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Optimal Capacity, Location and Number of Distributed Generation at 20 kV Substations

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Abstract: Restructuring of the electrical industry and the impetus for using new energies has brought about the increasing applications of Distributed Generation (DG). Hence, these resources are expected to play a crucial role in near future of this industry. Installing DG units in distribution network may result in positive impacts such as, voltage profile improvement and loss reduction and negative impacts such as, the increase in the short-circuit level. These impacts depend on the exploitation methods, installation place and the capacity of these resources. Therefore, finding the optimal place and capacity of DG resources are of the crucial importance. Accordingly, this paper is aimed to find the optimal place and capacity of DG resources, in order to improve the technical parameters of network, including power losses, voltage profile and short-circuit level. Identifying the optimal number of the DG resources one of the advantages of the proposed method is which provides a balance between the number of installed DGs and the maximum technical acquirable advantages of them. Another advantage of proposed method is capability of simultaneous deciding of optimal capacity and location of a number of DGs. Genetic Algorithm is used to minimize the Objective Function and to find the best answers during the investigation. Finally, the proposed algorithm is tested on distribution network of Zanjan Province in Iran and the simulation results are presented and discussed.

Key words: DG Optimal Location, DG Optimal Size, Distributed Generation, Objective Function, Genetic Algorithm.

INTRODUCTION

DG is defined as an electrical power resource which directly connected to the network (Mohab M. Elnashar, 2009). Application of DG is increasing rapidly due to the limitations of fuel cells and the new environmental view points. In addition, the governments of the developing and under-development countries are supporting the DG for they can supply the required electrical energy of their increasing customers. Installing DGs at the network buses have a direct impact on the flowing power and the voltage of the network. This impact depends on many different factors and may be positive or negative (Koutroumpezis, 2010). The positive impacts of installing DG resources include increasing the power quality, improving the voltage profile, reducing the power loss, decreasing the requirements of installing new transmission lines and deferring the necessity of improving the capacity of substations (Gozel,, 2009; Subrahmanyam, 2009). On the other hand, the main adverse impact of installing DG is the increase in short circuit level of the network (Koutroumpezis, 2010).

The studies show that if the capacity and location of DGs are not identified appropriately, not only the network parameters are not improved, but also they are deteriorated (Mendez Quezada, 2006; Acharya, 2006). Thereby, two of the most important factors of DG plans are identifying the capacity and location of these resources (Sudipta Ghosh, 2010). The place and capacity of DGs can be decided according to the improvement of one or more parameter, in order to increase the efficiency and decrease the adverse effects of installing them. However, siting and sizing DGs, with the aim of improving a single parameter, enhances the considered parameter significantly, but may have negative impact on other parameters of the network. On the other hand, sitting and sizing DG with the purpose of enhancing some of the parameters of the network will result in improvement of the considered parameters. Considering the impacts of different parameters is an important issue, while having a multi- objective sitting and sizing. On the other hand, increasing the number of installed DGs at the network will causes some extra costs due to the DGs installing and their service costs. Hence, there should be a balance between the imposed costs and the improvement of the considered parameters of the network. This balance can be created by deciding the optimal number of DGs. Therefore, the technical parameters of the network can be improved significantly, while the imposed costs are not illogically.

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