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Applying the Grey Forecasting Model to the Energy Supply Management Engineering

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Abstract

The demand for energy supply has been increasing dramatically in recent years in the global. In addition, owing to the uncertain economic structure of the county, energy has a chaotic and nonlinear trend. In this paper, An improved grey G(1,1) prediction model is proposed to the energy management engineering. It is one approach that can be used to construct a model with limited samples to provide better forecasting advantage for long-term problems. The forecasting performance of the improved GM(1,1) model has been confirmed using the China's energy database. And the results, compared with those from artificial neural network (ANN) and times series. According to the experimental results, our proposed new method obviously can improve the prediction accuracy of the original grey model.

Keywords: Grey forecasting model , Energy supply, Management engineering;

1. Introduction

Recently the global economic recession leads to the fluctuation of energy prices, which has made energy supply to be increasingly unstable. Therefore, in order to take the way of sustainable development, it has the vital practical significance to complete the analysis of energy supply and demand gap forecast, and provide the decision data for the establishment of energy management engineering.

Multivariate modeling along with co-integrated techniques or regression analysis has been used in a number of studies to analyze and forecast energy consumption [1-4]. Recently, grey forecasting approach has gained popularity in energy demand forecasting. Zhou et al. [5] presented a univariate trigonometric grey predictive model for forecasting electricity demand in China. This method constructs residual series into generalized trigonometric model to increase the accuracy of GM(1,1) model. Akay et al. [6] observed that there are chaotic phenomenon and non-linear trend in historical electricity consumption data. It applied a method combining the grey prediction model with rolling mechanism, which is applicable for prediction with high accuracy, but limited to case with limited data or little calculation effort. Wang et al. [7-9] proposed the reconstruction of background value using interpolation algorithm, it improve prediction accuracy of models to some extent.

The aim of this paper is to focus on forecasts for China's energy management engineering using the combinative interpolation Grey predictive modeling. The rest of this paper is organized as follows. In Section 2, the present

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energy situation of China is described. Section 3 presents the conventional GM(1,1) model, and proposes combination interpolation method to reconstruct GM(1,1) model. The application of improved GM(1,1) model and model comparisons are explained in Section 4.The last section summarizes and proposes related solving suggestions for energy supply system engineering.

2. Analysis of China's energy supply management engineering

As the increasing of oil demand and the imported energy, China has played an important role in global energy markets. With China's rapid economic growth, the strong demand for energy of China will rise. The strong growth of energy demand in China mainly depends on China's rapid economic growth, and depends on China's large population, as well as depends on China's ongoing urbanization. The status quo of China's energy supply are mainly reflected in the following points:

Firstly, the accelerating process of industrialization, especially the demands of heavy industry for energy present new challenges constantly, in which the energy consumption of power, steel, nonferrous metals, building materials, oil refining and chemical industries account for about 70% of total energy consumption in China.

Next, the per capita energy consumption in China are 1.8 tons standard coal, and there are still a considerable growth room for China's per capita energy consumption compared to the per capita consumption of Western developed countries which are 7 tons of standard coal.

Moreover, China is in the process of urbanization, the accompanying energy growth will be very fast. Data showed that the average annual resources consumption of urban population are 3.5 times more than the rural population. And there are about 18 million rural people who flow into cities every year. The proportion of urban population will reach to about 75% by 2050, which will produce a large number of new increasing energy demand.

Finally, another critical factor is that China is a world factory, in which 40% of the products are for export. The export products are of high energy density, low added value, while the energy consumption of these products is calculated within China's total energy demand.

3. The establishment of forecasting model

3.1. Modeling idea of conventional GM(1,1) forecasting model

Assume that $X^{(0)}=\{X^{(0)}(1),X^{(0)}(2),\cdots,X^{(0)}(n)\}$ is the original series. Applying accumulated generating operation *(AGO)*, it can get that:

$$X^{(1)}=\{X^{(1)}(1),X^{(1)}(2),\cdots,X^{(1)}(n)\}$$

where $X^{(1)}(k)=\sum_{i=1}^{k}x^{(0)}(i)$ $(k=1,2,\cdots,n)$. $X^{(1)}(k)$ is called accumulated generating operation of $X^{(0)}(k)$ denoted as *1-AGO*.

The first order linear ordinary differential equation expressed as

$$\frac{dx^{(1)}}{dt}+ax^{(1)}=b \tag{1}$$

which is called whitened differential equation of *GM(1,1)*, of which the difference form is:

$$x^{(0)}(k)+az^{(1)}(k)=b \tag{2}$$

where *a,b* are parameters to be identified. *a* is called developing coefficient, and *b* is called grey input. Solve it using least square method and obtain:

$$[a,b]^T=(B^TB)^{-1}B^TY_n \tag{3}$$

where