ABSTRACT

Presence of the distributed generation (DG) in electric systems can represent a significant impact on the operational characteristics of distribution networks. The optimal placement and sizing of generation units on the distribution network has been continuously studied in order to achieve different aims.

In this paper our aim would be optimal distributed generation allocation for voltage profile improvement, loss and Total harmonic Distortion (THD) reduction in distribution network. Harmony Search Algorithm (HSA) was used as the solving tool, which referring two determined aim; the problem is defined and objective function is introduced according to losses, security and THD indices. The applied fast harmonic load flow method is based on the equivalent current injection that uses the bus-injection to branch-current (BIBC) and branch-current to bus-voltage (BCBV) matrices which were developed based on the topological structure of the distribution systems. This method is executed on 12 bus harmonic unbalanced distribution system and show robustness of this method in optimal and fast placement of DG, efficiency for improvement of voltage profile, reduction of power losses, and THD.

Index Terms—Unbalanced radial distribution network, harmonic load flow, power losses, Total harmonic Distortion (THD), Harmony Search algorithm (HSA), optimal placement

1. INTRODUCTION

Distributed Generation is an electric power source connected directly to the distribution network or on the customer site of the meter. Before installing distributed generation, its effects on voltage profile, line losses, short circuit current, amounts of injected harmonic and reliability must be evaluated separately. The planning of the electric system with the presence of DG requires the definition of several factors, such as: the best technology to be used, the number and the capacity of the units, the best location, the type of network connection, etc. The impact of DG in system operating characteristics, such as electric losses, voltage profile, stability, total harmonic distortion and reliability needs to be appropriately evaluated. The problem of DG allocation and sizing is of great importance. The installation of DG units at non-optimal places can result in an increase in system losses, implying in an increase in costs and, therefore, having an effect opposite to the desired. For that reason, the use of an optimization method capable of indicating the best solution for a given distribution network can be very useful for the system planning engineer. The selection of the best places for installation and the preferable size of the DG units in large distribution systems is a complex combinatorial optimization problem. DGs include technical, economical, regulatory, and possibly environmental challenges. As in the majority of planning process, a cost function is normally constructed to represent the overall operating and investment costs of a distribution planning area. Engineering parameters such as capacity, reliability, power losses, voltage regulation, power quality, load demand, are associated with the operation and investment. A general procedure for determining the optimal DG location therefore becomes necessary so as to ensure that their effects on distribution systems are positive, that they minimize electrical grid losses and they maintain an acceptable voltage profile [1].

Several optimization techniques have been applied to DG placement, such as genetic algorithm [6], tabu search [7], heuristic algorithms [8, 9] and analytical based methods [10]. In all of optimization techniques it must be considered that distribution networks are radial and its R:X ratio is very high. And also due to unbalance, distribution network matrices are ill conditioned and conventional load flow methods based on Gauss–Siedel and Newton–Raphson techniques are inefficient in solving such networks. Because of this drawback, Teng [11] presents a three-phase backward/forward procedure. In recent years several efforts have been done to optimize and replace the tradition power systems with new power systems by renewing their structure. The studies conducted by EPRI show that the distribution generation will reach to %25 by year 2010. The most advantage of DG is proximity to consumer which results decreasing costs of transfer and distribution. Employing the optimal allocation of DG in electricity network brings many advantages. But the improper allocation causes many problems in the network, such as: increasing losses,