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Modelling of unsuppressed electrical demand forecasting in Iraq for long term

Nooriya A. Mohammed [a, b]

[a] University of Erlangen-Nürnberg, Germany
[b] Planning and Studies Office, Ministry of Electricity, Iraq

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ABSTRACT

One of the main obstacles to Iraq's economic and social development is the lack of reliable electricity supply. In recent years there has been a significant increase in grid-based electricity capacity, but it is still far from being sufficient to meet demand growth. Therefore, it is necessary to build a suitable and flexible forecasting model for this energy system. In this paper, the results of two models are compared to other previous studies of Iraq's energy system to provide the yearly unsuppressed load forecast in the long term. The relationship between the actual load supply and four sets of historical data: population, gross national product, consumer price index and temperature, is examined. The result shows that a reduction in the prediction of electricity demand including suppressed demand occurs when increasing the growth of the consumer price index and removing the war affect. The suppressed consumer demand is estimated by developing a heuristic algorithm and the impact of the reserve margin and load diversity factor is considered to obtain the final forecast. The main contribution of this paper integrates various factors, after rebuilding the lost information, and includes the influence of relevant independent variables, each one for a given weight.

1. Introduction

Load demand forecasts are very important to plan the power system that delivers economic and reliable electric energy. In general, the economic factors and the change in climatic variables will have a direct impact on the demand pattern. Then, the accuracy of demand forecasting influences the reliable supply to face future demand growth. Based on the forecast, electric utilities coordinate their resources to meet the actual demand using a cost-effective plan. In the case of Iraq, the electricity supply fluctuated in the last three decades. Between 1991 and 2003, the supply dropped as a result of wars and economic sanctions [1]. The gap between electricity supply and demand has expanded after that date for two reasons: deterioration of security conditions and high growth in demand. Such events pose a very challenging task for Iraq energy forecasters and planners considering a long-term horizon. The main problem in this paper starts when we try to develop an accurate load forecasting model. In the previous years, there exist no econometric models for electricity demand forecasting in Iraq which could be used as a basis to develop a suitable model. In the same token, the available data are not always reliable, and with a little quantitative of data are not sufficient to provide a good model with different techniques, such as a time series approach or others. The models should be able to deal with qualitative data. Therefore, under these circumstances, the fundamental step is to rebuild and correct these available data. It may happen that considering generation a suitable data, instead of deterministic data, will lead the model to better and more robust results. Then, the corrected data are used to investigate two different econometric models: the linear logarithmic and nonlinear ANN approach. During the analysis of the factors that have an impact on the growth in supply to face the high growth in demand of the electric system, it was found that the weights of these impact factors are not identical with other countries that face the same challenges. This could be deduced from research works in the published literature, such as in Sri Lanka, where the shortage in supply occurred as a result of a growth in economic factors. Therefore, it used the econometric models to estimate the impacts of income and the price elasticities on the prediction of the electricity demand [2]. A large variety of forecasting techniques have been proposed in energy planning in the past two decades, which are [3] classified into three main

E-mail addresses: nooria.abed@gmail.com, nuria.mohammed10@yahoo.com.

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Nomenclature

LS	Load Supply
GNP	Gross National Product
CPI	Consumer Price Index
POI	Population of Iraq
MTP	Maximum Tem-Perature
DV	Dummy Variable
ε	Error of the model
α	Constant term
β	Coefficients of regression
R^2	Coefficient of determination
R_A^2	Adjusted R2
EA	Energy Agency
ANN	Artificial Neural Network
OLS	Ordinary Least-Square

categories: the traditional models & approaches, artificial intelligent models & approaches and Support Vector Regression (SVR) models. The data selection to analyse the demand forecasting model depends on the technique that was used, the scale time to forecast (short, medium and long run) and the availability of the statistical system information. In Ref. [4], it was confirmed that the forecasting accuracy depends not only on the numerical efficiency of the employed algorithms, but also on the quality of the analysed data and the ability to incorporate important exogenous factors into the model. In Ref. [5] the load forecasting techniques in three major groups were presented: the Traditional Forecasting Technique, Modified Traditional Technique and Soft Computing Technique. In Ref. [6] it was shown that, although the GDP is still the most important factor for electricity demand, electricity demand is negatively related to structural changes and efficiency improvement. By using a macroeconomic technique, a long-run electricity demand model was developed in order to analyse the main factors affecting electricity demand in the People's Republic of China (PRC). In 2006 [7], was using an econometric method to forecast the electricity demand of Venezuela over a long term. In this paper, an econometric methodology is used to forecast the electricity demand for the consuming sectors by analysing the stationarity of the data, carrying out a co-integrating analysis and using the error correction model. The results showed the evolution of the explanatory variables and the forecasting of the Venezuelan electricity demand.

In Ref. [8], a forecasting model was developed by using a linear logarithmic model and historical data of electricity consumption, GDP, GDP per capita and population, that influence the annual electricity consumption. In Ref. [9], the focus was on three different time scales using Artificial Neural Networks (ANNs) with linear modelling techniques for modelling and forecasting the electricity demand. In Ref. [10], the rule-based forecasting procedure was used, in order to improve and increase the forecasting accuracy in comparison to the traditional time series model ARIMA. The results showed that the improvement will depend on the conditions of the data, the knowledge development and validation. In order to forecast the future projection of the electricity load demand in India for the long run [11], used eleven input variables for two methods. The ANNs methodology depended on using Principal Components (PCs), then a comparison was made with multiple linear regression (based on original data and the principal components) and ANNs with original data as input variables. The results showed that the use of ANNs with PCs is more effective. In Ref. [12], a novel forecasting procedure was presented that improves these approaches and is able to combine long and short-term features by employing temporal disaggregation techniques. The conclusion from these studies in literature is that the econometric approaches are broadly used for medium- and long-term load forecasting and a well-known method, which are used for analysing statically the relationship between load demand electricity and describing variables to build an accurate forecasting model. It is also clear that the traditional multiple regression technique is the most widely used to predict the load electricity that is affected by exogenous factors, especially economic growth-related variables in the long term. These studies revealed acceptable results of the econometric regression method. Furthermore, the ANN models are considered more accurate than other nonlinear methods. Where a comparison of the results has been done by some authors, which have reported a performance of ANN forecasting methodologies, then that is at least as good as conventional linear parameterisations. In literature, by using different methods we can forecast the load of the power system, however the amount and quality of previous data and the variables which they need to forecast, make them different in terms of accuracy from case to case. As [13] confirmed, the ANN techniques can achieve better performance to handle complex, nonlinear problems, however in our study the results show that the ANN method failed to provide accurate forecasting. In contrast [14], presented the modelling approach for long-term electricity demand forecasting, via the application of ordinal regression analysis. The annual forecasts of electricity demand in the Greek power system are provided for the years 2016–2025. The Gross Domestic Product (GDP) has been identified as the greatest influential parameter in the evolution of electricity demand. Then, the innovation that had to be developed in this paper is how to cope with quality issues of the data that are available in Iraq, in order to build an accurate forecasting model. In this model new variables are presented as inputs and then the engineers and economic facts are provided that led to these innovations. In addition, the fundamental aim of this study is to investigate the validity of the prediction model and its performance when it is compared to the actual data and the prediction which has been presented by the EA [15]. The EA provided more complex forecasts for the Iraqi electricity demand, which assumed multiple scenarios. In a central scenario it is assumed that the consumption growth averages more than 6.5% per year over the period 2010–2035, responding to an economic growth, population growth and the closing of the gap between demand and available supply. The assumption is based on the expectation of the consumption growth in the industry sector, residential sector and service. The procedures analysing linear and nonlinear models are used to explain the effects of the economic and social environment, in order to get model to have more flexibility to update the data, and are also used to prepare long-term load forecast.

It explains, firstly, that the strengths and weaknesses of the forecasting linear model formulation depend on the available data with low quality, and then describes the results of the model with data before and after corrections. Then, by adopting the correction data as an input for two models, the linear and nonlinear (ANN), it estimates the basic load forecasting. After that, a heuristic algorithm is used to estimate the consumer suppressed demand by using five sets of data, ranging from 1988 to 2013 and representing the annual electricity consumption by residential, commercial, industrial, agricultural and governmental sectors. It is expressed as a percentage of the actual annual maximum peak load. In addition, it implies an adequate reserve margin to insure the stability of the electrical system. Then, it adjusts the outputs of the load forecast model by adding the diversity factor. The final results which show the validation model of planning the load forecast, are described in Table 7.