JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Hybrid Distributed Generation Allocation on IEEE 30 Bus Test System to find out the losses and maximum loading in Transmission Network

Vishal Karsan Gadhvi[1], Dr. Vijaykumar. B. Gadhavi[2]

[1]PhD Scholar, Swaminarayan University, Kalol, Gandhinagar, Gujarat, India
[2] PhD Supervisor, Associate Professor, Faculty of Engineering, Swaminarayan University, Kalol, Gandhinagar, Gujarat, India.

[1]vishalgadhavi90@gmail.com, [2]vijaybgadhavi@gmail.com

Abstract: *Distributed (DG) generation units are increasingly relevant now in the electrical transmission network. The goal of the optimal transmission network DG unit allocation is to have the best locations within the network. There has been an effort to monitor the most sensitive buses in the transmission network for voltage collapse. A procedure was provided here to use the PSAT toolbox in Matlab to allocate DG units on the regular IEEE 30 Bus System. The approach is based upon an examination of the continuity of electric current flow and the assessment of the most sensitive buses in the test system for voltage failure. The proposed approach shows considerable lowering of actual and reactive energy losses, improved voltage profiles and increased transmission network loading capabilities.*

Keywords: **DG Technologies available, Placement algorithm, Effect of DG Unit Placement, Case Survey on the IEEE 30 Bus Test System, PSAT toolbox in Matlab Conclusion, comparison of data with and without DG.**

1. Introduction

A grid of electric power is an electrical problem network used in electrical power supply, transmission and use. One power generator, which is a source, power and the first transmission system that transfers power from the power station to the client and the distribution system which delivers power to neighboring companies [1, 2], is an electric power system bifurcated mainly in two parts.

Comparatively partial generating generators which generate some kW to 10 MW of power and which are regularly related to the grid at the distribution or substation level. A diverse range of distributed generating units use gas-based turbines, fuel cells and diesel engine generators, wind turbines, solar photovoltaic generation, hydroelectric generators and biomass power. Distributed generation (DG), also known as on-site generation, generation push, decentralized energy production, discrete energy generation and generation of energy from several small energies [3].

Distributed generation enables electricity from many sources to be collected which can have fewer environmental impact and increase source security. The relation between the DG and the network will affect the stability of the power structure, i.e. the voltage, the angles and frequencies [4].

One of the key challenges in the field of architecture was to quickly and greatly assign and pass DG units and to determine many methodologies. For this reason, the process Lagrange, two degrees gradient method as well as the method for sensibility analysis were used [5, 6].

This analysis is a way for placing DG units in a power transmission network; it is focused on studying load flow and determining the highest voltage collapse susceptible buses. Due to this objective reason and the iterative algorithm, DG units with assured capabilities are attached to these buses. In the charging flow analysis, a collapse bus voltage or maximum charged bus is determined. This is done on an IEEE 30 testing device.

2. About Hybrid Distributed Generation (DG) [7]

Single network, like the home or the enterprise, can have a distributed generator, or it may form part of a micro grid (a smaller grid that is often connected to a larger power supply system), like a large manufacturing plant, a military base or a large college campus. When connected to the lower voltage distribution lines of the electrical power plant, distributed generation will help to provide renewable, stable power to additional consumers and minimize electricity loss by transmission and distribution lines [7].

Popular distributed systems include in the residential sector:

- Solar PV Panels Solar
- Small turbines of wind
- Fuel cells with natural gas
- Generators of emergency backups normally fed by petrol or diesel fuel

Distributed generation can include resources in the commercial and industrial sectors such as:

- Heat
- Solar PV Panels
- Wind
- Hydroelectricity
- Incineration of municipal solid waste
- Natural gas or biomass fired fuel cells
- Combustion engines, like backup generators, which can be powered by oil

3. Environmental Impacts of Distributed Generation [7]

Distributed generation can benefit the world by reducing the amount of power to be produced at central power stations and, in exchange, by reducing the impacts of centralized generation on the environment. In particular:

- Cost-effective solutions for distributing power in homes and companies may be used to produce electricity using renewable energies such as solar or wind.
- Distributed generation may use electricity, for example by a combined heat and power grid, which would be lost otherwise.

- The "grid failure" (wast energy), as occurred during transmissions and distributions in the electrical supplies system, is reduced or eliminated by the use of local energy sources.

4. About PSAT toolbox for Matlab

The Matlab Tool box for Power System Analysis is a wide-ranging Matlab toolbox for the analysis and simulation of an electrical system. GNU Octave is also friendly to PSAT's facilities. With graphical user interfaces (GUIs), all operations can be measured, and a Simulink-based library results in a user friendly tool to build and analysis a network [8].

PSAT's main features are: "Power flow; Continuation Power Flow; Optimum Power Flow; Small Signals Stability Analysis; Simulation of time domain; Complete Graphical User Interface; User Defined Models; Flexible AC Transmission Models such as Wind Turbine, multi-form Data Files, Export results for plain text, Ms Excel and LaTeX Files ect..

5. Case Study and Results

Table 1: Characteristics of the IEEE 30-bus test system

System Characteristics	Value
Total number of buses	30
Total number of source	5
Main source	2
Distributed source	3
Number of load buses	21
Total number of transformers	5

In this system bus 1 is consider as a slack bus, buses 2, 5, 8, 11 and 13 as a generator bus and remaining buses as a load bus.

The system consists of a main source, which is connected to bus 1 and 2, three DG connected to buses 30, 7, and 5. The DGs connected to buses 5, 8, 11 and 13 are represented by synchronous condenser. Buses 3, 6, 7, 9, 10, 12, 14 to 30 are at a voltage level of 1.0 kV and bus 11 is at higher voltage level of 1.082 kV.

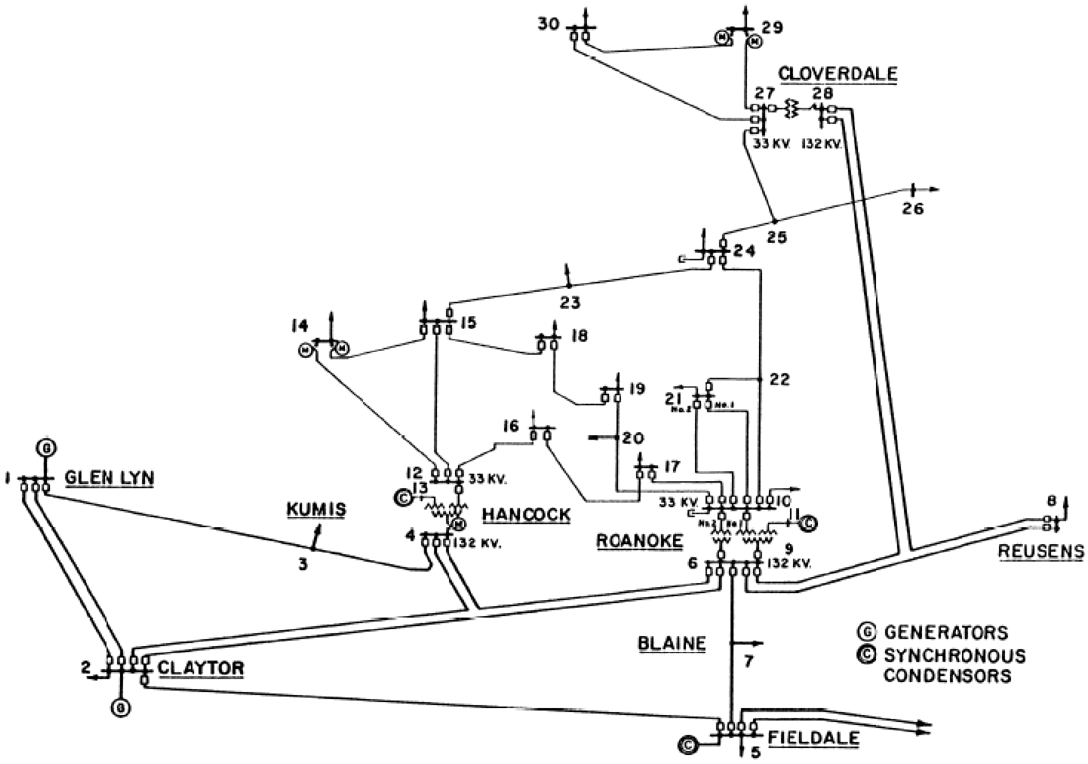

Figure 1: IEEE 30-bus test system

From this Power Flow results we can get the voltage profile for this system and also we can identify the most sensitive bus among these 30 buses. The bus no. 30 has weakest bus voltage. Where the voltage getting down is select for next iteration process where we can add one certain capacity Distribution Generation will installed and complete above mention procedure to achieve our target where minimize the losses and increase the loading capacity of this system.

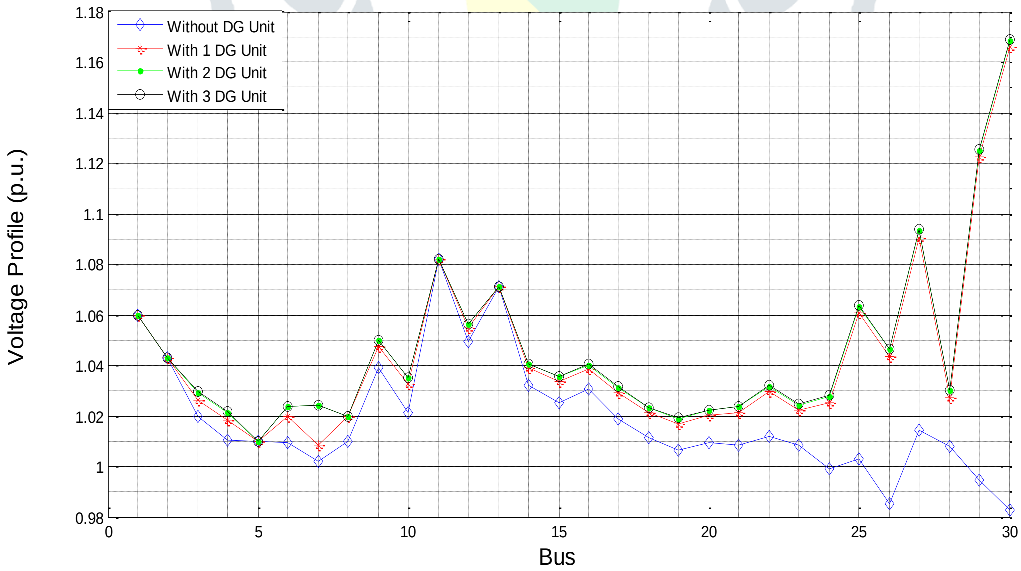

Figure 2: Voltage profile curve for an IEEE 30-bus test network with DG units.

In this way we can implement this method for three DG units install on consecutive Buses 30, 07, and 05.

6. Effect after Placement of DG Units

Power Losses [9]

To further clarify the concept of DG, it is also necessary to define the relative size of the DG units to the total power of the load in the same area. The penetration level (PL) can be defined as:

$$PL = \frac{P_{DG}}{P_{load}+P_{DG}} \times 100\ \%$$

Where P_{DG} stands for the total active power of all DG units installed in system and P_{load} is the total active power of the load. For calculation of accurate active power losses reduction (PLR) by DG units, we have the following relation:

$$PLR = \frac{P_{loss} - P_{loss}^{DG}}{P_{loss}} \times 100\ \%$$

Power Transfer Capacity [9]

The growth of electrical energy demand requires more power transfer capacity (PTC) of transmission network, but the construction of new transmission lines facilities is constrained by environmental concerns and increasing costs. Distributed generation systems provide new alternatives in expanding the transmission network capacity of existing transmission lines. DG units provide a direct and rapid bus voltage control that enhances power transfer in transmission lines and used to change directly the power flow by controlling injected power to the system. More importantly, it can independently set and control the real and reactive power flow on a transmission network, in order to line utilization and system capacity and for minimizing reactive current flow (which in turn minimizes distribution lines losses). The power transfer capacity of transmission network by using of DG units can be defined as follows:

$$PTC = \frac{P_{slack} - P_{slack}^{DG} + P_{loss} - P_{loss}^{DG}}{P_{slack}} \times 100\ \%$$

Where,

$$P_{slack} = P_{loss} + P_{load}$$

$$P_{loss} = P_G - P_{load}$$

$$P_{loss}^{DG} = P_G^{DG} - P_{load}$$

P_{slack} =Total active Power of the slack bus;

P_{slack}^{DG} =Total active power of the slack bus with DG units;

P_{loss} =Total active power losses of the transmission lines;

P_{loss}^{DG} =Total active power losses with DG units;

P_{load} =Total active power of the loads;

P_G =Total active power of the generation units;

P_G^{DG} =Total active power of the generation units with DG units.

Maximum Loading

By execution of CPF method on IEEE 30 Bus System we can obtain maximum loading of this system.

Table 2 represents the effect of execution of this method on penetration level (PL), power losses reduction (PLR), and maximum loading. By execution of this method, the penetration level increase to 20.92%, the total active power losses reduced to 21.18 % and power transfer capacity increased to 55.47 %. However, maximum loading of the system was increased about 2.2%.

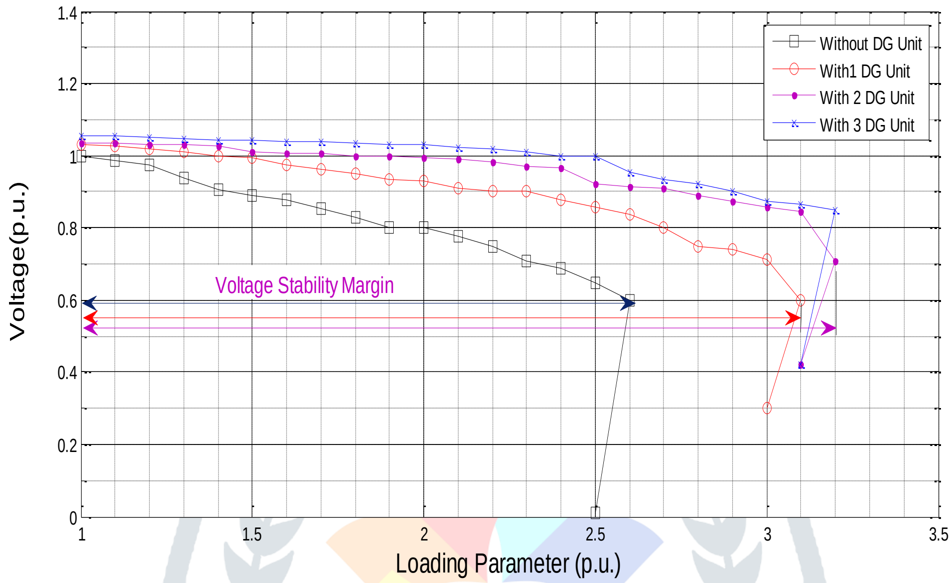

Figure 3: Effect of placement DG units on maximum loading and voltage stability Margin (IEEE-30 Bus system).

Table 2: Effects of proposed method on penetration level (PL), power losses reduction (PLR), and maximum loading on IEEE 30-Bus system

Test System	No. of DG Unit	Bus DG Unit	PL (%)	PLR (%)	PTC (%)	Maximum Loading λ_{max} (%)
Normal State	0	-	-	-	-	1.6
Iteration 1	1	30	8.1	5.8	4.6	2.1
Iteration 2	2	30-7	14.99	6.68	14.52	2.2
Iteration 3	3	30-7-5	20.92	21.18	55.47	2.2

CONCLUSION

The results of this method on a Sample IEEE 30-bus test system are obtained with and without DG units. The method is simple, because one has to simply observe the voltages at weak buses at the voltage collapse point is improved after installing Hybrid DG. The identified buses are selected for selecting location of Hybrid DG units. By execution of this method, the penetration level increase to 20.92%, the total active power losses reduced to 21.18 % and power transfer capacity increased to 55.47 %. However, maximum loading of the system was increased about 2.2%. The results show the efficiency of Hybrid DG units.

References

1. Basic Introduction about Electrical Power System and basic principal of Power system http://en.wikipedia.org/wiki/Electric_power_system
2. CELLI and PILO, "Optimal distributed generation allocation in mv distribution networks," *Proc. 22nd IEEE PES Int. Conf. on PICA 2001*, May 2001.
3. Georgilakis, Optimal Distributed Generation Placement in Power Distribution
4. Y. H. WAN and RAU, "Optimum location of resources in distributed planning," *Power System, IEEE Trans.*, vol. 9, pp. 2014–2020, November 1994.
5. Griffin, K. Tomsovic and A. L, "Placement of discrete generations systems for reduced losses," *IEEE 33rd Annu. Hawaii Int. Conf. Syst. Sciences (HICSS)*, 2000.
6. Reza, J. G. Slootweg and L. vander, "Investigating impacts of DG on transmission system stability," *Power System, IEEE PowerTech.*, June 2003.
7. Official Website of the United State Govt. United States Environmental Agency (EPA)
8. http://faraday1.ucd.ie/psat.html - PSAT tool box for Matlab basic introduction.
9. Akbarimajd andHasanHedayati, "A method for placement of dg units in distribution networks," *IEEE Trans. on Power Delivery*, vol. 23, July 2008.