Electrical Power and Energy Systems 33 (2011) 17–27

Contents lists available at ScienceDirect

Electrical Power and Energy Systems

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

Monthly electricity demand forecasting based on a weighted evolving fuzzy neural network approach

Pei-Chann Chang [a,*], Chin-Yuan Fan [b], Jyun-Jie Lin [a]

[a] Department of Information Management, Yuan Ze University, Taoyuan 32026, Taiwan, ROC
[b] Department of Industrial Engineering and Management, Yuan Ze University, Taoyuan 32026, Taiwan, ROC

A R T I C L E I N F O

Article history:
Received 29 January 2009
Received in revised form 24 June 2010
Accepted 13 August 2010

Keywords:
Neural networks
Fuzzy neural networks
Electricity demand forecasting
Genetic algorithms
Energy management

A B S T R A C T

This research develops a weighted evolving fuzzy neural network for monthly electricity demand forecasting in Taiwan. This study modifies the evolving fuzzy neural network framework (EFuNN framework) by adopting a weighted factor to calculate the importance of each factor among the different rules. In addition, an exponential transfer function ($\exp(-D)$) is employed to transfer the distance of any two factors to the value of similarity among different rules, thus a different rule clustering method is developed accordingly. Seven factors identified by the Taiwan Power Company will affect the power consumption in Taiwan. These seven factors will be inputted into the WEFuNN to forecast the electricity demand of the future. The historical data will be used to train the WEFuNN. After training, the trained model will forecast the future electricity demands. Finally, the WEFuNN model is compared with other approaches, which are proposed in the literature. The experimental results reveal that the MAPE for WEFuNN model is 6.43% which is better than the MAPE value for other approaches. Thus, the WEFuNN model is more accurate in forecasting the monthly electricity demand than the other approaches. In summary, the WEFuNN model can be practically applied as an electricity demand forecasting tool in Taiwan.

1. Introduction

The depletion of the natural resources has become a pressing issue all over the world. It is impossible to revive the natural resources and the development of alternative source of energy is not good enough to implement. Thus, the efficient use of available resources is mandatory.

Electricity is one of the main types of energy. Fossil-fuel based electricity generation is the most widely used method of electricity generation. Thus, electricity generation is not only exhausting the natural resources but also polluting our environment. It is impossible to stop the usage electricity immediately but it is important to use the electricity efficiently. A major step in efficient management of power systems is sound capacity planning, scheduling and operation of power systems. A key point for capacity planning and scheduling is the knowledge of future electricity demand distribution. It is difficult to forecast electricity demand because the demand series contain unpredicted trends, high noise levels and we have to consider exogenous variables. Although the demand forecasting is difficult to implement, the need and relevance of forecasting the electricity demand has become a much-discussed issue in the recent years. This has led to the development of various new tools and methods of forecasting in the last two decades. In the past, straight line extrapolations of historical energy consumption trends served well. However, with the emergence of alternative energies and technologies (in energy supply and end-use), fluctuating economic inflation, rapidly rising energy prices, industrial developments, global warming issues, etc., it has become imperative to use modeling techniques which capture the effect of factors such as average air pressure, average temperature, average wind velocity, rainfall, rainy time, average relative humidity, daylight time and technological variables. To address these problems, a weighted evolving fuzzy neural network for the electricity demand forecasting of Taiwan has been developed and tested in this paper to provide monthly predictions.

The rest of the paper is organized as follows. In Section 2, various forecasting tools applied for electricity demand forecasting are surveyed. Section 3 gives an introduction of the electricity demand problem in Taiwan. Then, we present a WEFuNN model in Section 4 to resolve this problem. We apply the Taguchi method in Section 5 to determine the best combination of parameters for WEFuNN. In Section 6, an experimental test is conducted to determine the effectiveness of the proposed model in terms of mean average percentage error (MAPE). MAPE values of various approaches are compared in this section. Finally, the conclusion drawn from the experimental results are summarized in Section 7.

* Corresponding author. Tel.: +886 3 4638909; fax: +886 3 4638884.
E-mail address: iepchang@saturn.yzu.edu.tw (P.-C. Chang).

0142-0615/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ijepes.2010.08.008