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Research on the Path to Alleviate the Shortage of "Dual Carbon" Talents in China and Promote High-quality Development

Kang Liang [1], Hao Zhang [1, *], Zhenxian Li [1]

[1] National Pipeline Corporation Beijing Pipeline Co., Ltd

* haozhang0318@163.com

Abstract. To achieve the "dual carbon" goals, technological innovation is required, and more importantly, talents capable of disruptive technological innovation are needed. Such talents come from universities, research institutes, and also from innovative enterprises standing at the forefront of innovation. Therefore, establishing and improving the "dual carbon" talent cultivation system and demonstrating it is of great significance for filling the talent gap, enhancing the development momentum, and improving the quality of China's development. In the context of "dual carbon", there is a lack of high-end interdisciplinary talents. It is urgent to break the traditional cultivation mode, strengthen the cooperative cultivation mode of universities and research institutions, guided by the need to address major economic and social development requirements in China, and cultivate talents who are truly dedicated to national construction and apply their knowledge to practical work in China.

Keywords: Background of "Dual Carbon"; High-end interdisciplinary; "Dual Carbon" talents; Sustainable development.

1. Introduction

China is the world's largest energy consumer and carbon emitter, with its total greenhouse gas emissions accounting for nearly 30% of the global total [1]. There is an increasing demand for high - end compound talents in the "dual - carbon" field. (Generally, they refer to professional talents who, against the background of the "dual - carbon" goal, possess professional knowledge and skills in interdisciplinary fields and can integrate and apply this knowledge and skills to the practical work of green development, providing rich and high - quality resources for the implementation of the innovation - driven development strategy) [2]. At present, China is in a critical period of economic transformation and upgrading and the conversion of development momentum. The demand for "dual - carbon" talents, especially high - end compound talents, is more urgent than ever [3].

2. The Situation and Challenges Faced by China in the Cultivation of "Dual - Carbon" Talents

2.1 Challenges Brought by Global Transformations in the Talent Field

Due to the rampant COVID - 19 pandemic worldwide from 2019 to 2022, the current talent employment market has been severely impacted. Coupled with the economic stagnation caused by the countermeasures, the global economy has experienced a serious contraction. It is estimated that in the next five years, 40% of the core skills in the talent market will undergo significant changes, and more than 50% of employees will need to receive retraining [4]. It is predicted that by 2030, 400 - 800 million people globally will be replaced by automation, accounting for 20% of the current global labor force [5].

2.2 The Incompatibility between the Existing Disciplinary Team Construction and China's Dual - Carbon Talent Market

Academic disciplines and majors are the basic reserves of higher education and important carriers for cultivating high - level professional and technical talents with innovative awareness, practical and application abilities [6]. China has a large number of existing professional discipline branches, with a total of 740 undergraduate majors. The country also actively encourages the development of interdisciplinary subjects to promote employment. These are mainly distributed in the following majors: Management Science and Engineering, Climate Change and Ecological Environment, New Energy Science and Engineering, Environmental Engineering, Resource and Environmental Economics, Energy Economics, etc. [7]. According to current market skill requirements, the International Labour Organization divides "green occupations" into three categories: low - skilled, medium - skilled, and high - skilled. Among them, high - skilled occupations are relatively few in number and require high professional skills, such as climate change scientists, energy auditors, energy system designers, etc. [8]. Based on this current situation, China's current talent reserve can hardly meet the demand for high - end compound talents in the process of moving towards carbon neutrality by 2060.

2.3 Inadequate Talent Supply Caused by the "Greening" of Occupations

In 2022, the demand for talents in the carbon neutrality field increased by 408.26% year - on - year; in 2021, the demand for newly issued positions increased by 753.87% year - on - year. As expected, the green and low - carbon industry will develop rapidly in the next decade, and it also provides new opportunities for personnel in non - energy industries to upgrade their skills. To address the talent gap after the "greening" of occupations, how governments at all levels, education departments, the industrial sector, and the financial sector should coordinate to formulate forward - looking talent cultivation strategies, cultivate a reserve of "carbon neutrality" talents, and meet the needs during the transition process is a severe challenge currently faced in the "dual - carbon" transformation.

3. Forecast of the Talent Demand in the "Dual Carbon" FieldSection Headings

3.1 Data Sources

The data for this study were sourced from the China Statistical Yearbook from 2019 to 2022, the number of carbon-related practitioners released by "Finance Eleven", as well as index data such as the growth of the number of job positions on Liepin.com from 2019 to 2022. These data were comprehensively used to forecast the shortage of talents in the "dual carbon" field and predict the demand trend for talents in the "dual carbon" field in the coming decades.

3.2 Research Methods

Based on the data of talents in the "dual carbon" field in China from 2019 to 2022, this study relied on the grey system theory to predict the "dual carbon" talent reserve in China from 2023 to 2030. This method was first proposed by Professor Deng Julong, who pioneered the application of the grey system theory [9]. The GM(1,1) model is the most widely used in grey prediction models. It features relatively high fitting accuracy, simple calculation, and is suitable for predicting with a small amount of data .See Table 1 for the comparison of model accuracy levels.

Table 1. Judgment Criteria for Model Fitting Inspection

Model fitting grades	C	P
Grade 1 (Good)	C≤0.35	P≥0.95
Grade 2 (Qualified)	0.35≤C＜0.50	0.80≤P＜0.95

Grade 3 (Barely acceptable)	0.50≤C＜0.65	0.70≤P＜0.80
Grade 4 (Unqualified)	C≥0.65	P＜0.70

3.3 Research Ideas

This research collates experimental data and draws graphs, and then establishes the GM(1,1) model to predict the total value of dual-carbon talents in China from 2023 to 2030. Firstly, a current situation analysis is carried out based on the data from 2019 to 2022. Secondly, the GM(1,1) grey prediction model is adopted to predict the number of "dual-carbon" talents in China from 2023 to 2030 and analyze the development and change trends. Finally, discussions are carried out according to the analysis results, and corresponding suggestions are put forward.

3.4 Research Results

3.4.1 Ratio Test

Before establishing the grey prediction model GM(1,1), a ratio test is performed on the time series. See Table 2.

Table 2: Ratio Test of the Order of Magnitude of the Number of Talents in the New Energy Field in China

year	The number of talents in the new energy field in China (in ten thousands of people)			
	Original value	Ratio of grades	Value of the sequence after translation transformation	Ratio of grades after translation transformation
2019	5.04	-	18.04	-
2020	5.34	0.944	18.34	0.984
2021	10	0.534	23	0.797
2022	12.37	0.808	25.37	0.907

It can be seen from the data in Table 2 that all the grade ratios of the sequence after translation transformation are within the interval (0.67, 1.492). Therefore, all of their grade ratios are within the interval (e^(-2/(n + 1)), e^(2/(n + 1))), which indicates that the sequence after translation transformation is suitable for constructing a grey prediction model.

3.4.2 Residual Test

According to the model calculation, the residual test results of the GM(1,1) model for the number of talents in the new energy field in China are obtained, as shown in Table 3.

Table 3. Residual Test Results of the Prediction Model for the Number of Talents in the New Energy Field in China

year	The number of talents in the new energy field in China (in ten thousands of people)			
	Original value	Ratio of grades	Residual	Relative error (%)
2019	5.04	5.04	0	0
2020	5.34	5.851	-0.511	9.577
2021	10	9.014	0.986	9.863

year	The number of talents in the new energy field in China (in ten thousands of people)			
	Original value	Ratio of grades	Residual	Relative error (%)
2022	12.37	12.706	-0.336	2.72

Table 3 shows the fitting results of the grey prediction model. The smaller the relative error value, the better. Generally, a value less than 20% indicates a good fit. As shown in the table, the average relative error of the model is 5.54%, which means that the model has a good fitting effect.

3.4.3 Posterior Variance Test

According to the model calculation, the posterior variance test results of the GM(1,1) model for predicting the number of talents in the new energy field in China are obtained, as shown in Table 4.

Table 4: Posterior Variance Test Results of the GM(1,1) Model for the Number of Talents in the New Energy Field in China

Development coefficient a	Grey action quantity b	Posterior variance ratio C value
-0.155	14.63	0.035

The above table shows the development coefficient, the grey action quantity, and the posterior variance ratio. The grey prediction model can be constructed with the development coefficient and the grey action quantity. It can be concluded from the analysis of the above table that the posterior variance ratio is 0.035, indicating a high-precision model.

3.4.4 Analysis of the Prediction Results of the Number of Talents in the New Energy Field in China

According to the model calculation, the predicted values and trend charts of the number of talents in the new energy field in China from 2023 to 2030 can be obtained, as shown in Table 5.

Table 5: Predicted Values of the Talent Quantity Model in the New Energy Field of China

year	Original value	Predicted value
	(ten thousand people)	(ten thousand people)
2019	5.04	-
2020	5.34	-
2021	10	-
2022	12.37	-
2023	-	17.019
2024	-	22.054
2025	-	27.934
2026	-	34.801
2027	-	42.819
2028	-	52.183
2029	-	63.117
2030		75.886

The goals of carbon peaking and carbon neutrality run through the entire process and all aspects of China's economic and social development. As China's investment in and expenditure on energy change, there will be a corresponding significant shift in the employment situation in the energy sector. As shown in Table 5, it is estimated that by 2030, the demand for "dual-carbon" talents in China will be around 750,000, and the demand for "dual-carbon" talents will continue to rise. According to the prediction of the International Renewable Energy Agency, as the newly created jobs in the clean energy sector exceed the jobs lost in the fossil fuel sector, the total number of employees in the energy sector will increase by nearly 9 million from now until 2030[10]. In this

paper, the proportion of the number of people predicted in China in this field accounts for about 8.33% of the global predicted number.

To increase the credibility of the prediction methods in this paper, a comparison is made with the prediction information disclosed by other research institutions. According to the estimate of the China Petroleum and Chemical Industry Federation, during the "14th Five-Year Plan" period, the talent reserve in the "dual-carbon" field in China should be around 550,000 - 1,000,000. The "2021 Semi-annual New Energy Talent Trend Report" released by Liepin.com shows that in the next 5 to 10 years, the newly added number of talents in the "dual-carbon" field in China should exceed around 3.6 million. The "Dual-carbon Talent Insight Report" released by the Climate Action Youth Alliance (CAYA) predicts that the number of relevant employees will grow to 500,000 - 1,000,000 in 2025. Judging from the predictions of various domestic research institutions, the predicted values in this paper have relatively high credibility.

Meanwhile, the demand for talents in the "dual-carbon" field in China also shows an upward trend in a curve (see Figure 1).

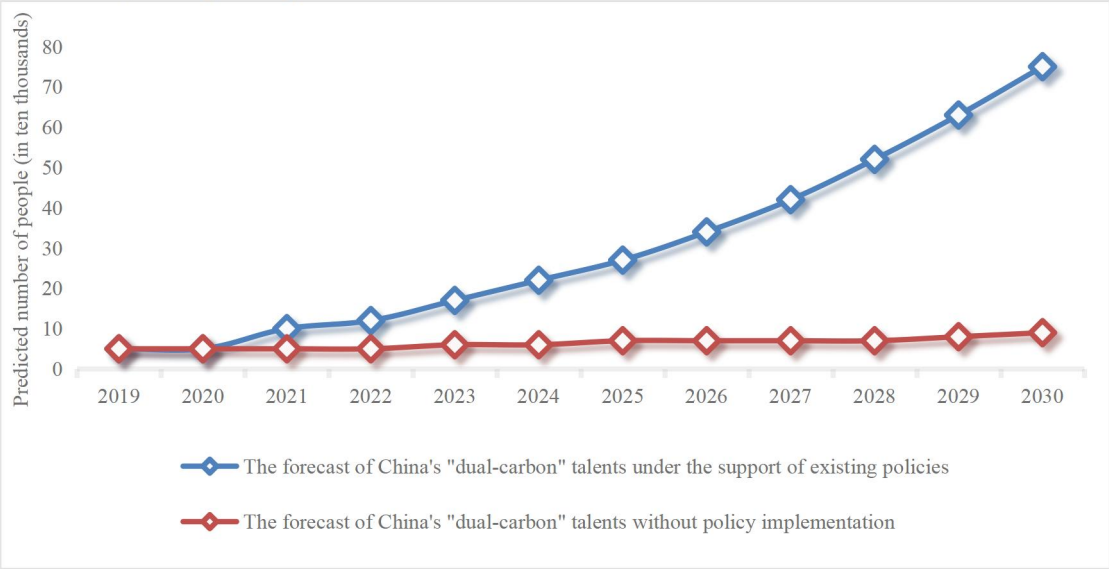

Fig. 1 Prediction Trend Chart of the Number of "Dual-Carbon" Talents in China from 2024 to 2030

Suppose China does not adopt relevant powerful policies and measures for the green and low - carbon transformation, the distribution of talents in China's "dual - carbon" field will show a linear growth. This paper uses the general linear method y=kx+b with unknown parameters k and b to estimate the baseline of population growth. After calculation, k=0.3、b=4.74.Based on this situation, there will be only 83,400 talents in China's "dual - carbon" field in 2030.

4. Measures to Strengthen the Cultivation of "Dual - Carbon" Talents in China

4.1 Standardize the Training Market System for "Dual - Carbon" Talents

At present, under the guidance of the government - leading departments, Chinese enterprises cultivate high - level talents through forms such as running "dual - carbon" vocational ability training classes, graduate course refresher courses, and master's degree classes. Firstly, it is necessary to continuously improve the cultivation mechanism that encourages public participation. Actively carry out the design of new - type "dual - carbon" courses for the whole people, unify the accreditation standards and behavioral norms of training institutions, and establish new ideas for talent cultivation. Secondly, the government should uniformly accredit various types of certificates required to achieve the "dual - carbon" goals. Thirdly, deepen and innovate the training bases for talent teams in various regions. Fourthly, allocate training resources according to the actual population size. As the total supply of talents in the "dual - carbon" field further expands, building a

high - quality and balanced education service system is an important guarantee for accelerating the construction of a powerful country in education, science and technology, and talents.

4.2 Make Multi - faceted Efforts and Play a "Combination of Policies" for "Dual - Carbon"

In order to build a high - quality support system for "dual - carbon" talents and form a talent cultivation system supported by a multi - dimensional implementation of technology, industry, field, region, and international aspects. Firstly, it is necessary to strengthen the think - tank construction of Chinese universities in this field. Integrate the scientific research forces of universities to innovate and improve the classified management of "dual - carbon" talent cultivation. Secondly, further promote and support universities to jointly establish high - end compound talent cultivation projects for "dual - carbon" with backbone enterprises in the industry and scientific research institutions. Thirdly, the government should take a long - term view of the "dual - carbon" talent cultivation plan and reject the short - term, quick - fix model. Under the premise of implementing the "dual - carbon" talent cultivation mechanism, concentrate funds on the scientific research fields of core technologies, support research institutions to solve common key problems, and reduce the phenomenon of repeated waste of low - level human resources.

4.3 Establish the Transformation Concept of High - End Compound "Dual - Carbon" Talents

A crucial step in the cultivation of "dual - carbon" talents lies in changing concepts. In view of the current needs of China, from scientific research talents to industrial talents, they all need to establish the concept of "carbon", improve their "dual - carbon" literacy, and let the "dual - carbon" concept take the lead. Given this situation, emerging technologies in the new energy industry should be retained, and new policies to promote the development of renewable energy should be continuously introduced, so as to transform "dual - carbon" talents into "sustainable development - type" talents.

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