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Allocation and sizing of distribution transformers and feeders for optimal planning of MV/LV distribution networks using optimal integrated biogeography based optimization method

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ABSTRACT

Optimization techniques have got much attention for solving complex problems related to different fields. Most of the planning researches deal with primary and secondary distribution systems separately because of complexity of both. This may lead to a local minimum for each but not a global minimum for both. In this paper, we try to reach the global minimum of joined primary and secondary distribution systems planning problem, which is essentially more complicated than planning each of them separately. To overcome such complexity, biogeography-based optimization (BBO) is employed in this work. BBO is a new technique for problem solving, developed by Dan Simon and has attracted wide attention in the last years. BBO is not a reproductive technique and this makes it distinguished from other strategies. Besides, BBO solutions can last or "survive" forever and are modified directly via migration from other solutions, so that BBO solutions directly share their features with other solutions. All of those above mentioned features of BBO algorithm may prove that it can perform efficiently for solving optimization problems and that it might be able to provide better performance compared to other optimization algorithms. In this paper, BBO is employed for solving the problem of optimal planning of a distribution system (OPDS) including both medium voltage (MV) and low voltage (LV) networks and based on uniform or non-uniform load density, where a planning procedure is employed iteratively to find the optimal location and rating of distribution transformers and substations, as well as the type and route of MV and LV feeders. The results are compared with genetic algorithm (GA) and particle swarm optimization (PSO), which indicate that BBO provides better performance in all cases.

1. Introduction

Distribution systems planning is considered as one of the most important issues in electric power engineering. A distribution system comprises low voltage (LV) and medium voltage (MV) networks. The aim of LV network planning process is to determine the location and size of distribution transformers and LV conductors, such that their capital cost in addition to the line losses cost are minimized. By the same token, the aim of MV network planning process is to determine the location and size of distribution substations and MV feeders, such that the capital cost in addition to the line losses cost are minimized. System reliability indices, such as SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index), also need to be minimized during the planning procedure. Some planning constraints and limitations need to be satisfied during the planning process. These constraints include the bus voltage level (voltage drop) and actual feeder current which need to be maintained within their acceptable standard ranges.

Optimal planning of distribution systems (OPDS) aims to minimize an objective function composed of the line losses cost, system reliability cost, and investment cost, with the bus voltage and feeder current, as constraints, maintained within their standard acceptable ranges. Since the planning problem is extremely complex, non-linear and discrete, this leads to the importance of employing optimization methods which can deal efficiently with discrete and nonlinear objective functions. In this paper, a discrete model for distribution system cost function is applied to represent the cost of distribution system elements/components as the continuous model severely decreases the solution accuracy. The discrete cost function model is employed in only a few researches in the literature [3,12].

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