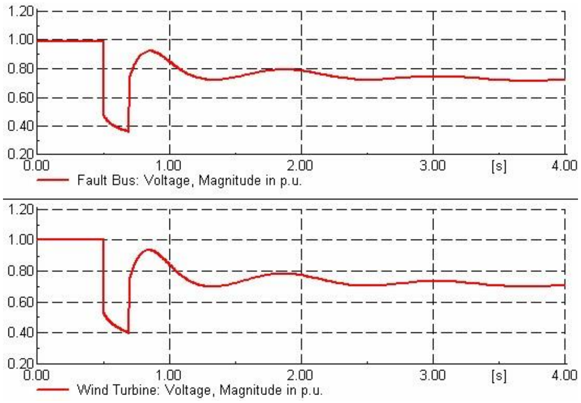

Fig. 3. Voltage at the fault bus and the wind turbine for the system without a STATCOM

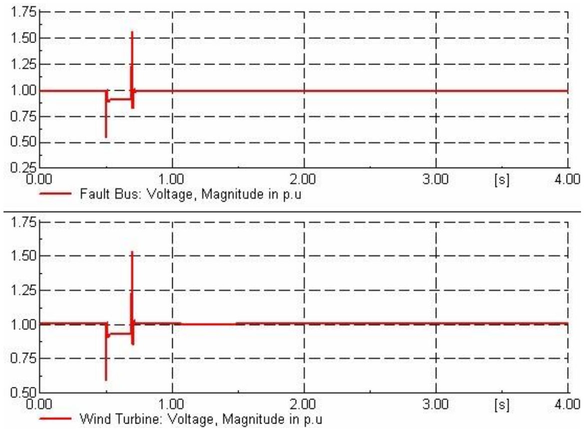

Fig. 4. Voltage at the fault bus and the wind turbine for the system with a STATCOM

VI. FINAL COMMENTS:

Since the DFIG is an induction machine, it needs reactive power adjustment when there are disruptions to the grid. When linked to a poor grid, STATCOM is a workable solution to supply the required reactive power adjustment. Additionally, a grid-connected wind farm with a higher rating STATCOM can be utilized for more reliable voltage management and efficiency, however the rating of the gadget.

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