Research on the Performance Evaluation Index System Construction and Countermeasure of Low-carbon Economic Development in China

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Abstract. The development of a low-carbon economy to achieve energy conservation and emission reduction has become an important way for countries around the world to cope with global warming and the environment is deteriorating. While China's economy is developing rapidly, it has also paid a huge environmental cost. How to develop a low-carbon economy, achieve energy conservation and emission reduction, and create a better living environment for the people has become a common concern of the whole society. Based on the definition of low carbon performance concept and scope, this paper attempts to construct an index system that includes low carbon environmental benefits and low carbon economic benefits, objectively evaluates low carbon effects and efficiency, and proposes countermeasures around low carbon development. Provide effective support and theoretical basis for the government to formulate corresponding policies and reward and punishment mechanisms.

1. Introduction
The disorderly exploitation and utilization of resources by human beings has led to the deterioration of the living environment. This trend is particularly serious in China, especially in recent years, smog weather has appeared frequently throughout the country, seriously affecting people's normal activities, and has become a major problem that the government needs to solve. On December 26, 2016, the National People's Congress officially passed the Environmental Protection Tax Law, which determined the responsibility and obligation of enterprises to undertake environmental pollution control and was officially implemented on January 1, 2018. The key to smog treatment is to reduce the concentration of fine particles (PM2.5) in the air, which requires enterprises to carry out low-carbon production and management activities. In the report of the 19th National Congress, emphasizing the establishment of a sound economic system for the development of a green and low-carbon cycle, green and low-carbon will become one of the important areas of China's future economic growth and new kinetic energy. This paper designs a comprehensive evaluation model to study China's low-carbon economy energy-saving emission reduction problems and development performance evaluation, and provides support and basis for China's energy-saving emission reduction program formulation and low-carbon economy realization.
2. Related theoretical basis

2.1. The connotation of low carbon economy

The UK government's report "Our future energy - creating a low-carbon economy" first proposed the concept of low-carbon economy. The report pointed out that global carbon dioxide emissions are expected to fall by 60% by 2050, and low-carbon economy refers to technological innovation and industrial transformation and other means to minimize greenhouse gas emissions, and ultimately form a sustainable economic system with low pollution and low energy consumption. The low-carbon economy is characterized by low energy consumption, low pollution and low emissions. It is driven by low-carbon technology, with low-carbon energy as the core, low-carbon industry as the carrier, low-carbon city as the platform, and low-carbon management as the guarantee. It is gradually developing into a revolution in global economic development involving production patterns, lifestyles, values and national rights. Since the reform and opening up, China has been blindly pursuing the growth of GDP, and the pollution generated by industrial development has not been effectively regulated. The rapid economic development and the ecological environment have created conflicts, resulting in a series of environmental problems, and carbon dioxide emissions have exceeded the standard. The essence of a low-carbon economy is to improve energy efficiency and optimize energy structure, with the goal of mitigating climate change and promoting sustainable human development. The circular economy advocates an economic development model that develops harmoniously with the environment. Its core is characterized by a closed cycle of materials, which reorganizes economic activities into a resource recycling model of “low mining – high utilization – low emissions”.

2.2. The scope of low carbon performance

Responding to the "greenhouse gas" effect requires the joint efforts of different countries and all mankind. The literature on low carbon performance has covered a number of other organizations such as industry companies, countries, regions, cities, and schools. It also includes products and projects, but there is no uniform definition of the concept of low carbon performance. Based on the analysis of the factors affecting carbon emissions, Salvador Enrique Puliafite used the Lotka-Volterra model to analyze the impact of population size, GDP growth rate and energy efficiency on carbon emissions [1]. Ma Yanlin et al. believe that low-carbon performance refers to companies that determine their low-carbon development goals and guidelines based on their low-carbon development strategies, make full use of all available resources related to enterprises, reduce carbon consumption, reduce pollution, and promote them within the company. And the effect of implementing a low carbon concept [2]. Wang Aiguo based on the meaning of “performance”, that carbon performance refers to reducing the effectiveness or economy of carbon emissions, emphasizing the relationship between carbon inputs and outputs. Some scholars believe that the carbon performance of enterprises refers to the consumption of greenhouse gas emissions per unit of fossil energy [3].

2.3. Low carbon performance evaluation index system and evaluation method

Jia used TOPPSIS method and Fuzzy Analytic Hierarchy Process (FAHP) to explore the ambiguity and nonlinearity in low carbon economic evaluation. The design of indicators for low-carbon performance evaluation can be designed with reference to four aspects of Kaplan's “Balanced Credit Card” (BSC) [4]. Ye Ziyi used this method to establish a set of regional economic benefits, regional resident experience, regional internal management and regional Innovative development of four dimensions of low-carbon performance evaluation system to quantitatively and qualitatively evaluate regional carbon performance, this indicator system can also be constructed based on entropy theory [5]. The existing research also has a static and dynamic perspective, combined with the physical and monetary dimension to establish a system, such as Zhang Caiping, Xiao Xu. Based on the above content, the low-carbon performance index system includes four aspects: carbon intensity, carbon dependence, carbon exposure and carbon risk [6]. At the same time, Zhang Caiping constructed a low-carbon performance evaluation index integrating the comprehensive carbon resource efficiency,
economic benefit and environmental benefit from the perspective of the material flow and the whole life cycle of the enterprise product, which clearly and clearly reflected the enterprise's the efficiency and effectiveness of carbon emissions. It is based on the theory and method of enterprise resource value flow, and the constructed enterprise carbon performance evaluation index system is composed of indicators corresponding to the four dimensions of carbon cost efficiency, carbon economy efficiency, carbon emission reduction efficiency and carbon emission intensity, and is made of steel. The enterprise has applied this indicator system specifically for example [6]. Under the same method, Tan Deming et al. designed a model of resource efficiency, economic efficiency, and carbon emission efficiency [7]. Some scholars only start from a dynamic perspective, such as Mai Haiyan has designed a set of dynamic indicators including low carbon level deviation index, low carbon level sustainability and low carbon initiative [9]. Wang Aiguo comprehensively carbon carbon performance in five aspects of carbon input capacity, carbon operation capacity, carbon production capacity, carbon development capacity and carbon risk capability, and attempts to evaluate the efficiency and effectiveness of low carbon performance from a financial perspective [10]. The index system designed by Ma Xiaoyan et al. includes five dimensions of economy, energy, technology, facilities and environment. It mainly evaluates the low carbon performance of enterprises from the comprehensive benefits of economy and environment [11]. The low-carbon performance evaluation methods used in the above studies mainly include five common methods: AHP, DEA, fuzzy comprehensive evaluation, principal component analysis, and AHP-DEA gray correlation evaluation model. Measurement method.

Generally speaking, there is no unified definition of the concept of low-carbon performance in the domestic literature. The research scope is mainly for small-scale research and testing in some industries or cities. The research perspective on low-carbon performance evaluation is extensive, but the basic theoretical research is not deep enough. Second, there is no literature to summarize the specific principles for designing a low-carbon performance indicator system. Thirdly, the index system constructed in the literature has been complicated, and the obstacles that may be encountered in the process of implementation are large, which affects the effectiveness and efficiency of the evaluation. Therefore, based on the definition of low carbon performance concept and scope, this paper attempts to construct a low carbon economy development performance evaluation index system, objectively evaluate low carbon effect and efficiency, and propose countermeasures around low carbon development, in order to formulate corresponding policies for government departments. And the reward and punishment mechanism provides effective support and theoretical basis.

3. Research design

3.1. Principles for building a low carbon performance system

From the perspective of low-carbon economy, the performance evaluation system involves many factors such as economy, energy and environment. When constructing the evaluation system, it should follow the necessary principles to achieve the comprehensive, comprehensive and dynamic evaluation performance evaluation objectives. This indicator system must meet the following principles:

Scientific principles. China's energy-saving emission reduction performance evaluation mainly through quantitative analysis and qualitative analysis. Quantitative analysis is to develop a scientific evaluation system, use detailed statistical data, use reasonable tools, use mathematical tools to establish evaluation models, and conduct performance evaluation. Qualitative analysis relies mainly on the subjective experience of the evaluator, combined with various factors, and subjective evaluation of the characteristics of the evaluation object. Qualitative analysis and quantitative analysis interact in performance evaluation and are indispensable.

Principle of operability. The so-called operability, that is, the designed performance evaluation system has features that are easy to measure, easy to compare and easy to control. Performance evaluation of energy conservation and emission reduction should be based on the purpose and needs of the research, as well as the complexity of mathematical modeling and the availability of data for
specific operational processes. Therefore, the performance evaluation system should be concise, easy
to operate, and easy to implement. The designed performance evaluation system can be aggregated by
scientific methods on the basis of statistical data, and can be widely applied at different times and
regions. At the same time, the system also has certain stability, and its performance results can be
taken by taking necessary measures. Get promoted.

Systematic and sustainability principles. The systemic principle, that is, the performance evaluation
system comprehensively reflects the whole process and all aspects of low carbon performance and the
efficiency and effect of carbon input and carbon output. The design indicators eliminate subjective
colors as much as possible, and have sufficient theoretical basis and objective Reflect the true low
carbon performance. Finally, to be sustainable, it can dynamically reflect low carbon performance
levels, in line with contemporary themes.

3.2. Design of low carbon performance evaluation index system

3.2.1. Factors Affecting Energy Saving and Emission Reduction in China Based on Low Carbon
Economy. Facing fierce international competition, developing a low-carbon economy is an inevitable
choice for China to cope with the global economy. At the same time, energy conservation and
emission reduction has become an emerging communication discipline that integrates economic,
energy, technology, ecology, geography and other research fields. Under the requirements of low-
carbon economy, its connotation and extension have been deepened and expanded. Make research in
this field more complicated and urgent. Therefore, it is of great theoretical and practical significance to
analyze the structural relationship and restrictive effects between the factors affecting energy
conservation and emission reduction based on low carbon economy.

Energy-saving emission reduction based on low-carbon economy includes saving energy
consumption and reducing carbon emissions, while at the same time taking into account factors such
as industry, enterprise, government, economic and social environment. Based on the above analysis,
this study summarizes the following 16 factors affecting China's energy conservation and emission
reduction based on low-carbon economy, namely energy consumption (total energy consumption, high
energy use ratio, energy intensity), and CO_{2} emissions (CO_{2} emissions, CO_{2} emission intensity),
industrial structure and corporate behavior (industrial structure, enterprise development model, energy
conservation and emission reduction awareness, enterprise scale, management level, low carbon
technology innovation capability), economic and social development and environmental governance
(economic development level, society Welfare, environmental governance level), system and social
environment (social culture atmosphere, policy formulation and implementation).

3.2.2. Establishment of a performance indicator system for energy saving and emission reduction
based on low carbon economy. In this paper, an index system is established with the goal of improving
energy conservation and emission reduction performance. The first level indicators are energy
conservation, CO_{2} emission reduction, and economic and social development level. The first level
indicators are further subdivided. Status, energy saving effect, CO_{2} emission reduction status, CO_{2}
emission reduction effect, economic and social development level, environmental governance. The
performance index system and measurement scale of energy saving and emission reduction in China's
low carbon economy are shown in Table 1.
Table 1. Performance Indicator System for Energy Saving and Emission Reduction in Low Carbon Economy.

| Primary indicator | Secondary indicators | Three-level indicator |
|-------------------|----------------------|-----------------------|
| Energy saving     | Energy conservation status | Unit GDP energy consumption Unit industrial added value energy consumption |
|                   | Energy saving effect  | Unit industrial added value energy consumption reduction rate |
|                   | CO₂ reduction status  | CO₂ emissions per unit of GDP Unit industrial added value carbon dioxide emissions |
| CO₂ emission reduction | CO₂ reduction effect | Unit industrial added value carbon dioxide emission reduction rate Per capita GDP |
|                   | Economic and social development level | Disposable income per capita resident Per capita energy consumption Environmental protection investment |
|                   | Environmental governance | Number of waste gas treatment facilities Close the number of small chemical companies Green grade enterprises |

3.2.3. Determination of weight. In order to reflect the value of the data more objectively and realistically and avoid the influence of subjective factors, the entropy method is used to determine the weight of the index.

Step 1: Data processing and entropy calculation

According to the needs of the research, because the data selected in this paper has different units, in order to avoid the research results being affected by different dimensions, the data is dimensionless. According to the research indicators selected in this paper, these indicators are divided into two categories: small excellent indicators and large excellent indicators. The dimensionless treatment is as follows:

\[ y_{ij} = \frac{k_{ij} - \min k_{ij}}{\max k_{ij} - \min k_{ij}} \quad \text{(Small optimization)} \]  

\[ y_{ij} = \frac{\max k_{ij} - k_{ij}}{\max k_{ij} - \min k_{ij}} \quad \text{(Large optimization)} \]  

Where \( y_{ij} \) is the value after the indicator economy processing; \( k_{ij} \) is the j-th indicator of the i-th province (city).

After the original data is processed, the entropy calculation can be performed:

\[ m_j = -\frac{1}{\ln n} \sum_{i=1}^{n} \frac{y_{ij}}{\Sigma_{i=1}^{n} y_{ij}} \ln \left( \frac{y_{ij}}{\Sigma_{i=1}^{n} y_{ij}} \right) \]  


Where \( m_j \) is the entropy value calculated from the post-processing index of the \( j \)-th item.

After the entropy value is obtained, the coefficient of difference between the indicators can be calculated, and the weight is finally determined. The difference coefficient is: \( f_j = 1 - m_j \). It can be seen from the formula that the larger the \( m_j \) is, the smaller the \( f_j \) is. The smaller the \( m_j \) is, the larger the \( f_j \) is. The larger the entropy value of the index is, the smaller the impact on the comprehensive performance evaluation is. The smaller the impact on the overall performance evaluation.

Step 2: Calculate the weight value of each indicator

According to the calculation formula of the above entropy value and weight, the performance index of energy saving and emission reduction can be brought into the formula to obtain the weight of each indicator:

\[
W_{\text{(Energy saving)}} = (0.0462, 0.0624, 0.0386, 0.0508)
\]

\[
W_{\text{(CO2 reduction)}} = (0.0582, 0.0676, 0.0413, 0.0498)
\]

\[
W_{\text{(Development level and governance)}} = (0.0982, 0.1525, 0.0742, 0.0458, 0.0644, 0.0874)
\]

The value of the weight of a certain indicator indicates the relative importance of the indicator in the whole evaluation system. The larger the weight value, the more important the indicator; the smaller the weight value, the weaker the index is in the whole evaluation system.

In the energy conservation indicator layer, the most important indicator is the energy consumption per unit of industrial added value. This indicates that the energy consumption per unit of industrial added value is the most important when evaluating the energy saving effect of China, and the interpretation ability is strong, and the evaluation of energy saving effect is the most appropriate. Secondly, the rate of reduction of unit industrial added value, energy consumption per unit of GDP and energy consumption per unit of GDP, respectively, indicating that the interpretation of the importance of energy conservation performance evaluation is gradually reduced; Among the layers, the most important indicator is the carbon dioxide emissions per unit of industrial added value, which indicates that the unitized industrial carbon dioxide emissions are the most important in the indicator layer, which is explained in the performance evaluation system of energy conservation and emission reduction. The ability is strong, the second most important is the carbon dioxide emissions per unit of GDP, indicating that the lower the carbon dioxide emissions per unit of GDP, the better the emission reduction effect; the third indicator level is the level of economic development and environmental governance, The strongest explanatory power in this indicator level is the resident dominance income. The larger the index, the higher the level of economic development and the effect of environmental governance. When the per capita disposable income is higher, people's requirements for environmental quality also follow. The increase, the higher the enthusiasm for environmental governance, the better the effect of governance, people Affect GDP and the proportion of green rating companies and other indicators of the level of economic development and governance evaluation of environmental explain better.

4. Conclusions and revelations

The concept of low-carbon economy is an inevitable choice in the context of the deepening contradiction between economic development and environmental protection. Developing a low-carbon economy and effectively protecting the environment on which human beings depend are the correct choices made by human beings after reflecting on their own behaviors. In the past, the economic development that relied on sacrificing the environment has become unsustainable. It is necessary to explore the path of sustainable human development by developing a low-carbon economy. At the national level, we must vigorously advocate the concept of a low-carbon economy, transform the economic development model, promote economic restructuring and upgrading, and create favorable conditions for promoting healthy economic development. At the individual level, we should actively implement a low-carbon economy. The philosophy is to protect our living environment and save resources. Only in this way can we give the low-carbon economy more vitality and better protect the environment on which human beings depend. In response to the problems that arise in the
development of China's low-carbon economy at the corporate, social and personal levels, we propose the following:

(1) Increase scientific and technological support and enhance the space for technological innovation

At present, the Chinese government mainly adopts subsidy policies to support low-carbon industries and related technologies. Under the strategic decision to accelerate the deployment of strategic emerging industries, the Chinese government has introduced a series of subsidy policies. The state has vigorously implemented the subsidy policy, which has directly promoted energy conservation and emission reduction. The direct beneficiaries of the subsidy policy are regions and industries, but they cannot directly give incentives to scientific research institutions and enterprise R&D departments. Because technology research and development not only requires the necessary time investment and capital investment, but also research and development often has certain risks and strong uncertainty. This has led some regions to focus on the introduction of equipment and technology for the rapid development of low-carbon energy-saving industries, which has led to insufficient investment in key technology research and development. In order to enhance the innovation ability of self-seeking, the government's low-carbon energy-saving support policies should be transferred from industry to technology research and development, and increase the subsidies for independent innovation and upgrading of key technologies, and the limited investment in science and technology research and development in China. Under the implementation of various subsidies, it will effectively stimulate the original driving force of technological innovation of scientific research institutions and enterprises, and avoid the phenomenon of “technology hollowing out” caused by heavy technology introduction and neglect of technology research and development.

(2) Strengthen the combination of production, education and research to improve the systemicity of low-carbon energy-saving technologies

Let the advanced technologies of energy conservation and emission reduction go out of the laboratory and truly transform the real projects, it is necessary to combine production, education and research. In the field of energy saving and emission reduction technologies, the conversion rate of most scientific and technological achievements is currently not high. There are many reasons for this. The most important thing is that the technology innovation model of industry, academia and research is backward, which restricts the timely transformation of technological innovation results. Therefore, joint development should be widely carried out in the process of developing industry-university research and cooperation technology innovation activities. The research enthusiasm of universities and scientific research institutions will be fully mobilized to serve the needs of technological innovation of enterprises. At the same time, it promotes the joint use of joint development, commissioned development and consulting services. At the same time, it pays attention to shifting the focus of industry-university-research cooperation from cooperation based on scientific and technological achievements to cooperation focusing on technological innovation capabilities. Energy-saving and emission-reduction technologies are a highly practical and highly engineering technology. Therefore, for the enterprise, while introducing high-tech achievements, it is necessary to digest and absorb in time and carry out independent innovation on this basis. It is necessary to pay attention to the establishment of a comprehensive support system for low-carbon energy-saving technologies, which will play a good supporting role for the effective operation of energy-saving and emission-reduction technologies.

(3) Expand social propaganda and create a low-carbon atmosphere

China has always held a positive attitude towards the development of a low-carbon economy. In order to develop a low-carbon economy faster and better, it is necessary to mobilize the whole society and actively participate in low-carbon actions. This process requires society to: broadly popularize low-carbon knowledge. At present, many people in China have heard of the concept of low-carbon economy, but little is known about the contents of low-carbon economy. Therefore, it is necessary to expand the popularization of low-carbon knowledge, such as frequent low-carbon public welfare propaganda and lectures on low-carbon economy knowledge. Wait; mobilize the enthusiasm of the
people. The low-carbon economy has penetrated into all aspects of our lives very early. The survey shows that people with higher knowledge pay more attention to low-carbon life and green life, while ordinary people rarely do it. To this end, people should be mobilized to participate in low-carbon economy. In the process of construction, for example, by letting people participate in the filming of low-carbon economy-related movies or videos, holding low-carbon economy-related entertainment activities, etc., let the people not "eat melons", but realize that they are building low-carbon Life, an important part of developing a low-carbon economy. All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper. Please keep a second copy of your manuscript in your office.

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