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POWER QUALITY AND VOLTAGE CONTROL ISSUES IN POWER SYSTEM AFTER INTEGRATION OF DISTRIBUTED GENERATION

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ABSTRACT

Distributed generation (DG) is a developing concept in the power sector, which signifies good substitutes for electric supply instead of the traditional centralized power generation concept. This paper presents the basic principles of incorporating distributed generation technologies in low voltage networks and particularly focuses on the economics of DG installations and the impact that DG may have on voltage control leading to improved power quality.

Power system operation is very exciting from system security, reliability and efficiency points of view. The demand of electrical power is increasing continuously and existing power system networks are very complex, large scale, centralized and far from load centres to make energy supply to all customers must be continuously stable and reliable. Integrated distributed generation and existing power systems are capable of supporting energy security, such as during peak demand or power shortages. However it also has some disadvantages. In this study, IEEE-5 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. A Distributed Generation as matched to the traditional method of power generation has numerous 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' [8].

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. 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-5 bus test network. The test network under study 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

2. METHODOLOGY

The proposed methodology was implemented using PSAT 2.1.7 simulation software. An IEEE-5 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 [5], 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:

- 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

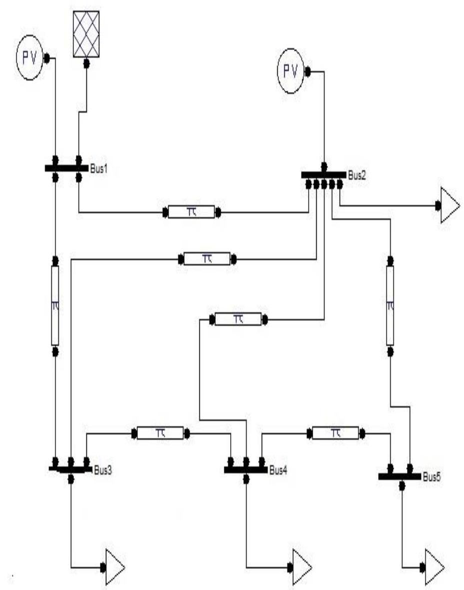

Fig-1: IEEE-5 bus network without DG connection

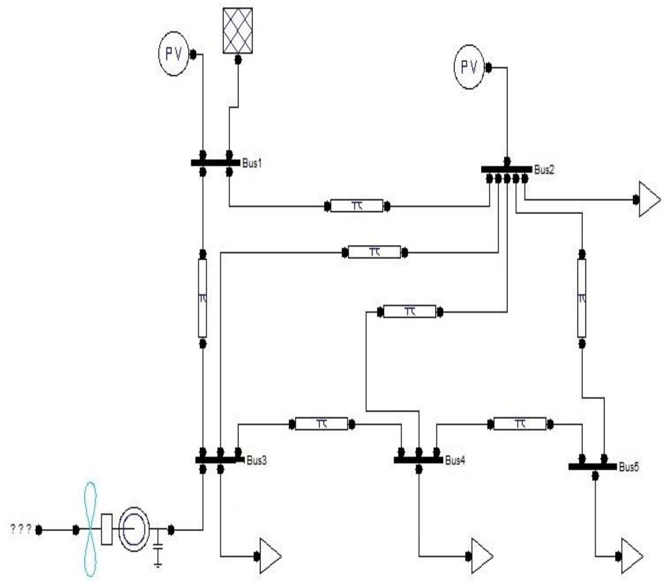

Fig-2: IEEE-14 bus network without DG connection

3. RESULT AND DISCUSSION

Assessment of the simulation results found with and without DG connection shows an enhancement in the reactive power loss from 12.8637p.u. to 11.1595 p.u in bus no.2. If the DG was connected at the optimal location (Table-1 and Table-2) respectively. The difference 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 generation and load with DG connection

Bus	**Q. gen (p.u)**	**Q. load (p.u)**
Bus 1	0.81074	0
Bus 2	11.1595	0.49166
Bus 3	0	0.73749
Bus 4	0	0.24583
Bus 5	0	0.49166

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

Bus	**Q. gen (p.u)**	**Q. load (p.u)**
Bus 1	1.0231	0
Bus 2	12.8637	0.47111
Bus 3	0	0.70666
Bus 4	0	0.23555
Bus 5	0	0.47111

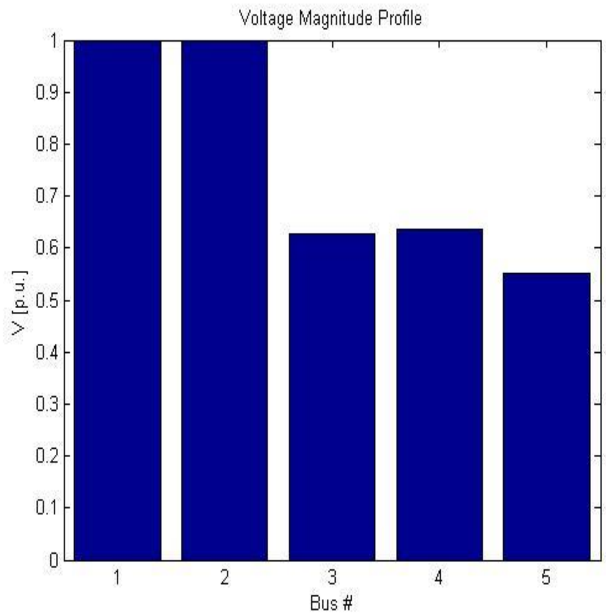

Fig-3: Voltage profile with DG connection.

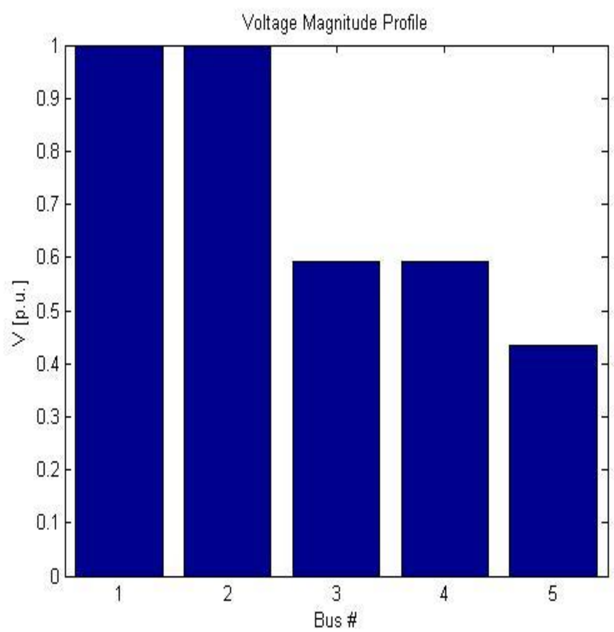

Fig-4: Voltage profile without DG connection

4. CONCLUSIONS

From the above study, it has been determined that the DG has several advantages like - it is eco-friendly, economical, uses renewable sources of energy, no toxic by-products etc. However, it also disrupts the voltage profile of the network if not connected at the optimal location. This study shows that the optimal location of the DG has been found by the study of the weakest bus and bus no. 3 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.

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