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# Energy Loss Minimization with Optimal Allocation of Distributed Generation in Radial Distribution Network: A Review

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ABSTRACT

In this work we are mainly focussed on Load flow analysis of Radial distribution system. In this dissertation work, we are going to simulate an IEEE-33 Bus system by using the BFS Algorithm in MATLAB, for solving the load flow problems. Firstly, we are going to make the radial distribution system of proposed test system in MATLAB in which we have to estimate the voltage magnitude profile and active power and reactive power losses at individual bus. In this work we use the BFS algorithm is utilized for calculating the load flow investigation in proposed system.By using the concept of distributed generation, we are going to estimate the optimum allocation of DG which is best suited for this system, where we have to manage the voltage value and power losses of the whole systemIn this work we are estimating VOLTAGE STABILITY INDEX at each bus, To estimate the accurate place of Distributed generation. After that size of DG is our main concern. When Distributed generation is inserted in the system, find the voltage profile and power of the system, and find the losses of the system.After DG placement, comparative analysis is being made for voltage profile and loss minimization. And VOLTAGE STABILITY INDEX is being calculated with and without DG.On comparing the results we see that the voltage profile and power losses are very much reduced by using distributed generation concept.

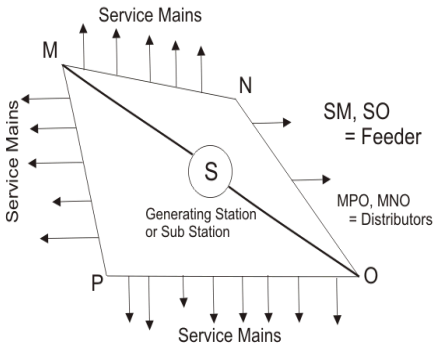
## 1. INTRODUCTION

**Introduction to Power system**

An electric power system is utilized to provide electricity and utilize that power which is a network of electrical components. An example of this is the network that provides electricity to a particular area's homes and industry, this type of system is known as the grid system and classified as generators that generate and transfer electric power. A system which transmits electric power from the generating centres to the load centres known as transmitting system whereas system which distribute power to houses and industries known distribution system.

There are some criteria or characteristics for effective operation of a power system and they are stated as:

To satisfy the demands of various load buses and many losses requires a satisfactory amount of power generation.The magnitude of the bus voltage should be maintained at a very close value to the rated voltage value.




**Load Flow Study**

Load flow study is considered as one of the considerable parts of the power systems arranging & also the process. And also it give the sine wave based stable state or situation for the whole system including the voltages, the genuine and also the mechanical power formed and ingested and also the line

delicate. And as the load is the static sum and also the power circulated via transmission lines, the idealist likes to know as the Power Flow concentrate as opposed to load flow study.

Standard Procedure For the formulation of load flow problem in power system

## II. PROPOSED WORK

This chapter deals with the problem formulation for optimal sizing and location of distributed generation in the radial distribution network.

**Problem Formulation**: This section deals with development of mathematical model for objective function and different constraints for radial distribution system in the presence of Distributed generation.

**Objective Function:**

The objective of the optimal size and location of DG problem to minimize the total power loss and voltage profile can be expressed as

Minimize

$$PL = \sum_{i=1}^{n} \sum_{j=1}^{n} [\alpha ij(PiPj + QiQj) + \beta ij(QiPj - PiQj)] \qquad (5.1)$$

Where

$$\alpha ij = \frac{rij}{vivj} cos\ (\delta i - \delta j)$$

$$\beta ij = \frac{rij}{vivj} cos\ (\delta i - \delta j)$$

Zij = rij + jxij

Where

Zij is the impedance of the line between bus i and bus j;

rij is the resistance of the line between bus i and bus j;

xij is the reactance of the line between bus i and bus j;

Vi is the voltage magnitude at bus i

Vj is the voltage magnitude at bus j

**Backward- Forward Sweep Algorithm Method**

Power engineers facing many problems due to the increase in the power demand, voltage instability and transmission line overloading. Reactive power unbalancing, voltage collapse, unexpected lines and generator outages are the major cause of voltage instability. The problems of improving voltage profile and decreasing power losses in any system can be solved by optimal ways. There are the problems of single and three phases.

Now, FACTS devices and load flow studies are the solution for the improvement of the voltage profile and stability of present power system. For minimize transmission line losses and improve voltage stability, a backward forward sweep method based on the approach for load flow analysis of an IEEE 33 bus test system is used.

To understand the nature of the installed network load low studies are performed. It is used to determine the static performance of the system. Power systems are analysed in steady-state operation. Some special features of distribution networks are as follow in category:-

- Radial or weakly meshed networks
- High R/X ratios
- Multi-phase, unbalanced operation
- Unbalanced distributed load
- Distributed generation

In this paper, a new method for solving the power flow problem for distribution feeders without using conventional load flow methods (Gauss Seidel, Newton Raphson, and Fast Decoupled) is presented. This method uses simple algebraic equations to find out iteratively of outgoing powers and voltage magnitudes of various nodes and mismatches at the last nodes of main feeder and so on and depending upon mismatches the substation injection is corrected judiciously and this process is repeated until convergence. This makes the algorithm very robust and numerically efficient for convergence for wide variation of distribution network.

**What is distributed generation?**

Distributed generation (or DG) can be defined in many ways but in general it bring up as a moderate (typically 1 kW – 50 MW) electric power generators which produces electricity next to a location which is nearby to the customers or we can say these are secured as an electric distribution

system. Distributed generators comprises of:

- Synchronous generators, induction generators, reciprocating engines, micro turbines (combustion turbines that run on high-energy fossil fuels such as oil, propane, natural gas, gasoline or diesel), combustion gas turbines, fuel cells, solar photovoltaic and wind turbines.

We can also define, Distributed Generation (DG) as any kind of electrical generator or static inverter which generates alternating current and having following features such as:

- It has the competency for parallel operation with the utility distribution system.
- It has the capability to function individually from the utility system and also feed a load which can be fed by the utility electrical system. Sometimes it referred as a "generator".
- Distributed generator can be introduced into an electric power system for the improvement of the voltage magnitude profile and also reduces the total transmission losses in the power system.
- When the Distributed generators are connected to the power system grid, it affects the various profiles of the system such as the voltage regulation, sustained interruptions, harmonics, sags, swells, etc.
- Along with the different features, DG comprises of an often function in which it make use of the surplus heat from the generation method as an further form of energy for space heating, process heating, dehumidification and also for cooling over absorption refrigeration.

We can also call the term Distributed Generation as Distributed Resources (DR) as these both the terms are simply interchangeable. But then, we found a major difference in both the terms and it was that the DR is envisioned to embrace non generating technologies for instance power storage devices like batteries and flywheels along with generators despite the fact that DG is restricted to only minimal scale (less than 20 MW) in energy generation sited adjacent to point of use.

## Simulation and Results

In order to test the effectiveness of the proposed controller, the algorithm was tested on standard IEEE radial distribution networks. These are the IEEE 33-bus radial network. These networks were chosen because they have been used extensively in literature for radial distribution network analysis. The proposed controller was first tested on the IEEE 33 bus network. Load and line data for this network are given in tables.

In this chapter we have done the load flow analysis of IEEE 33 bus system using forward backward sweep algorithm and find out the voltage profile and power losses of the particular radial distribution system. We also find the voltage stability index of IEEE 33 bus system. further we have to use the concept of distributed generation and find the optimal location of DG in IEEE 33 bus system system, where we got the minimum losses and size of DG is also our main concern. Here we use three type of DG which has different power factor. For different power factor, size of DG is also different and then find the comparative analysis of all DG in this work.

**Algorithm for Load Flow analysis of IEEE 33 Bus System:**

Step-1 Load bus data and line data of IEEE -33 bus for base case

Step-2 Using forward backward sweep method make the load flow analysis

Step-3 find out the voltage profile and power losses in load flow flow analysis

Step-4 Find out the voltage stability index for IEEE 33 bus system

Step-5 Find out the optimal allocation of DG where we have to place DG which gives minimum power losses.

Step-6 For three different types of DG, place DG one by one and get the results

Step-7 Find the voltage profile and power losses at each bus after DG placement

Step-8 Comparing the voltage profile and power losses

In MATLAB, we are going to solve the load flow problem with help of programming and will find their data's and results and then comparing the results obtained from both the approaches.

Step-3 find out the voltage profile and power losses in load flow flow analysis :-Following are the Data's obtained in MATLAB after programming as: After Load flow analysis using backward Forward sweep algorithm the voltage profile at all the buses is shown below in graphical format.

Real power Losses before DG placement

Find out the voltage stability index for IEEE 33 bus system

After load flow analysis by forward Backward algorithm, For an IEEE 33 bus system the voltage profile and real power losses is shown above after that we have calculated one stability indices that is VOLTAGE STABILITY INDICES is calculated for this system.

## CONCLUSION

This dissertation work illustrated the optimal Distributed Generation placement based approach for the analysis of load flow problems in radial distribution system with the help of MATLAB based software. Size and location of DG are fundamental factors in the application of DG for loss minimization. An analytical expression based method is proposed for finding the optimal size of DG and location is found where loss is minimum. It has been shown that voltage profile is significantly improved by placing DG in Distribution system and the losses have been reduced by 53.39% . In practice, the choice of the best site may not be always possible due to many constraints. However, the analysis here suggests that the losses arising from different placements vary greatly and hence this factor must be taken into consideration A Distributed Generation which is connected over the most critical bus on a IEEE 33 Bus test system for improving the voltage magnitude profile and reducing the total losses in the system. The simulation of the IEEE 33 bus system over critical bus is done with or without using the DG and the obtained results are compared thereafter.

The algorithm is applied in this dissertation i.e. Backward-Forward Sweep Algorithm Method in MATLAB and a comparison is plotted between the results obtained from the both the approaches. Finally, after the comparison of results from both the approaches, we concluded that the simulation of IEEE 33 bus system by using the approach of Backward-Forward Sweep Algorithm Method in MATLAB gives far better results in comparison to the approach based on the Distributed Generation for the improvement of Voltage magnitude profile and reduction of total power losses in the system.

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