Improvement of Power System Stability in wind Generation by using FACT Devices: A Review

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Abstract— This project is established predictive power control strategy which is used to improve stability of power system. This has been done presence of wind farm based double fed induction generator using static series synchronous compensator & super capacitor energy storage system. In our proposed system super capacitor energy storage system used to control active power in grid side converter and SSSC is used to reduce the low frequency oscillations. SCESS is composed of a capacitor bank and a dual switch DC/DC converter which is connected to DFIG through the DC link. In this method, it is used to control the active and reactive power of the Rotor Side Converter [RSC] as well as damping controller design for SCESS and SSSC. For improving the power system stability, an SSSC is used, which is a modern power quality FACTS device that employs a voltage source converter connected in series to a transmission line through a transformer. The Model Predictive Control (MPC) is used, which will predict the future value of the system in order to increase the damping ratio of the system. Thus, the system has been simulated and tested on Matlab software.

Keywords: AC, FACTS, IPFC, PSS, SVC, STATCOM, SSSC, TCSC, TCPS, UPFC

I. INTRODUCTION

Generally, stability means the capacity of power system to hold synchronism during occurrence of a severe transient disturbance such as fault in equipment and transmission line or loss of generation or lumped load. Many researchers have performed to increase the stability of wind generation by using FACT device. The FACTS regulators offer a distinct prospect to normalize the transmission of alternating current (AC), increasing or falling the power flow in specific lines and responding almost instantaneously to the stability problems. The potential of this technology is based on the possibility of monitoring the method of the power flow and the ability of connecting networks that are not effectively interconnected, giving the possibility of trading energy between reserved agents. Flexible Alternating Current Transmission System (FACTS) is a static equipment because there is no rotating part used for the AC transmission of electrical energy. It is meant to enhance controllability and increase power transfer capacity. The additional flexibility of FACTS allow to diminish the problems connected with the defective of supply issues of renewable. SVCs and STATCOM devices are well suited to provide ancillary services (such as voltage control) to the grid and fault rid through capabilities which standard wind generation cannot provide Furthermore, FACTS reduce fluctuations in the grid.

A. Objectives:

- It increases the system constancy and system power factor.
- It increased the power transmission capability of the transmission lines.
- It controlled the steady state and temporary over voltages.
- It enhanced the load power factor, and therefore, reduced line losses.
- Eliminate harmonics and reduce voltage distortion with appropriate shunt filters and improved system capability
- Restrain voltage fluctuation and flicker
- Increased transmission system reliability and availability.

II. LITERATURE REVIEW

A. P.Vijayalakshmi and Dr.K.Balamurugan (2018)

DFIG based wind turbine design has been done and the wind turbine is connected along with the grid side for a power control strategy to improve power system stability and simulated using MATLAB/Simulink. In this system, the stability is being analyzed; voltage signals are measured at various levels. The voltage and current measurement has been done at the inverter side. Damping controller has been designed for SCESS and SSSC. The output of the system was simulated and has been examine that the system requires some computational time to get stable. Future work will be of designing a wind turbine by using functional model predictive control.

B. Shazly A. Mohamed,N. LUO (2018)

The technological advancements in wind energy conversion have led to increased wind power generation in recent years. Static synchronous compensator(STATCOM) issued extensively in power systems due to its ability of providing the flexible power flow control. The foremost stimulus for choosing STATCOM in wind farms is that it can provide bus bar system voltage support either by supplying or absorbing reactive power into the system, thereby can improve the steady state stability limits of the network. This paper compacts with the effect of STATCOM on the wind farm performance. The wind turbines considered are fixed speed ones with squirrel cage induction generator. In this work the performance of wind farm with and without STATCOM is investigated under fault conditions.

C. Balamurugan et al (2017)

Performance improvement of SVC and STATCOM installed in WECS systems is analyzed in this paper. Stability improvement, voltage regulation, increase of power transmission and control of reactive power to accelerate

voltage recovery after fault occurrence, are considered as major improvement factors. The simulation results show better for the wind farm stability performance of STATCOM compensation compared to SVC compensation. It is found that the stability of the wind farm has increased, when the SVC and STATCOM devices are connected to the systems.

D. Jaswinder Singh and Naresh Chand (2015)

In this review on various controllers and techniques which is used for voltage stability and reactive and active power control in multiline. The different researcher used the different controller for stability and power quality improvement. But we see that second generation facts devices give better result as compare to other controllers because they control the power in multiline and connected in series with the system. The double fed-induction generator is also used in wind power generation for stability analysis. The output generation of wind power is depend upon amount of wind. Which depend upon the nature and not constant at all the time. Due to this a variable speed type double fed induction generator is used. For extracting the maximum wind for generation a electrical power, we can use a maximum power point tracking system is used. The many controllers and techniques are devolved by the researcher for maximum power generation from wind.

E. V. Amarnath Reddy et al (2012)

In this we existing the FACTS device (STATCOM) -based control scheme for power quality improvement in wind generating system.. The power quality problem and its concerns on the consumer and electric service are presented. The operation system developed for the STATCOM in MATLAB/SIMULINK for maintaining the power quality is to be simulated. It has a capacity to cancel out the harmonic parts of the current. It keeps the source voltage and current in-phase and support the reactive power demand for the wind generator.

F. Yuvaraj .Dr S.N.Deepa

theoperation factor of transmission line.STATCOM scheme for power quality improvement in grid connected wind generating system.the power quality problems and its consequences on the consumer and electric utility are presented. the operation of the system developed for the statcom in matlab/ simulink for maintaining the power quality is to be simulated. it has a capacity to cancel out the harmonic parts of the load current. it keeps 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 chance to increased.

G. Alok Kumar Mohanty, Amar Kumar Barik

Power demand has increased significantly while the extension of power generation and transmission has been limited due to limited resources and environmental precincts. as a result, some transmission lines are heavily loaded and the system stability becomes a power transfer-limiting factor. flexible ac transmission systems (facts) controllers have used for solving various power system steady state control problems. flexible ac transmission systems or facts are devices which allow the flexible and control of power systems.development of system stability using facts controllers has been investigated. This paper is aimed towards the benefits of utilizing facts devices with the purpose of improving the operation of an electrical power system. stability and can facilitate grid code compliance for WPP.

H. AAdamczyk

Increasing number of wind turbines is changing electricity generation profile all over the world. This brings challenges for power system operation, which was designed and developed around conventional power plants with directly coupled synchronous generators. In result, safety and stability of the electrical network with high wind energy saturation might be compromised. For this reason transmission system operators (TSO) impose more stringent connection requirements on the wind power plant (WPP) owners. On the other hand flexible AC transmission systems (FACTS) devices offer enrichment of grid stability and can facilitate grid code compliance for WPP. In this paper state-of-the-art in FACTS for WPPs with AC connection is given.

I. Sidhartha Panda and Ramnarayan N. Patel

Flexible AC Transmission System (FACTS) devices, when placed at the mid-point of a long transmission line, play an important role in controlling the reactive power flow to the power network and hence both the system voltage fluctuations and transient stability. This paper deals with the location of a shunt FACTS device to improve transient stability in a long transmission line with predefined direction of real power flow. The validity of the mid-point location of shunt FACTS devices is verified, with different shunt FACTS devices, namely static var compensator (SVC) and static synchronous compensator (STATCOM) in a long transmission line using the actual line model. It has been observed that the FACTS devices, when placed slightly off-centre towards sending-end, give better performance in improving transient stability and the location depends on the amount of local/through load.

III. POWER QUALITY IMPROVEMENT BY USING FACT DEVICES

A. Example of FACTS Controllers for Enhancing Power System Control.

- Static Synchronous Compensator (STATCOM)
- Static VAR Compensator (SVC) -Controls voltage
- Unified Power Flow Controller (UPFC)
- Convertible Series Compensator (CSC)
- Inter-phase Power Flow Controller (IPFC)
- Static Synchronous Series Controller (SSSC)

B. Benefits of Utilizing Facts Devices

The benefits of utilizing FACTS devices in electrical transmission systems can be summarized as follows:

- Better utilization of existing transmission system assets
- Increased transmission system reliability and availability
- Increased dynamic and transient grid stability and reduction of loop flows
- Increased quality of supply for sensitive industries.

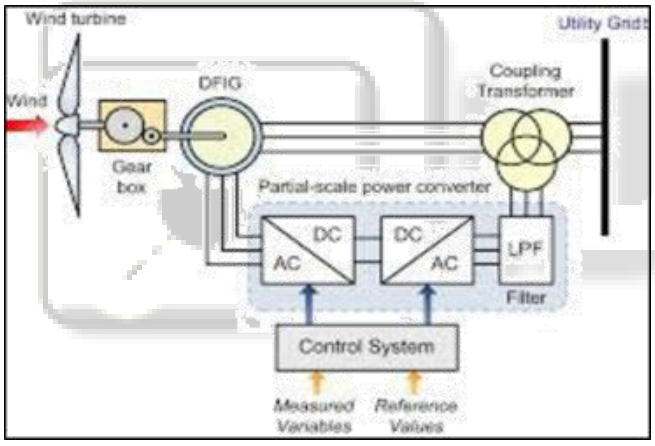
In this project we used STATCOM to improve power system stability.

C. STATCOM and Its Capabilities

- The main motivation for choosing STATCOM in wind farm is its ability to provide bus bar system voltage support either by supplying and/or absorbing reactive power into the system. The STATCOM can supply both the capacitive and inductive compensation and is able to independently control its output current over the rated maximum capacitive or inductive range irrespective of the amount of ac system voltage. Statcom provide full capacitive-reactive power at any system voltage-even as low as 0.15p.u. The STATCOM can also contribute to the low voltage ride through requirement because it can operate at full capacity even at lower voltages. In this paper, a voltage source converter (VSC) PWM technique based STATCOM Fast reactive power adjustment
- Fast response, able to implement dynamic compensation in real time.
- Effectively avoid parallel resonance.
- Able to produce and absorb reactive power.
- Deliver fewer harmonics to system.
- Restrain voltage fluctuation and flicker.

IV. METHODOLOGY

A. DFIG in Wind Energy Conversion System



B. Configuration of DFIG Wind Turbine

Generator (DFIG)-based wind generators used variable speed operation. Wind turbines use a doubly-fed induction generator (DFIG) consists of a wound rotor induction generator and an AC/DC/AC converter. The stator winding directly connected to grid and the rotor is provide for at variable frequency through the AC/DC/AC converter. The DFIG allows take out maximum energy from the wind for low wind speeds by adjusting the turbine speed. The optimal turbine speed producing maximum mechanical energy for a given wind speed is proportional to the wind speed. Another advantage of the DFIG technology is the ability for power electronic converters to generate or absorb reactive power. Nowadays, among all the renewable energy sources, wind systems are more monetary as compare to others. Variable wind speed systems deliver 20 to 30% more energy in comparison with the constant speed systems. They also decrease power swaying and improve reactive power injection.. During the preceding years, permanent magnet synchronous generators (PMSGs) are greatly used in wind turbine applications because of their advantages such as low weight and velocity, high efficiency.

V. CONCLUSION

From the above discussion, it can be seen that the wind power is characterized by fluctuation due to intermittent primary source, which can damage the electrical network stability because of the imbalance between production and consumption. It is necessary to meet the energy needs by utilizing the renewable energy sources like wind, biomass, hydro-cogeneration, etc. It is also concluded that the voltage variations and load current harmonics are the two main issues arising when the wind farm is connected to the grid. So it must be mitigated using various FACT devices.

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