Effect on voltage profile of grid connected wind farms and its improvement

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Abstract— Ecological and Supporting impact for a Sustainable development have Inspired the growth of electrical generation from renewable energies. A imperative demand for more electric power coupled with Convectional resources has led to an increased need for energy production from renewable energy sources such as wind and solar. The latest technological Development in wind energy conversion and an increased support from governmental and private institutions have led to increased wind power generation in recent years. Wind power is the fastest growing renewable source of electrical energy Wind power generation of electricity is seen as one of the most practical options and with better relation Techno commercial inside the active matrix now a days. This study provides the results of a study conducted to assess the "effect on voltage profile of grid connected wind farm it's improvement though application of SSSC" system.

I. INTRODUCTION

Modern power system consists of interconnected network of various types of generator, transformer, transmission line, loads. Now a day significant development in the area of wind energy, it integrated in to grid at faster rate. The wind energy is clean and required less operating cost as the fuel cost is negligible. However it may require high installation cost for same MW output as compare to conventional sources .Presently size range of wind turbine is varying from few watts to MW due to development in manufacturing technology. The fundamental issues of wind turbine are fault ride through, system voltage and frequency limits, active system voltage and frequency limits, active power regulation and frequency control, as well as reactive power/power factor/voltage regulation. In this study the voltage profile of grid connected wind farm is investigated and its improvement through application of SSSC is presented.

II. SQUIRREL CAGE INDUCTION GENERATOR

It is directly connected to grid via transformer, it draw reactive power from grid, In order to reduce reactive Liability on grid capacitor bank is used for providing local reactive power. Due to fixed speed wind fluctuation cause mechanical fluctuation which will result in electrical fluctuation such as voltage variations this it require reactive power compensation and rigid grid [2].

III. REACTIVE POWER COMPENSATION

The reactive power is mainly require setting up magnetic field in generator and transformer core. Inadequate reactive power cause reduction in voltage on other hand excessive reactive power cause rise in voltage so effective reactive power compensation is essential for maintaining voltage limit within desirable limits. Presently power electronic based shunt and series compensation such as SVC, STATCOM, SSSC, TCSC, UPFC, DPFC, etc. are used to maintain voltage profile [4].

IV. STATIC SYNCHRONOUS SERIES COMPENSATOR

The VSC based series compensator, called static synchronous series compensator was proposed by Gyugyi in 1989 within the concept of using converter based technology uniformly for series and shunt compensation as well as transmission angle control. SSSC comprises of a VSC, a dc link capacitor and a coupling transformer. With proper control a voltage is injected in a transmission line. The injected voltage is in quadrature with the line current. If injected voltage is greater than zero, SSSC behaves like a capacitor and if injected voltage is less than zero, SSSC behaves like an inductor [6, 7].

V. POWER SYSTEM ANALYSIS TOOLBOX (PSAT)

PSAT has been thought to be open source and convenient. PSAT has been developed using Matlab which run on common OS, such as UNIX, LINUX, Windows, and Mac OS X. PSAT is also the first power system software which runs on GNU/Octave platforms. Once the power flow has been solved, the user can perform further static and/or dynamic analyses [5].

VI. SAMPLE SYSTEM AND TEST RESULT:

In this paper sample system of standard IEEE 6 bus is considered, which included SCIG connected to grid and power flow simulation is carried out using N-R method with following base parameter.

1) Base MVA=100MVA
2) Base KV =66KV
3) Frequency=50

A. *TEST SYSTEM A*

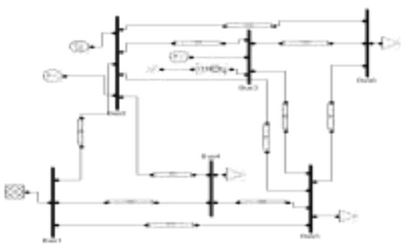

Fig 1 Test system A

In the test system A standard IEEE 6 bus with SCIG connected to bus no 3 and power flow simulation is carried out using PSAT. The test systemA and Power flow results of test system A are as shown in "fig.1" and "fig.2 respectively.

Bus	V	phase	P gen	Q gen	P load	Q load
	[p.u.]	[rad]	[p.u.]	[p.u.]	[p.u.]	[p.u.]
Bus1	0.8988	0.0000	1.1029	0.7105	0.0000	0.0000
Bus2	1.0500	-0.0341	0.5000	0.2588	0.0000	0.0000
Bus3	1.0700	-0.0553	0.6000	0.9754	0.0000	0.0000
Bus4	0.8988	-0.0965	0.0000	0.0000	0.7000	0.7000
Bus5	0.9709	-0.0820	0.0000	0.0000	0.7000	0.7000
Bus6	1.0014	-0.0835	0.0000	0.0000	0.7000	0.7000

Fig 2: power flow result of test system A

B. *TEST SYSTEM B*

In this system B standard IEEE 6 bus with SCIG is connected at bus-3 and static synchronous series compensator (SSSC) is connected in series with line between Bus 2 and Bus 6 and power flow simulation is carried out using PSAT and result of simulation are as follow shown in "fig.3" and "fig 4" respectively

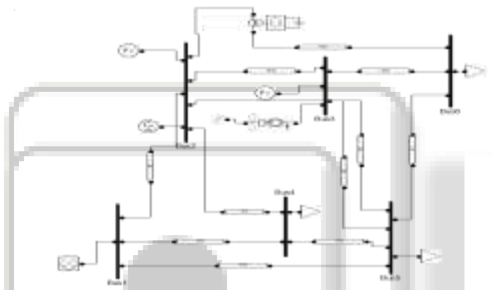

Fig. 3: Test system B

Bus	V	phase	P gen	Q gen	P load	Q load
	[p.u.]	[rad]	[p.u.]	[p.u.]	[p.u.]	[p.u.]
Bus1	1.0500	0.0000	1.0676	0.1471	0.0000	0.0000
Bus2	1.0500	-0.0647	0.5000	0.9544	0.0000	0.0000
Bus3	1.0700	-0.0673	0.6000	0.7285	0.0000	0.0000
Bus4	0.9899	-0.0731	0.0000	0.0000	0.7000	0.7000
Bus5	0.9887	-0.0887	0.0000	0.0000	0.7000	0.7000
Bus6	1.0186	-0.0949	0.0000	0.0000	0.7000	0.7000

Fig. 4: power flow result of test system B

C. *RESULT ANALYSIS:*

By comparing voltage profile of Test system A and Test System B it is clear that there is improvement in voltage magnitude at all the bus as the SSSC inject the voltage the quantitative and graphical analysis is presented in below table as shown in "fig 5" and "fig 6".

Bus	V(WITHOUT SSSC	V(WITH SSSC	%AGE IMOROVEMENT
	[p.u.]	[p.u.]	
Bus1	1.05	1.05	0.0000
Bus2	1.05	1.05	0.0000
Bus3	1.07	1.07	0.0000
Bus4	0.90	0.99	10.1275
Bus5	0.97	0.99	1.8292
Bus6	1.00	1.02	1.7146

Fig. 5: Quantitative analysis of voltage profile

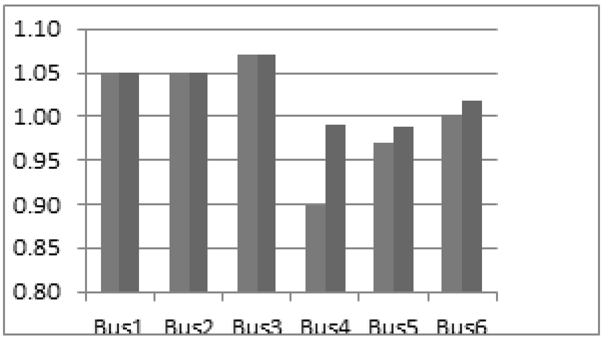

Fig. 6: Graphical analysis of voltage profile

VII. CONCLUSION

In this paper the effect on voltage profile of grid connected wind farms and it's improvement through application of SSSC have been studied and following conclusions were made:

When SCIG is connected with grid it draws reactive power in order to generate active power.

The reactive power burden is effectively reduce on grid by application of SSSC and thereby improvement in voltage profile

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