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Simultaneous allocation of DGs and remote controllable switches in distribution networks considering multilevel load model

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ABSTRACT

Reliability improvement and loss reduction are two important goals in optimal sizing and siting of distributed generations (DGs). Also, remote controllable switches can be utilized in distribution networks to increase the role of DGs in reliability improvement. Therefore, this paper presents a GA-based method to allocate simultaneously DGs and remote controllable switches in electric distribution networks. The goal of proposed approach is reliability improvement and energy loss reduction. The optimal sizes of distributed generators are also determined during the optimization procedure. A multilevel yearly load model is utilized to achieve the optimal solution. Numerical studies on a 33-bus distribution network show satisfactory results.

1. Introduction

DG[1] is a small generator which can operate stand-alone or in connection with distribution networks. Energy loss reduction and reliability improvement are two most important benefits of DG installation in distribution networks [1].

DGs can reduce the electrical network loss because they produce the power in the proximity of load, then it is better to allocate DG units in places where they can provide a higher loss reduction. Because DGs are so expensive, loss reduction is a very important and usual object for DGs allocation [2,3].

The other important effect of DGs on distribution networks is the improvement of network reliability. They can reduce the amount of required load shedding, the amount of interrupted load during faults and the restoration time [4]. Only those DGs can participate in improvement of network reliability and reduce the system ENS[2] that can operate in islanding mode. When a fault occurs, some switches open. In this situation some parts of distribution network are isolated and not supplied by the main grid. Islanding occurs when a portion of the network is isolated from the main system and is supplied by local DGs [5]. In islanding mode, it is necessary that DGs can maintain the voltage and frequency within their standard permissible levels, follow the load changes and stay stable in large load switching [1]. On the other side it is evident that the size of DGs has a significant role in both loss reduction and reliability improvement. Therefore the size of DGs should be optimized when they are allocated.

Optimal DG allocation to reduce the energy loss is proposed in [2,3], simultaneous loss reduction and reliability improvement is another objective function for DG allocation [4,6]. Optimal DG and recloser allocation has been proposed to improve reliability in another work [7].

When the operation of DG in islanding mode is permitted, RCS[3]s are the most important and fast tools to isolate islands from the network; therefore they have significant effects on DGs operation. Because of this, simultaneous allocation of DGs and RCSs can conclude the optimal system reliability.

Some useful algorithms have been proposed to solve the DG or RCS allocation problem. Voltage and loss sensitivity analysis [7] and GA[4] [6] are some methods have been used so far. GA is used for simultaneous allocation of switches and protective devices [8]. Immune algorithm [9], linear programming [10], ant colony [11] and simulated annealing [12] are some other methods that have been proposed to find the optimal locations for switches.

In this paper, as the main contribution of the work, a GA based algorithm is proposed to find simultaneously the optimal places and sizes of DGs and optimal locations for RCSs to minimize energy loss and ENS of the system. Because DGs are highly expensive, it is possible that the optimal selected DG cannot fulfill the peak load of the island but it can supply the island load in the most portion of the year. Therefore a multilevel load is considered and it is shown that a multilevel load model can lead to a more beneficial result.

Test cases on a 33 bus network with good results illustrate the idea.

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[1] Distributed generation.
[2] Energy not supplied.
[3] Remote controllable switches.
[4] Genetic algorithm.

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