Chapter 2
Swarm-Intelligence-Based Optimal Placement and Sizing of Distributed Generation in Distribution Network:
Swarm-Intelligence-Based Distributed Generation

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ABSTRACT

In the distribution system, distributed generation (DG) are getting more important because of the electricity demands, fossil fuel depletion and environment concerns. The placement and sizing of DGs have greatly impact on the voltage stability and losses in the distribution network. In this chapter, a particle swarm optimization (PSO) algorithm has been proposed for optimal placement and sizing of DG to improve voltage stability index in the radial distribution system. The two i.e. active power and combination of active and reactive power types of DGs are proposed to realize the effect of DG integration. A specific analysis has been applied on IEEE 33 bus system radial distribution networks using MATLAB 2015a software.

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INTRODUCTION

Nowadays, distributed generation has a very significant importance in electric power generation around the world due to its techno-economic advantages. DG can be defined as a smaller generating unit closer to the load consumption point (El-Fergany, 2015a; Moses, Mbuthia, & Odero, 2012). Typically, DG can be the renewable (non-conventional) i.e. small hydro, solar, wind, wave, tidal etc. or non-renewable (conventional) energy sources. Furthermore, these resources can be found naturally, depending on the geographical factor of the location. DGs are already implemented during the early days where the electricity was generated and supplied only to the neighborhood areas. As the time goes, centralized generation takes place and the power plant generates the electricity and transmits it through a transmission line to the far customers. This is because of the technological innovation where alternate current (AC) grid is invented, allowing the electricity to be transmitted over a long distance. Differs with the direct current (DC) grid during the early days, the transmission is only applied to a small area due to the limitation on a supply voltage (Pepermans, Driesen, Haeseldonckx, Belmans, & D'haeseleer, 2005). Later, DG was discovered to have more potential values than the existing centralized generation. By changing the way on how electric power system is being operated. It creates a new technology which is more efficient and clean for the future generation. DGs also provides continuity of electricity supplies to the customer and helps in reducing the electricity demand during the peak loads because of the installation of DG on the customer site of a meter (Ackermann, Andersson, & Söder, 2001). By integrating DG into the existing system, it will improve the performance of power system in term of voltage stability and voltage profile improvement and losses reduction. However, the distribution system is designed to operate in a one-way direction, integration of DG will transform the passive network to an active network, which eventually may increase the complexities (Mahesh, Nallagownden, & Elamvazuthi, 2015). The non-optimal placement and sizing of DG causes the instability of voltage and increase the losses in the distribution system. It may violate the value of the voltage profile lower than the permitted limit. Hence, the research on this subject has been focused more on determining and analyzing the optimum placement and sizing of the DG to improve the voltage stability and reduce the power losses in the distribution system. The proposed method has been tested on an IEEE 33-bus test system using MATLAB 2015a software package.

LITERATURE REVIEW

The maximum benefits from DG can only be obtainable if it is optimally placed with correct sizing. Hence, literature studies have shown that there are several methodologies that had been used to find the optimum placement and sizing of the DG. The methods are the analytical approaches, genetic algorithm, fuzzy-GA methods, linear and non-linear programming methods etc. But, the most of the authors have focused and kept power loss reduction as an objective function. For instance, author (Gözel & Hocaoglu, 2009) presented the loss sensitivity factor depends on the equivalent current injection by using two Bus-Injection to Branch-Current (BIBC) and Branch-Current to Bus-Voltage (BCBV) matrix to obtain the optimum size and location of the DG in the distribution system. The power loss reduction remains the main objective of the study. The optimal placement and sizing of distributed generation for power loss reduction using PSO optimization algorithm has been found in (Kansal, Kumar, & Tyagi, 2013). The author in (Viral & Khatod, 2015) presented an analytical approach for allocating the optimal placement and sizing of DG in the balanced radial distribution network aiming power loss reduction in the