Research on Monthly Electricity Consumption Forecasting Method

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Abstract

In this paper, the research mainly divided into three parts: first, the research background and existing research methods have been briefly discussed in the introduction. The second part is the theoretical basis as well as instance analysis, which choose the reasonable mathematical model and carry out a certain city monthly electricity consumption forecasting research based on the authentic data. In the third part, correction measures are proposed according to the cause of the error. Finally, each monthly electricity consumption forecasting method discussed in this paper is compared and a conclusion is drawn.

Keywords

Monthly electricity consumption, forecasting method, prediction model.

1. Introduction

1.1 Background

Power consumption prediction is an important index for the planning and construction of power system. It is also an effective guide for power demand management. In recent years, load management in the power industry has become more and more standardized, power data classification has become clearer, and the problem of data missing has been greatly improved [1], so that a deal of power consumption forecasting methods emerge. Finding and optimizing electricity consumption forecasting methods is of great significance for electric power enterprises to draw up plans, promoting social and economic development.

1.2 Previous Research

The research on power consumption forecasting has been developed for more than 30 years [3]. There are many power consumption forecasting methods, but in practical application, the traditional time series methods are still the dominant methods, and most of the intelligent forecasting methods relying on artificial intelligence and big data are in the experimental research stage. Each prediction method has its advantages and disadvantages; the analysis of the application conditions is the key to choose the appropriate methods to solve the problem of prediction. Generally speaking, the commonly used forecasting methods include two types, classical methods and the intelligent methods. The classical methods include regression analysis method, electric elasticity coefficient method, output value single consumption method, large industrial specific trend analysis method, monthly correlation specific gravity method, etc. Intelligent methods include artificial neural network method, grey system method, wavelet analysis, combination prediction method, ARIMA model and so on.

2. Theoretical Basis and Instance Analysis

The electricity consumption obviously changes with the seasons and generally increases year by year. Therefore, the above two characteristics should be taken into consideration when selecting the forecasting method. This paper uses monthly electricity consumption data in a certain city from 2009 to 2017 to predict that in 2018, and then compares it with actual value.

2.1 Trend Analysis Method

Trend analysis is the most popular quantitative prediction method. It is based on the known historical data to fit a curve, from which to estimate the predicted value. This method is a certain extrapolation, so random errors can be ignored. The basic form is:

$$Y_t = f(t,\theta) + \varepsilon_t \quad (1)$$

Where Yt is the predicted object, ε_t is the predicted error and θ is the specific parameter. Take electricity consumption forecast for August 2018 as example. The fitting curve and R2 are as Tab.1.

Tab.1 Fitting result

	R^2	Function
Polynomial fitting	0.9672	Y_t=-117.95x^2+16162x+119516
Exponential fitting	0.9540	Y_t=129985$e^{0.0785x}$
logarithmic fitting	0.9901	Y_t=55346ln(x)+117862

The regional economic has been apparently rising, so that exponential function is more suitable. The actual value y=285485.45, the predicted value Y_t =269341.00 by the polynomial model, the accuracy was 94.34%; the predicted value Y_t =284980.02 by the exponential model, the accuracy was 99.82%. Then use the same method to forecast electricity consumption in other months.

2.2 Monthly Correlation Method

The monthly electric power market index has obvious seasonal regularity. Meanwhile, the economy and production have strong inertia in the short term, so the electric power market index of the next month is closely related to that of the previous month. Therefore, monthly correlation specific gravity method is reasonable.The basic form of the monthly correlation method is shown as follows:

$$Y_t = \frac{X}{W_x} * W_y \quad (2)$$

where Yt means the Yth month electricity consumption this year, X means the Xth month electricity consumption this year, Wx means the Xth month electricity consumption last three years or more and Wy means the Yth month electricity consumption last three years or more.

Take electricity consumption forecast for August 2018 as example. The actual value y=285485.45 and the predicted value $\overline{Y_t}$ =289538.40, so the accuracy is 98.58%. Related parameters are as Tab.2. Then use the same method to forecast electricity consumption in other months except January and February.

Tab.2 Parameter calculation result (10^4Kwh)

	May(x=5)	June(x=6)	July(x=7)	August(y=8)
W_{2014}	7.62	8.77	9.91	11.02
W_{2015}	7.78	8.94	10.13	10.40
W_{2016}	7.62	8.83	10.11	11.06
W_{2017}	7.52	8.40	9.50	10.91
W_x	7.64	8.73	9.91	10.85
X	209867.99	244358.86	243988.60	/
Y_t	298111.73	303520.20	266983.26	/

2.3 Grey Model

In Grey Model, the randomness of time series is reduced by the accumulation and data sequences with strong regularity are generated. The required time points are predicted according to this law. This method has the advantages of high prediction accuracy, few samples needed, simple calculation and verifiable [4].

Because the data greatly affected by seasonal fluctuations cannot be fitted with the gray model, to forecast electricity consumption for August 2018, this paper selects the electricity consumption data in August from 2009 to 2017, and use GM(1,1) model. Small error frequency P = 1.0 and posterior difference ratio C = 0.0148 so the prediction level and the fitting effect is "good". The actual value y=277000, the predicted value is 289538.40, so the accuracy is 97.03%. The fitting curve by MATLAB is as Fig.1.

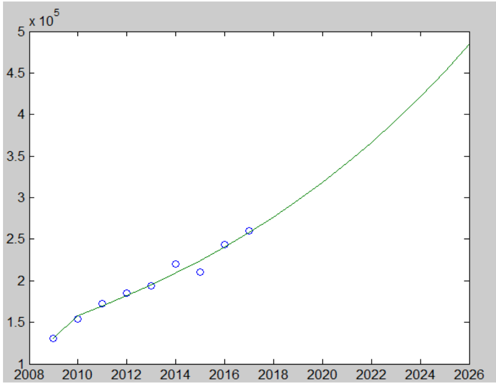

Fig. 1 The fitting results of GM (1, 1)

2.4 SARIMA Model

The ARIMA (p, d, q) model is an extension of the ARMA (p, q) model. ARIMA (p, d, q) model can be expressed as:

$$\left(1-\sum_{i=1}^{p}\phi_i L^i\right)(1-L)^d X_t=\left(1+\sum_{i=1}^{q}\theta_i L^i\right)\varepsilon_t \tag{3}$$

where L is the Lag operator, $d \in Z, d > 0$. This paper selects the monthly electricity consumption data in from 2009 to 2017, and use seasonal ARIMA to forecast that in 2018 by SPSS, see Fig. 2.

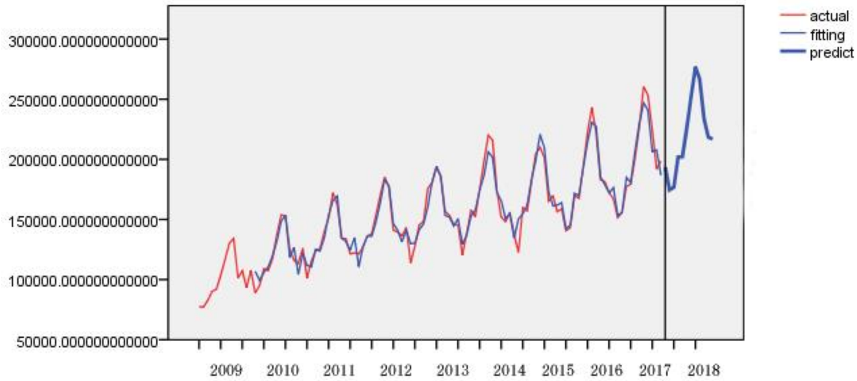

Fig. 2 The fitting results of SARIMA

3. Revision of the Result

In some months, the forecast accuracy did not reach the expected effect, so the methods need to be further modified.

Chinese traditional festivals are based on the lunar calendar, which varies from year to year in the Gregorian calendar. The error in January and February is largely due to the impact of the Spring Festival, which is around for a period of time in January to February. How electricity consumption fluctuates differs from region to region. According to characteristics of the city that the paper studies on, which is comparatively developed, electricity consumption should be significantly reduced around the Spring Festival as most factories are closed and the outflow of migrant workers. For example, since the Lunar New Year falls on January 28, 2017, earlier than previous years, the forecast value of February is lower than actual value.

In order to improve the prediction accuracy of monthly electricity consumption, this paper proposes a correction method based on the data of daily electricity consumption. As for January and February, we can first find out the lunar calendar of each day in these two months, then use forecasting methods based on historical daily data of the corresponding lunar calendar to predict that of the required year. Consider that the number of weekends per month is approximately constant, result would come out by summing up daily predicted value. The result shows that the accuracy of January and February prediction can rise by 99.26% and 98.33%, respectively, which is more than 3% higher than that without revision. Data processing renderings are shown as Fig.3.

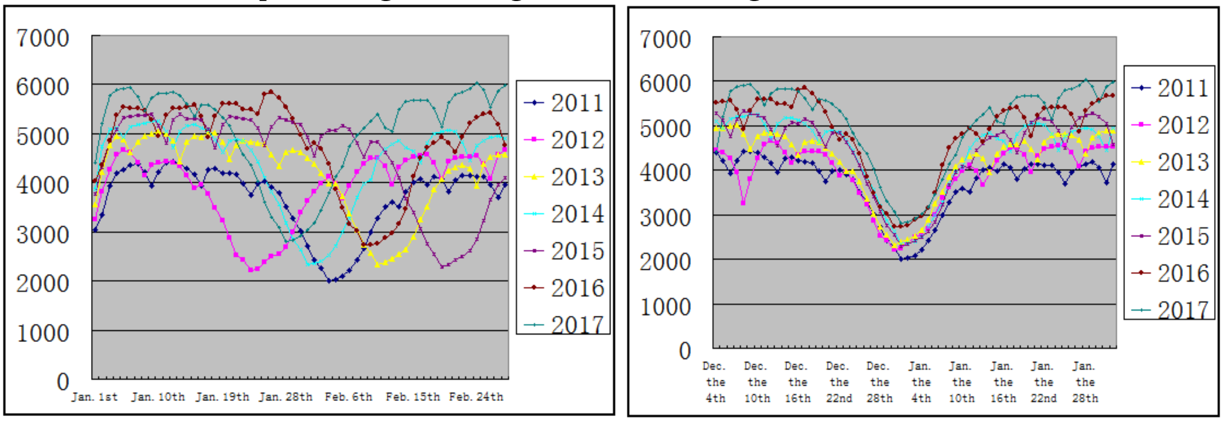

Fig. 3 Calendar conversion comparison diagram

4. Conclusion

Electricity consumption forecast is the foundation of planning and operation for electric power system. This paper discusses several electricity consumption forecasting methods, conducts case studies and corrects the prediction results in January and February. The methods mentioned in this paper are convenient and accurate, but there is still a lot of room for improvement. At present, the traditional method is more reliable in the practical application. The modern intelligent prediction method are mostly on a theoretical level and needs to be improved, simplified and tested continuously before it can be applied to the actual power prediction.

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