The Research of Regression Method for Forecasting Monthly Electricity Sales Considering Coupled Multi-factor

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Abstract. The monthly electricity sales forecasting is a basic work to ensure the safety of the power system. This paper presented a monthly electricity sales forecasting method which comprehensively considers the coupled multi-factors of temperature, economic growth, electric power replacement and business expansion. The mathematical model is constructed by using regression method. The simulation results show that the proposed method is accurate and effective.

1. Introduction

The electricity sales forecasting is an important work of the relevant departments of power system, and the electricity demand forecasting is great significance for the power sector and related economic and energy sector. The electricity sales are one of the indicators of the electricity demand forecasting, which accurately predicting help arrange power production plan, but also can provide the basis for electricity network planning and design.

At present, the commonly used forecasting methods for the electricity sales include trend extrapolation, total regression, ARIMA, extrapolation, gray prediction and so on. Wang Chengshan and other detail analysis and comparison of different grey system forecasting model, sum up the advantages and disadvantages of various grey system model and its scope of application, and point out that the annual electricity consumption growth rate is lower, the grey system forecasting model results will be more accurate. Zeng Siyong and Yang Wenjun predict the annual electricity consumption of a county by establishing a regression analysis model between time trend and electricity consumption. The results show that 99.14% of the county electricity consumption is determined by the annual change, and the forecast result is more accurate. Zhang Shiqiang gives an overview of the ARIMA model. Taking Chengdu city as an example, he use the ARIMA model forecast the electricity consumption of Chengdu in 2006-2010. The results show good prediction effect in short term, but with the years become longer the prediction error is also grower. Zeng Ming and other use trend extrapolation method, linear regression method and gray model method respectively forecast the power consumption of Guizhou Province in 2015-2020, and analyze three kinds of forecasting methods. The results show that different prediction methods have different prediction accuracy. The gray model prediction method is relatively high accuracy.

In this paper, the influence of temperature and economic growth factors on the electricity sales is taken into account, and the prediction model considering temperature and economic growth factors is established to predict the monthly electricity sales.

2. Mathematical model

This paper considers the impact of economic and temperature growth to the electricity sales and establish prediction model of trend of economic growth to forecast the monthly electricity sales. Trend of economic growth is quantified by adding time trend or expressed by the economic growth index got from the monthly growth rate of industrial added value. Because secundiparity added value growth rate and GDP growth is highly consistent direction, and the above-scale industrial added value has a large proportion of the value increase in secundiparity. Taking into account the availability of data, the above-scale industrial added value growth express monthly trend of economic growth situation at monthly level. By constructing a linear regression model between monthly electricity sales and average temperature and the economic growth index of the same month, the monthly electricity sales can be predicted.

The specific method steps are as follows: ①Obtain the added value growth data of the above-scale industrial of the historical period and the forecast month, and convert into the base period of $\mathrm{I}_0 = 100$ economic growth index, that is $\mathrm{I}_i = (1 + GY_i) \times \mathrm{I}_{i-1}$ where I_i is the monthly economic growth index, GY_i value added for the industrial scale, I_0 economic growth index base period; ②Obtain the electricity sales and the monthly average temperature data of the historical period and the forecast month, and with the data in accordance with the order of the year; ③Establish a forecasting model to join the economic growth index, and set up a linear regression equation with the monthly electricity sales as the dependent variable, the monthly average temperature and monthly economic growth index as independent variables, that is $\mathrm{E}_i = \mathrm{A} + \mathrm{BT}_i + \mathrm{CI}_i$ where E_i is the monthly electricity sales, T_i is the monthly average temperature, A is the constant term, B is the coefficient of T_i, and C is the coefficient of I_i; ④ The average temperature predicted value of the forecast month is obtained. The average value of the average temperature of the sampling period is taken as the average temperature prediction value of the predicted month;⑤Calculate the economic growth index of the forecast month, according to the forecast value of the added value of the above-scale industrial of the forecast month given by the relevant economic research department, which be translated into the economic growth index of the forecast month; ⑥ Calculate the electricity sales of the forecast month. According to the constant term and the coefficient obtained by ③ regression, the forecast value of the predicted monthly average temperature and the economic growth index are substituted into the regression equation, and the predicted value of the monthly electricity sales can be calculated. Procedure is shown in fig. 1.

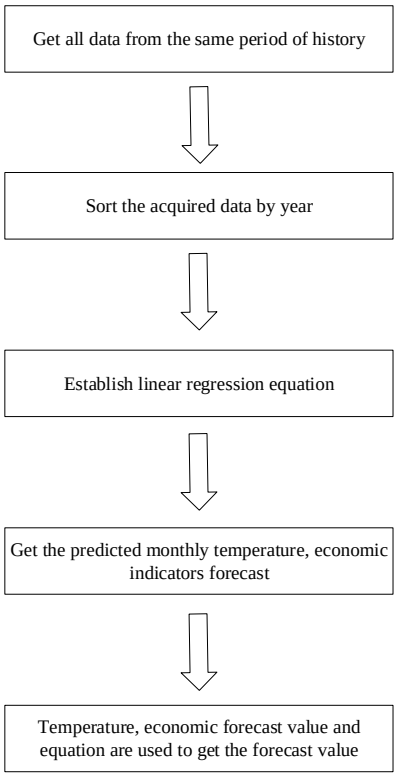

Figure 1. Procedure sketch map

According to the above technical scheme, it is known that the linear regression equation between the monthly electricity sales, the average temperature and the quantification index of the economic growth trend which is expressed the time trend item or the economic growth index is obtained to get the monthly electricity sales forecast value which will help formulate monthly power planning and power grid scheduling and power monthly production plan.

3. Example analysis

The historical data of 2010-2016 years in June is taken as the sample period to predict the electricity sales of June 2017 Based on the method proposed in this paper. In the sample period, the electricity sales, the monthly average temperature, the growth rate of the above-scale industrial added value and the index of economic growth of a province are shown in table 1

①Obtain 2010-2016 years in June the growth data of the above-scale industrial added value and convert it to the economic growth index of 100 in 2009; ②Obtain the electricity sales and the monthly average temperature data of 2010-2016 year in June. These data and ① data from year to year in order, seeing Table 1; ③Establish a forecasting model of adding economic growth index, that is $E_i = 0.417 + 1.304T_i + 0.196I_i$ where E_i is the monthly electricity sales, T_i is the monthly average temperature, A is the monthly economic growth index. The coefficients of the regression equation are all checked by T. The model fits the historical data very well and can explain 99.7% of the historical data. ④Take 25.54 which is the average value of the average temperature in June 2010 - June 2016 as the value of the average temperature forecast for June 2017; ⑤Because the Henan Provincial Bureau of statistics has announced that the growth rate of the above-scale industrial added value is 11.5% in June 2017. It is 425.53 that 11.5% is translated into the forecast month's economic growth index (If not published, the

above-scale industrial added value growth forecast value of the month which is given by the relevant economic research departments translate into the forecast month's economic growth index). ⑥In June 2017, the average temperature forecast and the economic growth index are substituted into the ③ regression equation, and the forecast for the electricity sales is 11.73 billion kWh in June 2017.

Table 1. The electricity, temperature, and economic data of the sample period

Project	The electricity sales/billion kWh	The average temperature/℃	Time trend	The growth rate of the above scale industrial added value/%	Economic growth index(2009=100)
2010-06	5.985	25.43	1	27.4	127.40
2011-06	6.303	24.29	2	26.3	160.91
2012-06	7.208	26.82	3	19.5	192.28
2013-06	8.096	25.19	4	23.8	238.05
2014-06	8.906	25.27	5	22.1	290.65
2015-06	10.203	26.41	6	16.3	338.03
2016-06	10.866	25.35	7	12.9	381.64

In June 2017, the actual electricity sales of Henan province is 11.651 billion kWh, the forecast error of the method is 0.68% and the accuracy is higher, which prove the effectiveness of the method.
This example shows the way to predict the electricity sales in June 2017. The prediction of electricity sales of rest months can be done in the same manner. The whole electricity sales in 2017 could also be forecasted by summarizing the predicted results for each month. So the whole electricity sales of Henan Province in 2017 would be 244 billion kWh.

4. Conclusion

This paper presented the method for forecasting monthly electricity sales which comprehensively considers the factors of temperature, economic growth, electric power replacement and business expansion. And mathematical model is constructed by using regression method. The simulation results show that the proposed method is accurate and effective. And the whole electricity sales of Henan Province in 2017 have also been forecasted by using this method.

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