Power Quality and Transient Stability Improvement of Grid Connected Wind Energy System Using STATCOM

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ASTRACT-One of the major issues concerning a wind farm interconnection to a power grid concerns its dynamic stability on the power system. Voltage instability problems occur in a power system that is not able to meet the reactive power demand during faults and heavy loading conditions. Flexible AC Transmission Systems (FACTS) devices such as the Static Synchronous Compensator (STATCOM) and the Unified Power Flow Controller (UPFC) are being used extensively in power systems because of their ability to provide flexible power flow control. FACTS devices can be used in wind power systems to improve the transient and dynamic stability of the overall power system. The STATCOM is from the family of FACTS devices that can be used effectively in wind farms to provide transient voltage support to prevent system collapse. In the present research paper power quality improvement using STATCOM under faults is proposed. Improvement of power quality with and without STATCOM and reactive power injecting by a STATCOM is studied. Simulation results are given, commented and discussed. The test results prove the effectiveness of the proposed STATCOM controller in terms of fast damping the power system oscillations and improving the power quality and transient stability.

Keywords-- *Transient Stability, Power Quality, Induction Generator, Active Power, Reactive Power, FACTS, STATCOM, Wind Farm*

INTRODUCTION

The wind power penetration has increased dramatically in the past few years, hence it has become necessary to address problems associated with maintaining a stable electric power system that contains different sources of energy including hydro, thermal, coal, nuclear, wind, and solar. In the past, the total installed wind power capacity was a small fraction of the power system and continuous connection of the wind farm to the grid was not a major concern. With an increasing share derived from wind power sources, continuous connection of wind farms to the system has played an increasing role in enabling uninterrupted power supply to the load, even in the case of minor disturbances. The wind farm capacity is being continuously increased through the installation of more and larger wind turbines. Voltage stability and an efficient fault ride through capability are the basic requirements for higher penetration. Wind turbines have to be able to continue uninterrupted operation under transient voltage conditions to be in accordance with the grid codes [2]. Grid codes are certain standards set by regulating agencies. Wind power systems should meet these requirements for interconnection to the grid. Different grid code standards are established by different regulating bodies [3].

One of the major issues concerning a wind farm interconnection to a power grid concerns its dynamic stability on the power system [4]. Voltage instability problems occur in a power system that is not able to meet the reactive power demand during faults and heavy loading conditions. Stand alone systems are easier to model, analyze, and control than large power systems in simulation studies. A wind farm is usually spread over a wide area and has many wind generators, which produce different amounts of power as they are exposed to different wind patterns. The applicability of a STATCOM in wind farms has been investigated and the results from early studies indicate that it is able to supply reactive power requirements of the wind farm under various operating conditions, thereby improving the steady-state stability limit of the network [6]. Transient and short-term generator stability conditions can also be improved when a STATCOM has been introduced into the system as an active voltage/VAR supporter [5, 7]. Reactive power is required to compensate for the additional reactive power demand of the generator and the matching transformers so that the wind power installation does not burden the system [9].The transient behaviour of wind farms can be improved by injecting large amounts of reactive power during fault recovery [8, 10].

WIND TURBINE MODEL AND INDUCTION GENERATOR

Figure 1 shows the Wind Turbine Model. The mathematical relationship for the extracting of mechanical power from wind may be given by:

$$Pt = \frac{1}{2}.\rho.\pi R^2 V^3\ Cp \qquad (1)$$

Where Pt is the power developed by the wind turbine, ρ is the air density [kg/m3], R is the blade radius[m], V is the wind speed [m/s] and Cp is the power coefficient which depends on both the tip speed ratio and the blade angle of inclination