Advances and Applications in Mathematical Sciences
Volume 22, Issue 1, November 2022, Pages 71-78

FORECASTING ELECTRICITY CONSUMPTION IN INDIA BY USING UNIVARIATE TIME-SERIES ANALYSIS

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Abstract

Modelling electricity expenditure is useful in outlining of production and dissemination by electricity power expenditure. Analysis of Univariate time-series has been utilized for modelling and forecasting domestic electricity consumption in India. We compare a different statistical forecasting model to predict the electricity demand in India using univariate data from 1990 to 2017. In this study, Autoregressive integrated moving average (ARIMA), Error, Trend and Seasonality (ETS), Holt, Simple Exponential Smoothing (SES) models are discussed. The best fitted model for the given data is obtained by least error value of the model. From the results, ARIMA (0,2,1) is best model to fit the time series data with minimum error value of 1.42. In terms of the Minimum error value, the Mean Absolute Percentage Error (MAPE) value from four models above is 1.42%, 1.55%, 1.67%, and 7.11%, respectively, which indicates high accuracy. In conclusion, India's electricity consumption will continue to increase for the next ten years (2018-2027).

I. Introduction

Electric energy is a very needful in this advanced world. Power supply empowers better public health and financial development. Economically Developing countries face difficulties in planning the power grid infrastructure to needed to support quickly developing metropolitan populations. In any case, there are numerous techniques that add to the forecast of future electric energy demand [6].

2020 Mathematics Subject Classification: 90B50; 91B84; 62M10.

Keywords: Electricity Forecasting, Univariate Data, Time-series Analysis, India, ARIMA.

Received March 1, 2022; Accepted July 4, 2022

Demand forecasts are required for the extension, control and planning of power systems. The forecasts help in deciding the ideal mix of creating limits and which the mechanism to operate in a given period, in order to limit cost and guaranteed supply in any event, when nearby failures may happen in the power system [1]. A Study by [2] depicts a way to deal with get suitable models for predicting monthly petroleum gas utilization of residentials. Karthika, et al., [7] compared the various forecasting model to forecast monthly electricity consumption in Tamil Nadu, India.

Volkan S. et al., [11] summarize that the ARIMA forecasting of the complete elementary electricity demand gives off an impression of being more solid than that of the summation of the individual predictions. For forecasting electricity demand, The ARIMA and SARIMA models can productively be utilized. Bashirahamad [3] conclude Time series models are productive when contrasted with underlying models since demonstrating and forecasts can be efficiently done. The significance of this modelling is that similar information can be design with various periodic patterns which if there should be an occurrence of primary model are monotonous errand. Salifu Katara et al., [10] compared the various ARIMA models to predict private business and Industrial electric energy demand in Tamale.

Catik, et al., [4] evaluate inflation forecasting accuracy of alternative time series models. Heizer et al., [5] shows that there are seven essential steps strides in predication process, which are decide the utilization of the prediction, select the thing to be predict, decide the time horizon of the prediction, select the prediction methods, assemble the historical data essential to make the forecast, approve and carry out the outcome. Pappas, et al., [9] introduced the classical methodology, to forecast the electric energy demand. Various ARIMA models developed and in this way the criteria "Akaike Information Criterion: AIC, Akaike Information Criterion corrected value (AICc), and Bayesian Information Criterion: BIC" utilized to clarify the one. Taylor, et al., [6] analyzed the exactness of various univariate techniques for short-term electric energy demand forecasting for lead times as long as a day ahead. Mucuk et al., [8] forecasted the elementary electric energy demand in Turkey for the year from 2007 to 2015 by utilizing the Box-Jenkins strategy. In this study, we compared the various Univariate forecasting methods to forecast the electric energy consumption in India.

II. Data and Methodology

The data were collected from International Energy Agency (IEA) for years 1990 to 2017, totally 28 years. The data analysis was performed using four methodologies, ARIMA, ETS, Holt Method and Simple Exponential Method.

1. ARIMA Model. A class of statistical models for investigating and predicting historical data is an ARIMA model. It takes into account a setup of standard steps in time series historical data, and as such gives a powerful method for making capable time series predicts [9]. Its order is generally identified as (p, d, q),

here p - The order of the autoregressive part,

d - The number of times of difference,

q- The order of the moving average part.

To utilize this model, first, Autocorrelation Function (ACF) and Augmented Dickey Fuller (ADF) tests are used for testing the stationarity of the time series data. After the stationarity test, the most appropriate ARIMA model for forecasting is identified as ARIMA (0, 2, 1) with MAPE value 1.4260. Figure 1 shows the forecast values from this model.

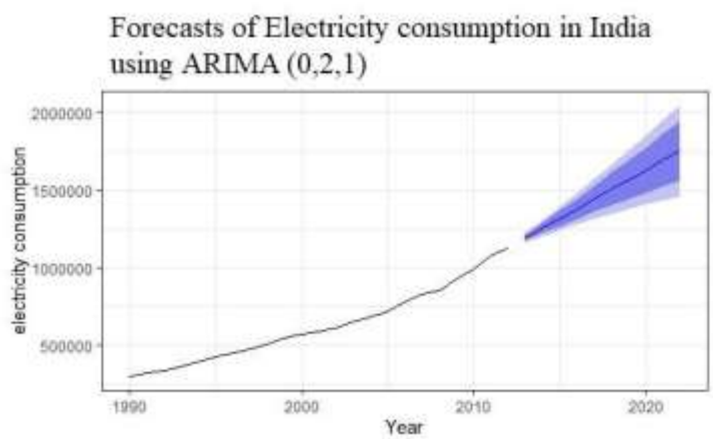

Figure 1. Forecasts of Electricity demand in India using ARIMA (0,2,1) Model.

2. ETS

ETS is a period arrangement determining a strategy for univariate data that can be reached out to help information with a deliberate pattern or occasional part. Outstanding smoothing anticipating techniques are comparative in that an expectation is a weighted amount of past perceptions, yet the model unequivocally utilizes a dramatically diminishing load for past perceptions. In particular, past perceptions are weighted with a mathematically diminishing proportion [7]. ETS model alluding to the unequivocal displaying of Error, Trend, and Seasonality. In this paper, we use ETS model with a multiplicative pattern to conjecture ten years of Electricity utilization with value of MAPE 1.5501. In figure 2 forecasts from ETS model is shown.

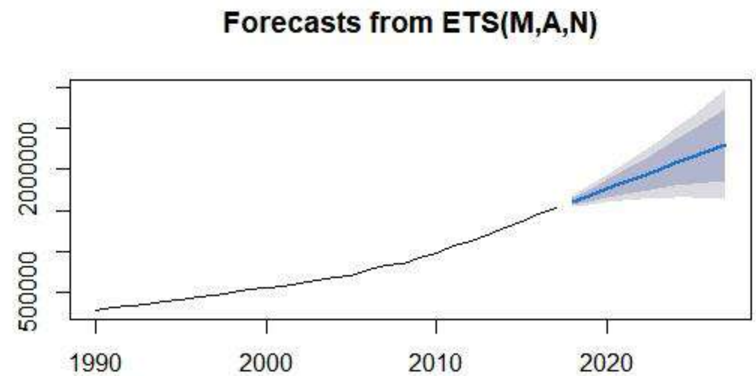

Figure 2. Forecasts of Electricity demand in India using ETS.

3. Holt's Model

This model is a famous smoothing model for anticipating information with pattern. It has three conditions to create a last figure. The first condition is an essential condition for smoothing the parameters that gives changes the final period's pattern. The pattern is revived as times goes on during that time condition, it is communicated as the difference among the last two qualities. The last condition is utilized to create the last figure. This model uses two boundaries, first one is for the general smoothing and second one is for the pattern smoothing condition. Double Exponential Smoothing is another name for this model. Figure 3 depicts the results from Holt's model.

In this paper, we utilize Holt’s technique to predict ten years of Electricity utilization with MAPE value 1.6703.

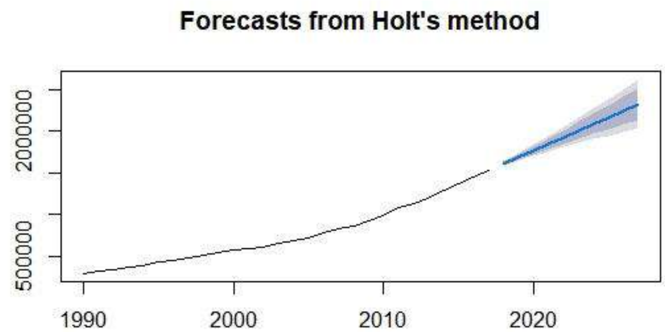

Figure 3. Forecasts of Electricity demand in India using Holt’s Model.

4. Simple Exponential Smoothing

This model is a univariate time series forecasting method for univariate time series data without a pattern. This model needs a singular limit, smoothing coefficient. It gives the rate of the perceptions at prior time steps exponentially. α is set to an incentive some place in the range of (0,1). Enormous qualities imply that the model gives essentially on the most recent insights, though more modest characteristics mean a more prominent measure of the set of experiences is viewed as when making an assumption. Figure 4 shows the forecast values of the SES model. In this paper, we use SES to predict ten years of Electricity utilization with MAPE value 7.1143.

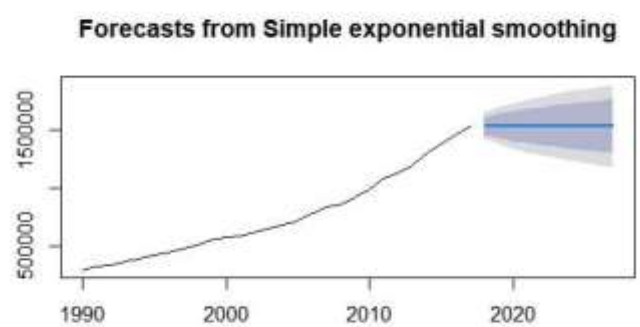

Figure 4. Forecasts of Electricity demand in India using Simple Exponential Smoothing model.

III. Results

The Mean Absolute Percentage error, AIC, AICc, and BIC from the over three techniques are thought about in Table 1. The outcomes demonstrated that the error minimization ability of the ARIMA model with MAPE value of 1.4260, which outperforms the other three methodologies, ETS 1.55, Holt's Model 1.6703 and SES 7.1143 separately. It clearly shows that, for the univariate time series data, ARIMA (0,2,1) model gives accurate prediction for electricity demand forecasting for next ten years in India. Table 2, shows the forecasted value from 2018 to 2027 of electric energy demand in India, which indicates the increasing trend in electricity consumption in India.

Table 1. Comparison of Errors from four Different forecasting Models.

	MAPE	AIC	AICc	BIC
ARIMA	1.4260	579.34	579.86	581.85
ETS	1.5501	633.30	636.03	639.97
Holt	1.6703	641.22	643.95	647.89
SES	7.1143	710.89	711.80	714.80

Table 2. Forecast Values of electricity consumption in India using ARIMA (0,2,1).

Year	Forecast value of electricity consumption
2018	1608454
2019	1686271
2020	1764087
2021	1841904
2022	1919720
2023	1997537
2024	2075353
2025	2153170

2026	2230986
2027	2308803

IV. Conclusion

ARIMA, ETS, Holt's model and Simple Exponential Smoothing are three methodologies used to predict the univariate time series data from 1990 to 2017. These four methodologies are compared to predict the yearly electricity power consumption in India for next ten years (2018-2028). These prediction model gives the MAPE value of 1.42%, 1.55%, 1.67%, and 7.11%, respectively. Finally, we conclude that from the results we got from these models, that the ARIMA indicated that the ARIMA (0, 2, 1) is the best model to predict the given time series data with minimum MAPE value of 1.42.

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