Research Journal of Applied Sciences, Engineering and Technology 3(3): 149-152, 2011
ISSN: 2040-7467

Received: April 23, 2010 Accepted: May 14, 2010 Published: March 30, 2011

Electric Power Demand Forecasting: A Case Study of Lucknow City

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Abstract: The study of forecasting identifies the urgent need for special attention in evolving effective energy policies to alleviate an energy famine in the near future. Since power demand is increasing day by day in entire world and it is also one of the fundamental infrastructure input for the development, its prospects and availability sets significant constraints on the socio-economic growth of every person as well as every country. A care full long-term power plan is imperative for the development of power sector. This need assumes more importance in the state of Uttar Pradesh where the demand for electrical energy is growing at a rapid pace. This study analyses the requirement of electricity with respect to the future population for the major forms of energy in the Lucknow city in Uttar Pradesh state of India. A model consisting of significant key energy indicators have been used for the estimation. Model wherever required refined in the second stage to remove the effect of auto-correlation. The accuracy of the model has been checked using standard statistical techniques and validated against the past data by testing for 'expost' forecast accuracy.

Key words: Energy forecasting, energy modeling, power demand

INTRODUCTION

The crucial issue of managing the demand is of a great importance in formulating the future development policy for the whole country. Since Electricity is one of the necessities in the ordinary business of life, and a major driving force for economic growth and development. The unstorable nature of electricity means that the supply of electricity must be always available to satisfy the growing demand. Since the commission of power plants and the transmission may take between five to seven years, and power purchase from another source is limited, it is imperative that the power development plan must be well conceived. Inevitably, a reliable medium and long run load forecasts are prerequisites for a well-conceived power development plan. An under forecasted load leads to an under expanded power system which leads to the black out of power system. On the other hand, an over forecasted load leads to an over expanded power system.

In this case, the unnecessary costs are passed on to the power consumers through a higher power tariff.

There are several factors that affect electricity demand. The key factors are electricity price, number of electricity appliances, income, temperature, and consumer load pattern that differ by regions and consumer groups (Bansal, 2005; Yee, 2011). A reliable load forecast methodology must "correctly" gauge the effects of the key factors on electricity demand. The electricity demand, which includes public lighting, will be forecasted by customer groups (Thailand Long-Term Load Forecasts, 2006).

On the other hand, utilization hours for electric power generation equipments has continued to drop since 2000 and will continue to decline in 2008, according to predictions of the Power Grid Corporation, De-rated output operation or even shutting down units of power generation during low demand periods not only increases energy consumption, but also affects equipment life span and is overall uneconomical.

Uttar Pradesh is a state located in the northern part of India with a population of over 19 million people and an area of 93,933 sq mile (243,286 km²). It is India's most populous state, as well as the world's most populous sub-national entity. The demand of power is increasing day by day in our daily life. So forecasting of power is very important for the future. The State was having deficit in power supply of -12.6% of total demand in June 2007 while in June 2008 it was having the deficit of -13.7% (District Profile, 2009; Central Electricity Authority of India, 2008) In another way transmission and distribution losses in 2002-03 was 36.64% and in 2005-06 it was 37.17% of the total power supply in the state (UPPCL report, 2009).

As per the 2001 Indian Census, (Census of India, 2001) Lucknow had a population of 22,66,933; and in 1991 it was 19,13,166. The percentage level of the

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city with respect to the total population of U.P. was 2.22 in 2001 and 2.09 in 1991 and also having 10th position rank wise in 1991. The maximum temperature during summer season is between 40 and 45ºC (District Profile, 2009; Central Electricity Authority of India, 2008).

This study has studied the electric power demand forecast in 2023 corresponding to the city temperature with respect to the population in the Lucknow City which is the capital of "Uttar Pradesh" state of India (Bhardwaj, 2010). Few research papers are written with respect to the population (Sharma, 2002) as well as temperature of the particular areas individually (Barakat, 1992).

MATERIALS AND METHODS

A power load survey was carried out from "ETI Transmission Sub-station" situated in west side of the Lucknow City, which is having in coming from the Grid. The survey was carried out in the month of June 2008. Estimate of population is based on the based data available as per the 2001 Indian Census also data available from the survey was taken as material of the forecasting.

Single exponential smoothing technique is used in the process of forecasting because the error found in this process was under the acceptable limit of accuracy.

Population calculation and load survey of Lucknow city:

Population calculation: Growth rate is essential value to find the population in a specified year based on a particular time. The time frame can be defined between the standard base year and final year with respect to the time span of 9 months. Following formula can be suggested for growth rate calculation (Bhardwaj, 2009).

$$N = B[\{(100+G)/100\}^{T}-1] \quad (1)$$

where,
N = Net increase in population between 2001 and 1991
B = Base year value of 1991
G = Growth rate
T = Total period between 2001 and 1991

So, growth rate = 1.28 %

Since the correct data of 2008 is not available, so in this particular calculation we will take 2001 value as base year value and time span between 2001 and 2008 i.e., 9.34. The population in 2008 will be 25, 52,877 using the relation = $B\{(100+G)/100\}^{T}$.

In the similar calculation 32, 91,914 will be the population in 2023. In the case of 2023 we have also taken the base year value of 2001 and time periods between 2001 and 2023.

Load survey: The Loads are taken from 220 kV sides of the transformers. As per the practical survey of Lucknow in the month of June 2008 following results are presented in Fig. 1.

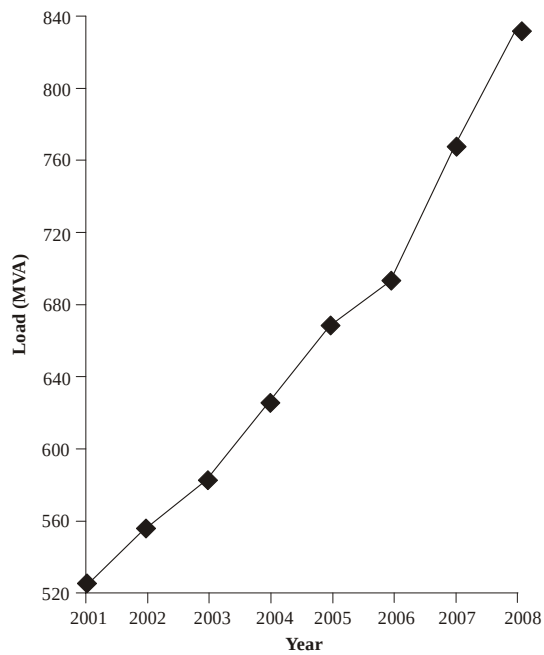

Fig. 1: Lucknow total load 2001-2008

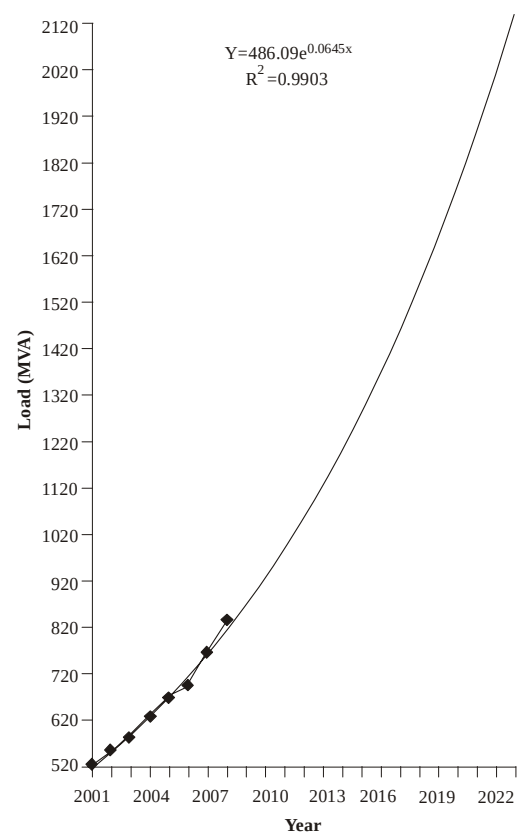

Fig. 2: Lucknow forecast trend for 2023

Table 1: Total load and per capita demand of Lucknow

Year	Total load(MVA)	Per capita demand(MVA)
2001	524.7	2.31×10^{-4}
2008	831.6	3.26×10^{-4}
2023	2143	6.51×10^{-4}

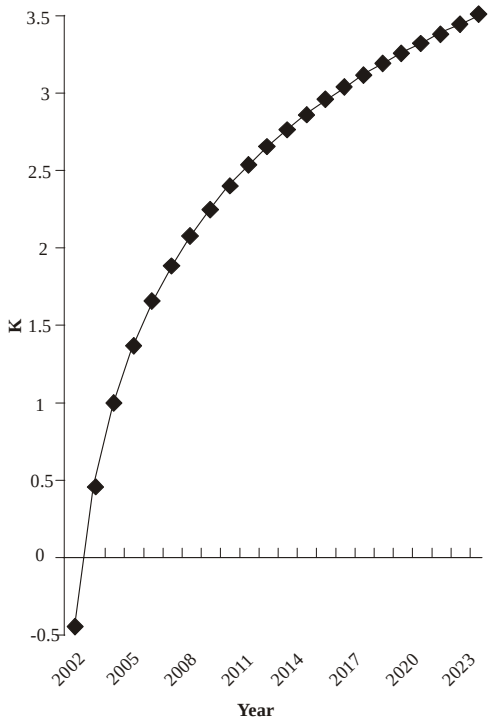

Fig. 3: The values of K for Lucknow City

As per the trend the net power demand in the year 2023 will be 2143 MVA (Fig. 2). Table 1 shows the per capita demand for the Lucknow city.

The model: The final modified model proposed (Bhardwaj, 2009) for consumption of electricity is of the following functional form

$$\ln(Ei/Pi) = K \ln(Eb/Pb) - 3.48881 \ln(T/10) - 10.99549 \ln\{1/(Yi-Yb)\} \quad (2)$$

where, *'i'* and *'b'* represents the values of corresponding subscripts to the *i*th year and that of the base year (2001) and E, P, Y and T are electricity demand, population, year, and absolute temperature of the city in ºC, respectively. The value of constant K can be obtained from Fig. 3.

Analysis of model accuracy: In order to ascertain the accuracy of the above model, the plots comparing the actual consumption with the model estimation have been verified (Fig. 4). The plots illustrate acceptable level of accuracy of the model.

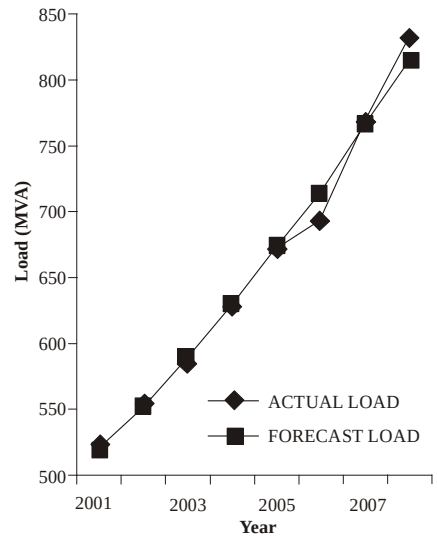

Fig. 4: Lucknow load comparison

RESULTS AND DISCUSSION

As per the analysis and forecasting of this long term planning, the net electric power demand estimation is 2143 MVA. The results project the enormous capacity requirement for realizing the power demand by the year 2023. The analysis gives result that the Lucknow has an increase of per capita demand approximate three times when compare with a constant maximum temperature, which we have taken i.e., 45ºC. However as per the Global warming report temperature will rise up to 3ºC till the year 2050.

Long term planning is of a vital significance for the growth of power sector. The study emphasizes the urgent need for an effective long term planning for generation expansion to meet the state's rapidly growing demand. The study indicates various options available nowadays to meet the power demand by 2023 i.e., increase additional generation capacity, reducing the present level of transmission and distribution losses, etc.

In this study, a model has been verified which explains the demand of electrical energy till the year 2023 in the Lucknow City. The model has been refined and validated to ensure consistency. Error of the forecast model has also been checked and that is found to be in the range with an average error of +0.08%. The model has been employed for forecasting the future energy requirement until 2023. The policy implications of the forecast results have been critically analyzed. The results identify the basis on which electricity energy planning can be carried out and emphasize the need for evolving effective strategies.

ACKNOWLEDGMENT

The authors gratefully acknowledge the advice and help rendered by Shri B.P. Sharma (Retired) Dy. Director, Central Electricity Authority, New Delhi, India in carrying out this study.

REFERENCES

Bansal, R.C. and J.C. Pandey, 2005. Load forecasting using artificial intelligence techniques: A literature survey. Int. J. Comput. Appl. T., 22(2-3): 109-119.

Bhardwaj, A.K., 2010. Electric Power Demand Forecasting: A Case Study of Kanpur City. National Seminar on Utilisation and reliability of power system: An Indian scenario organized by S I E T Allahabad (India). Retrieved from: http://www.dsal.uchicago.edu/reference/gazetteer/paper.html?objectid=DS405.1.134_V05_092.gif (Accessed date: January 16, 2010).

Bhardwaj, A.K., A.K. Srivastava and R.C. Bansal, 2009. Electric power demand forecasting: A case study of agra and allahabad cities. Electrical India Magazine, 49(10): 40-44.

Barakat, E.H. and S.A. Al-Rashed, 1992. Long range peak demand forecasting under conditions of high growth. IEEE Trans. Power Sys., 7(4): 1483-1486.

Central Electricity Authority of India, 2008. Government Website [Online]. Retrieved from: http://www.cea.nic.in/power_sec_reports/executive_summary/2008_07/25-26.pdf.

District Profile, 2009. Government Website [Online] Available: Lucknow. Retrieved from: http://agra.nic.in/hist.htm.

Census of India, 2001: Data from the 2001 Census, including cities, villages and towns. Census Commission of India. Government of India Website [Online] Available. Retrieved from: http://web.archive.org/web/20040616075334/www.censusindia.net/results/town.php?stad=A&state5=999. (Accessed date: September 03, 2007).

Sharma, D.P., P.S.C. Nair and R. Balasubramanian, 2002. Demand for commercial energy in the State of Kerala, India: An econometric analysis with medium-range projection. Energ. Policy, 30: 781-791.

Thailand Long-Term Load Forecasts, 2006. NIDA Consulting Center, National Institute of Development Administration Thailand, 08: 109-124.

UPPCL report, 2009. Transmission and Distribution Losses during 10th five year Plan.

Yee, S., R.C. Bansal, A.K. Bhardwaj and A.K. Srivastava. 2011. Electricity market price forecasting using vector support machines. Int. J. Comput. Aided Eng. Technol., 3(1): 1-18.