Achievements of green economic development in China from the perspective of environmental governance modernization

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Abstract. President Xi Jinping's concept of green development contains prosperous concepts of economic development and environmental governance modernization. It is an important guideline for the coordination between economic development and energy development. The concept of green development adheres to the two main lines including high-quality economic development and environmental protection, helping the construction of ecological civilization and the harmonious development of economy in China. This paper analyzes the new achievements of China's economic green development in the process of ecological civilization construction. It uses the regional development index method to analyze the comprehensive development index of Beijing and neighboring Tianjin municipality and Hebei province, showing the breakthrough of China's economic green development. It also helps further understand the characteristics and theoretical contributions of Xi Jinping's ecological civilization thought, which will effectively promote an in-depth development of China's ecological civilization strategy. Meanwhile, it provides China's plan and wisdom for promoting world economic development, global ecological governance and building a community of shared future for mankind.

1. Introduction
Recently, the environmental issues caused by energy development in developing countries have attracted worldwide attention [1]. China and India, as the two largest developing countries, have increasingly serious environmental problems. Environmental problems not only damage people's health and quality of life, but also have a long-term adverse impact on the development of the country [2]. The purpose of green development concept is to provide sustainable and good ecological environment for human survival and development [3], its connotation involves many natural and semi-natural elements in the ecological environment [4], and the process of energy development and utilization is closely related to each element. Improper energy development and utilization has a certain threat to the healthy and stable economic development.

This paper analyzes China's economic development situation and the comprehensive development index of Beijing and neighboring Tianjin municipality and Hebei province on the basis of the calculation method of regional development index, which involves four factors including energy conservation and emission reduction, air quality, green investment and ecological construction, showing the breakthrough of China's green economic development. At the same time, facing the concept of green development, the improvement countermeasures of energy development and utilization are put forward.
2. New achievements of green development in China

Green development is a mode of economic growth and social development with efficiency, harmony and sustainability [5]. It is a new development mode taking environmental protection as a critical pillar of sustainable development with constraints of ecological environment capacity and resource carrying capacity. Through the in-depth implementation of the concept of green development, China has strengthened the protection of the ecological environment and pollution prevention, starting a good defense of blue sky, clear water and pure land. Meanwhile, the utilization efficiency of resources is continuously improved, and the green, low-carbon and environmental-protection living style is strengthened. The specific performance is as follows:

(i) With the continuous improvement of resource utilization efficiency, the effect of energy conservation and emission reduction has been significantly strengthened. In 2019, China's energy consumption per 10000 yuan of gross domestic product (GDP) decreased by 2.6% compared with that in 2018, the carbon dioxide emission of 10000 yuan GDP decreased by 4.1%, and the water consumption of 10000 yuan GDP decreased by 6.1%. Clean energy has been widely used. In 2019, coal consumption accounted for 57.7% of the total energy consumption, which was 1.5% lower than that in 2018; natural gas, hydropower, nuclear power, wind power and other clean energy consumption accounted for 23.4% of the total energy consumption, which was 1.3% higher than that in 2018.

(ii) The improvement of ecological protection has been greatly strengthened; the efforts of ecosystem protection and restoration have been significantly increased; and the comprehensive control of soil erosion has been steadily promoted. In 2019, the afforestation and the forest tending areas were 7.07 million and 7.73 million hectares, respectively. The new area of soil erosion control was 54000 square kilometers. By the end of 2019, 474 national nature reserves have been constructed.

(iii) The environmental quality has been significantly improved, and the people lives under blue sky with clear water. In 2019, the average ratio number of days with good air quality in 337 cities of China was 82%. Average concentration of fine particulate matter (PM2.5) in cities below the standard was 2.4% lower than that in 2018. The proportion of excellent (I-III) surface water quality sections in China increased by 3.9% compared with that in 2018, and the proportion of poor grade V sections decreased by 3.3%. Among the 322 cities that have carried out regional acoustic environment monitoring, 2.5% of the cities have good acoustic environment quality, and 66.8% have good acoustic environment quality.

China's ecological and environmental protection work has entered a critical period. In this context, China has made great achievements in controlling the air and water pollution, ecological construction, low-carbon development, energy conservation and emission reduction, and the people's sense of green development has continued to increase recently. Taking the regional development index change of Beijing and neighboring Tianjin municipality and Hebei province since 2010 as an example, this article discusses the outstanding contribution of green development to promoting the overall harmonious development of the region, and it puts forward effective strategies from the perspective of rational energy development and utilization to further implement the concept of green and harmonious development.

3. Methods

3.1. Construction of regional development index evaluation system

Taking regional development index evaluation system of Beijing and neighboring Tianjin municipality and Hebei province as an example, it is constructed from five development concepts of innovation, coordination, green, openness and sharing, including 5 first-level factors, 18 second-level factors and 48 third-level factors. Specific indicators are shown in [6]. Table 1 gives the indicators of green development.
Table 1 Indicators of green development

| First level indicator | Second level indicator | Third level indicator | Weight |
|-----------------------|------------------------|-----------------------|--------|
| Green development     | Conserve energy and reduction of emissions | Energy consumption per unit GDP | 2      |
|                       |                        | Water consumption per unit industrial added value | 2      |
|                       |                        | Sulphur dioxide emission per unit GDP | 1      |
| Air quality           | Proportion of days with air quality above grade 2 in the whole year | 1.5 |
|                       | Average concentration of PM2.5 | 2.5 |
| Green investment      | Proportion of energy conservation and environmental protection expenditure in general public budget expenditure | 2 |
|                       | Proportion of investment in environmental pollution control in GDP | 2 |
| Ecological construction | Per capita urban green space | 2 |
|                       | Proportion of wetland area to area under jurisdiction | 1 |
|                       | Per capita water resources | 2 |
|                       | Proportion of surface water inferior to class V | 2 |

Therefore, the regional development index is an evaluation index system of regional development index based on the advanced development concepts of innovation, coordination, green, openness and sharing. Taking Beijing and neighboring Tianjin municipality and Hebei province as an example, when using the index system to calculate the index, we first take 2010 as the base period and set the index value as 100. Then we observe the change trend of the index value of innovation, coordination, green, openness and sharing and the comprehensive index value of regional development. Secondly, five sub-indexes of innovation, coordination, green, openness and sharing development are calculated respectively, then a total regional development index of Beijing and neighboring Tianjin municipality and Hebei province is synthesized.

3.2. Weight determination
First, the first level indicators in the index system take the form of equal weight, and each level index is 20 points. Second, the weight of the third level indicator is given in the form of expert scoring. The research group invited a total of 10 experts in regional development, foreign trade, environmental economy, public service and other related fields. Each expert independently scored the weight of the three-level indicators, and then comprehensively analyzed and evaluated by the research group, and finally set the weight of the three-level indicators.

3.3. Standardized treatment
In order to ensure the additivity of each index layer, the index values are standardized. Taking the value of the index in 2010 as the benchmark, each index is standardized according to the difference between the positive index and the reverse index. The processing methods are as follows: $y_t$ is a measured index value, $y_{2010}$ denotes the measured index value in 2010, $P_t$ corresponds to the standardized index value, where $t=2010, \ldots, 2019$.

- Standardization of positive indicators: $P_t = \frac{y_t}{y_{2010}}$
- Standardization of reverse index: $P_t = \frac{y_{2010}}{y_t}$

3.4. Standardized treatment
The index value of each index is obtained through comprehensive evaluation with index weighting method. The basic formula of exponential weighted analysis method is as follows:
Composite index: 
\[ S = \sum P_i W_i \]
where \( P_i \) is the evaluation value obtained after dimensionless treatment, which is multiplied by the corresponding weight \( W_i \) to get the score of a sub-index, and \( W_i \) is the weight value of the \( i \)th sub index; the comprehensive index of all levels of indicators is obtained by calculating the scores of each sub-index respectively and summing up.

Through the standardization of indicators, weighted summation is used to get the value of secondary index, primary index and the final total index. Firstly, taking 2010 as the base period, the three-level indicators of each year are standardized to get the standard value of the three-level indicators; then, the weighted sum of the three-level indicators of each year is obtained to get the secondary index value, and the first level index value is obtained according to this method, namely the sub-index value of innovation, coordination, green, openness and sharing development; finally, these five sub-indexes are weighted to get the Beijing and neighboring Tianjin municipality and Hebei province development index of each year. According to the index changes, the regional development changes can be observed.

4. Results and discussion
The calculation results show that the regional development index of Beijing and neighboring Tianjin municipality and Hebei province in 2019 is 167.72, increased by 7.59 points compared to that in 2018, as shown in Figure 1. According to the survey obtained from the National Bureau of statistics, the green development index of Beijing and neighboring Tianjin municipality and Hebei province in 2019 is 164.65, increased by 17.81 points compared to that in 2018, with the largest increase among five sub-indexes. It reflects that the collaborative construction and prevention of ecological environment in Beijing and neighboring Tianjin municipality and Hebei province is further strengthened, the cooperation mechanism is gradually improved, and the ecological construction and environmental governance have achieved results.

![Figure 1. Development index of Beijing and neighboring Tianjin municipality and Hebei province in 2010-2019](image-url)

In terms of energy consumption reduction, the energy consumption of Beijing and neighboring Tianjin municipality and Hebei province will continue to decrease by 53.5% compared with that in the energy saving and emission reduction area, which can be further reduced by 53.5% compared with that in 2019. In terms of air quality, the number of days with air quality at level II or above accounted for 62.6% of the whole year, an improvement of 4.0 percentage points over 2018. The annual average
The concentration of PM2.5 in the region decreased from 55 μg/m³ in the previous year to 50 μg/m³ in 2019, a decrease of 9.1%. Among them, the average annual PM2.5 concentrations in Beijing and neighboring Tianjin municipality and Hebei province were 42 μg/m³, 51 μg/m³ and 50.2 μg/m³, respectively, decreased by 17.6%, 1.9% and 5.8% compared to 2018. In terms of green investment, the regional energy conservation and environmental protection expenditure increased by 16.2% compared with 2018, accounting for 5.4% of the general public budget expenditure, an increase of 0.5% over 2018. In terms of ecological construction, the per capita urban green space area of the region increased from 19.1 square meters per person in the previous year to 19.7 square meters per person in 2019.

5. Conclusion and outlooks
The rational development and utilization of energy helps green development. It is not only conducive to promoting the adjustment of energy structure and changing the traditional energy structure, but also conducive to accelerating the transformation of energy utilization mode, improving the ecological environment, cultivating new economic growth fields and driving the development of related industries. The specific measures are as follows:

(i) Coordination of the relation between energy development and utilization and ecological civilization construction

The construction of ecological civilization requires the basic formation of industrial structures, growth and consumption ways that can promote resource conservation and ecological environment. It is necessary to put the construction of resource-saving and environment-friendly society in the prominent position of industrialization and modernization development strategy, implementing the energy development strategy of developing economy and development at the same time and putting saving in the first place. Energy development and utilization should be coordinated with the achievement of ecological civilization.

(ii) Optimization of the energy consumption structure

We need to improve the utilization of new energy, actively develop clean energy such as natural gas, nuclear power and renewable energy, to decrease the coal consumption content, and to facilitate the continuous control of energy constitution. We should strengthen the development and progress of clean energy, improve the content of clean energy in installed capacity and power generation, and promote the optimization of energy structure. We will greatly increase the proportion of new energy applications, and promote the development of novel nuclear power, effective photoelectric photothermal, macro-scale offshore wind power, efficient energy storage, and smart grid.

(iii) Control of the total coal consumption

We should attach importance to the coordinated control of regional coal consumption, continue the coal control measures in critical areas. Also, we need to continue to strengthen the total coal control in key coal control areas. In addition to the vigorous control of key areas, we should take more specific and strict coal consumption control measures, establish a unified regional coal decomposition mechanism, and implement mandatory management of coal consumption. We should accelerate the transfer of coal consumption to the western region and optimize the layout of coal industry.

(iv) Development of the energy saving industry

We will promote energy conservation in an all-round way, such as the energy-saving equipment technology in construction and transportation. We need to improve the effective development and energy-saving technologies. We need to strengthen the research and development of key technologies for energy conservation at the source of industry, integrate the waste heat and gas resources of high energy consuming technologies such as steel, cement and power generation across industries, and develop waste heat heating, power generation and low-temperature waste heat power generation. Industrial enterprises can be encouraged to apply solar collectors for heating in low-temperature heating section. Wind power and solar power generation are encouraged to integrate with enterprise energy supply and control system, and the local consumption of renewable energy would be increased. We should vigorously promote the application of building energy-saving materials and products, and promote energy-saving technology of transportation.
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