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Reduction Power Loss in 33 Bus Systems with Improvement of Power Quality

M.Tech. Scholar Haripratap Yadav Assistant Professor Abhay Solanki
Department of Electrical and Electronics Engineering
Jawaharlal Institute of Technology
Borawan, MP, Khargone, India

Abstract - **Penetration of distributed generation (DG) units in distribution network has increased rapidly stimulated by reduced network power loss, improved bus voltage profile, and better power quality. Appropriate size and allocation of DG units play a significant role to get beneficial effects. The objective of this study is to demonstrate a simple and fast technique to determine appropriate location and size of DG units. A voltage stability indicator (VSI) is derived which can quantify the voltage stability conditions of buses in distribution network. According to VSI, vulnerable buses of the network are arranged rank-wise to form a priority list for allocation of DG units. To determine the size of DG units, a feed forward artificial neural network is prepared in MATLAB environment (The Math Works, Inc., Massachusetts, USA). The effectiveness of the proposed methodology has been tested on a 52-bus radial distribution network. After appropriate allocation of DG units, voltage profiles of most of the buses are increased significantly. The results also indicated that the total loss of the distribution network has reduced by nearly 76.39%, and voltage stability conditions of buses are improved considerably. Voltage stability conditions of bus-10, bus-20, and bus-33 are raised by 23.16%, 29.23%, and 37.64% respectively.**

Keywords- **Voltage stability condition, Distributed generation units, Priority list, Allocation, ANN**

I. INTRODUCTION

The liberation of the energy market and the new conditions in the energy field are leading towards the finding of more efficient ways of energy production and management. The introduction of new ideas capable of evolving in the new conditions might lead to more suitable solutions compared to any possible malfunctions the new market model can create. The electricity marketplace is undergoing a tremendous transformation as it moves towards a more competitive environment.

The 'growing pains' of this transformation price instability, an ageing infrastructure, changing regulatory environments – are causing both energy users and electric utilities to take another look at the benefits of distributed generation (DG).This restructuring comes at a time when:

- Demand for electricity is escalating domestically and internationally;
- Impressive gains have been made in the cost and performance of small, modular distributed generation technologies
- Regional and global environmental concerns have placed a premium on efficiency and environmental performance; and
- Concerns have grown regarding the reliability and quality of electric power.

II. DISTRIBUTED GENERATION BACKGROUND

2.1. Definition

Generally, the term Distributed or Distributed Generation refers to any electric power production technology that is integrated within distribution systems, close to the point of use. Distributed generators are connected to the medium or low voltage grid. They are not centrally planned and they are typically smaller than 30 MWe (DTI 2001). A distributed electricity system is one in which small and micro generators are connected directly to factories, offices, and households and to lower voltage distribution networks.

Electricity not demanded by the directly connected customers is fed into the active distribution network to meet demand elsewhere. Electricity storage systems may be utilized to store any excess generation. Large power stations and large-scale renewable, e.g. offshore wind, remain connected to the high voltage transmission network providing national back up and ensure quality of supply. Again, storage may be utilized to accommodate the variable output of some forms of generation. Such a distributed electricity system is represented in figure 2-2 below.

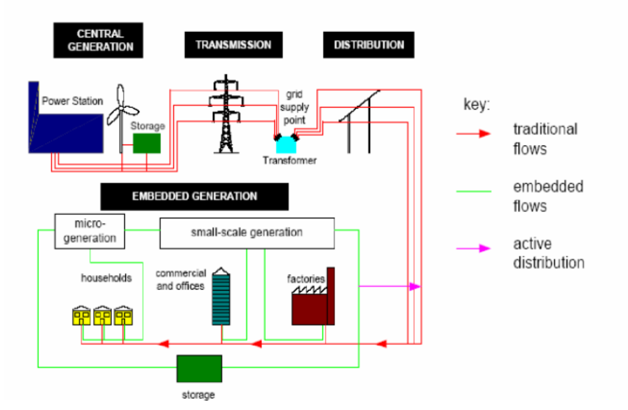

Fig. 1 A Distributed Electricity System.

Both options require significant investments of time and money to increase capacity. Distributed generation complements central power by

- Providing in many cases a relatively low capital cost response to incremental increases in power demand,
- Avoiding T&D capacity upgrades by locating power where it is most needed, and
- Having the flexibility to put power back into the grid at user sites.

Significant technological advances through decades of intensive research have yielded major improvements in the economic, operational, and environmental performance of small, modular gas-fuelled power generation options. Forecasts predict a total 520GW from newly installed DG around the globe by 2030.

III. TECHNOLOGY STATUS

The technical and commercial status of distributed generation globally depends very much on the past history of a country's power industry. Countries, whether developed or developing, with power sectors that are largely state controlled either remain tied to a centrally controlled transmission system that is connected to large-scale fossil fuel, hydro or nuclear power stations, or are developing such systems.

Countries where liberalization has taken place, on the other hand, have the incentive to consider alternatives. It is in these countries that distributed generation has started to gain a foothold because of its lower capital cost, modular construction and short build times. The mix of distributed generation technologies exploited depends on, among other things, energy market and political issues. The USA probably leads the world in developing distributed generation, driven by commercial issues and by poor power quality and the lack of security of supply in a number of states. In other words, the market is demanding solutions that distributed generation technologies can provide. This has resulted in a distributed generation market that is dominated by low-cost, high-reliability fossil-fuel plant (usually gas-based) but that has a growing renewable component.

IV. EFFECT OF DG SIZE AND LOCATION

The loss sensitivity based analytical method has been used to find the optimal location and size of DG without use of admittance, impedance or jacobian matrix. The analytical expression for finding the optimal **size and power factor** for different types of distributed generation units to achieve the highest loss reduction in the distribution system was presented.
The rapid increase of load on the system needs additional power supply sources. Due to the non-availability of conventional sources, the non-conventional sources support the system by supplying the power to the loads. The **placement and sizing of DG** is an important task for the planning engineers because the improper location and sizing introduce more power loss and voltage stability problems. By proper **allocation and sizing of DG** leads to achieve greater power loss reduction and improves the voltage profile of the system. Hence the determination of optimal location and sizing.

V. PROBLEM FORMATION

The aim of the proposed work is to minimize the designed objective function to reduce power loss, voltage profile improvement with optimal location and fixed DG size. This algorithm determines the optimal size and location of DG units that should be placed in the system where maximum loss saving occurs. First optimum sizes of DG units for all nodes are determined for base case and best one is chosen based on the maximum loss saving. If single DG placement is required this process is stopped here. This process is repeated if multiple DG locations are required by modifying the base system by inserting a DG unit into the system one-by-one.

1. How to calculate DG size and Location

Thus the new active current I_{ai}^{new} of the i^{th} branch is given by

$$I_{ai}^{new} = I_{ai} + D_i I_{DG}$$

Where Di = 1; if branch i∈α = 0; otherwise
The loss P_{La}^{com} associated with the active component of branch currents in the compensated currents in the compensated system (when the DG is connected) can be written as

$$P_{La}^{com} = \sum_{i=1}^{n} (I_{ai} + D_i I_{DG})^2 R_i \quad (1)$$

The loss saving S is the difference between equation 1 and 2 and is given by

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$$S = P_{La} - P_{La}^{com}$$
$$= -\sum_{i=1}^{n}(2D_i I_{ai} I_{DG} + D_{DG} I_c^2) R_i$$

………………..(2)

The DG current I_{DG} that provides the maximum loss saving can be obtained from-

2.The corresponding DG size is

$P_{DG} = V_m$ IDG……………………………………..(3)

Vm is the voltage magnitude of the bus m. The optimum size of DG for each bus is determined using eqn 1. Then possible loss saving for each DG is determined by using eqn 2.The DG with highest loss saving is identified as candidate location for single Dg placement. When the candidate bus is identified and DG is placed, the above technique can also be used to identify the next and subsequent bus to be compensated for loss reduction.

3. Sizing of DG units

A DG unit is a small scale power generation ranging from multi-kilowatt to few megawatt and is usually connected to a distribution network. The impact of the DG unit on distribution network may be positive or negative, depending upon the size and operating condition of the DG unit. Usually, the DG unit size should be consumable within the distribution substation boundary. Further increase of the DG size can cause reverse flow of power through DG buses and then high system losses.

4. Computational procedure

The installation of non-optimal size DG unit results in an increase of system losses, implying the reduction of voltage magnitudes of buses in the network. A fast systematic approach to allocate DG units and then determination of their sizes need step-by-step computational procedure. The procedure for proposed methodology is as follows:

- Run the power flow solution at base case of the system.
- Calculate the VSI of each bus and store.
- Arrange the VSI of the buses in descending order to form a priority list.
- Place the DG unit at top-ranked bus.
- Change the size of the DG unit randomly within a certain limit and calculate the voltage magnitude of the highest priority bus to form the training data set of the proposed ANN.
- Train the three-layered feed forward ANN properly with training data set.
- Evaluate the MVA for the voltage profiles of 0.95 p.u. for buses using the ANN model.
- Repeat steps 5 to 7 to allocate the DG units subsequently at other weak voltage stable buses and continue until all buses of the network reach to desired voltage.

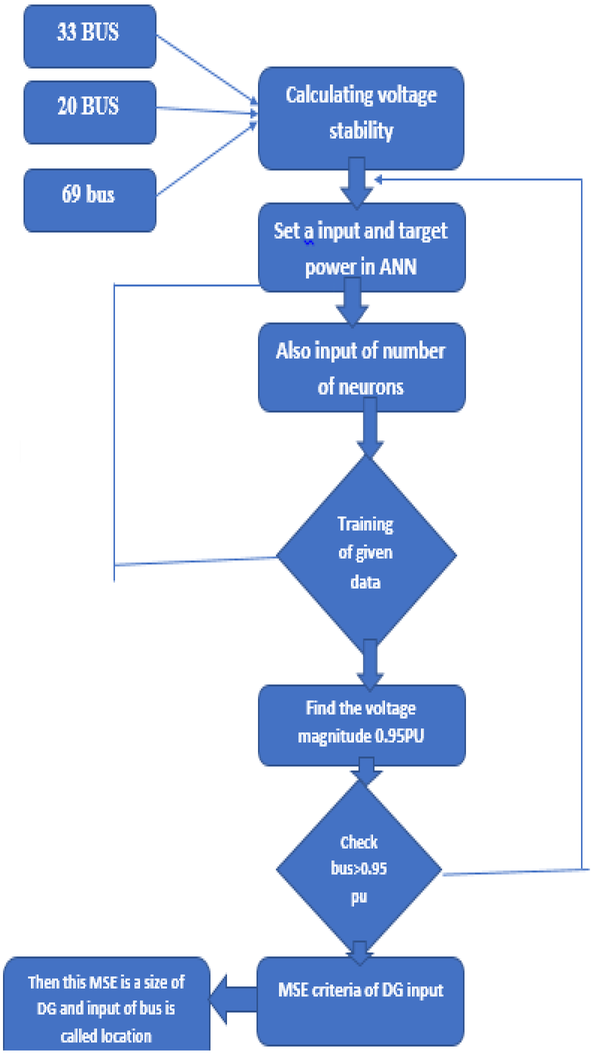

Fig. 2 Flow chart.

Integration of DG is the crucial factor in application of loss minimization and voltage improvement. This paper presents a load flow based programming with ANN algorithm to find out the optimal location of DG unit for voltage profile improvement and minimizing power loss in IEEE 33 Bus distribution system. The methodology used is capable of analyzing the influence on some system characteristics of DG allocation can be very useful for the system planning engineer when dealing with the increase of DG penetration that is happening nowadays.

The proposed algorithm can identify the best location for single DG placement in order to improve the voltage at all buses & to minimize total power losses. This method is so fast and efficient. At the same time it's so accurate in determining the losses, voltage stability with 0.5840 MVA DG size at 33 bus location. A two-stage methodology of finding the optimal locations and sizes of DGs for maximum loss reduction of radial distribution systems is presented. A single DG placement algorithm is

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proposed to find the optimal DG locations and a ANN method is proposed to find the optimal DG sizes. Voltage and line loading constraints are included in the algorithm. This methodology is tested on IEEE 33 bus system. By installing DGs at all the potential locations, the total power loss of the system has been reduced drastically and the voltage profile of the system is also improved. Inclusion of the real time constrains such as time varying loads and different types of DG units and discrete DG unit sizes into the proposed algorithm is the future scope of this work.

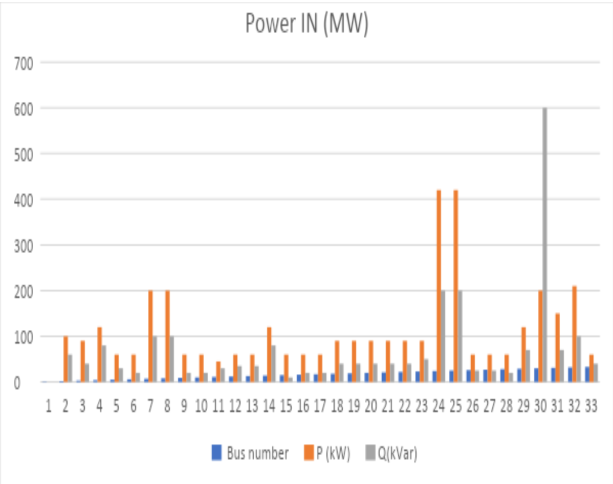

Fig.3 33 Bus System power variation.

Table 1 Bus location and Size.

S.N.	DG Size	Critical Bus Location
1.	1.7636	33
2.	0.1558	69

Table 2 MSE of Our method

S.N.	DG MSE	Proposed MSE
1.	10^{-7}	10^{-15}

Table 3 Accuracy of Our method

S.N.	Base paper Accuracy	Proposed Accuracy
1.	99.98%	99.997%

VI. CONCLUSION

A novel event classification technique for smart DG systems is proposed. The proposed event classification technique is able to detect and classify local events which have a considerable impact on the safety and operation of DG systems. The technique is implemented using the pattern recognition feature of ANNs. Four parallel ANNs are used for classification. Each neural network is optimally designed to classify events based on a specific local parameter. The output of each neural network is arranged in a vector form and the majority vote of the four ANN classifiers is selected as the final classification output. A total of 310 sample cases of islanded and grid-connected events have been generated to test the performance of the technique. The accuracy of the proposed event classification technique has been verified using 10-fold cross-validation.

VII. FUTURE SCOPE

An overview on ANNs in power systems. Neural networks have been used in a broad range of Electrical applications. Artificial intelligence technologies viz., expert systems (ES) and ANNs. In recent years, another term 'intelligent control' has come to embrace diverse methodologies combining conventional control and emergent techniques based on physiological metaphors, such as pso ,fuzzy logic, RNNs have been studied for many years with the hope of understanding and achieving human-like computational performance. The benefits include massive parallelism, architectural modularity, fast speed, high fault tolerance and adaptive capability. NN applications to power systems can be categorized under three main areas: regression, classification and combinatorial optimization. Applications involving include transient stability analysis, load forecasting, static and dynamic stability analysis. The area of combinational optimization includes unit commitment and governing control.

REFERENCES

[1]. P. Hines, J. Apt, and S. Talukdar, “Large blackouts in north america: Historical trends and policy implications,” Energy Policy, vol. 37, no. 12, pp. 5249 – 5259, 2009.
[2]. A. Bayod-Rujula, “Future development of the electricity systems with distributed generation,” Energy, vol. 34, no. 3, pp. 377 – 383, 2009.
[3]. B. Guha, R. Haddad, and Y. Kalaani, “A novel passive islanding detection technique for converter-based distributed generation systems,” in IEEE PES Conference on Innovative Smart Grid Technologies (ISGT), February 2015.
[4]. B. Guha, R. Haddad, and Y. Kalaani, “Anti-islanding techniques for inverter-based distributed generation systems - a survey,” in Proceedings of the IEEE SoutheastCon, April 2015.
[5]. “Renewables 2014 global status report,” http://www.ren21.net/Portals/0/documents/Resources/GSR/2014/GSR2014 full%20report low%20res. pdf, 2014.
[6]. Rashid, M.H., Power Electronics, Prentice Hall of India, New Delhi, 1993.
[7]. Ogata, K., Modern Control Engineering. Englewood Cliffs, NJ: Prentice Hall, 2001.
[8]. Dubey, G.K., Fundamentals of Electrical Drives. New Delhi, Narosa Publishing House, 2009