Singaporean Journal Scientific Research (SJSR)
ISSN: 2231 - 0061Vol.2, No.2 pp.80 - 84
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available at:: http://www.iaaet.org/sjsr

Analysis of Voltage Sag with Different DG for Various Faulty Conditions

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***Abstract*— Distributed Generation has played a very vital role for the improvement of voltage profile nowadays. The application of DG is going to increase in upcoming future as it has a lot of positive impacts such as compatible size, losses reduction, and voltage support. Somehow it has some negative impact also such as voltage regulation, harmonic distortion and conflict with relaying and reclosing.In addition, recently, distributed generation has gained a lot of momentum due to market deregulation, environmental impact concerns, and development of new technologies to power generation and necessity of increasing the reliability of industrial plants**.**This paper mainly investigates toward the impact of various DG like synchronous machine and induction generator on the IEEE 13 bus system. Different types of faults are explained here and its impacts have been investigated. To support this argument, simulation has been achieved on PSCAD/EMTDC, where results show the effect of DG and different fault on voltage sag.**

***Index Terms*—**Voltage sag, voltage dip, synchronous generator (SG), induction generator (IG), power quality, PSCAD, Distributed Generation (DG)

1. INTRODUCTION

Distributed generator has made much more attention in this world for improving voltage sag efficiency. DG has mainly connected with the interconnection to the buses to improve various impacts like power quality, protection and Reliability [1]. Now distributed generation dominate only 16% of total generation, some studies showthat within the next two or three years, distributed generation may represent up to 30% of all new generation. Moreover distribution generator has a lot of positive impact such as lower capital cost due smaller size. However, the negative impacts of distributed generation include some operating conflicts for fault clearing, reclosing and interference with relaying.[2].

The relationship between power quality and distribution system has been a subject of interest for several years. Typically, the frequencies of Fluctuations lie between 1 and 35 Hz. The disturbance becomes perceptible for voltage variation frequency of 10 Hz and relative magnitude of 0.26% [2].Power quality (PQ) is a term which broadly refers to maintaining near sinusoidal waveform of power distribution bus voltage at rated voltage and frequency. Voltage sags are recognized as the most important PQ problem affecting industrial customers as they can cause the most sensitive equipment's like ASD'S, PLC's to trip, thus affecting industrial production process leading to revenue loss [3] .There has been an increasing interest in Distributed Generation (DG) during the past few years .The technical and economic benefits associated with DG have contributed to the proliferation of DG installations. Synchronous generators are the common choice for relatively large installations. The most prominent advantage of synchronous generators over other types of DG isthe quality of power and the ease of operation due to mature manufacturing technology and familiarity of synchronous generators. The limited reactive power capability of a synchronous distributed generator due to its relatively small size. Due to these characteristics, the excitation control isusually implemented in constant power factor or constant reactive power mode.

To analysis this property of several DG, PSCAD is used here. PSCAD/EMTDC is one of the foremost commercial electromagnetic transient simulation tools. It has been developed by the Manitoba HVDC Research Center since 1975. PSCAD is a graphical front-end to EMTDC for creating models and analyzing results. In PSCAD one combines blocks to form a power network [4].

The studied has been performed for two condition, one for without DG another for with DG. Without the DG, the network is a passive network that supplies power (and load) in one direction. When the DG is connected to the network it becomes an active network that may operate with different power flows including reverse power flow from the 'load' bus to the grid and it may also be subjected to phenomena hitherto solely observed in transmission networks. The connection of DG can increase the feeder capacity limit. The connection of DG to a distribution network generally contributes to the mitigation of voltage sags by increasing the fault level at distribution buses, which consequently results in mitigation of voltage sags due to the faults on distribution feeders [5].

2. VOLTAGE COMPONENT

A.Voltage Sag

Voltage sag as defined by IEEE Standard 1159-1995, IEEE Recommended Practice for Monitoring Electric Power Quality, is a decrease in RMS voltage at the power frequency for durations from 0.5 cycles to 1 minute, reported as the remaining voltage [6].The measurement of voltage sag is stated as a percentage of the nominal voltage; it is a measurement of the remaining voltage and is stated as sag to a percentage value.

Thus a voltage sag to 60% is equivalent to 60% of nominal voltage, or 288 volts for a nominal 480 Volt systems [6]. Voltage sag disturbs the whole performance of the system. In some cases, reduced voltage sag plays a vital role in order to run small scale industries like steel etc.

B. Voltage Dip

In North America a voltage dip is usually understood to mean the amount by which the nominal voltage declines – in percentage terms this, is 100-voltage sag [6].

Thus, a voltage dip of 40% equates to voltage sag to 60%. Unfortunately in practice there is confusion, and the terms voltage sag and Voltage dip are sometimes interchanged. It is therefore important that data is clarified [6].

3. NETWORK COMPONENT MODELS

In this paper, all network components were represented by three-phase models. In the studies about steady-state voltage profiles, power losses, and stability, the network variables were represented by phasor. Such analyses were conducted by using a load flow and a transient stability program [7]. To analysis this impact, we have to understand about voltage component, IEEE 13 bus system is taken which is shown in figure 1, synchronous generator and induction generator.

A. IEEE -13 Bus Systems

To anal yes the voltage profile in islanding mode of operation, the IEEE test feeder is simulated using PSCAD/EMTDC Software [8].The system under consideration is 3 phase balanced system. The system is analyzed under different fault. 3 phase voltage source is provided to bus 1 which is of RRL type. In the main substation, Bus 1 is selected as the slack bus voltage where the substation rated 10 MVA; 11kV is connected to the system through 33/11 kV step down transformer and again11/6.6KV respectively.

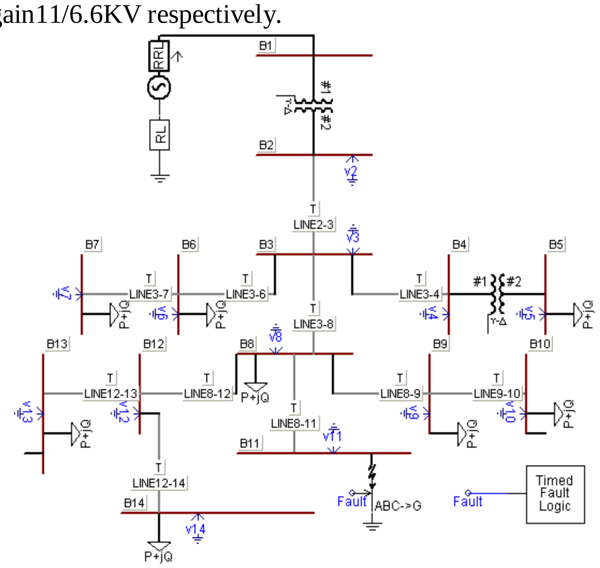


Figure1: standard IEEE 13 bus system

DG is connected through b11 bus and fault is connected through b13which is shown if figure 1.In this paper, Analysis of voltage sag is calculated and performed with the help of distributed generation, synchronous generator and Induction Machine. The Voltage profile is highly improved with the use of DG. Distributed generation (DG) is defined by the Electric Power Research Institute (EPRI) as a small scale (0–50 MW) energy resource connected directly to the distribution network [9]. The above shown 13-bus system is observed and realized with and without Distributed Generation.A comparative graph of Without DG, with synchronous DGand induction DG graph is shown in figure a, b and c respectively. A comparative study between synchronous and induction Machine reveals that voltage profile is highly improvised and modified by the use of synchronous generator implied in the wind turbine. The paper has been investigated when DG is connected across b13 bus and different type of fault is connected.

B. Induction Generators

Although most induction generators in operation are employed in wind power plants such machines have also been used in medium-size hydro and thermal plants. Therefore, in order to keep the results as generic as possible, the mechanical torque was considered constant, i.e. the regulator and prime mover dynamics were neglected. In the above IEEE 13 bus system, induction machine is taken as squirrel cage induction type. The rated RMS phase voltage is taken as 7.967 kV and rated RMS current as 0.028kA. During faults, an induction motor may function as a generator for a short period of time, helping to hold up the voltage magnitude [11].

C. Synchronous Generators

At present, most distributed generation systems employ synchronous generators, which can be used in thermal, hydro, or wind power plants. The most prominent advantage of synchronous generators over other types of DG **is** the quality of power and the ease of operation due to mature manufacturing technology and familiarity of synchronous generators [12]. In addition, typically, there are two different modes of controlling the excitation system of distributed synchronous generators. One aims to maintain constant the terminal voltage, and the other one aims to maintain constant the power factor. Power factor control mode is usually adopted by independent producers to maximize the active power production .Here synchronous machine is taken for consideration. The rated RMS line to neutral voltage is taken as 10.392 KV and rated RMS line current is taken as 35.283kA.

4. RESULT AND DISCUSSION

The result of IEEE 13 bus system is shown here. Two conditionsistaken, one is without fault and another is with fault. The graph of reactive power, electric torque, mechanical speed, turbine power, wind speed and active power is shown in figure d and e respectively. The various types of impact of voltage sag has been shown here.

Case1: Positive Impact

In positive impact, two conditions areanalyzed here. One is without fault condition and other is with fault condition. With the help of data and graph, the analysis has been done.

A. Without Fault Condition

Table 1: voltage across all buses without DG, with synchronous and induction DG during without fault DG

Vmax	Without DG	With SG	With IG
v3	0.4109	0.08889	0.42165
v4	0.47344	0.10866	0.48560
v5	0.28383	0.06544	0.29124
v6	0.59528	0.15496	0.61071
v7	0.62730	0.16677	0.64361
v8	0.06194	0.21953	0.09048
v9	0.11058	0.64461	0.1616
v10	0.12849	0.81135	0.18793
v11	0.12885	0.81508	0.18843
v12	0.12647	0.50493	0.11778
v13	0.13319	0.80425	0.091216
v14	0.192392	1	0.179252

Table 1: voltage across all buses without DG, with synchronous and induction DG during without fault DG is connected across b13 bus.When fault is not connected to any bus, the magnitude of voltage is same for B7 bus compared to with fault condition , but after the magnitude of voltage in induction motor is reduced to some extent and there is no effect of fault when the system is connected synchronous DG than with fault condition. Also, the magnitude of voltage is high in the case of synchronous as the size of transmission line increases and also when load increases which is shown in figure 2 and table 1.

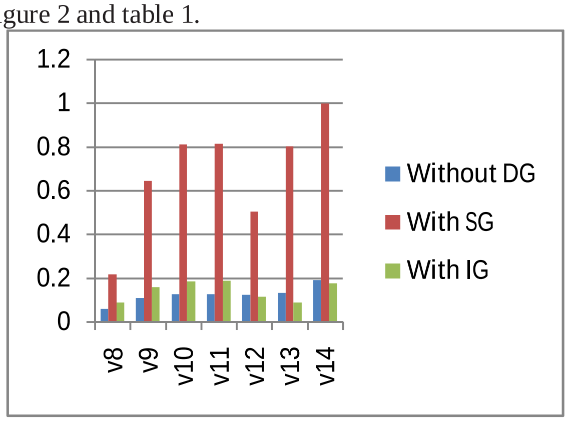


Figure 2: voltage (KV) vs time (sec) across various buses with and without DG during without fault condition

B. With Fault Condition

During with fault condition, when various DG is connected across the bus system, the magnitude of voltage across all the bus is high as in case of synchronous than induction DG. There is less voltage sag produced in case of synchronousDG. The voltage profile has increased in case of synchronous DG than in the case of induction DG which is shown in table 2 and figure 3.

Table 2: Voltage across all bus with synchronous DG and induction DG during fault condition

Vmax	Without DG	With SG	With IG
v3	0.468511	0.097838	0.491666
v4	0.534323	0.110145	0.556618
v5	0.315762	0.065931	0.334772
v6	0.650438	0.155263	0.676634
v7	0.681633	0.166864	0.708923
v8	0.108367	0.228244	0.204712
v9	0.187239	0.649458	0.342599
v10	0.213118	0.814321	0.400985
v11	0.172442	0.814210	0.238070
v12	0.214293	0.504928	0.252405
v13	0.226235	0.804169	0.192693
v14	0.320063	1	0.376553

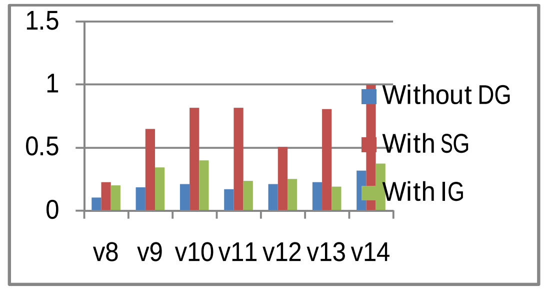
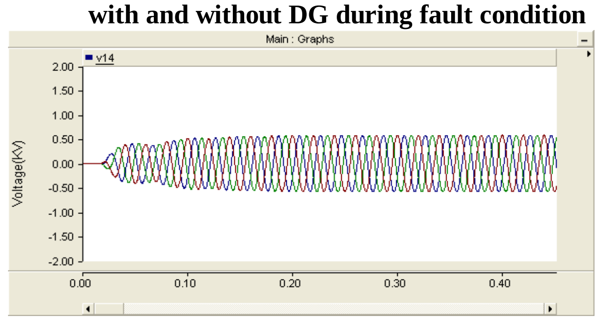
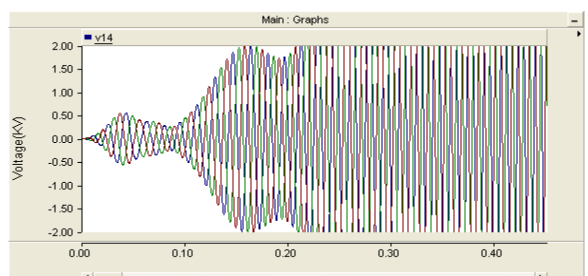


Figure 3: voltage (KV) Vs.time (sec) across various buses with and without DG during fault condition



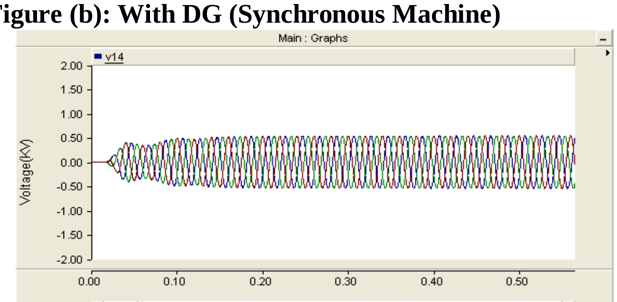
Time (second)

Figure (a): Without DG



Time (second)

Figure (b): With DG (Synchronous Machine)



Time (second)

Figure(c): With DG (Induction Generator)

I. single phase fault

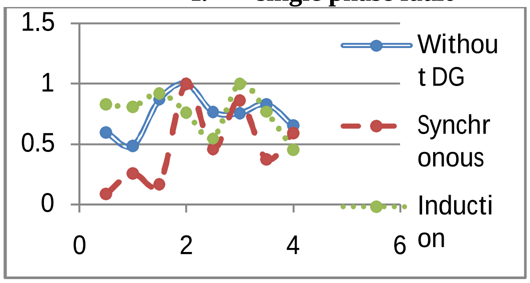


Figure 4: comparative graph under1φ fault

In single phase one phase and one neutral are connected. In case of single phase fault which is shown in figure 4, we can see voltage sag is more found in induction generator during time period 1-2 seconds. In case of synchronous generator, we can see voltage profile has been improved.

C. Two phase fault

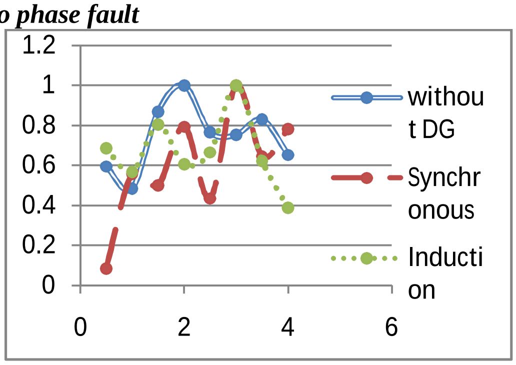


Figure5: comparative graph under 2φ fault

In two phase fault, two phase and neutral are connected. In case of two phase fault which is shown in figure 5, voltage sag is somehow more in induction generator than the voltage sag in synchronous generator during the time period 1-2 seconds.

D. Three phase fault

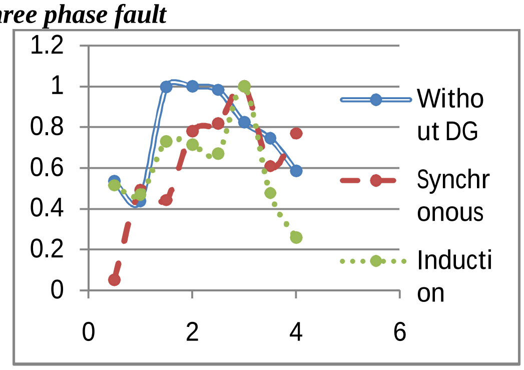


Figure (6): comparative graph under3φ fault

In three phase fault, all the three phases and neutral are connected. In case of 3 phase fault which is shown in figure 6, we can see that voltage sag is more in induction generator during the time 1-2 seconds.

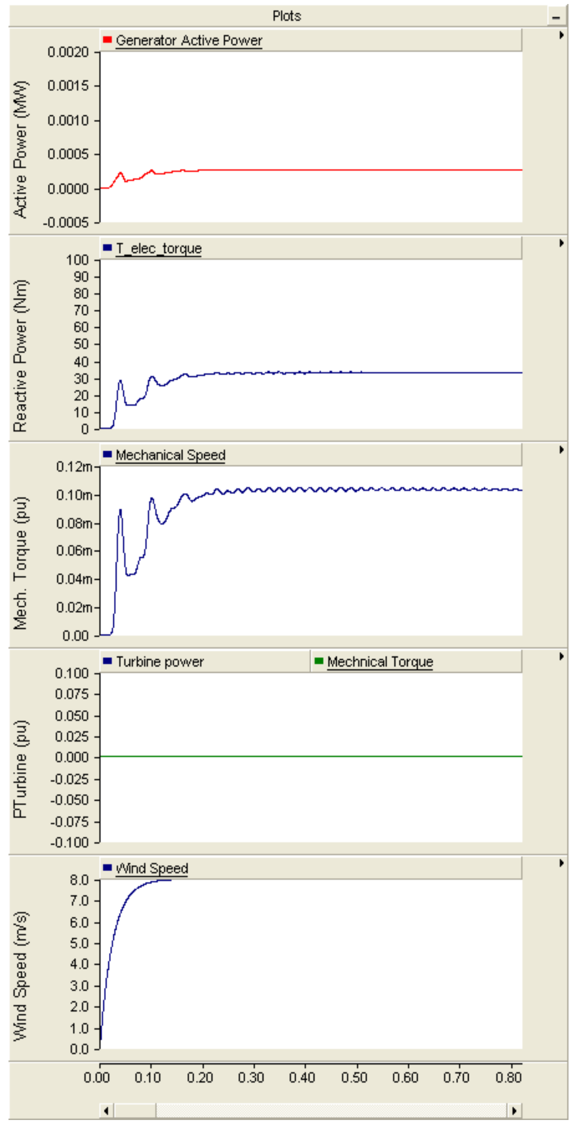


Figure (d): active power, torque, mechanical speed, turbine, turbine power, wind speed

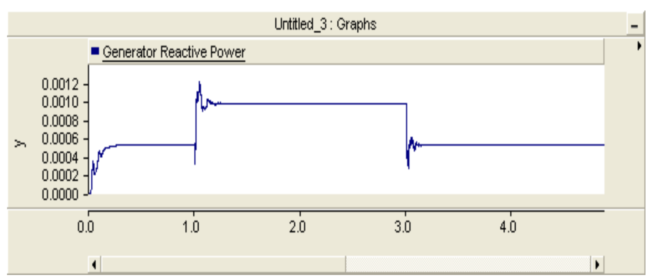


Figure (e): reactive power

5. CONCLUSION

The above results shows that in case of synchronous generator, voltage profile is improved due to its reactance power absorbed during recovery process i.e. voltage drop is increased to 2-3 times of its nominal value. The voltage during 1Φ fault, 2Φ fault, and 3Φ fault has been analyzed here. Usingsynchronized generator, voltage profile is improved much more than in case of induction generator. In case of synchronous generator, sag duration increases due to increase in size. By increasing size of DG, voltage sag increase is adjusted. Thus by comparing the induction and synchronous generator, synchronous generator make large impact on the voltage sag and by increasing the voltage profile. In the overall conclusion , it can said that voltage sag found is more in induction generator and voltage profile is increased when it is connected to synchronous generator.

REFERENCES

1. Xueha o HU, Member, IEEE, and Yan ZHAOet al" Study of Impacts of Two Types' DistributedGeneration on Distribution Network Voltage Sags", China Electric Power Research Institute, HaidianDistrict,Beijing,2008.
2. Ali Saidian, DavarMirabbasi, Mehrdad Heidari," The Effect of Size of DG on Voltage Flicker and Voltage Sag in Closed-Loop Distribution System", 5th IEEE Conference on Industrial Electronics and Applications, 2010.
3. *A.Radhakrishana.* M. Eshwardas and Gokul Chebiyam, "Impactof Voltage Sags in Practical Power System Network", IEEE 2001.
4. SannaUski, Bettina Lemström, Juha Kiviluoma, Simo Rissanen and Petteri Antikainen," Adjoint wind turbine modeling with ADAMS, Simulink and Pscad/Emtdc", Nordic Wind Power Conference, 1-2 March, 2004.
5. J.V. Milanovi, H. Ali and M.T. Aung." Influence of distributed wind generation and loadcomposition on voltage sags", The Institution of Engineering and Technology 2007.
6. Ian K.P. Ross, MIEE, Omniverter Inc," voltage sags: an explanation - causes, effects and correction - part i", nov-dec 2007.
7. WalmirFreitas, Jose C. M. Vieira, Andre Morelato, Luiz C. P. da Silva, Vivaldo F. da Costa, and Flavio A. B. Lemos," Comparative Analysis Between Synchronous and Induction Machines for Distributed Generation Applications",IEEE Transactions on Power Systems, Vol. 21, No. 1, February 2006.
8. ChandanaBommareddy, ElhamMakram," Power Quality Studies In The Presence Of DG", Student Member, IEEE.
9. Martin L. Baughman," IEEE Power Engineering Society, Power System Analysis, Computing andEconomics Committee," IEEE.
10. Emma M. Stewart, R. Tumilty, John Fletcher, Andrew Lutz, G. Ault, and Jim McDonald," Analysis of a Distributed Grid-ConnectedFuel Cell During Fault Conditions", IEEE Transactions On Power Systems, Vol. 25, No. 1, February,2010.
11. J. Wang, S. Chen, T. T. Lie," System Voltage Sag Performance Estimation", IEEE transactions on power delivery, vol. 20, no. 2, April 2005.
12. Edward R. Collins, Jian Jiang," The Role of a Synchronous Distributed Generator on Voltage Sags", 11th International Conference on Harmonics and Quality of Power, 2004.