ABSTRACT

The present power system for the generation and distribution of electricity is ruled by the centralized large power generations which is transmitted at high voltages to the load centers and distributed to the utilities at the distribution level voltages through the distribution networks. These centralized power plants are mostly of conventional types such as thermal, nuclear and hydro plants. These are constructed far away from the outlying consumers so that the transmission of electricity is required for the long distance. The system loss gets increased due to long distance transmission and the voltage regulation becomes very poor due to the drop in voltage at the far end. The excessive growing power demand forces the power system to build new generating stations to meet out the demand. In addition to the long distance transmission, the huge investment requirement, environmental and security issues make the conventional plants as a less attractive solution and the electrical researchers are forced to develop new approaches to meet the increasing power demand.

Introduction of Distributed Generation (DG) at the point of consumption itself is considered to be a hopeful approach to solve these problems. DG can provide the required power for the increase in load demand and at the equivalent it improves the performance of the system. The transmission issues are made obsolete by locating the DG at the end user location. The on-site power generation rather than centrally eliminates the huge investment cost, ineffectiveness and interdependencies linked with transmission and distribution.

The restructured power system environment promotes the insertion of DG in the distribution networks. The optimal allocation and type of DG contribute an essential function in the power system owing to the intensifying
concerns over the load growth, environmental issues due to the extension of the distribution system and rebate policies provided to the distribution network operators.

This work aims to optimally allocate the various types of DG systems and their combination in the radial distribution networks for minimizing real power loss occurred in the networks. The choice about the type of DG system installation in the deregulated environment is taken by the investors, which depends on the geographical location, fuel availability, transport services and climatic conditions.

The investors of developing countries like India are more anxious about the investment cost involved in the insertion of DGs. If the size of DG is large then huge investment is required for the installation of DGs in the Radial Distribution Networks (RDNs). Therefore the sizing of DGs should be the best promising minimum value such that it reduces the losses effectively in the RDNs.

The voltage at the remote end of the rural distribution feeders are greatly reduced with the poor voltage regulation due to the long length of feeders. The voltage sensitivity index is the measure of voltage deviation from the nominal value. If this index is zero, then the network performance is good. Hence, for the optimal allocation of DG systems, the voltage sensitive index of the RDN for the insertion of DG is also to be considered in addition to the real power loss reduction.

In this thesis, the optimal allocation of DG systems for real power loss minimization is carried out in the RDNs for the four types of DG systems. The four types of DG systems considered are DG supplying real power only, DG supplying both real and reactive power, DG supplying real power and consuming reactive power and DG supplying reactive power only.
In this work, the optimal allocation of single DG system is solved by using loss minimization approach and Bus Voltage Sensitivity Index (BVSI) ranking approach for all the types of DG system. The work is validated by using a 15 bus RDN, IEEE 33, and IEEE 69 RDNs. By considering the advantages of the above two methods, a new index known as Distributed Generation Sitting Index (DGSI) is framed.

For single DG placement the novel DGSI ranking method is applied for the optimal allocation of all types of DGs. To verify the efficacy of DGSI ranking method, the economic analysis and loss savings per MVA installation are carried out. This method is tested on a 15 bus, IEEE 33 and IEEE 69 RDNs. The results prove the competence of the DGSI method compared to the other methods.

In this thesis, the DGSI ranking method is extended for multiple DGs placement of all four types and their all possible combinations. The single DG placement algorithm is employed here. This methodology is applied where the DISCOs initially applied a DG system to meet the load demand, but after certain time period it is needed to insert another DG system. Due to economic reasons the location and sizing of previously installed DG system is not altered. The results show the optimum allocation of all possible combinations of DG systems for minimizing the real power loss in RDNs. For the simultaneous placement of multiple DGs, this method can’t be applicable since it produces the local optimum solution not the global optimum solution.

In this thesis, to produce the global optimum solution for simultaneous placement of multiple DGs, the Self Adaptive Differential Evolution (SADE) algorithm and Weight Improved Particle Swarm Optimization (WIPSO) algorithm are used. These algorithms use the locations of DGs found out from the single DG placement algorithm and determine the
optimum sizing of DGs for real power loss minimization in the RDNs. These methods are validated on IEEE 33 and IEEE 69 bus systems. The results found are optimal and within limits.

Thus, this research work analyses the performance of all four types of DG systems in their standalone DG placement and multiple DGs placement of all combinations. This research work compares the performances of loss minimization approach, BVSI ranking approach and a proposed novel DGSI ranking approach for single DG placement of all the four types of DG system and extends the application of DGSI ranking approach for multiple DGs placement. For simultaneous allocation of multiple DGs, SADE and WIPSO algorithms are adopted. These methods are applied on the test systems and the results show the effectiveness of the proposed methods in single DG and multiple DGs placement.