A probabilistic methodology for distributed generation location in isolated electrical service area

H.M. Khodr*, Marco R. Silva, Zita Vale, Carlos Ramos

GECAD – Knowledge Engineering and Decision-Support Research Center of the Polytechnic Institute of Porto (ISEP/IPP), Rua Dr. António Bernardino de Almeida 431, 4200-072 Porto, Portugal

A R T I C L E   I N F O

Article info
Received 16 April 2008
Received in revised form 21 May 2009
Accepted 4 October 2009
Available online 1 November 2009

Keywords:
Distributed generation
Probabilistic methodology
Source location

A B S T R A C T

Distributed generation unlike centralized electrical generation aims to generate electrical energy on small scale as near as possible to load centers, interchanging electric power with the network. This work presents a probabilistic methodology conceived to assist the electric system planning engineers in the selection of the distributed generation location, taking into account the hourly load changes or the daily load cycle. The hourly load centers, for each of the different hourly load scenarios, are calculated deterministically. These location points, properly weighted according to their load magnitude, are used to calculate the best fit probability distribution. This distribution is used to determine the maximum likelihood perimeter of the area where each source distributed generation point should preferably be located by the planning engineers. This takes into account, for example, the availability and the cost of the land lots, which are factors of special relevance in urban areas, as well as several obstacles important for the final selection of the candidates of the distributed generation points. The proposed methodology has been applied to a realistic case, assuming three different bivariate probability distributions: the Gaussian distribution, a bivariate version of Freund’s exponential distribution and the Weibull probability distribution. The methodology algorithm has been programmed in MATLAB. Results are presented and discussed for the application of the methodology to a realistic case and demonstrate the ability of the proposed methodology for efficiently handling the determination of the best location of the distributed generation and their corresponding distribution networks.

1. Introduction

Distributed generation (DG) represents a change in the paradigm of electrical energy generation. The emergence of new technological alternatives (photovoltaic systems, wind power, cogeneration, etc.) allows to generate part of the required energy closer to the places of consumption, improving quality levels and minimizing the investments costs associated with of transmission and distribution systems [1]. In general terms, the development of DG plants aims at improving environmental aspects and quality of energy (uninterrupted provision of electrical energy with suitable voltage level, current, frequency, amongst others) [1–3]. These generation types can benefit from a decision-support tool able to assist decision making in the scope of a project of installation of DG plants. In a first stage, a programming tool determines the location of the DG point’s candidates. After this, we can proceed to optimize the capacities, number of units and technology to be implemented.

The objective of this research work is determining the region of higher probability for location of DG plants that will feed the loads under study. These loads have been previously estimated [4–6].

In order to determine the region of greater probability for location of DG plants, a probabilistic methodology, previously used for the optimal location of electric substations, will be adapted [7,8]. To achieve this objective, three distribution probability functions are used: normal, Freund’s bivariate exponential distribution and Weibull. The obtained solution must fulfill the parameters of reliability and electrical power quality for the study developed in this work. It should be noticed that this methodology considers the fact that the load center for a group of consumers varies with time [7].

The decision of the location of DG plants is a crucial aspect in the model, with a strong impact on the operation and investment costs.

In [9] an algorithm using primal-dual interior point method for solving non-linear optimal power flow problems was proposed. The main purpose is to optimize location and sizing of DG on distributed systems for solving the problem of line loss reduction. Most of the benefits of employing DG in existing distribution networks have both economic and technical implications and they are interrelated.