Electric Power Systems Research 80 (2010) 196–203

Contents lists available at ScienceDirect

Electric Power Systems Research

journal homepage: www.elsevier.com/locate/epsr

An optimization planning technique for Suez Canal Network in Egypt

A.A. Abou El-Ela, A.A. El-Zeftawy, S.M. Allam, Gasir M. Atta*

Electrical Engineering Dept., Faculty of Eng., Shebin El-Kom, Egypt

ARTICLE INFO

Article history:
Received 17 October 2007
Received in revised form 19 April 2009
Accepted 1 September 2009
Available online 13 November 2009

Keywords:
Transmission system planning
Wind energy systems
Reliability
Artificial neural network (ANN) technique
Optimization techniques

ABSTRACT

This paper introduces a proposed optimization technique POT for predicting the peak load demand and planning of transmission line systems. Many of traditional methods have been presented for long-term load forecasting of electrical power systems. But, the results of these methods are approximated. Therefore, the artificial neural network (ANN) technique for long-term peak load forecasting is modified and discussed as a modern technique in long-term load forecasting. The modified technique is applied on the Egyptian electrical network dependent on its historical data to predict the electrical peak load demand forecasting up to year 2017. This technique is compared with extrapolation of trend curves as a traditional method. The POT is applied also to obtain the optimal planning of transmission lines for the 220 kV of Suez Canal Network (SCN) using the ANN technique. The minimization of the transmission network costs are considered as an objective function, while the transmission lines (TL) planning constraints are satisfied. Zafarana site on the Red Sea coast is considered as an optimal site for installing big wind farm (WF) units in Egypt. So, the POT is applied to plan both the peak load and the electrical transmission of SCN with and without considering WF to develop the impact of WF units on the electrical transmission system of Egypt, considering the reliability constraints which were taken as a separate model in the previous techniques. The application on SCN shows the capability and the efficiently of the proposed techniques to obtain the predicting peak load demand and the optimal planning of transmission lines of SCN up to year 2017.

1. Introduction

The basic principal of electrical transmission systems (ETS) planning is to minimize the network construction and operational costs to satisfy the requirement of delivering electric power in safety and reliability modes from generation units to the load centers [1]. ETS design problems consist of a set of choosing candidate circuits, that should be built in order to minimize the investment and operational costs, and to supply the forecasted demand a long a planning horizon [2]. ETS planning addresses the problem of broadening and strengthening an existing transmission network to optimally serve a growing electricity market to minimize the objective function, subject to performance, quality, physical, reliability, and logical constraints. This planning must be capable to meet the needs of future optimum generation and load conditions [3]. Numbers of ETS planning techniques have been studied and analyzed to apply the suitable one for planning ETS. These techniques are,

1. Heuristic planning technique, that finds wide applications and gives a good design scheme but based on experience of the analyzer [4].
2. Mathematical planning optimization techniques, they handle correctly the complex nature of the cost function. Most of these techniques have developed approximate cost functions to make their exploitation as follow,
   - Mixed integer-linear programming, the non-linear part of the running costs is approximated by number of linear segments. This technique is not practical for solving large systems [5].
   - Non-linear continuous function, which has a complex non-linear cost function and also is not practical for solving large systems [6].
   - Linear function approximation, it is the simplest and most possible approximated functions used to simulate the cost function of the existing and proposing line. It is developed to solve real life planning problems with several thousands of variables and constraint equations consuming reasonable computation time [7].

The cost function and its constraint equations must be represented by some variables like current, power, and voltage. As the system reliability means a system design incorporating more redundancy, an optimum and economic analysis is required to minimize the amount of investment required to realize the system reliability [8]. A high level reliability means to decrease the cost of loss revenue and more transmission lines to be added to the network, this will increase the investment

* Corresponding author.
E-mail address: gasser_tamer@yahoo.com (G.M. Atta).

0378-7796/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.epsr.2009.09.001