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A Study on Improvement of the Transient Stability Using STATCOM in DFIG Based Wind Farm

Vimal Ptael[1], Ravi Kumar Paliwal[2]
[1]*Electrical engineering department, parul institute of technology*
[2]*Electrical engineering department, parul institute of technology*

Abstract— For the stable operation of grid connected to wind farm when the fault ride through the grid disturbance then voltage stability is a main important function for this operation. This paper look in to voltage source static var compensator such as STATCOM for the voltage stability issue as shunt compensator for DFIG-based wind farm connected to load and a grid. It can also study to maintain stable voltage the FACTS devices effectuation as a dynamic voltage restorer at the common coupling point and because of that coordinated power system protecting DFIG based wind farm form isolating during and after the disturbance. The model of power system is simulated in MATLAB and during grid faults, the solution of the simulation show that wind turbine generator of the stable operation of system to remain in service.
Keywords- STATCOM, wind farm, doubly fed induction generator, transient stability.

I.INTRODUCTION

Wind energy is significant for distributed renewable energy resources. However, voltage stability issues with wind farms may need such systems to be increased with reactive power compensation devices. If measurement is not taken to ensure the stability of the power system, the wind power methodology developed could face the risk of being stopped. In DFIG, the induction generator is connected to a grid at the stator terminals as well as at the rotor mains via a partially rated variable frequency AC/DC/AC converter. Variable frequency converter is combination of rotor side converter (RSC) and grid side converter (GSC). When DFIG based wind turbine joined with weak power network defined by short circuit ratio, then heavy load operation and during a grid disturbance near to point of common coupling, by reason of low capability of power of GSC, it cannot provide enough voltage support and reactive power there for risk of disconnection of wind turbine form the network and voltage is unbalance. Therefore, voltage stability is the important issue in maintaining continuous procedure of wind turbines equipped with DFIG. In gird connected mode, DFIG is also supply reactive power but by reason of less reactive power capability it cannot provide sufficient reactive power in absence of external reactive power. This problem can be solved by using reactive compensation devise such as STATCOM.

II.LITERATURE SURVEY

Yu Zou, Malik E. Elbuluk, Senior Member, IEEE, and Yilmaz Sozer, Member, IEEE, “Simulation Comparisons and Implementation of Induction Generator Wind Power Systems”

This paper explain performance of comparison of a wind power systems based on two different induction generators as well as the experimental demonstration of a wind turbine simulator for the maximum power extraction. The two induction machines studied for the comparison are the doubly fed induction generator (DFIG) and squirrel-cage induction generator (SCIG).The techniques of direct grid integration, independent power control, and the droop phenomenon of distribution line are studied and compared between the SCIG and DFIG systems.

Naimul Hasan , Shuaib Farooq, "Dynamic Performance Analysis of DFIG based Wind Farm with STATCOM and SVC"

This paper look in to the equivalence and implementation of FACTS devices like STATCOM and SVC for the voltage stability issue for DFIG-based wind farm connected to a grid and load. The study also contains the implementation of FACTS devices equally dynamic voltage restorer at the point of common coupling to maintain unfluctuating voltage. Thereby protecting DFIG-based wind farm integrated power system from isolating throughout after the disturbances.

Djemai Naimi, Tarek Bouktir and Ahmed Shi, "Improvement of Transient Stability of Algerian Power System Network with Wind Farm"

In this ocular that the Algerian government makes Funds earmarked for a renewable energy supplied from 0.5% of petroleum rental. While solar energy remains the main focus of cause to boost production from renewable energy, Algeria is looking at wind power by several projects, which will be integrated in the Algerian network. consequently the enhancement of the rate of the wind power penetration limit without overloaded line and to investigate the power quality issue to the transient stability problem caused by the wind power connection and with an acceptable voltage level ensured by integration of flexible Ac transmission system (FACTS) device such as Static Synchronous Compensator (STATCOM) which is the main objective of this research work. Furthermore, in order to choose a comparative study between several types is established and the adequate type of wind turbine. It must be noted that all simulations are carried out on PSAT/Simulink.

Different Technology Categorization

(a) Squirrel cage induction generator (SCIG).

(b) Doubly-Fed Induction Generator (DFIG).

(a) Squirrel cage induction generator (SCIG)

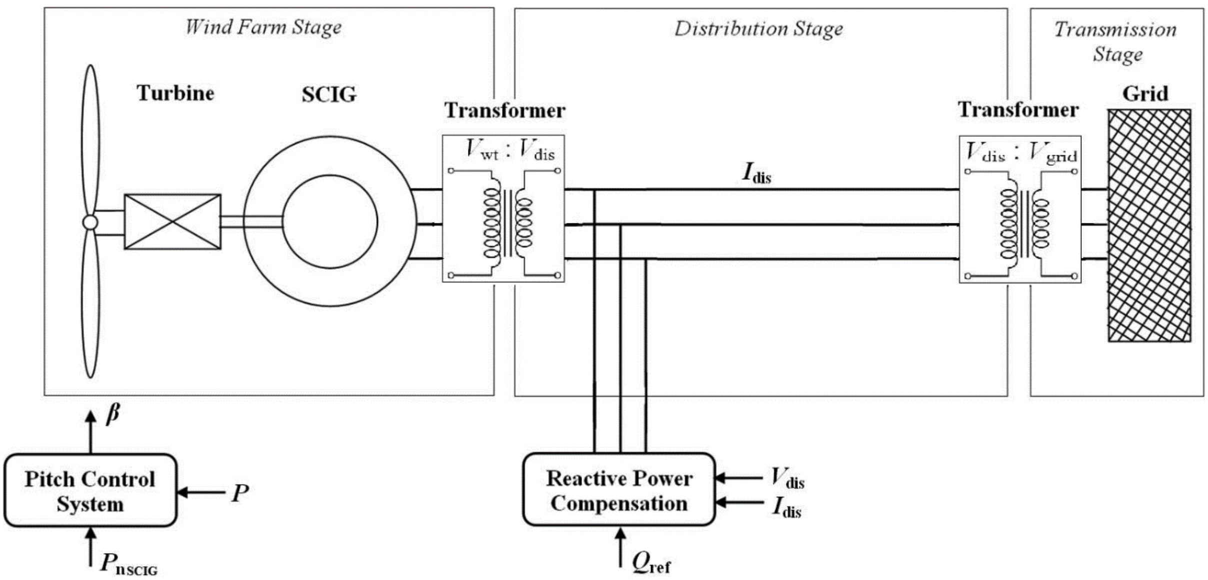

Figure1. SCIG wind power system topology [3]

Figure1 shows the schematics of the SCIG system including the wind turbine, reactive power compensator, and pitch control. The system includes three stages for rescuing the energy from wind turbine to the power grid. The first one is wind farm stage which treats with low voltage *V*wt, the second is distribution stage which has average voltage *V*dis, and the third is grid transmission stage which has more voltage *V* grid. The three-phase transformers take care of the interface between stages.

As mentioned, nominal power *P*n SCIG is considered as active power reference to regulate the pitch angle while *I*dis and *V*dis and denote the distribution phase current and line-to-line voltage, and they are supervised to favor the reactive power compensation for distribution line. This fairly straightforward technique was first used since it is simple and has rugged construction, reliable operation, and low cost [3]. However, the fixed-speed essential and potential voltage unbalance problems severely limit the procedures of wind turbine. Since SCIG is of fixed-speed generator, for a particular wind speed, the output active power is fixed as well [3]. Thus, with the gain of wind speed, so does the output power till the nominal power is reached. The wind speed at this moment is called nominal wind speed. Beyond this speed, the pitch angle system will prevent the output power from exceptional the nominal value. That is, when the wind speed is under nominal value, the power capture can change with the change of wind speed; and when the wind speed is over nominal value, the pitch angle control system will limit the generated power by changing the pitch angle

(b) Doubly-Fed Induction Generator (DFIG).

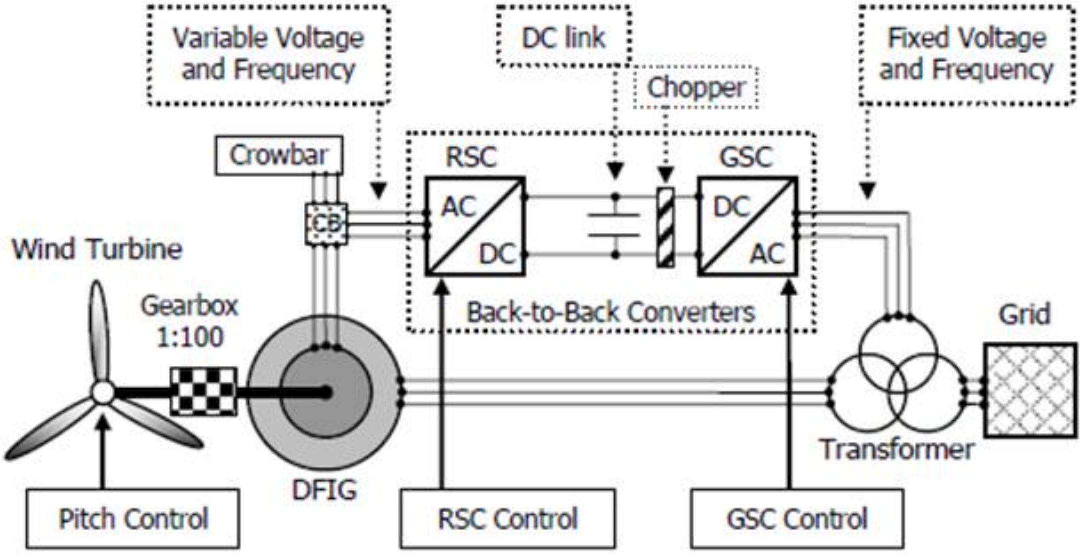

Figure2. DFIG with back-to-back PWM voltage source converters [1]

The wind turbine driving DFIG wind power system which is consists of a wound-rotor induction generator and an ac/dc/ac insulated gate bipolar transistor (IGBT)-based pulse width-modulated (PWM) converter and it is known as back-to-back converter with capacitor dc link, as shown in Figure 3. The stator windings of the DFIG are instantly connected to the network so that some unwanted high currents may be induced in the rotor windings, the protection system may block the RSC in conventional DFIG in absence of fault. The voltage across DC-link is another unwanted transient, which can reach high grades, related to the imbalance of active power between RSC and GSC. The back-to-back converter consists of two parts: the grid-side (stator side converter) converter and the rotor-side converter shown in this configuration. Both are voltage source converters using IGBTs, while a capacitor between two converters acts as a dc voltage source. The slow speed of the RSC disconnection from the rotor winding and the very low residual terminal voltage throughout the fault, after fault sensing, would cause such unbalance.

III. DIFFERENT STABILITY

(a) Transient Stability

Power systems stability has been and continues to be of major concern in system operation. Modern electrical power systems have grown to a large complexity due to increasing interconnections, installation of large generating units and extra-high voltage tie-lines etc. Transient stability is the ability of the power system to maintain synchronism when subjected to a severe transient disturbance, such as a fault on transmission facilities, sudden loss of generation, or loss of a large load.

(b) Power System Stability

Power system stability is the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance

IV. Configuration of STATCOM

The STATCOM is a shunt-connected reactive power compensation device that is able of generating or absorbing reactive power and in which the output can be varied to control the particular parameters of an electric power system. STATCOM provides or absorbs reactive power to or from the grid to compensate small voltage variations at the connection point of the wind farm with the grid [1]. When a voltage dip occurs, STATCOM is also used.

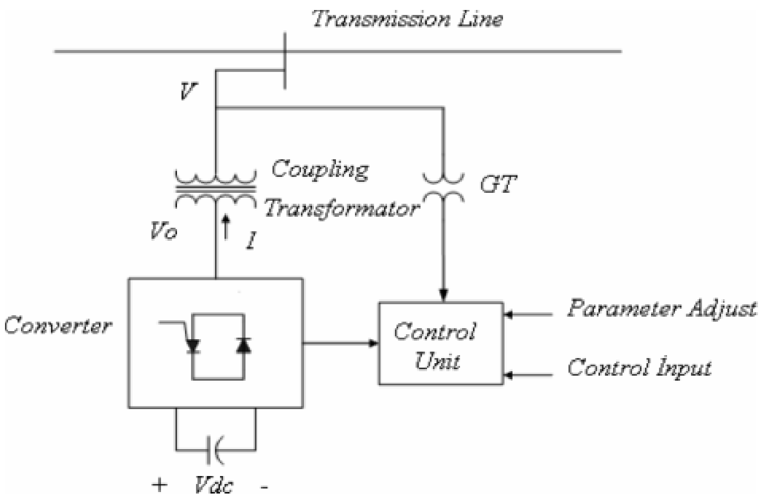

Figure3. Systematic of STATCOM [1]

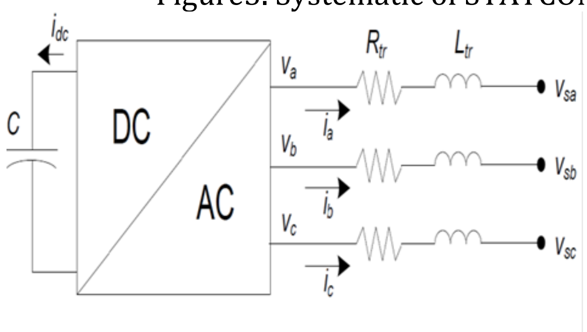

Figure4. Schematic of STATCOM [1]

If V=Vs (Pu values), no current flows through Rtr and Ltr. If V>Vs, current ows through Rtr and Ltr. As the impedance is essentially inductive, the current phasor is perpendicular to Vs and V voltages. STATCOM injects reactive current to the grid (Capacitive current) [1]. If V < Vs, current flows through Rtr and Ltr. This time the current flow is opposite to the previous, which implies that STATCOM absorbs reactive power from the grid [1]. Normally a STATCOM is put in to support electricity networks that have a poor voltage regulation and often poor power factor. A STATCOM is a voltage source converter (VSC) based device, with the voltage source behind a reactor. The reactive power at the STATCOM terminals depends on the amplitude of the voltage source.

V. WIND TURBINE

Wind energy is extracted by wind turbine blades and transmitted by the gearbox and rotor hub to the mechanical energy in the shaft, which drives the generator to convince the mechanical energy to electrical energy. The turbine model is based on the output power characteristics Expressed as [3]

$$p_m = c_p(\lambda,\beta).½\rho A v^3 \omega^2$$

Where ρ is the air density, r is the turbine radius, ν is the wind speed, and Cp is the turbine power coefficient which represents the power conversion efficiency and a further about general expression for *CP* is given by a generic equation used to model (λ,β) [4]. This equation, based on the

$$C_p(\lambda,\beta) = c_1\left(\frac{c_2}{\lambda_i} - c_3\beta - c_4\right)e^{\frac{-c_5}{\lambda_i}} + c_6\lambda$$

With

$$\frac{1}{\lambda_i} = \frac{1}{\lambda + 0.08\beta} - \frac{0.035}{\beta^2 + 1}$$

The coefficients *c*1 to *c*6 are: *c*1 = 0.5176, *c*2 = 116, *c*3 =0.4, *c*4 = 5, *c*5 = 21 and *c*6 0.0068 [4]. The *Cp*1 λ characteristics, for different values of the pitch angle β (deg). The maximum value of *p C* is *Cp max* = 0.48 which is achieved for β = 0 degree and for tip speed ratio of the rotor blade tip speed to wind speedλ = 8.1. This particular value of λ is defined as the nominal value (λ _nom). Such disturbances are the most usual in the grid, the grid disturbances thought in this paper are of short duration, maximum a few hundreds of milliseconds. Since the considered grid disturbances are much faster than wind speed variations, the wind speed can he assumed constant [4]. Therefore, natural wind fluctuations need not be taken in to account. The wind speed is set to a constant 6 m/s.

VI.CONCLUSION

Flexible AC Transmission System (FACTS) is one aspect of the power electronics revolution that happened in all areas of electric energy. This paper investigates the using of the STATCOM which is one of the FACTS's family to support the fixed speed wind power plant in order to fulfillment the needed voltage-dip ride-through capacity The steady state behavior of an interconnected DFIG based wind farm with STATCOM is analyzed. Under short circuit Conditions the STATCOM can provide a major improve in the transient stability of power systems that incorporate wind generation. A case was developed in which when the load is connected at the point of common coupling there is a voltage dip which if not timely corrected then it will eventually leads to voltage instability of interconnected power system, the responses of both the system is analyzed and is found that STATCOM have made the voltage and reactive power made them stable. The SCIG system presents the require of external reactive power source to support grid voltage, and it can keep the output power at the nominal level by pitch control but cannot consequently vary the rotor speed to accomplish maximum wind power capture at different wind speeds. The DFIG technology allows distilling maximum energy from the wind for low wind speeds by optimizing the turbine speed, while belittling mechanical stresses on the turbine throughout gusts of wind.

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REFERENCES

1. Naimul Hasan , Shuaib Farooq, "Dynamic Performance Analysis of DFIG based Wind Farm with STATCOM and SVC" International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 7, July 2012Jyh shing roger jang, Chuen Tsai Sun, "Neuro-fuzzy modelling and control".
2. M. Molinas, S. Vazquez, T. Takaku, J.M. Carrasco, R. Shimada, "Improvement of Transient Stability Margin in Power Systems with Integrated Wind Generation Using a STATCOM: An Experimental Verification",IEEE-2005.
3. Yu Zou, Malik E. Elbuluk, Senior Member, IEEE, and Yilmaz Sozer, Member, IEEE, "Simulation Comparisons and Implementation of Induction Generator Wind Power Systems" IEEE TRANSATION SONINDUSTRY APPLICATION, VOL, 49, NOMAY/JUNE2013..
4. Djemai Naimi, Tarek Bouktir and Ahmed Shi, "Improvement of Transient Stability of Algerian Power System Network with Wind Farm" IEEE 2013.
5. Seman Slavomir, Antero Arkkio, Julius Saitz, Jouko Niiranen, "Performance Study of a Doubly Fed Wind Power Induction Generator Under Network Disturbances" IEEE Transactions on energy conversion, vol. 21, no. 4, December 2006.
6. BOOK: R. mohan mathur, rajiv k. verma - thyrister based FACTS controller for electrical transmission system.

