Improvement of Voltage Stability and Reactive Power of Wind Farm Load Bus Using STATCOM & SSSC

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Abstract— **In wind farm load bus, the voltage stability and reactive power of the load bus in connected load system that are fed by a grid connected wind farm. In the control of load bus voltage stabliabity and reactive power, 10 MVAr static synchronous compensator (STATCOM) and SSSC is connected Doublely feed induction generator wind farm. In voltage stability and reactive power control achieved results have proved that STATCOM and SSSC yield good results when used in terms of shunt and series compensation of the system.**

Index Terms—**Wind farm, STATCOM, SSSC.**

I. INTRODUCTION

One of the renewable energy sources, wind turbines have been used widely in recent years. The motives behind this common use of wind turbines can be the low cost and its being environment friendly. However, when wind turbines are produced with large power, some problems arise in connecting it to power systems. One of the reasons for this is that the changes in load demand of the system make the system unstable. This stability in the power system brings about the voltage and reactive power problem of the system. In Power systems, voltage and reactive power control problems are important for continuous case stability. These problems have been solved through power electronics drivers included in Flexible AC Transmission systems (FACTS). Parallel FACTS drivers such as STATCOM AND Series FACTS Drivers SSSC have been used widely in transient voltage control due to their high performance. When the load connected to a bus load in STATCOM controlled wind farm which is installed into the circuit, the effects of terminal voltage, reactive power and speed regulation have been examined in terms of rotor stability performance, and STATCOM control has been observed to yield good results. The moment-slip characteristics of Induction Generator operating under low voltage in the system to which wind farm is connected were examined. It was found that with the use of SSSC and STATCOM, the results can be improved in case of an unexpected condition in the system. By using SSSC and STATCOM, failure analysis was done in DFIG at different times, and it was observed that SSSC and

STATCOM yielded time responses quickly in the control of voltage stability, reactive power and speed characteristics.

II. COMPONENT SECTION

STATIC SYNCHROUS COMPENSATOR (STATCOM)

STATCOM system is a static synchronous generator operated as a static compensator connected in parallel whose output current (inductive or capacitive) can be controlled independently of the AC system voltage. STATCOM is installed at load bus in the wind farm. It's aim is to help the wind farm in situations of voltage dips, voltage regulation, power factor control and power flow stabilizing.

A charged capacitor acts as a source of direct current. This current feeds an AC/DC power converter, which produces a set of outputs with controllable three-phase voltages. Also, the frequency of these voltages is the AC system frequency. The AC/DC power converter is controlled by PWM techniques, so the output voltages achieved are practically sinusoidal. These controllers are possible by the high switching frequency of the IGBT, GTO, IGCT or IEGT transistors of the power converter. The system connects to the grid via a transformer,. The system is characterized by a rapid response time and its ability to provide a control voltage to the connection point through reactive power compensation. It can be used for filtering harmonics, improving transient and dynamic stability, dynamic over voltages and under voltages, voltage collapse, steady state voltage, excess reactive power flow and undesirable power flow. This enables that the wind farm, for instance, to have a better response in voltage dips as well as more stable system

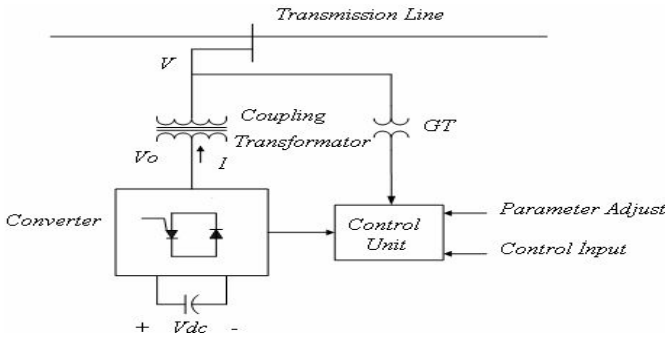

Figure1. Systematic diagram of STATCOM

STATIC SYNCHRONOUS SERIES COMPENSATOR (SSSC)

The Static Synchronous Series Compensator (SSSC) is a series connected FACTS controller based on VSC and can be viewed as an advanced type of controlled series compensation SSSC operated with an appropriate DC supply

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(an energy source and/or sink, or a suitable energy storage) can inject a component of voltage in anti-phase with the voltage developed across the line resistance, to counteract the effect of the resistive voltage drop on the power transmission. The capability of the SSSC to exchange both active and reactive power makes it possible to compensate for the reactive and resistive voltage drops, maintaining a high effective X/R ratio independently of the degree of series compensation.

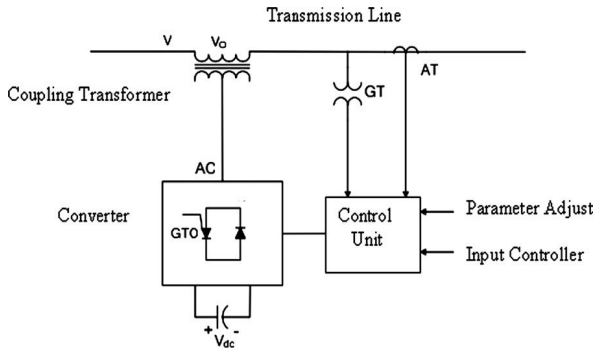

Figure 2. Systematic Diagram of SSSC

WIND TURBINE

Wind turbine is set on the DFIG. The voltage on the stator is applied from grid and the rotor winding connected with voltage source converter. The operation of the DFIG is controlled by the convertor and its operated normal and fault condition operation. Figure shows the basic structure of the DFIG wind power generation system.

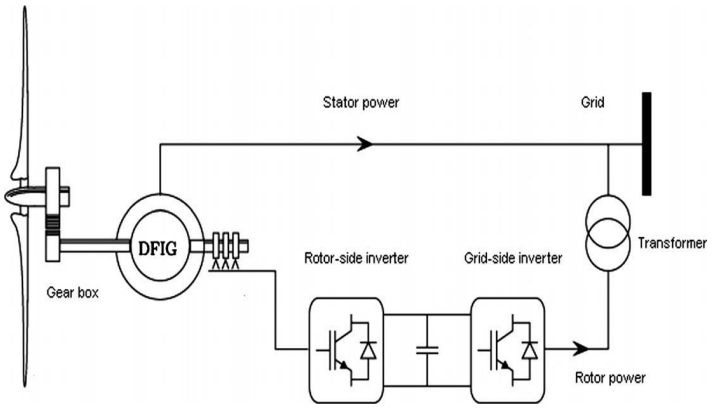

Figure 3 DFIG

III. BASE SYSTEM STUDY

In the Scientific research and essays vol.5 (15), PP 1993-2003, 4-August 2010 full length research paper "Investigation of the control voltage and reactive power in wind farm load bus by STATCOM and SVC" study, the voltage stability and reactive power of the load bus fed by a wind farm has been control by STATCOM or SVC (Shunt compensation) FACTS controller. The simulink results of voltage stability and reactive power shown figure 7 & 8.

IV. STUDY OF DISIGEN SYSTEM

In this study, 575 V, 50 Hz and 3MW three wind farm plants was produces voltage regulation, which is dependent on the voltage value of the 10.5 MVAr capacitor group is connected in the back to back convertor. A three phase booster transformer is obtained from wind plant voltage increase from 575 to 25kv , 120 kv grid voltage was reduced to 25 kv by using three phase step down transformer. Bus 3 is used as load bus in the system. Various active and reactive powers ware connected in load bus. STATCOM of 10 Mv was used as parallel to load bus and SSSC of 10 Mv connected in series in load bus.

V. SIMULINK MODEL STATCOM & SSSC

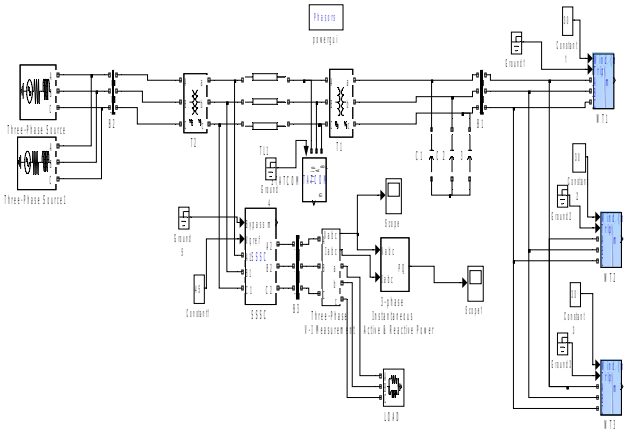

Figure 4.Simulink Diagram STATCOM & SSSC

VI. SIMULATION RESULTS

On the simulation study of the system, wind power plant system was found to be more stable structure with STATCOM & SSSC FACTS devices. Voltage and reactive power control of STATCOM and SSSC which is connected to the load bus. Capacity of active load is 4 MW and reactive load is 2 MWAr. Simulation results of voltage stability and reactive power is shown figure 5 & 6.

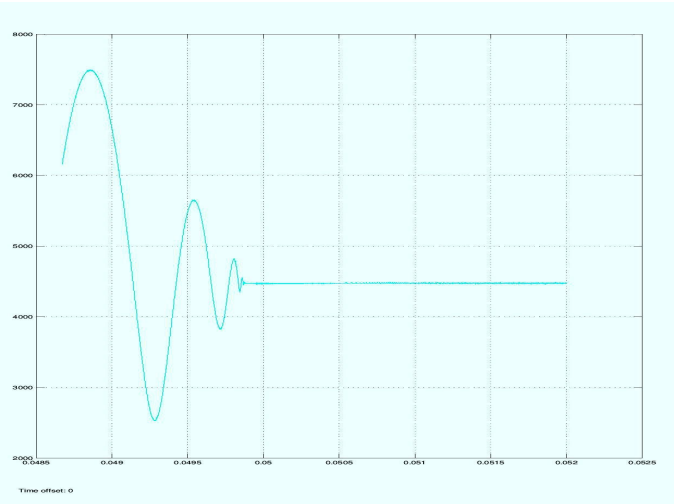

Figure.5 Voltage Stability with STATCOM & SSSC

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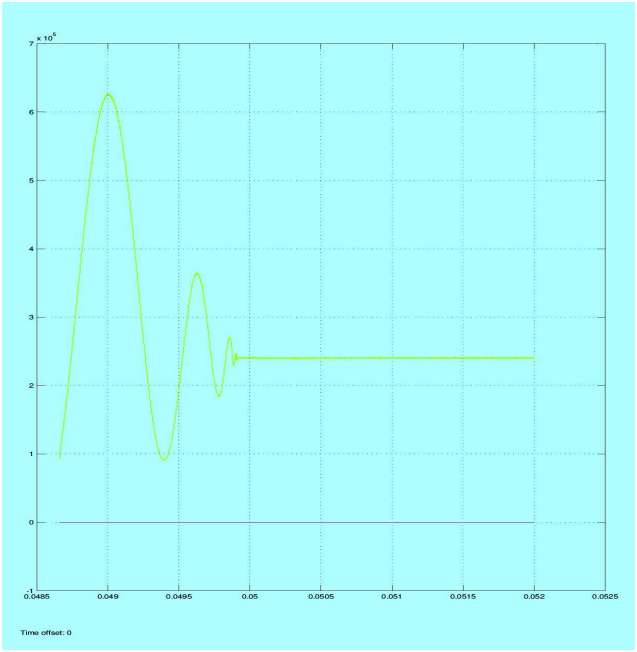

Figure 6 Reactive Power with STATCOM & SSSC

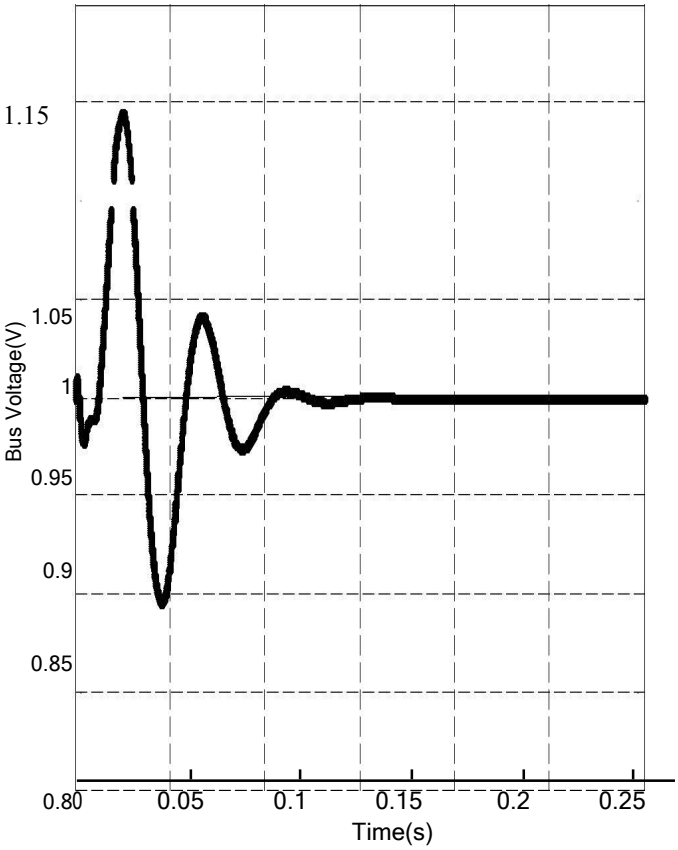

Figure7. Voltage Stability with STATCOM

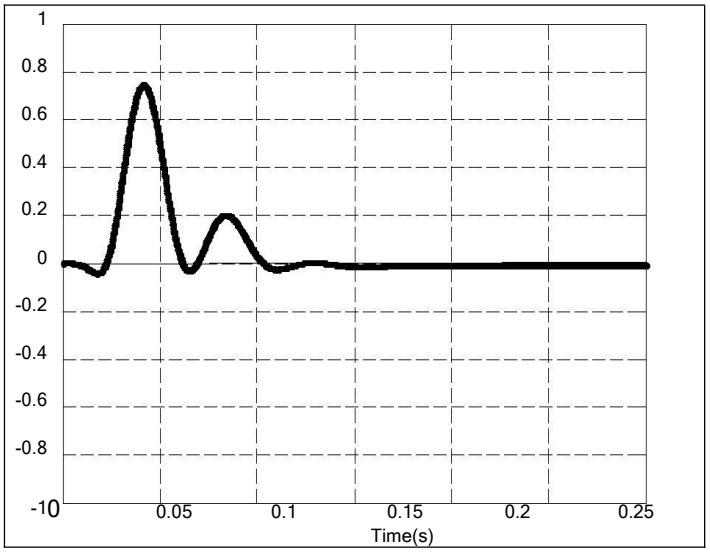

Figure8 Reactive Power with STATCOM

On the comparative study simulation results (Design system model) with base system model (Figure 5 & 7, figure 6 & 8), voltage stability reduced to 50 percentage (0.1 to 0.049) and reactive power stability also reduced 50 percentage (0.1 to 0.48) using STATCOM & SSSC FACTS Controllers.

VII. CONCLUSION

According to simulation study, wind power plant system found to more stable structure with STATCOM & SSSC (shunt & Series compensation) FACTS devices.

The effects of STATCOM & SSSC FACTS devices on the voltage stability, reactive power losses were investigated.

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