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A Comprehensive Distributed Generation Planning Optimization with Load Models

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Abstract— In this paper a comprehensive model for Distribution Systems Planning (DSP) in the case of using Distributed Generation (DG), with regard to load models is provided. Proposed model optimizes size and location of the distributed generation. This model can optimize investment cost in distributed generation better than other solutions. It minimizes the operating costs and total cost of the system losses. This Model affects the optimum location and size of the distributed generation in distribution systems significantly. Simulation studies based on a new multiobjective evolutionary algorithm is achieved. It is important that in the analysis made in this paper, DG is introduced as a key element in solving the DSP. Moreover, the proposed method easily and with little development can satisfy the other goals.

Index Terms— Economic Analysis, Distributed Generation, Distribution Systems Planning, Load Models.

1 INTRODUCTION

Distribution Companies (DISCOs) should apply new strategies in order to increase economic power generation (because of load growth) and giving services to customers and not being remained behind in market competition of electrical power. By using of new alternatives, these goals are available for solution of planning problem of distribution system in addition to traditional ones.

The load growth value is predicted in traditional options so that it may reach to a certain level. Then, a new capacity shall be added to the given system. By considering new electrical substations or via expanding the capacity of the existing substations through new feeder, such a new capacity will be obtained by both of them [1], [2]. One of the new options to planning for increase in capacity is Distributed Generation. DG may lower total costs in the system, decrease load flow within system, and improve voltage profile [3], [4], and leading to decreased system losses [3]-[5], relieving the heavy loaded feeders and increase lifetime of equipments [6].

From [7]-[10], a perfect revision is carried out on load models which are applicable to load flow and dynamic studies. Such studies are conducted on frequency or voltage dependent load models.

During recent years, the studies on evolutionary algorithms have shown that these methods have not many of previous problems [11]. In general, these methods may obtain multiple pareto optimal solutions in one single run.

This paper suggests using of DG by DISCOs, as a new economic tool for Distribution System Planning (DSP) Problem. The proposed approach makes decision on DG optimal location and size and the optimized power which should inject through distribution system. The derived results from this model may be used for bill estimation of customers of Distribution Company. Two comprehensive scenarios will be discussed to cover various probabilities. Similarly, in this paper, the effect of load models on DG location and size planning optimization has been argued. We will see that load models considerably affect on planning for location and size of DG within distribution networks. Also, an approach is given to solve the problem which is based on Strength Pareto Evolutionary Algorithm (SPEA).

2 DISTRIBUTION SYSTEM PLANNING MODEL

In the case of load growth in power electricity market, DISCO has two options to meet such demand.

1- Scenario A: Purchasing the required extra power from main grid and extending the existing substations in distribution network. At this scenario, DISCO has to develop the existing substations by installation of new transformers and upgrading some existing feeders' capacities if they have not sufficient thermal capacity, and purchasing power from the main grid.

2- Scenario B: Investment on DG as an alternative candidate option for solving the DSP problem and purchase power from main grid and extending of the existing substation.

A. Model Formulation

This paper aims to minimize the investment and operating costs of DG, reduction of active and reactive losses, improvement in voltage profile and relieving the heavy loaded feeders. It also conducts study about impact of voltage dependent load models, namely, residential, industrial and commercial load models within different scenarios of planning. Load models are defined as follows.

$$P_i = P_{0i}\left|V_i\right|^{\alpha} \;/\; Q_i = Q_{0i}\left|V_i\right|^{\beta} \qquad (1)$$