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LOAD DISTRIBUTION ANALYSIS FOR BLACK SEA REGION IN TURKEY

Emel Onal
Istanbul Technical University, Electrical Engineering Dep. Maslak, Istanbul, Turkey
e-mail:eonal@itu.edu.tr

Abstract: *In this study, the short term load estimate of the free consumer industrial zone in the provinces of Samsun, Çorum, Sinop, Ordu, Amasya in the Black Sea Region is estimated and the peak load energy consumption values of April 14 -April 20, 2014 is estimated. Simple regression analysis and moving average models which are usual methods for estimation have used, also artificial neural networks have used which has increased significantly in recent years in the Prophet program, which is prepared by the MA & Fraunhofer Institute, and which has many applications in different fields. Actual load values for year 2014 are entered in the input values. It has been determined that the artificial neural networks have been applied with the help of the Prophet program, the results are closer to the true values. Absolute success is calculated for all methods.*
Keywords: *Load forecasting, Neural Network Analysis, Short term load, Moving average model.*

1. INTRODUCTION

It can be said that there are two main factors in the planning and installation of electrical energy systems. The first is qualification and the second is safety. Qualification the expansion of electric power systems to meet future electric energy needs and peak loads, the provision of transmissions and safety can be explained by preventing the collapse of the system and the collapse of the chain of failure that will come to any breakdown system. One of the most important steps and the first step of the above criteria is load estimation. Same time, the load forecast for the electricity sector is to provide energy balance one day ahead of the proposals submitted by participating in the "Day Ahead Market" by anticipating the amount of energy that will be consumed by the companies after a day. The changes made in the Electricity Market Balancing and Settlement Regulation from the Pre-Day Plan to the Day-Ahead Market on December 1, 2011 are far more than a necessity for the participating companies to make very good forecasts of electricity demand, and they have turned the company's profit / loss statement into important influences. The planning of the energy system requires the handling of the load estimate separately for different time periods. The work started in 2006 with regard to the load forecast was first carried out monthly and yearly, and now the hourly application is started [1-3]. Load estimates are made by dividing into sub periods, long term, middle term, short term and very short term. Short-term load estimations can be made from one hour to a one-month period. The short-term load estimate is used in the preparation of the production programs of the production units and in the control of the maintenance programs. The generation and disconnection of the generators is determined by short term load estimation. Short-term load forecasting is a great advantage in terms of load sharing among power plants, determination of the most suitable unit and economic operation. In general, the short-term load estimates are tried to predict in real time the peak load values in the load curve. As a result of the great importance of the operation of energy systems, the accuracy of short-term load forecasting is also of great importance. In this study, it is compared with artificial neural networks method with short term load estimation problem. For this, a 24-hour algorithm is chosen from the hourly, monthly and yearly time periods in the Prophet program that the Fraunhofer Institute had prepared. The reason for the use of artificial neural networks is their ability to make generalizations, especially in the solution of nonlinear problems, from the limited number of values used for the performance and training they show compared to traditional methods. In this study one-week load forecast is made with artificial neural networks by using actual power data of 2014 for the free consumer industrial zone in the cities of Samsun, Corum, Sinop, Ordu, Amasya provinces and districts.

2. FEATURES OF LOAD CURVE

Before constructing a correct load estimation model, the load characteristic of the region to be estimated should be investigated and the factors influencing the load should be investigated. When estimating the load, it is important to consider which group the consumer is involved in. Electricity consumption and load characteristics of different groups of consumers are different. In order to be able to examine the characteristics of the loads, it is necessary to classify them as follows. 1. Residential loads 2. Commercial loads 3. Industrial loads 4. Agricultural irrigation 5. Lighting 6. Other loads. Due to the fact that the industrial load can be regarded as the basic loads with little change depending on the weather conditions, weather conditions are not used as input. The burden of the free consumer zone in the Black Sea Region of Samsun, Corum, Sinop, Ordu, Amasya and the provinces where the load forecast is to be carried out is investigated over a period of 1 week.
In Figure 1, a weekly load curve starting from April 7, 2004 to April 14, 2004 is given. For a weekly load, the load on weekdays is higher than the load on the weekend. The times are lower than the other days, the hours that correspond to the weekends. In Figure 2, we can observe 5 days' load changes starting on Monday and continuing on Friday. There is a difference on weekdays when social activities are at a higher level than at the end of the week. Looking back on Monday and Fridays, it seems that these days are affected by the closing of the weekends and that electricity consumption is lower than on other work days (Tuesday, Wednesday, Thursday). It is understood that Monday, Friday, Saturday, Sunday and other work days should be classified separately. Figure 3 which the industrial zone load curve for one year, runs from June 1, 2013 to June 1, 2014.

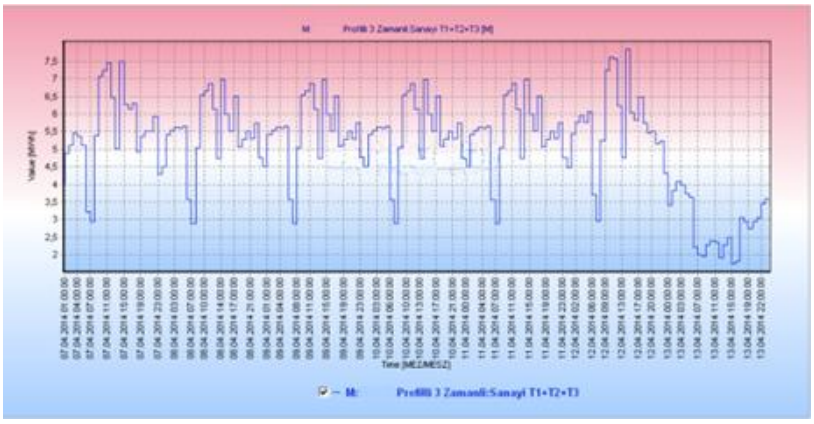

Figure 1. The weekly (weekdays + weekend) load curve of the industrial zone which is a free consumer in the provinces of Samsun, Corum, Sinop, Ordu, Amasya (MW/h)

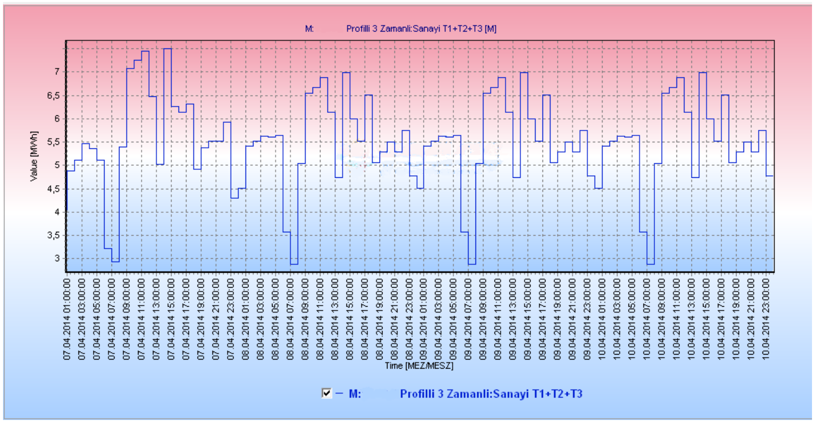

Figure 2. The weekdays load curve (MW/ h) of the industrial zone which is the free consumer in the provinces of Samsun, Corum, Sinop, Ordu, Amasya

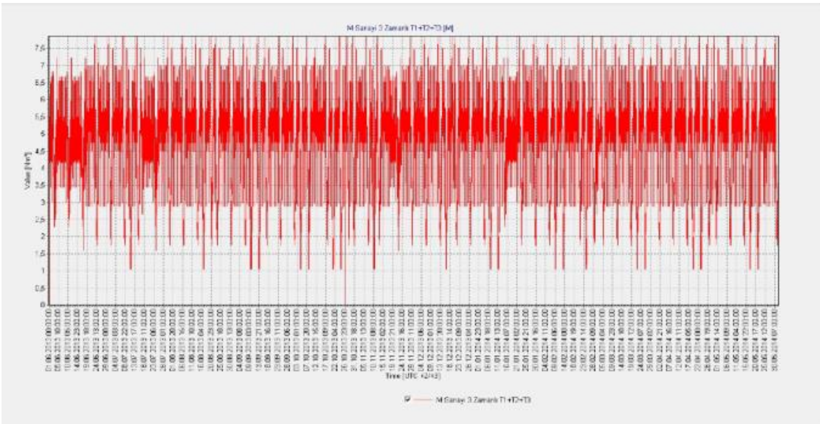

Figure 3. The yearly load curve (MW/ h) of the industrial zone which is the free consumer in the provinces of Samsun, Corum, Sinop, Ordu, Amasya

3. LOAD FORECASTING MODELS

The short-term load forecast has increased the importance of planning and operating the energy system. The most commonly used methods for short-term load estimation are regression analysis, time series, Box Jenkins models and derivatives (Autoregressive Model, AR, Moving Average Models, MA Mixed Autoregressive-Moving Average Models, ARMA), fuzzy logic and artificial neural network methods [4-6]. In order to compare the effectiveness of the artificial neural network method in the problem of short term load estimation, simple regression method and moving average method are used in statistical estimation methods and estimations are made with moving average method (MA). In the created regression model and the moving average method, as in the artificial neural networks, only the consumption data is used as the input. Simple regression is used for the 5-day load change that starts from Monday and continues until Friday, while moving average method is used for Saturday and Sunday.

$$Y = a + bX \quad (1)$$

$$\sum Y_i X_i = a \sum X_i + b \sum X_i^2 \qquad a=0,\ b=1.003 \quad (2)$$

By solving the equations (1) and (2) by looking at the total consumption of Tuesday and Wednesday for the weekdays, and the hourly values are solved by the coefficients a, b for each hour [7-8]. When the coefficients *a* and *b* are substituted in the power equation (6), the load forecast values for 5 days for 24 hours are found. The Moving Average method (MA) is used to set the estimate value for days in the MA weekend. The results of the estimation of the short-term load estimates obtained from the estimation methods starting from April 14, 2014 to April 20, 2014 are shown in Figure 4.

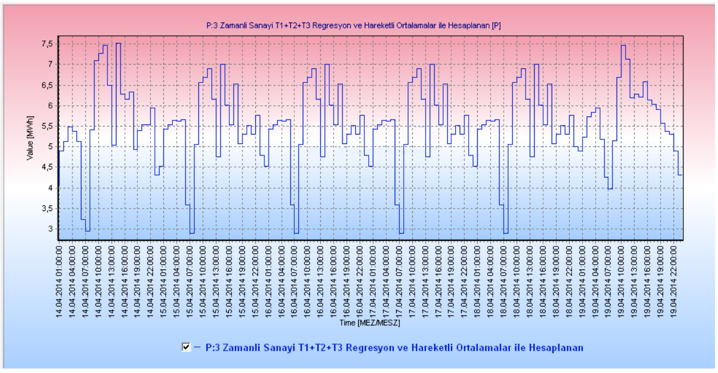

Figure 4. Estimated load curve by regression and MA method of industrial zone which is free consumer in Samsun, Corum, Sinop, Ordu, Amasya provinces and districts (MW/h)

4. THE RESULTS FOUND WITH BY USING NEURAL NETWORK

In this study, Ariprog artificial neural network of Prophet program which is an artificial neural network model with multi-layered, forward feed, which is an educational learning, is used for short term load estimation. The entrance of the network is similar to the day of the day that corresponds to the day of the exit of the network. Since the load estimation problem is also not linear, the network to be used must be a multi-layer artificial neural network. The artificial neural network takes the power of computing and information processing from its parallel distributed structure, the ability to learn and generalize. Generalization is defined as the generation of appropriate responses by the artificial neural network model for entries not encountered during the training or learning process. These superior features demonstrate the ability of the artificial neural network analysis (NNA) to solve complex problems. Linear non-learning is preferred because of its features such as generalization, adaptability, fault tolerance hardware, speed analysis and design simplicity. The flow diagram followed during the artificial neural network planning in the Prophet program prepared by the Fraunhofer Institution is shown in Figure 5.

After performing data analysis on the artificial neural network flow diagram for short term load estimation, the necessary calendar model is created. When data are analyzed on Monday and Friday, it is observed that these days are affected by the closing of the weekends and that electricity consumption is lower than other working days (Tuesday, Wednesday, Thursday). Therefore, the calendar day to be used for the artificial neural network is determined from the previous day itself, but it can be constructed as the calendar model 3111177 to be used in the artificial neural network by looking at the weekend of the week before the weekend. For the study of artificial neural network, 1- year consumption data of 2014 year of industrial zone which is free consumer in Samsun, Corum, Sinop, Ordu, Amasya provinces and provinces has been transferred into the program as time series entered in the program. After the calendar model entered the program, the prediction method ArifProg artificial neural network is used.

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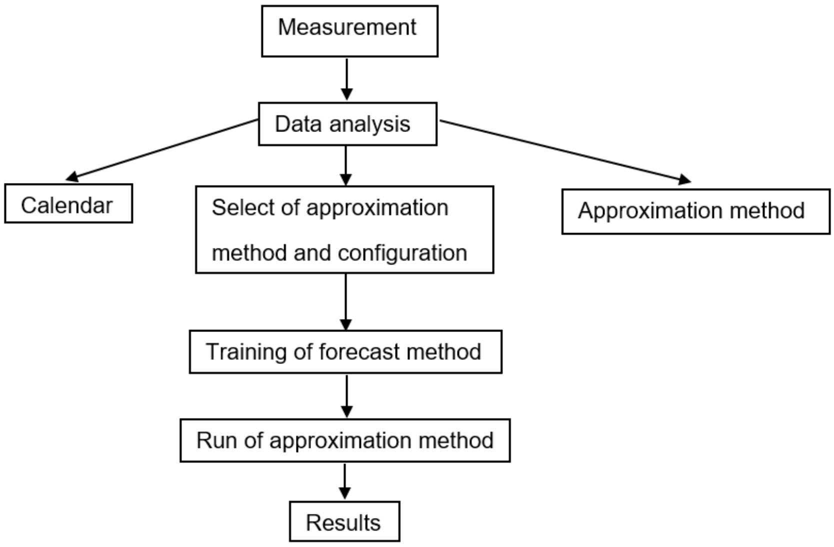

Figure 5. Flow diagram of artificial neural network in Prophet program

A model entry consists of one or more intermediate and one output layer. All the processing elements in a layer depend on all the processing elements in a top layer. No information processing is performed at the entry layer. The number of processing elements in this area depends entirely on the number of input problems. The number of elements in the output layer is again determined based on the applied probing. In artificial neural networks, a network is shown as an entry and it is also reported how it will produce a result as input (educational learning). Inputs are applied to the input layer, processed in the intermediate layers, and outputs are obtained from the output layer. According to the training algorithm used, the error between the network output and the desired output is propagated backwards, changing the weights of the network to the error minimum. When entering 1-year consumption data as input in the program, the estimated print time series is specified as output. The program is first verified that the prediction method is executed by selecting training time prediction method and then validating it by one-tenth of the training time interval. Estimation results using the artificial neural network are printed in the exit time series as shown in Figure 6.

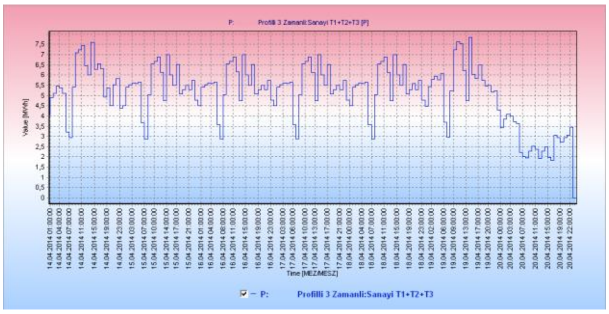

Figure 6. Samsun, Corum, Sinop, Ordu, Amasya provinces and districts of the free consumer industrial zone of the NNA estimating load curve (MW/h)

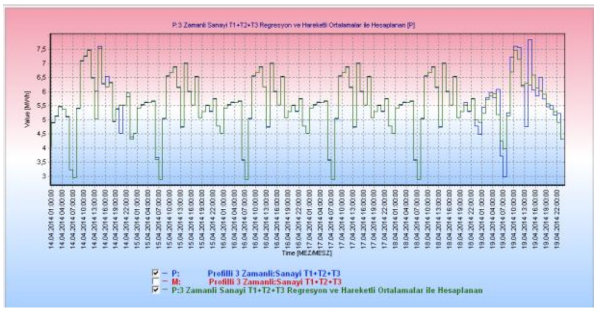

Figure 7. Both 24-hour day-to-day load curves of real values as well as the result of both the regression method moving average method

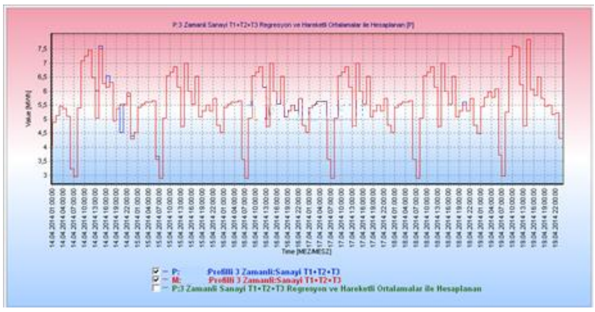

Figure 8. Both artificial neural network method results and 24-hour daily load curves of real values

Table 1. Absolute success percentage of neural networks and MA prediction models

Date	The regression method and MA method	ANM
	Absolute success percentage	Absolute success percentage
14.04.2014 00:00	92.99	94.99
15.04.2014 00:00	95.99	94.99
16.04.2014 00:00	91.80	97.63
17.04.2014 00:00	94.65	94.27
18.04.2014 00:00	92.12	92.37
19.04.2014 00:00	79.76	82.55
20.04.2014 00:00	75.34	95.80

5. CONCLUSION

For the short-term load estimation, both the regression and moving average method and the Prophet program are estimated by using the time series files from the conventional estimation methods. The program for simulation uses one data file as input. After the training set is identified and edited, all inputs and outputs are presented to the network and applied to the artificial neural network inputs. At the end of the training, the weights on the net are determined. The artificial neural network model developed for short term load estimation is applied in the prepared Prophet program. Because real power values for the year 2014 are known, tests were made for days from April 14, 2014 to April 20. The same tests are also conducted with the regression analysis method and moving average methods to control the availability of the artificial neural network method. For the visual expression of the results, the 24-hour daily load curves of both the regression method, the moving average method, and the actual values obtained from the artificial neural network method results of the tested days are given on the same graphs. (Figure 7 and Figure 8) When all the graphs are examined, it is seen that the result of artificial neural network method is closer to real values than the result of regression method and moving average method. The same conclusion can also be drawn when the percentages of absolute successes given to the table are examined (Table 1). In this study, it is shown that the artificial neural network method can be applied to short term load estimation problem. In order to demonstrate the superiority of the method over traditional methods, the comparison is made by the regression method and the moving average method.

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