Journal of Science & Engineering Education (ISSN 2455-5061)
Vol.-2, Page-56-60, Year-2017

# Effects on Power System Stability due to Integration of Distributed Generation

*Manoj Kumar Nigam, Saumya Singh**,Christeena Francis***

*Assistant Professor,Dept. of EE, Christian College of Engineering and Technology, Chhattisgarh, India,nigam74_123@yahoo.com

**Assistant Professor, Dept. of EE, Christian College of Engineering and Technology, Chhattisgarh, India, er.saumya2009@gmail.com

***Assistant Professor, Dept. of EE, Christian College of Engineering and Technology, Chhattisgarh, India, christeenafrancis33@gmail.com

**Abstract**

*Power requirement is the most necessary requirement of the modern high power advanced technology. To fulfil this increased demand of power requirement, a new technology has been developed which is known as the Distributed Generation (DG). It uses renewable energy sources for the generation of electric power with little impact on the environment of the surrounding area at its site of construction, economical production, less exclusion of toxic sea wastes etc. however it also has some disadvantages. Under the study network of IEEE-14 bus network, the impact of connecting DG to the Distribution Network (DN) was studied. The simulation results shown indicate disturbances in the power system with the integration of distributed generation.*

***Index Terms:*** *Distributed Generation, Distribution network, non-renewable energy sources, renewable energy sources etc.*

## 1. INTRODUCTION

A Distributed Generation is a new technology which is becoming an important area of research and study nowadays. A Distributed Generation can be defined as a technology which is based on the use of renewable energy sources viz. solar energy, biomass energy, geothermal energy, tidal energy etc [1]. A Distributed Generation as compared to the traditional method of power generation has several advantages like – it occupies less area of installation, economical, flexible and environment friendly technology. Various authors defined distributed generation (DG) as follows:

1. The *Electric Power Research Institute* defines distributed generation as generation from 'a few kilowatts upto 50 MW' [7].
2. According to the *Gas Research Institute*, distributed generation is 'typically between 2 and 25 MW' [7].
3. *Cardell* defines distributed generation as generation 'between 500 kW and 1MW' [1].
4. The *International Conference on Large High Voltage Electric Systems* (CIGRE) defines DG as 'smaller than 50-100 MW' [7].

Besides having several advantages, a DG can also cause disturbances in the network if the connected DG is not of optimal size location. A DG can disturbs the voltages profile of the network thereby disturbing the reactive power balance in the network which results in more losses and hence reduces the stability of the connected grid network. Therefore, it is necessary to find out the optimal size and location of DG in order to minimize the losses [9].

The work presented shows the disturbances caused by the DG when it is interfaced with the DN. The study has been done on an IEEE-14 bus test network. The test network under study consists of 14 buses, 3 generators and 3 transformers and was simulated using PSAT 2.1.7 simulation software. The result showed that with the integration of DG the voltage profile of the network gets disturbed.

Section II discusses the implementation of the proposed methodology with and without DG connection and the optimal location of DG connection was found. Section III list the results obtained after simulation.

CCET
Journal of Science & Engineering Education (ISSN 2455-5061)
*Vol.-2, Page-56-60, Year-2017*

## 2. METHODOLOGY

The proposed methodology was implemented using PSAT 2.1.7 simulation software. An IEEE-14 bus network with and without DG connection was shown (Fig-1 and Fig-2) respectively.

### 2.1 Size and Location of Distributed Generation:

The placement of distributed generation in a distribution system improved the voltage profile with reduced losses. However, placing DG only at optimal location is not sufficient wherein the size of the DG should also be determined for its efficient working. Wind based distributed generation of 50MVA and 11kV had been connected under the study. Authors of [3], suggested the method for finding the weakest node for the optimal location of DG in any grid connected network. The weakest node may be traced out by searching of the maximum voltage drop i.e. the bus with the smallest voltage magnitude is the weakest bus.

### 2.2 Benefitsof Distributed Generation:

In spite of the several technical and economic impacts of the distributed generation systems, there are so many reasons to promote these distributed generation installations which may include the following main points[10].

- Reduction of greenhouse gas emissions
- Grid support
- Reduces the cost as there is no use of long transmission line
- Environment friendly
- Avoid the impact of massive grid failure.
- Better power quality and reliability.
- Independence from imported fuels
- Present Higher security of supply
- Promotion of development of certain technology
- Establishment of new industries with additional employment.

The weakest bus was observed in the bus no. 14, 13, and 12 whereas bus no. 14 being the weakest bus and the most suited location for the installation of DG. The engineers may also advise to install the DGs' at bus no. 12 and 13 as and when required.

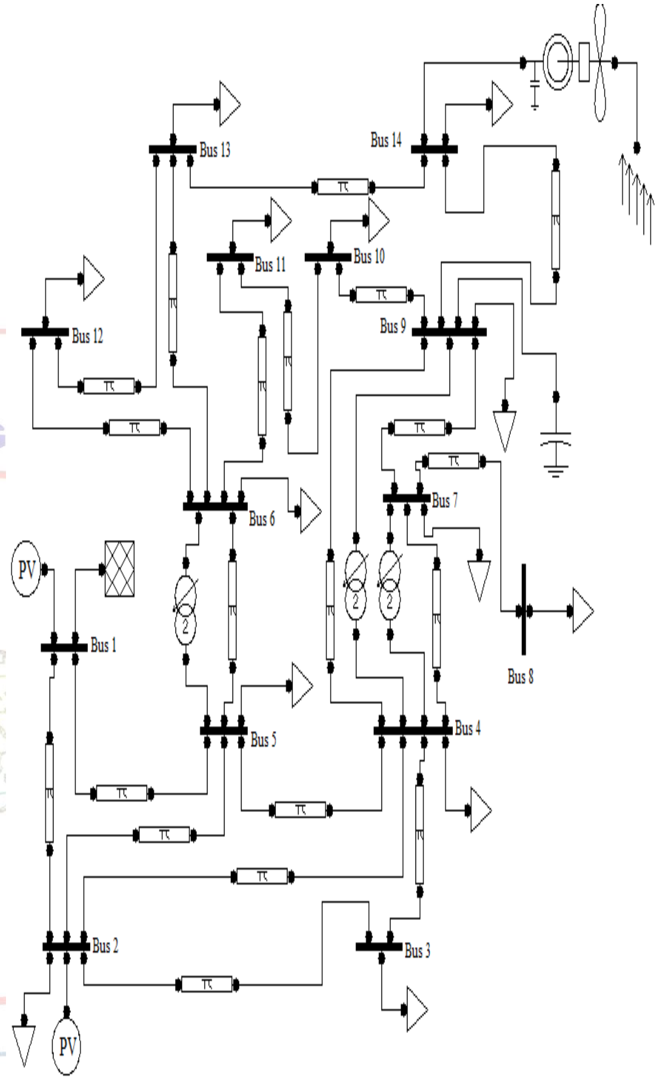


Fig-1: IEEE-14 bus simulation model with DG connection

Journal of Science & Engineering Education (ISSN 2455-5061)
*Vol.-2, Page-56-60, Year-2017*

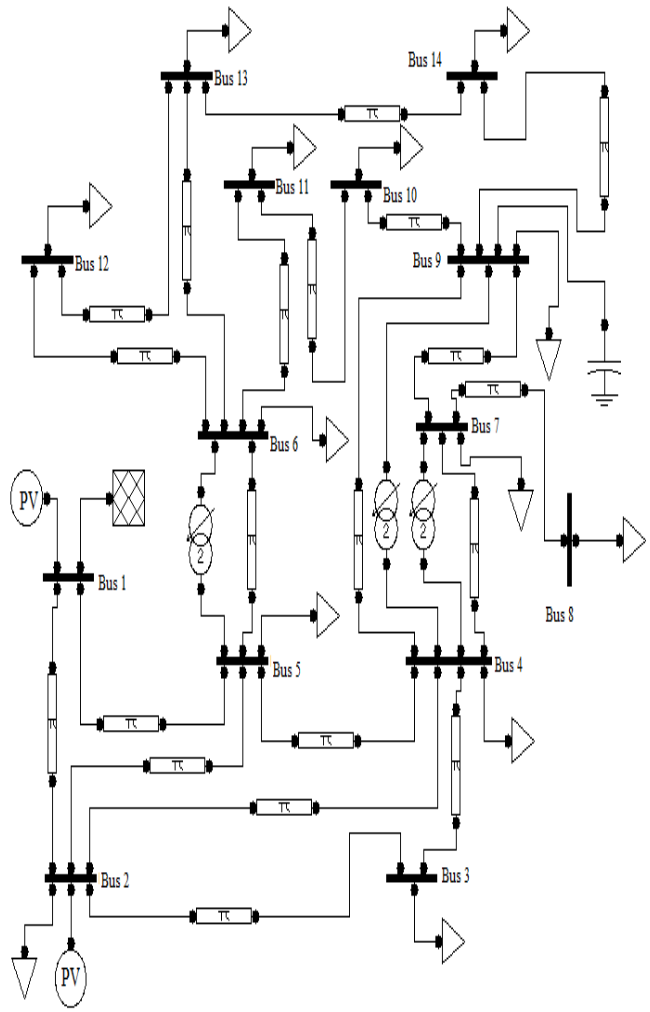


Fig-2: IEEE-14 bus simulation model without DG connection

## 3. RESULT AND DISCUSSION

Comparison of the simulation results obtained with and without DG connection shows an improvement in the reactive power loss from 5.3766 p.u. to 5.3438 p.u. if the DG was connected at the optimal location (Table-1 and Table-2) respectively. The variation in the voltage profile of the network with and without DG connection was shown (Fig-3 and Fig-4) respectively.

Table-1: Reactive power at electricity generation and load with DG connection

| **Bus** | **Q. gen (p.u)** | **Q. load (p.u)** |
|---|---|---|
| Bus 1 | 0.38329 | 0 |
| Bus 2 | 6.5306 | 0.25445 |
| Bus 3 | 0 | 0.38268 |
| Bus 4 | 0 | 0.07814 |
| Bus 5 | 0 | 0.03206 |
| Bus 6 | 0 | 0.15027 |
| Bus 7 | 0 | 0 |
| Bus 8 | 0 | 0 |
| Bus 9 | 0 | 0.27176 |
| Bus 10 | 0 | 0.11621 |
| Bus 11 | 0 | 0.03606 |
| Bus 12 | 0 | 0.03206 |
| Bus 13 | 0 | 0.11621 |
| Bus 14 | 0 | 0.10018 |

Table-2: Reactive power at electricity generation and load without DG connection

| **Bus** | **Q. gen (p.u)** | **Q. load (p.u)** |
|---|---|---|
| Bus 1 | 0.3894 | 0 |
| Bus 2 | 6.5577 | 0.25444 |
| Bus 3 | 0 | 0.38267 |
| Bus 4 | 0 | 0.07814 |
| Bus 5 | 0 | 0.03206 |
| Bus 6 | 0 | 0.15026 |
| Bus 7 | 0 | 0 |
| Bus 8 | 0 | 0 |
| Bus 9 | 0 | 0.27224 |
| Bus 10 | 0 | 0.1162 |
| Bus 11 | 0 | 0.03606 |
| Bus 12 | 0 | 0.03206 |
| Bus 13 | 0 | 0.1162 |
| Bus 14 | 0 | 0.10018 |

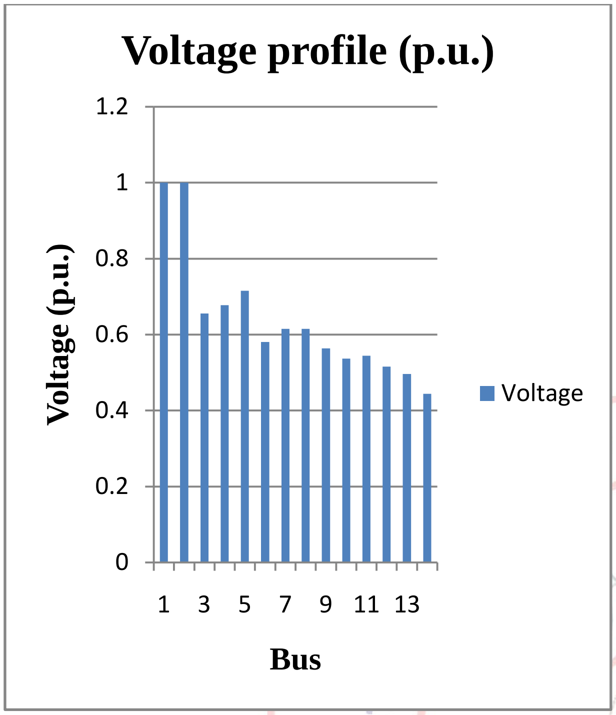


Fig-3: Voltage profile with DG connection.

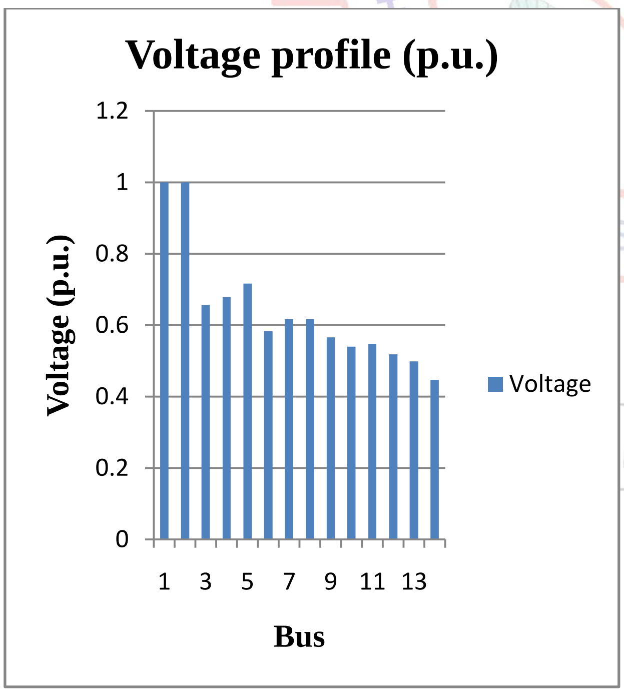


Fig-4: Voltage profile without DG connection

## 4. CONCLUSION

From the above study, it has been concluded that the distributed generation has several advantages like - it is eco-friendly, economical, uses renewable sources of energy, no toxic by-products etc. However, it also disturbs the voltage profile of the network if not connected at the optimal location. Under the study, the optimal location of the DG has been found by the study of the weakest bus and bus no. 14 was found to be the weakest. Integrating DG into the DN also decreases the stability of the connected grid network and thereby increasing the reactive power loss.

## REFERENCES

[1] CaplesDonal, BoljevicSreto, and F. Conlon Michael, "Impact of Distributed Generation on Voltage Profile in 38kV Distribution System", *Proc. 8th International Conference on the European Energy Market, Zagreb, Croatia, pp. 532-536, 2011.*

[2] AcharyaNaresh, MahatPukar, and Mithulananthan N., "An analytical approach for DG allocation in primary distribution network", *ELSEVIER Electrical Power and Energy Syst., vol. 28, pp. 669-678, 2006.*

[3] Rajaram S. P., Rajasekaran V., and Sivakumar V., "Optimal Placement of Distributed Generation for Voltage Stability Improvement and Loss Reduction in Distribu-tion Network", *International Journal of Innovative Research in Science Engineering and Technology, vol. 3, no. 3, pp.529-543, 2014.*

[4] Pecas Lopes J. A., Hatziargyriou N., Mutale J., Djapic P., and Jenkins N., "Integrating Distributed Generation into electric power systems: A review of drivers, challenges and opportunities", *ELSEVIER Electric Power System Research, vol. 77, pp. 1189-1203, 2006.*

[5] Banerjee Rangan,"Comparision of options for distributed generation in India", *ELSEVIER Energy Policy, vol. 34, pp. 101-111, 2004.*

[6] El-KhattamWalid, Hegazy Y. G., and Salama M. M. A., "Investigating Distributed Generation Systems Performance Using Monte Carlo Simulation", *IEEE Transaction on Power System, vol. 21, no. 2, pp.524-532, 2006.*

[7] Ackermann Thomas, AnderssonGoran, and SoderLennart, "Distributed Generation: a definition", *ELSEVIER Electric Power Systems Research, vol. 57, pp.195-204, 2000.*

[8] Gandomkar M., and Shooshtary P., "A Genetic Based Tabu Search Algorithm to Distribution Network

Expansion Planning with Distributed Generation”, *IEEE 2011*.

[9] B. Hussain, S.M. Sharkh, and S. Hussain, “Impact Studies of Distributed Generation on Power Quality and Protection setup of an Existing Distribution Network,”*School of Engineering Sciences, University of Southampton, SO17 1BX, UK, 2010.*

[10] S. K. Khadem, M. Basu and M.F. Conlon, “Power Quality In Grid Connected Renewable Energy Systems: Role Of Custom Power Devices, *“International Conference on Renewable Energies and Power Quality - ICREPQ’2010, EA4EPQ, Granada (Spain), 23rd to 25th March 2010.*