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Optimal sizing and location of SPV (solar photovoltaic) based MLDG (multiple location distributed generator) in distribution system for loss reduction, voltage profile improvement with economical benefits

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ABSTRACT

In this paper an analytical approach is used for optimal size and location of SPV (solar photovoltaic) based MLDG (multiple location distributed generator) in primary distribution system. The main objective of this research includes power loss reduction and voltage profile improvement along with economic benefits. DGs (Distributed Generators) are placed at single location to improve the performance of the system with respect to the power loss reduction and voltage profile improvement. For further reduction of power loss and enhancement of voltage profile, the estimated optimal size of a DG at single location serve as a constraint in locating the SPV based MLDG in the primary distribution system. The proposed approach are tested exhaustively on an IEEE 33 and IEEE 69 bus systems and it is found that the power loss reduction and voltage profile improvement is 57% and 0.943908 to 0.977294 pu respectively for IEEE 33 bus system where as it is 29% and 0.94882 to 0.95727 for IEEE 69 bus system as compared to the single DG placement. Obtained results are compared with the base value and found better as compared to the other techniques. From this research, it is revealed that the placements of MLDG are more significant and economical as compared to single DG placement.

1. Introduction

The share of renewable energy based distributed generators in power system has increased drastically up to 12.5% in the last few years in the world. This renewable energy based DGs (Distributed Generators) are playing an important role in distribution system. As the penetration of DG in distribution system is increasing, it is in the best interest of all the players involved to allocate RES (Renewable Energy Sources) based system with environmental benefits. The placement of DGs at an optimal location reduces the power loss and improves the voltage profile. As the utilities are facing severe problems of high power loss and poor voltage profile particularly in developing countries, therefore it becomes necessary to place the DGs of appropriate size at optimal location. It is reported that the inappropriate selection of location and size of DG leads to greater system losses [1]. The traditional approach for placement of DGs in the network consider minimization of power loss only [2–7]. Alternatively a "2/3 rule" in power systems can be employed for placing DG units at optimal location as it is used in sitting shunt capacitors in primary distribution system. According to this rule, the power rating of DGs should be approximately 2/3 capacity of the incoming generation at approximately 2/3 length of the line [8]. This rule is applicable to uniformly distributed radial system only.

In addition, various methodologies are available in the literature for optimal placement of DGs. These techniques include analytical, intelligent like fuzzy, ANN, GA, PSO etc, [9–35] but they have placed DGs at single or multiple locations with the increased total size of DG. Further, many researchers worked on the MLDG (multiple location distributed generator) but they had not considered the size of DGs same and had added DGs at multiple location with the increasing total DG power size [9]. However, in the proposed work the constant total DG power size for placing at MLDG are considered.

In this paper a repeated load flow method is used to calculate the power losses in the system. The location of the DG is selected on the basis of power loss reduction and voltage profile improvement. SPV (solar photovoltaic) based DGs are selected for insertion at strategic locations in order to reduce the power loss and to improve

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