ISSN 2229-5518

Distributed Generation Planning Optimization Using Multiobjective Evolutionary Algorithms

Mahmood Sheidaee, Mohsen Kalantar

Abstract— In this paper, a method to determine the size - location of Distributed Generations (DGs) in distribution systems based on multi objective performance index is provided considering load models. We will see that load models affect the location and the optimized size of Distributed Generations in distributed systems significantly. The simulation studies are also done based on a new multi objective evolutionary algorithm. The proposed method has a mechanism to keep the diversity to overcome the premature convergence and the other problems. A hierarchical clustering algorithm is used to provide a manageable and representative Pareto set for decision maker. In addition, fuzzy set theory is used to extract the best solution. Comparing this method with the other methods shows the superiority of proposed method. Furthermore, this method can easily satisfy other purposes with little development and extension.

Index Terms— Distributed generation, Distribution systems, Load models, Strength Pareto Evolutionary Algorithm.

1 Introduction

Optimization was used to reconstruct electricity industry and looked for the best location for distributed products. Development in technology and client requirements to have cheap electric power and reliable one caused more motivation in distributed generation .Discussion about reliability and maintaining prevent the penetration of DG resources in the distribution systems.

In [1] one approach was described based on genetic algorithm for multistage planning of distribution systems optimizations. In this work, it's expressed as a mathematical model and algorithmic one and also tested with real systems. In [2] – [5], it was studied on load models that are usable for power flow and dynamic studies. This study was done on load models depended on frequency or voltage. During the recent years, studies on evolutionary algorithm have shown that these methods don't have the difficulties of classical methods. In principle, multiple Pareto optimal solutions can be found in one single run.

This paper has discussed on load model effects in location and size planning and distributed generation optimization. We can see that the load models affect on location and size planning of DGs in distribution network. For the purpose of studying on load models, its delivered location and size planning for single DG, its assumed that the regarded DG has enough capacity. The proposed method is general and it can be used for case of multiple DG in the network with increasing some variables.

This paper also suggested a new Strength Pareto Evolutionary Algorithm (SPEA) based approach for solving the problem. The diversity-preserving mechanism embedded in the search algorithm makes it effective in exploring the problem space and capable of finding widely different solutions. A hierarchical clustering technique is implemented to provide a representative and manageable Parto-optimal set. Also, a fuzzy-based mechanism has used the best solution for extraction.

2 Load Models And Impact Indices

To determine different load model effects on distributed generation planning, 37-bus distribution system will be studied (appendix 1)[7]. The effect of load models depends on voltage, means residential, industrial and commercial, will be studied in different planning scenarios. Load model defined as followed.

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

Where P_i and Q_i are active and reactive power at bus i, P_{0i} and Q_{0i} are active and reactive power operating point in bus I, V_i is voltage in bus i and α and β are active and reactive power exponents. In a constant power model conventionally used in power flow studied $\alpha = \beta = 0$ is assumed. The values of the real and reactive exponents used in the present paper for industrial, residential and commercial loads are given in Table 1 [7].

TABLE 1
EXPONENT VALUES

Load Type	α	β
Constant	0	0
Industrial	0.18	6.00
Residential	0.92	4.04
Commercial	1.51	3.40

During studying residential, it's assumed that 38-bus systems just has residential load. It's assumed that for industrial and commercial load, all loads are a kind of industrial and commercial. In real situations, loads aren't exactly residential, commercial and industrial, so the mixture load class should be foreseen for distribution system. There are different ideas for studying DG effects in distribution systems .One of this idea is different