Proceedings of the 7th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/28/20231330

Research on the Prediction of Copper Consumption and Recycling Changes in China under the Background of Carbon Neutrality

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Abstract: This paper examines the recent development of China's copper industry in the context of "carbon neutrality." The issues of low resource self-sufficiency rate increased equipment levels, and limited industry discourse power in the global copper market are addressed in a number of different ways. Finally, based on the foregoing analysis, this study concludes that in order to achieve maximum resource utilization efficiency and carbon emission reduction, China's copper industry needs to strengthen technological innovation and cooperation, promote the development of the circular economy, and strengthen its synergy with other industries. The government should also create pertinent regulations and laws to encourage and direct businesses to devote more time and resources to recycling.

Keywords: carbon neutral, copper use, forecast

1. Introduction

In September 2020, China proposed at the UN General Assembly that it should strive to reach a peak in carbon dioxide emissions by 2030 and strive to become carbon neutral by 2060. In order to achieve the "double carbon" goal, all industries are faced with the problem of how to achieve low carbon development. This paper takes the copper industry as the research object and focuses on the change in the consumption and recycling amounts in the copper industry against the background of carbon neutrality. Based on Matlab technology, the prediction model of a double hidden layer BP neural network is established to predict the change in China's copper consumption demand in the next 40 years, and the result of increasing copper consumption and recycling amount in the future is obtained.

2. Development Status of Copper Use and Recycling in China

China has a shortage of copper resources, a low level of security, a shortage of raw material supply, and a high degree of dependence on foreign countries [1]. According to statistics from the US Geological Survey in 2021, the world's proven copper reserves in 2020 will be about 870 million tons, of which China's copper reserves will be about 26 million tons, accounting for only 3%. In 2020, the world will produce about 20 million tons of copper (metal production), of which China will produce about 1.7 million tons, accounting for about 8.5%. The static guaranteed life of the world's existing reserves is 43.5 years, compared with 15.3 years for China. Under the current conditions of

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high-intensity geological resource exploitation, the external dependence on copper raw materials is still greater than 70%. At the same time, limited by resource conditions, the technology and equipment level of domestic small and medium-sized copper enterprises is low, and the gap is larger than that of large copper enterprises [2]. As a traditional industry, domestic mining enterprises start late in digitization and intellectualization, and cannot better adapt to the requirements of low-carbon development [3]. As a result, while achieving the goal of "double carbon," the development of the Chinese copper industry faces a number of challenges, including low resource self-sufficiency, improved equipment level of some mining enterprises, and weak discourse ability of the international copper market. The development of wind power, photovoltaic, ultraviolet transmission line construction, industrial terminal electrification level, promotion of new energy transportation, power generation, transmission and electricity will promote copper consumption demand [4]. At the same time, under the requirement of low carbon, the development of new energy and other related industries has driven the market demand for copper, which is conducive to the rise of copper's price and has offset the increase of low carbon conversion costs to some extent [5]. A mature carbon trading market is an important guarantee for fair and low-carbon competition and for investment through market regulation mechanisms [6]. In the future, reasonable carbon pricing will provide economic support and incentives for copper producers to achieve carbon reduction through technological change.

3. Prediction of Copper Usage and Recovery in China

3.1. Model Analysis

In economic prediction, the BP neural network model is one of the typical widely used neural network models that belongs to the feedforward process network.

3.1.1. Model Structure

The three types of neurons in the neuron model are divided into an input layer, multiple intermediate hidden layers, and an output layer [7]. Their layered forward connections, meaning that each layer receives input from a layer of neurons only after each layer has avoided it. The output layer also has the final output data because neurons are made up of nonlinear transformation units, which makes a strong prediction of the nonlinear system ability [8]. For example, Figure1, assumes that there is only one hidden layer, forming three layers of the BP neural network, and the input layer consists of 0, U2, Unhidden nodes make up the input layer, hidden nodes make up the concealed layer, and M input nodes make up the output layer. Each special unit is set as the threshold unit in the input layer and the hidden layer, and the connection weight between the input layer and the hidden layer is shown as the output layer's connection weight to the hidden layer is represented by Figure 1.

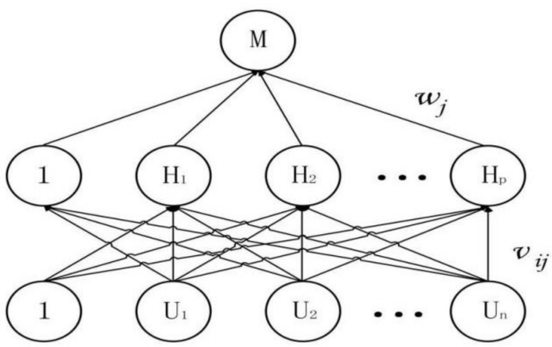

Figure 1: Nural network structure diagram.

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3.2. Calculation Process

(v_{ij}, w_j)The initial optional set of weights of the network is, in each case, divided into two steps: one is the forwards transmission (forwards pass), which includes the input, and calculates the corresponding transmission value; the second is the backwards transmission (backpass), which includes comparing the error of the given transmission with the network output, and then changing and reducing the error. The correction error is also divided into two steps. First, the error is assigned to the hidden node, and then the error is transferred to the input node, and the change is corrected repeatedly, so that the error between the network output and the target output is minimized, and then a satisfactory weight is obtained. The network process function relationship is as follows,$(v_{ij}, w_j)(v_{ij}, w_j)(v_{ij}, w_j)$

$$f(u) = \frac{1}{1+e^{-u}} \tag{1}$$

The specific steps are:

1.Set up primary values. Link weight between the input layer and hidden layer, and connection weight between the implicit layer and output layer. And assign the hidden cell threshold and the output cell threshold a random value of (-1,1).$v_{ij}w_{ij}\theta_j\theta$

2. Operate on each learning sample.

H_j One is the calculation of the hidden nodes.$H_j = \left(\sum v_{ij}U_i + \theta_j\right)$, Where j=1.2....,p

The second is the calculation of the M output point.$M = f\left(\sum w_j H_i + \theta\right)$

The third is the calculation of the error between M and the target input file, where y is the output value of the target$\delta_2\delta_2 = y - m$

The fourth is the error transmission, the calculation of hidden node error.$\delta_1\delta_{ij} = H_j\left(1 - H_j\right) * \delta_2 * \omega_j * m(1 - m)$

Fifth, the calculation of the weight change between the hidden node and the output node, which is the learning rate.$\omega_j\Delta\omega$

$\Delta\omega_j = \mu * m(1 - m) * H * \delta_2$, Where j=1,2,3...,p.

Six is the adjustment of the threshold value of the output layer unit.$\Delta\theta = \mu * m(1 - m) * H_j * \delta_2$

Seven is the calculation of the change between the hidden node and the input node. $\Delta v_{ij}\Delta v_{ij} = \mu * \delta_{ij}$

Eight is the adjustment of the hidden layer cell threshold value.

$\Delta\theta_j = \mu * m(1 - m) * H_j(1 - H_j) * \delta_2 + \omega_j(2)$

The whole learning process is to iterate repeatedly until the convergence requirements are met, which can stop, and the modified formula can also be used to speed up the learning speed.

$\Delta\omega_j(t + 1) = \mu * m(1 - m) * H_j * \delta_2 + \alpha\Delta\omega_j(t)(3)$

$\Delta v_j(t + 1) = \mu * \delta_1 * \delta_2 * U_i + \alpha\Delta v_{ij}(t)(4)$

Where a is the correction rate, usually 0.9; t represents the t iteration.

The global error function is calculated.

Let the total error of the s samples be the E

$E = \sum_{e=1}^{s} E_e = \frac{1}{2}\sum_{e=1}^{s}(y^e - m^e)^2(5)$

$E \geq \varepsilon$If, repeat steps 2,3; otherwise, go to 5.

finish.

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3.3. Analysis of the Results

In the process of China's economic and social development, copper plays an indisputable role. In order to maintain an effective long-term balance between copper production and demand, it is important to do a good job in copper demand prediction, so that it can greatly eliminate the significant fluctuation of copper production from the healthy development of the social economy [9]. There are many prediction methods, but due to the different prediction methods and the different basic data, the resulting prediction results are also very different. Only by ensuring the accuracy of the prediction, can we promote the scientific development of the copper industry under reasonable planning [10]. There are many factors affecting copper demand, and there are very complex relationships among various factors that are not simple linear or simple nonlinear functions that can be well described and effectively predicted [11]. The neural network prediction model has the ability to well describe complex nonlinear problems, and can well reveal the complex functional logical relationship between copper consumption demand and its influencing factors [12]. Compared with the highly simplified function relationship of the traditional prediction methods, the prediction results are closer to the actual results [13]. Therefore, based on Matlab technology, the double hidden layer BP neural network prediction model is established to predict the change in copper consumption demand in China in the next five years [14]. In Copper production is used to represent the value of copper consumption demand. The model takes copper production as the explanatory variable, and the explanatory variables are GDP growth rate, population growth rate, price index growth rate, electricity growth rate, air-conditioning refrigerator production growth rate, and building area growth rate in the past ten years, the growth rate of automobile output and the output value of non-ferrous metal industry as explanatory variables, then Table 1 can be obtained.

Table 1: Model input values.

a particular year	Steel production A cumulative value (ten thousand tons)	GDP increase Long rate	Population increase Long rate	Price-index growth rate	Power generation increase Long rate	Air-conditioning water tank production hyperplasia rate	Building Work area rate of rise	Automobile production growth rate	Total industrial output value of non-ferrous metal mining industry (100 million yuan)
In 2020,	784.33	20.26%	0.61%	1.04%	6.22%	6.14%	11.36%	6.33%	775.75
In 2015,	556.41	9.71%	0.67%	1.22%	11.71%	5.46%	14.68%	40.95%	433.54
In 2010,	432.36	10.27%	0.69%	0.45%	5.69%	5.77%	17.52%	13.30%	249.54
In 2005,	233.04	10.36%	0.71%	1.72%	9.22%	9.32%	8.75%	11.87%	175.63
In 2000,	132.06	6.48%	0.80%	-0.53%	6.15%	6.17%	7.03%	13.61%	114.35

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Output values were obtained using Matlab, as shown in Table 2. In the future, with the continuous growth of China's economy, the demand for copper in China will continue to grow accordingly.

Table 2: Model output values.

a particular year	Steel production, the output of a cumulative value (ten thousand tons)
In 2060,	2899.43
In 2050,	2490.56
In 2040,	2090.41
In 2030,	1843.05

4. Conclusion

The research of copper resource consumption and recycling has attracted more and more attention [15]. The purpose of this study is to predict future changes in copper consumption and recycling in China so as to provide reference and decision support for related fields. This study uses data analysis and trend analysis to forecast and analyze the future trends of copper consumption and recycling in China. The results suggest that China's total copper consumption will continue to grow, but at a slower pace. At the same time, with the adjustment of the structure of copper consumption, industrial use will occupy an increasing proportion. On the other hand, the recycling rate of copper will gradually increase, but the growth rate is slow due to the limitations of recycling technology. Due to some uncertainties in data analysis, there may be some bias in our conclusions. Carbon emissions from the copper industry have become an unavoidable problem as the goal of carbon neutrality has intensified. Future studies should explore the carbon emission situation and emission reduction options of the copper industry to provide technical support for achieving the goal of carbon neutrality.

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