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# TIME SERIES FORECASTING THE ELECTRICITY CONSUMPTION IN TURKISH REPUBLIC OF NORTHERN CYPRUS (TRNC)

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## ABSTRACT

*The time series method has been employed to develop electricity consumption models in TRNC. Utilizing only the historical electricity consumption, five different models were developed and evaluated. It was found that the simple regression estimation method of the linear trend model was the best model amongst all the others developed in this study. The results indicated that this model has a strong predictive ability and could be used to forecast short-term future annual electricity consumption.*

## 1. INTRODUCTION

Modeling electrical demand and consumption patterns and the dependence on other relevant variables, such as; economic, demographic, climatic, etc., is usually based on historical consumption figures. There are various load forecasting methods such as:

- Time series
- End-use and,
- Econometric methods.

The simple time series method is based on the extrapolation of historical patterns in demand or energy consumption patterns. This method is simple, yet reasonably accurate and it is easy to understand. This method assumes that historical electricity consumption is the only factor that affects current electricity consumption. The main disadvantage of this method is that it ignores effects that other parameters may exert on the electricity consumption. Thus, it is rarely accepted as the basis for a long-term (i.e., ten to 30 years) load forecast by many administrative bodies. On the other hand, the end-use method is based on complete enumeration of all energy-using devices. For the end-use method, consumption and demand data by the end-use, number of customers, consumption per-end use and future appliance trends are all required in order to develop consumption and demand models based on the end-use method. This method requires a large amount of data that is difficult and expensive to collect.

The econometric method investigates the underlying relationship between energy consumption and the economic environment. Local historical consumption, demand and economic data are required for econometric models. Though this method is widely accepted, computationally it is burdensome and requires a large, accurate historical database and some results have to be subjectively interpreted. Further details of load forecasting methods can be found in [1]

The supply and demand of electrical energy in TRNC is continuously tracked by the local state run utility company, KIB-TEK. Currently KIB-TEK is simply following the consumer demand. The

main goal of KIB-TEK is to meet customer load without any ability to control energy consumption. Rising costs and high rate load growth are some factors adversely affecting electric utilities of developing countries. Electricity consumption models are required for a variety of utility activities. KIB-TEK needs accurate estimations of power requirements for effective and efficient planning of future supply.

A large number of studies have been published [2-10] on electrical demand and energy consumption models. The main objective of this study is to produce a simple, reasonably accurate annual electricity consumption models using historical energy consumption data.

## 2. METHODS

### 2.1 Sources of data

For the period of 1988-2002, the values of annual electricity consumption (E) were obtained from KIB-TEK reports published annually [11, 12]. Figure 1 represents the annual electricity consumption. Through the period 1988-2002 there has been a continuous increase in electricity consumption, with exceptions in 1994 and 2001. Investigating the data for 1994 and 2001, revealed that while there was a reduction in power supplied by the S. Cyprus in 1994 in 2001 there was an economic recession.

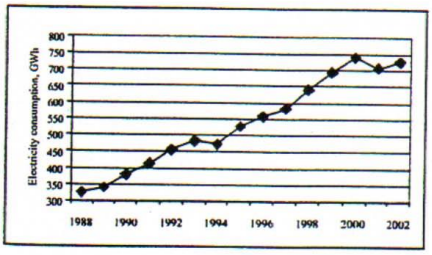


Figure 1. Electricity consumption in TRNC

### 2.2 Description of the modeling tecniques

A flow chart of processes, leading to evaluation of forecast based on the time series forecast model, is illustrated in Fig. 2. The two time series models are the linear trend model and the autoregressive trend model. There are no rules for preferring either of the models. The general form of the linear trend model is:

$$E_t = a + b\,t \qquad (1)$$

Where t is the time, $E_t$ is the energy consumption at that time, $a$ and $b$ are unknown parameters. The two possible methods for estimating $a$ and $b$ are the simple average method and the simple regression method. Each of these methods provide similar estimates of $a$ and $b$. However, the simple regression method should be used if more rigorous model evaluation is required.

Regarding to the autoregressive trend model, the general form is:

$$E_t = a + b\,E_{t-1} \qquad (2)$$

In the autoregressive trend model the current consumption value is based only on electricity consumption acquired in the previous interval. The unknown parameters $a$ and $b$ must be estimated. Three different methods are employed in this study to estimate the unknown parameters under the autoregressive trend model. These are: the straight average rate method, the compound average rate method, and the simple regression method. As with a linear trend model, the simple regression method should be used if more rigorous model evaluation is required. Further details of the models and the methods used to derive estimates of the unknown parameters $a$ and $b$ can be found in [1].

## 3. RESULTS AND DISCUSSION

The unknown parameters $a$ and $b$ for each method are estimated. The five models developed may be numbered as; 1) the simple average method 2) the simple regression method of the linear trend model, 3) the straight average rate method,

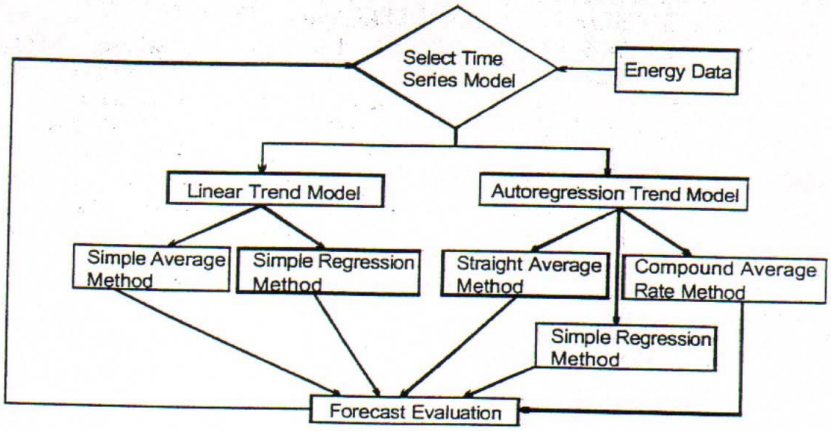


Figure-2. The Time Series Model

4) the compound average rate method, and 5) the simple regression method of the autoregression trend model. The estimates of the unknown parameters for each method and the $R^2$ values of simple regression models are presented in Table 1. Figure 3 plots the historical predicted values from the models against actual values of electricity consumption for the period studied.

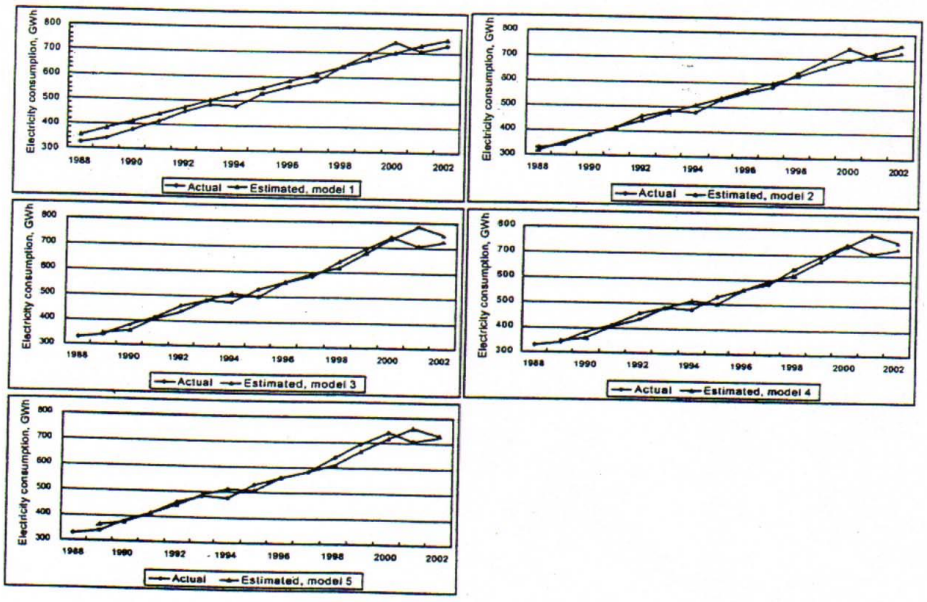


Figure 3. Actual and predicted electricity consumption in TRNC

Though all of the developed models are adequate, the historical predicted value from model 2 and 5 and the actual values lie closer to each other compared to other models. Furthermore $R^2$ value of the simple regression method of the linear trend model (i.e., model 2) is higher then the $R^2$ value of the simple regression method of the autoregressive trend model (i.e., model 5) so the final time series model is as follows:

$$E_t = 285.18 + 31.315\,t \qquad (3)$$

Table 1. Energy consumption model summary

| Model | a | b | $R^2$ |
|---|---|---|---|
| 1 | 325.6 | 28.575 | - |
| 2 | 285.18 | 31.315 | 0.97729 |
| 3 | 0 | 1.059929 | - |
| 4 | 0 | 1.058913 | - |
| 5 | 46.762 | 0.965165 | 0.96598 |

## 4. CONCLUSIONS

In the present study five different time series methods have been tested for effectiveness in forecasting future electricity consumption. The results suggested that model 2 can be used to estimate the future annual electricity consumption in TRNC. The graphical evaluation method and the $R^2$ statistics are used to evaluate the appropriateness of the developed models.

The effectiveness of model 2 can only be accurately evaluated after the data for the forecast period becomes available.

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