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Maximal optimal benefits of distributed generation using genetic algorithms

A.A. Abou El-Ela [a], S.M. Allam [a], M.M. Shatla [b,*]

[a] Electrical Engineering Department, Faculty of Engineering, Menoufiya University, Egypt
[b] West Delta Regional Control Center, Egyptian Electricity Transmission Co., Egypt

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ABSTRACT

Recently, the distributed power generation (DG) takes more attention, because of the constraints on the traditional power generation besides the great development in the DG technologies. To accommodate this new type of generation, the existing network should be utilized and developed in an optimal manner. This paper presents an optimal proposed approach (OPA) to determine the optimal sitting and sizing of DG with multi-system constraints to achieve a single or multi-objectives using genetic algorithm (GA). The linear programming (LP) is used not only to confirm the optimization results obtained by GA but also to investigate the influences of varying ratings and locations of DG on the objective functions. A real section of the West Delta sub-transmission network, as a part of Egypt network, is used to test the capability of the OPA. The results demonstrate that the proper sitting and sizing of DG are important to improve the voltage profile, increase the spinning reserve, reduce the power flows in critical lines and reduce the system power losses.

1. Introduction

1.1. General

The Electric Power Research Institute (EPRI) indicates that by 2010, 25% of the new generation will be distributed; and a study by the Natural Gas Foundation concluded that this figure could be as high as 30% [1].

1.2. DG definition, issues and benefits

1.2.1. DG definition

The Electric Power Research Institute defines DG as generation from 'a few kilowatts up to 50 MW' [1].

In Refs. [1–4], a large number of terms and definitions is used in relation to DG.

In general, DG can be defined as electric power generation within distribution networks or on the customer side of the network [1].

1.2.2. DG major policy issues

DG major policy issues can be summarized as:

- High financial costs; relatively has high capital costs per kW-installed power of DG compared to large central plants.
- System frequency deviations; the installations of DG increases the burden on the system operator to maintain the system frequency.
- Less choice between more costly primary fuels; most DG technologies are based on gas.
- Voltage deviations; the connection of DG has a significant influence on the local voltage level; Ref. [5] discussed the impact of DG on the voltage profiles.
- Change in power flows; an increased share of DG units may induce power flows from the low voltage into the medium-voltage grid.
- Bi-directional power flows; make it difficult to tune the protection systems in the grid.
- Lower reactive power; medium-sized and especially small DG technologies often use asynchronous generators. These units are not capable of providing reactive power.
- Higher harmonics; some DG technologies produce direct current. Thus, these units have to be connected to the grid via a DC–AC interface, which may contribute to higher harmonics.

* Corresponding author. Tel.: +20 482293266.
E-mail address: engshatla1@yahoo.com (M.M. Shatla).

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