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The Application of Grey Theory Model in the Predication of Jiangsu Province's Electric Power Demand

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Abstract

Based on the grey system theory, the paper establishes an electricity demand forecasting model for Jiangsu province, and verifies it using the data from the year 1997 to 2012. The result shows that the accuracy of this forecast model is "superior". This proved that GM (1, 1) model used for the electricity demand forecasting of Jiangsu province can fully meet the needs of the forecast of electricity. In the mean time, the electricity demand of Jiangsu from the year 2013 to 2015(which year is the end of China's twelfth five-year plan) was forecasted by applying the model and the result shows that the electricity consumption in Jiangsu province will increase rapidly in the next few years. Up to the year 2015, it will reach 0.7187 trillion kW·h, which requests the acceleration of the generation of power, so as to meet the needs of the economic development of Jiangsu province in the next few years.

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Keywords: Electricity demand; grey system; industrial structure

1. Introduction

There are several factors that contribute to electricity demand: economic development, industrial structure, income levels, climate, geography, national policies (such as electricity price), and etc.. Some of these factors

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are definite, while some are not. So it can be seen as a grey system, and the explanation and forecasting can be done with the theory and methods of Grey System [1].

Grey System Theory is a kind of systematic and scientific theory initiated by Chinese scholar Professor Deng Julong in the 1980s. Currently, it has been widely used in the power demand forecast. The theory agrees that all the random sample varieties are the changing grey varieties within a range, that is to say the whole random process is considered as the grey variety varying within a certain range. According to the past and the present known or uncertain information and with the approach of data generation, the raw data can be transformed into a greatly regular generating series and then the related research and modeling can be done. This method can be applied when there are few raw data, and the accuracy of forecasting can be highly increased by accumulating the data certainty relatively enhanced to some extent and the data uncertainty relatively weakened to some extent. Grey forecasting model is predicting with the model of GM, which is short for Grey Model. GM Models can be divided into GM (1, n) model and GM (1, 1) model: GM (1, n) model is the grey model established by the first order differential equations with *n* variables, which is a forecasting model established between the load and *n* influential varieties; while GM (1, 1) model is the most common grey model, which is established by the first-order differential equation only with a single variable and is also the special case of GM (1, n) model [2]..

2. The establishment of forecasting model based on grey theory

2.1 GM (1, 1) forecasting model [3-5]

Suppose that to time series $t_1, t_2, \cdots, t_n$, the existing demand load data series are $u_1, u_2, \cdots, u_n$, which can be called raw data series and can be recorded as:

$$u^{(0)}(i), (i = 1,2,\cdots,n) \tag{1}$$

Through accumulating the above series, a data sequence with the exponent-growing pattern will be available, known as the accumulated generating data series $u^{(1)}(i)$, that is:

$$u^{(1)}(i) = \sum_{k=1}^{i} u^{(0)}(k) \tag{2}$$

The following First Order Differential Equation can represent the application of GM (1, 1) model on the above single-variable series:

$$\frac{du^{(1)}}{dt} + a \cdot u^{(1)} = b \tag{3}$$

In the equation: a and b are parameters to be determined, which can be recorded as $A = [a \;\; b]^T$. The least squares approximate solution $\hat{A}$ in the equal-step time series A can be derived through discrete and differential:

$$\hat{A} = [\hat{a} \;\; \hat{b}]^T = [B^T B]^{-1} B^T Y_n \tag{4}$$

In which: $Y_n = [u^{(0)}(2), u^{(0)}(3), \cdots, u^{(0)}(n)]^T$

$$B = \begin{bmatrix} -[u^{(1)}(1) + u^{(1)}(2)]/2, \cdots, 1 \\ -[u^{(1)}(2) + u^{(1)}(3)]/2, \cdots, 1 \\ \cdots\cdots \\ -[u^{(1)}(n-1) + u^{(1)}(n)]/2, \cdots, 1 \end{bmatrix} \tag{5}$$

To time series $t^{(0)}(i)$, $(i = 1,2,\cdots,n)$, the initial condition: $u^{(1)}(1)$ is the initial value of $u^{(1)}(i)$, and