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Impacts of FACTs on Distributed Generation System

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ABSTRACT: Due to fast development of power demand, power system is forced to run near its stability limit. As the DG scheme is little scale electricity generation, there are numbers of challenges include steadiness of voltage, control of reactive power, islanding of DG, quality of power and many more. So, voltage stability has become a major topic related to research in electrical power scheme. As the mismatch among absorption and the production of reactive power results in voltage drop and this is the main reason of voltage collapse. It is affected on the voltage stability of the system. In order to avoid this, now a day's modern power schemes are implementing new evolving hightech apparatus like FACTs (Flexible Alternating Current Transmission Systems) as well as dispersal power generation structures etc. Research of this paper established of power quality problems associated with Distributed Generation (DG) schemes and in what way UPFC and SSSC known as FACTs apparatus give their significant contribution for the enhancement of quality of powerand voltage stability in power production system such as Distributed Generation.

Keywords: Distributed Generation System, Power Quality, FACTS Devices, SSSC, UPFC.

I. INTRODUCTION

Now-a-day step towards inventive perfection makes it fiscally appropriate to halter vigour from sun, wind, geo-thermal and various another renewable energy sources [13]. There are numerous kinds of difficulties in front of whereas the strewn power production systems remain associated to electricity grids one of the different complications and challenges have ascended in transmission network after deregulation in generation and transmission system [8]. These available schemes are probably to expression of many difficulties related to the steadiness of system. Subsequently reform in power segment of country like India, the power companies have suffered fast alternatives in viewpoint in relation to [9]. And also conveying the electric energy by using grid network brings to bear charges of voltage, maintain frequency guidelines, preserving the stability of electrical power system [10]. The DG systems which are prepared by using induction motor and it is directly linked which can disturb the voltage stability boundary harmful because of ingesting of reactive power. Thus, reduce utilization of reactive power of these DG elements, system wants reactive power compensation equipments like bank of capacitor, with magnitudes ranging nearby one third of DG components value which are connected at the DG systems terminals [7]. Still, ingesting of reactive power rises due to the ups urge of the power production [1]. Before innovation of FACTs devices it is difficult to manage healthy transmission network with the help of bank of capacitor and inductor connected in series and shunt in the network and operate individually, there is the research gap in the past system. But by introducing power electronics based FACTs apparatus, it is to control real and reactive power of the transmission power flow and completely operate present power transmitting system and maintain the system voltage stability as well. Consequently, diminishing the gap of research in power system. Inspired by this problem, the present study former aim to improve the steadiness of potential difference in distributed schemes that need way up DG in filtration [1]. Research paper, suggested that to use of FACT device such as UPFC & SSSC with Distributed Generation (DG) System. Wind farm schemes basis on Induction Generator is adopted as a DG. Impact of SSSC & UPFC with Fault & with fault without FACTS on DG simulated with MATLAB/SIMULINK Software [5]. The advantages proposed scheme include voltage steadiness, quality of power and to control reactive power in the system with the help of FACTs devices. The implication of this method is that the effectiveness of the system is depending on the type of FACTs apparatus and Point of Common Coupling (PCC).

II. DISTRIBUTED GENERATION SYSTEM

In other way, a DG system is known as small and/or minor size electrical power producer system run by sustainable ecological energy sources which increase electrical power supplying system up to the consumer's end [11]. Wind farm station and solar station or by small emanation energy sources, like micro turbine as well as fuel cells which are the best instances of distributed generation. DG elements are typically allied therefore, it works well in parallel through service network and DGs are mostly likely associated and protected nearness to the demand [12]. If Distributed Generation (DG) components can work in independent manner as micro grid, due to this unusual impact on stability and quality of power which are possible to be additional affect as the deficiency of the network support [2]. With increasing load and everyday growing anxiety towards declining fossil fuel quantity, power markets as well as technical segments provide several rewards after using of Distributed Generation (DG) energy sources [3]. Distributed generation Resources (DER) - minorelectric power producers usually located at operator's places where generated power is used and have loom as a displays potential option to encounter rising buyer necessities for electrical power with considering reliability and quality of power point of view [4].

III. ABOUT FACTS DEVICES

A. UPFC

Fig. 1 display the SLD of UPFC which is greatest multipurpose FACTs supervisor advanced so far, with all-inclusive abilities such as phase shifting, regulation of voltage as well as series compensation. It consists of dual voltage source converters connected by shared DC link.

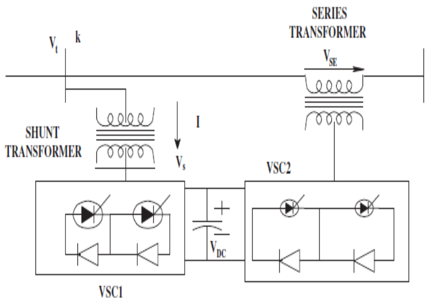

Fig. 1. SLD of UPFC.

Fig. 2 and 3 display the UPFC power flow control loops in relation to reactive and real power correspondingly. V_{seq} is element of inserted succession voltage in quadrature with the current of line. Q_{ref} considering as reactive reference scenery for load flow where UPFC associated of line and Q_{flow} considered as definite reactive power flow of line and V_{seq} is sequence element of inserted alternating current voltage in phase through the current of line [6]. The steadying indications for the UPFC controller is derivative from oscillation of damping block of power which usages with injected P_{flow} considering as a signal. $P_{flow\ ref}$ consider as a flow of reference real power magnitude of line where UPFC is linked. After load flow of the line magnitude is obtained where UPFC is to be coupled.

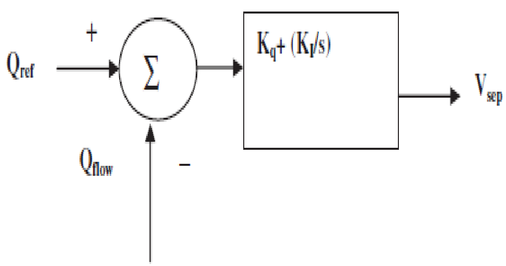

Fig. 2. Loop of reactive power flow.

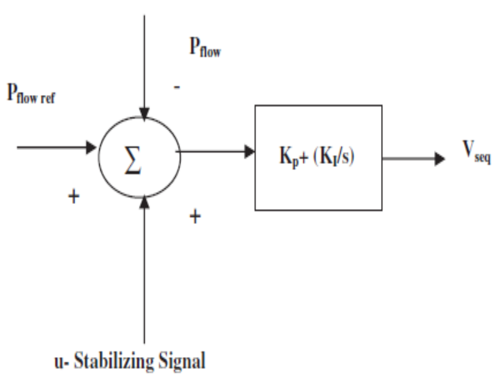

Fig. 3. Loop of realpower flow.

B. SSSC

Fig. 4 shows the single line diagram of unique FACTs device name is Static Series Synchronous Compensator which is consisting mainly of a transformer as well as voltage sourced converter linked in series with a power network. Through the current, adjustable voltage magnitude in quadrature is added by using this device. Therefore, rivalling of a capacitive reactance or inductive reactance which competed with adjustable series reactance of network which may affect the transferred electrical energy. Due to this, device also known as Series Power Flow Controller (SPFC). This apparatus useful for highest transmit of power by a portion of transferred electrical energy, almost autonomous of δ.

$$P_q = \frac{V^2}{X_{sc}}\text{Sin}\delta + \frac{V}{X_{sc}}V_q\text{Cos}(\frac{\delta}{2})$$

For upsurge the power to be transferred happen merely by using capacitor may, SSSC can reduction it via basically interchanging the sign (+ or -) of voltage which inserted. In the line reactive power plunged because of interchanging sign voltage adds straight due to this impedance of reactive line is augmented. By using sending and receiving end systems for the flowing of reverse power, when overturned polarization voltage is greater than the voltage awestruck crossways of the line.

$$|V_q| = |V_s - V_r| + IX_l$$

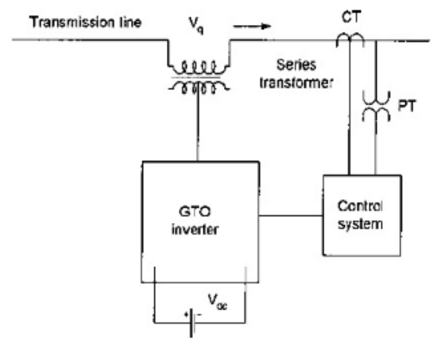

Fig. 4. Static Series Synchronous Compensator.

IV. CASE STUDY

Distributed generation scheme with wind farm which is containing of 6 ×1.5 MW wind turbines are associated with 25 × 10^3 V distribution system transfer power through 120 KV power network to 25 Km, 25 KV feeder which is publicized in Fig. 5 with a details MATLAB Simulink demonstration. Here, in this case study with wind farm of anine MW and is simulated by combination of 1.5 MW in 3 pairs. There are different types of generators use for wind turbine but for analysis of this system squirrel – cage Induction type is used. In this type of generator, winding of the stator is straight connectedin a line to the power network. And rotor of Induction Generator (IG) is driven with the help of variable pitch wind turbine. This type of generator speed always runs beyond synchronous speed, in order to generate power. Provide protection system to every wind turbine such as monitoring system current as well as voltage, speed of given machine. This type of generator reactive power immersed partially recompensed using capacitive panel linked at every bus of lower voltage of wind turbine. Turbines comprise of 400 × 10^3 VAR for every system of 1.5 × 10^3 KW pair. System is observed during twenty seconds in this simulation.

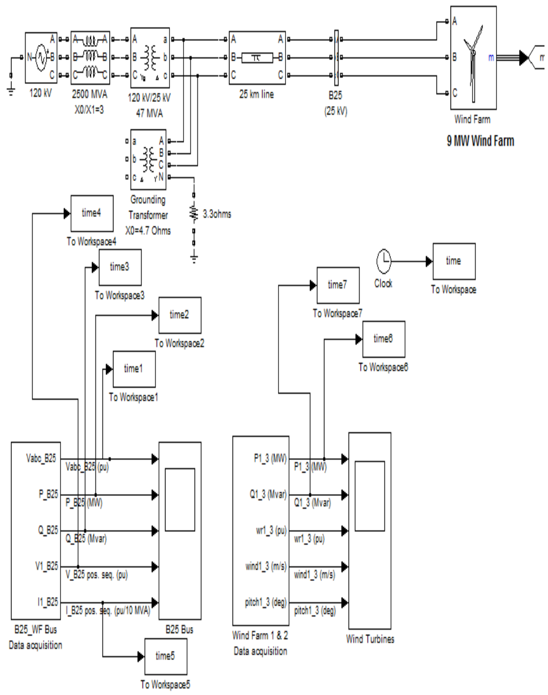

Fig. 5. 9MW DG system basis on wind farm without fault.

V. RESULT ANALYSIS

A. Simulation Result of SSSC

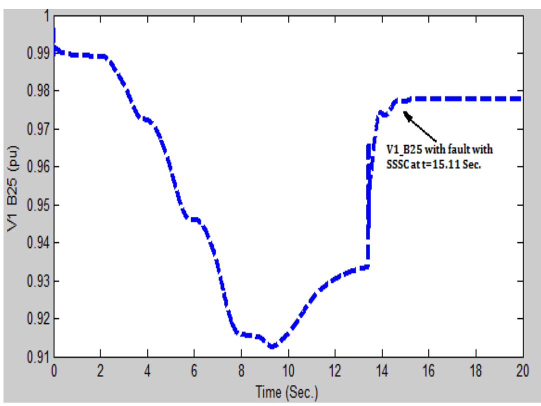

Fig. 6. V_1-B25 – time, 25 × 10^3V bus systems with fault with SSSC.

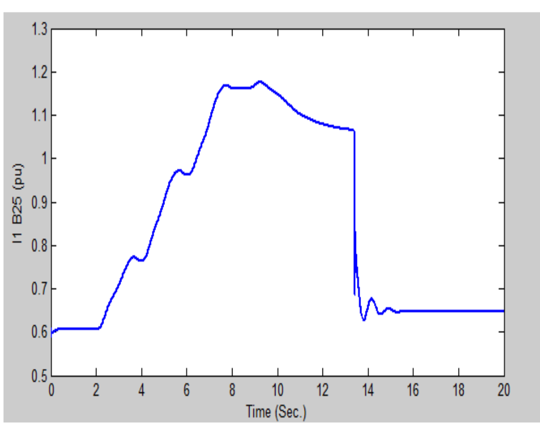

Fig. 7. I_1B25 – time, 25 × 10^3V bus systems with fault with SSSC.

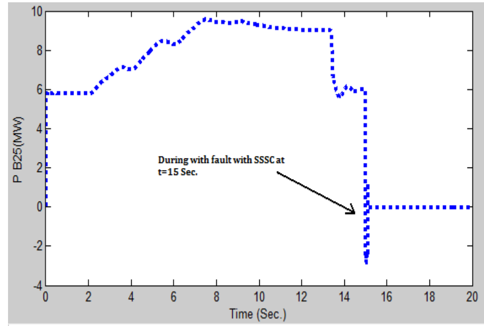

Fig. 8. P B25(MW) – time, 25 × 10^3V bus systems with fault with SSSC.

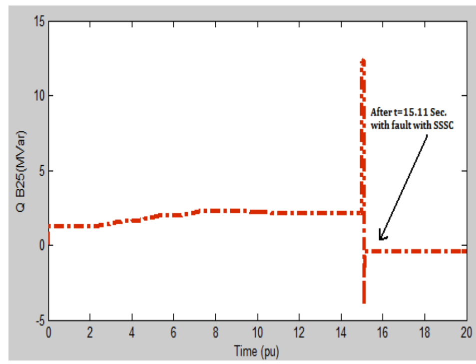

Fig. 9. Q B25(MVAR) – time, 25 × 10^3V bus with fault with SSSC.

B. Simulation Result of UPFC

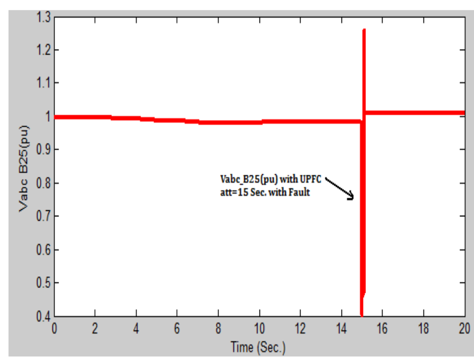

Fig. 10. V_{abc}– time, 25 × 10^3 V bus systems with fault with UPFC.

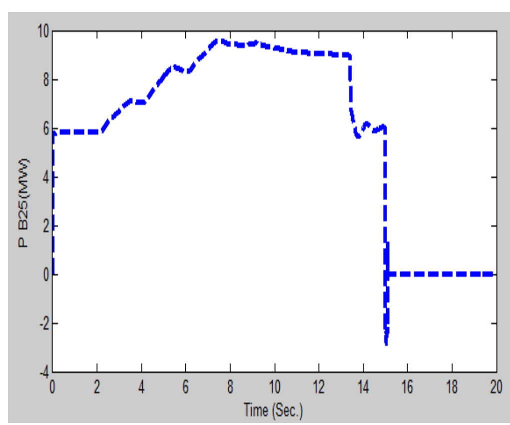

Fig. 11. P B25 – time, 25 × 10^3V bus systems with fault with UPFC.

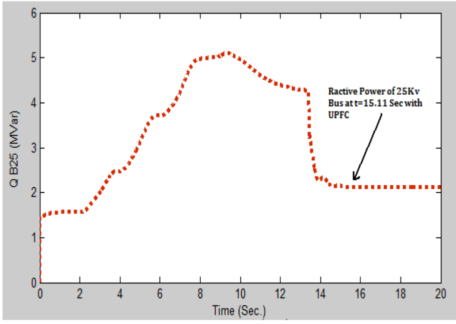

Fig. 12. Q B25 – time, 25 × 10^3V bus systems with fault with UPFC.

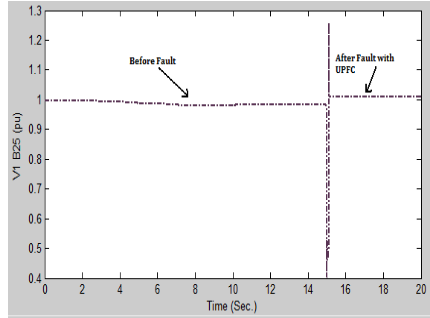

Fig. 13. V_1B25 – time, 25 × 10^3V bus systems with fault with UPFC.

C. Performance Analysis of SSSC and UPFC

Table 1: Impact of SSSC and UPFC on DGsystem with wind farm.

S.No.	Parameters	1	5	7
		w/o fault	With fault w/o SSSC	With fault w/o UPFC
1.	Vabc-B25 (pu)	0.98	0.98	1.20
2.	P-25 (MW)	6	5.48	4.90
3.	Q-B25 (MVAR)	1.650	-3.85	-0.9
4.	V1-B25 (pu)	0.98	0.986	1.05
5.	I1-B25 (pu)	0.60	0.649	0.20
6.	P1-3 (MW)	Each 3MW	Each 3 MW	Each 3 MW
7.	Q1-3 (MVAR)	1.79	0.2	1.5

VI. CONCLUSION

Simulation & Simulation results analysis demonstrated that, for the analysis when above two FACTs apparatuses put in action on shared connection point at numerous bus systems with squirrel cage IG of a nine MW based DG and observed the impacts of FACTs on Distributed Generation. Finally, this paper concluded that, here quality of power as well as stability of voltage of DG basis scheme enhanced by using FACTs apparatuses however it is rely on quality of electrical power improvement of altered FACTs apparatuses.

VII. FUTURE SCOPE

Impact of FACTs apparatus will also observe with another FACTs device and also compare the helpfulness of this apparatus with system. In addition, islanding of DG scheme willdetect and also identify the Non Detection Zone (NDZ) of the system.

Conflict of Interest. The authors declare(s) that there is no conflict of interest.

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