

# *Research on differentiated carbon emission reduction path under the background of coordinated development of Beijing, Tianjin and Hebei*

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**Abstract:** The coordinated development of Beijing Tianjin Hebei is a national strategy, which implements the coordinated development of Beijing Tianjin Hebei, promotes the coordination ability of regional economy, improves regional competitiveness, and thus promotes the development of the national economy. The Carrying capacity of the Beijing Tianjin Hebei region is limited. Although the environment of the three regions has been significantly improved through strong environmental protection measures in recent years, the large-scale and high emission development means have completely exceeded the Carrying capacity of the region. Carbon reduction can reduce the emissions of greenhouse gases such as carbon dioxide, thereby reducing the concentration of greenhouse gases in the atmosphere, slowing down the trend of global warming, protecting the Earth's ecological environment, and promoting sustainable development. For the Beijing Tianjin Hebei region, implementing carbon reduction should not be limited to a single province or city, but should be viewed from the perspective of regional coordinated development. This article first analyzes the current situation of environmental protection in the Beijing Tianjin Hebei region, and then analyzes the limitations of carbon reduction in the three regions. Finally, it proposes carbon reduction measures based on regional synergy perspective.

## **1. Current Situation of Economic Development and Environmental Protection in Beijing Tianjin Hebei**

### **1.1 Current Economic Development Status of Beijing Tianjin Hebei**

#### **1.1.1 Uneven economic growth rate, large gap in total output, and even greater per capita gap**

In terms of economic growth, the economic growth rate in the Beijing Tianjin Hebei region is relatively fast. Among them, Beijing and Tianjin are first tier cities in China, with high levels of economic development, and Hebei is gradually catching up. Taking 2022 as an example, the total GDP of Beijing Tianjin Hebei Gross regional product is 10.0 trillion yuan. At current prices, the GDP of the three regions is 1.71 times that of 2014; Separately speaking, Beijing's GDP is 4.16

trillion yuan, while Hebei Province's GDP is 4.24 trillion yuan. Hebei Province has surpassed the 4.2 trillion yuan mark for the first time, while Tianjin has also reached 1.63 trillion yuan after several years of slow economic development, which is 1.53 times that of 2014. The growth rate of Beijing Hebei is faster than that of Tianjin.

In terms of per capita income, Beijing's per capita income reached 77400 yuan/person, Tianjin's per capita income reached 49000 yuan/person, while Hebei Province's per capita income was only 30900 yuan/person. In the 2022 national per capita income ranking, Beijing ranked second, Tianjin ranked fifth, and Hebei Province ranked 17th, with a significant gap between the three.

### **1.1.2 Significant differences in the structure of the first, second, and third industries**

First, from the perspective of Primary sector of the economy, there are significant differences in the development of agriculture, forestry, animal husbandry and fishery in Beijing Tianjin Hebei region. Specifically, the Primary sector of the economy in Beijing mainly focuses on facility agriculture and agricultural tourism, pursuing an efficient and high value-added agricultural development model. The Primary sector of the economy of Tianjin is mainly animal husbandry and fishery, and focuses on the development of marine fishery and animal husbandry. The main industries in Hebei are traditional agriculture and animal husbandry, but with the development of technology and the promotion of policies, some modern agricultural management models are gradually emerging. Secondly, from the perspective of the Secondary sector of the economy, the industrial development in Beijing Tianjin Hebei region presents different characteristics. The Secondary sector of the economy of Beijing is mainly concentrated in high-tech industries, such as electronic information, biomedicine, aerospace, etc. The Secondary sector of the economy of Tianjin focuses on equipment manufacturing and petrochemical industry, focusing on the development of high-end equipment manufacturing and chemical industry. While the Secondary sector of the economy in Hebei is dominated by traditional manufacturing industries such as steel, nonferrous metals, textiles, etc., some emerging industries are also gradually growing with the adjustment and upgrading of industrial structure. Finally, from the perspective of the Tertiary sector of the economy, there are differences in the development of the service industry in Beijing Tianjin Hebei region. The Tertiary sector of the economy in Beijing is dominated by modern service industries such as finance, education, science and technology, and culture. The Tertiary sector of the economy in Tianjin is dominated by logistics, trade, finance, and other service industries, while the Tertiary sector of the economy in Hebei is relatively backward, mainly focusing on traditional logistics and trade services.

### **1.2 Environmental protection issues in the Beijing Tianjin Hebei region**

In terms of air quality, the air quality in the Beijing Tianjin Hebei region has received widespread attention, and the three regions have taken different measures in air pollution prevention and control. Since 2013, Beijing has implemented the "strictest" air pollution prevention and control measures in history, achieving significant improvements in air quality through measures such as restricting motor vehicles, banning straw burning, and closing heavily polluting enterprises. Tianjin and Hebei have also taken a series of measures in air pollution prevention and control, but the effectiveness is relatively weak, and air quality still needs to be improved. And Beijing is one of the first cities to achieve positive economic growth and negative carbon emissions growth. Taking January 2023 as an example, the proportion of excellent days in January 2023 in Beijing was 93.5%. Even among the top 20 cities in the country, except for Beijing, all other cities are in the south, while the proportion of excellent days in Tianjin during the same period was 74.2%. Hebei Province has not released relevant data.

In terms of water pollution protection, there is also a gap in sewage treatment and recycling among the three regions of Beijing, Tianjin, and Hebei. Beijing has taken proactive measures in sewage treatment, achieving comprehensive coverage of sewage treatment by constructing sewage treatment plants and laying sewage pipelines. At the same time, Beijing has actively promoted the use of renewable water resources and achieved the circular utilization of water resources. However, Tianjin and Hebei are relatively lagging behind in sewage treatment and recycling, and some areas have the problem of direct sewage discharge, which needs to be improved through strengthened management and investment.

## 2. Current research status at home and abroad

As the hot content of "carbon emission reduction", a total of 15897 relevant studies were retrieved on CNKI, including 10936 academic journals, 2126 Thesis, 592 conferences, 1814 newspapers, and 12 books. The contents involved the effects of carbon emission reduction policies, the path of carbon emission reduction policies, the factors affecting the realization of carbon emission reduction, the effects of carbon emission reduction, and regional differences. When searching for "carbon emission reduction+differentiation", a total of 50 studies were conducted. The proportion of research related to "carbon reduction" is only 0.31%, while there are a total of 29 journals, accounting for only 0.27%. When searching foreign databases under the theme of "Carbon Reduction+Differences", a total of 7 research results were obtained. It can be seen that there is a serious lack of research on "Carbon Reduction+Differences" both domestically and internationally.

Zhang Youguo and Bai Yujie (2021) analyzed from the perspective of regional carbon emissions, and this study believes that the achievement of the national "dual carbon" goal cannot be achieved without the active efforts of various regions. However, similar to the differences in carbon peaking in different countries or regions of the international community, significant differences in the carbon emission situation among different provinces in China have also emerged and will continue in the long term. Therefore, each region must choose a path that is suitable for the local "dual carbon" goals, in order to achieve the national "dual carbon" goals at a lower cost. To this end, each region should define its carbon emission reduction goals and steps according to its own carbon emission stage, formulate low-carbon development level promotion strategies according to the characteristics of carbon emission drivers and change trends, seek low-carbon transformation of industries on the basis of high-quality economic development, and deeply integrate its own "dual carbon" goal realization path into the country's major strategy of building a Dual circulation.<sup>[1]</sup> Yin Weihua (2021) believes that the "30.60" carbon emission target is increasingly becoming a hard constraint on China's economic development. This study uses the GTAP-E model to set four policy scenarios: developed economies only levy carbon taxes on themselves, developed economies levy carbon taxes on themselves and impose carbon tariffs on China, developed economies levy equal carbon taxes on China, and developed economies levy differentiated carbon taxes on China, Analyze the macroeconomic, resident welfare, and carbon emissions impacts of various economies under different emission reduction policies, and explore the feasibility of China's proactive adoption of cost fairness based differentiated carbon tax policies to address the threat of carbon tariffs in developed economies.<sup>[2]</sup> Zhang Xiaomei and Zhuang Guiyang (2015) started their research on cross regional carbon emission reduction, focusing on reviewing and commenting on inter provincial regional carbon emission accounting methods, regional patterns and transfers of inter provincial carbon emissions, drivers and performance of inter provincial carbon emissions, and decomposition of inter provincial carbon emission targets. By systematically summarizing and summarizing relevant research at home and abroad, this article objectively analyzes and evaluates the research status and existing problems of the above four issues. Finally, prospects were made for the key

areas and development directions of carbon emission reduction differences between provinces and regions in China, providing reference for policy and theoretical research. <sup>[3]</sup>

Jingna J, Tao L, Lei Y (2023) established a price and low-carbon competition model for two vertically differentiated enterprises with consumer preferences for low-carbon products - high-quality manufacturers (HM) and low-quality manufacturers (LM). In the Carbon emission trading market, when the unit carbon emissions reach the quota, enterprises can choose to buy (re, sell) carbon quotas. It is essential for the government to implement the quota and trading regulation (CATR). Investigate how manufacturers' pricing and carbon reduction rate (CRR) will be influenced by consumers' CATR and low-carbon preferences. In the absence of CATR, for manufacturers, there is always a positive correlation between price and CRR. However, under CATR, when CRR increases, hiking prices may not necessarily be the best choice for manufacturers. This study proves that in order to incentivize manufacturers to increase their carbon reduction rates, the government should increase the unit carbon quota instead of reducing it. <sup>[4]</sup> Shu T, Yue X, Qingsong W et al. (2022) used Shandong Province as an example to comprehensively explore the impact of 16 socio-economic factors on carbon emissions in different cities through an extended STIRPAT model. In order to reduce the uncertainty of research results and achieve "one city, one policy", this study first screened the influencing factors of carbon emissions in different cities as specific parameters for different cities in scenario setting. Secondly, based on the actual development situation of different cities, scenario combination schemes are obtained by freely combining different influencing factors to predict the peak time and size of carbon emissions. The research results show that 16 cities in Shandong Province exhibit differentiated peak gains. Among them, 8 cities will reach their peak year around 2025, 5 cities will reach their peak year around 2028, and 2 cities will be able to reach their peak year before 2030. <sup>[5]</sup>

### **3. Current Status of Differentiated Carbon Emission Reduction in Beijing, Tianjin, and Hebei**

There are certain differences in carbon emissions among the three regions of Beijing, Tianjin, and Hebei. Beijing has relatively low total carbon emissions and carbon emission intensity, indicating that its economic development is relatively low-carbon; The carbon emission intensity of Tianjin is slightly higher than that of Beijing, but the proportion of clean energy consumption is also gradually increasing; However, the total carbon emissions in Hebei are relatively high, and it relies heavily on traditional heavy industry and coal consumption.

#### **3.1 Large gap in total carbon emissions among the three regions of Beijing, Tianjin, and Hebei**

According to relevant data, Beijing's total carbon emissions reached approximately 99 million tons in 2018, Tianjin's total carbon emissions reached approximately 88 million tons in 2018, and Hebei's total carbon emissions reached approximately 235 million tons in 2018. It can be seen that the total carbon emissions of Hebei are much higher than those of Beijing and Tianjin, which is related to Hebei's traditional heavy industry and coal consumption. In 2020, the carbon emissions of the Jing-Jin-Ji will be 601 million tons, an increase of 335 million tons compared with 266 million tons in 2009. From the perspective of ecological compensation, although Chengde City of Hebei Province has explored cross regional carbon emissions trading, Luanhe River transboundary basin compensation and other horizontal compensation mechanisms with Beijing and Tianjin in recent years, ecological compensation is mostly reflected in supporting and subsidizing some projects, lacking long-term mechanism guarantee of marketization and socialization, which restricts the environmental governance and green development of Beijing Tianjin Hebei region, and there is still a certain gap with the modern world-class urban agglomeration of green and low-carbon cities.

### **3.2 Large gap in carbon emission intensity among the three regions of Beijing, Tianjin, and Hebei**

Carbon emission intensity refers to the carbon emissions per unit of GDP, and a higher intensity indicates a greater dependence of economic development on carbon emissions. According to relevant data, Beijing's carbon emission intensity was 0.69 kg/10000 yuan in 2018, Tianjin's carbon emission intensity was 0.91 kg/10000 yuan in 2018, and Hebei's carbon emission intensity was 2.3 kg/10000 yuan in 2018. It can be seen that Beijing's carbon emission intensity is relatively low, indicating that Beijing's economic development is relatively low-carbon, while Hebei's carbon emission intensity is relatively high, indicating that economic development is highly dependent on carbon emissions. Taking 2021 as an example, with the orderly promotion of industrial upgrading in the Beijing Tianjin Hebei region, the composition ratio of the three industries has changed from 6.2:35.7:58.1 in 2013 to 4.5:30.6:64.9 in 2021. Among them, the Tertiary sector of the economy has developed rapidly, but the Secondary sector of the economy still accounts for more than 30%, and the high carbon industry still occupies an important position. The high carbon industrial structure supported by heavy chemical industry has maintained a high carbon emission intensity since the mayoral period in provinces such as Hebei and Tianjin. Although Hebei has accelerated the adjustment of industrial structure in recent years, the proportion of Secondary sector of the economy in GDP is still 38.74%. As a major industrial province, Hebei Province focuses on heavy industry represented by the steel industry, while the development of high-tech and green low-carbon industries is relatively lagging behind.

### **3.3 There is a large gap in the energy consumption structure among the three regions of Beijing, Tianjin, and Hebei**

According to relevant data, in Beijing's energy consumption structure in 2018, clean energy (such as natural gas, wind energy, solar energy, etc.) accounted for about 70%, while coal consumption accounted for only about 20%. The proportion of clean energy in Tianjin is also gradually increasing, reaching over 50%. However, Hebei still relies mainly on coal in its energy consumption structure, accounting for over 60% of the total. This indicates that Beijing and Tianjin have relatively clean energy consumption structures, while Hebei needs to further optimize the energy consumption structure and reduce the proportion of coal consumption. By contrast, Beijing's total energy consumption has continued to rise, from 65.641 million tons of standard coal in 2012 to 71.036 million tons of standard coal in 2021, supporting an average annual economic growth of 6.4% with a low energy consumption growth rate of 0.88%. Among them, coal consumption has significantly decreased from 21.796 million tons in 2012 to 1.308 million tons in 2021, accounting for 1.4% of the city's energy consumption from 25.2%. The proportion of imported electricity in energy consumption has increased from 17.1% and 25.8% to 36.2% and 28.7%, respectively. Tianjin's energy consumption has gradually decreased from 83.1938 million tons of standard coal in 2015 to 82.0569 million tons of standard coal in 2021. Among them, industrial energy consumption in 2021 was 51.097 million tons of standard coal, accounting for 62.41% of the total energy consumption in Tianjin. The proportion of traditional energy consumption in Hebei Province has been continuously decreasing, with coal gradually decreasing from 88.9% in 2012 to 67.0% in 2021. The proportion of oil consumption has fluctuated and decreased, and the proportion of oil in total energy consumption has decreased from 7.5% in 2012 to 6.6% in 2021. The proportion of traditional energy such as coal and oil is relatively high.

## **4. Optimization Measures for Differentiated Carbon Emission Reduction in Beijing Tianjin Hebei**

Against the backdrop of coordinated development between Beijing, Tianjin, and Hebei, the three regions should adhere to ecological priority and green development. Starting from multiple fields such as collaborative planning, collaborative innovation, collaborative transformation, and collaborative prevention and control, the three regions should promote mutual coupling in carbon emission reduction, and coordinate to advance the world-class urban agglomeration of Beijing, Tianjin, and Hebei towards green and high-quality development.

### **4.1 Optimize spatial layout**

The Beijing Tianjin Hebei region, as an important political, economic, technological and cultural center in China, is also one of the regions with high carbon emission intensity. In order to achieve the goal of carbon reduction, the region needs to take a series of measures to optimize its spatial layout. Firstly, the Beijing Tianjin Hebei region should strengthen cooperation between cities and promote green development among them. Specifically, the region should strengthen cooperation between cities in areas such as transportation, energy, and communication to reduce the carbon emission gap between cities. Secondly, the Beijing Tianjin Hebei region should strengthen the construction of green infrastructure within cities. For example, the region should strengthen the construction of greening, water purification, building energy conservation, and other aspects within the city to improve its carbon sequestration capacity. Once again, the Beijing Tianjin Hebei region should strengthen the green transformation of industrial enterprises. The region should encourage industrial enterprises to adopt clean energy, energy-saving and environmental protection technologies to reduce their carbon emissions. Finally, the Beijing Tianjin Hebei region should strengthen the green development of agricultural production. The region should promote agricultural production models such as ecological agriculture, organic agriculture, and circular agriculture to reduce carbon emissions from agricultural production.

### **4.2 Promote energy structure adjustment**

The Beijing Tianjin Hebei region should actively promote energy structure adjustment and promote the development and utilization of clean energy. Specifically, efforts should be made to increase the utilization of renewable energy and promote clean energy transportation; Strengthen the improvement of energy efficiency, reduce energy consumption and carbon emissions; Strengthen the construction of carbon Emissions trading market and promote the consumption of clean energy. On the one hand, it can improve the tiered electricity price system for residents, guide electricity conservation, and optimize electricity Consumer behaviour. On the other hand, it can improve the price formation mechanism of natural gas Pipeline transport and steadily promote the marketization reform of natural gas valve station prices to promote the use of natural gas. At the same time, multiple channels are used to ensure the supply of natural gas and avoid gas and heating stoppages.

### **4.3 Strengthen technological innovation**

The Beijing Tianjin Hebei region should strengthen technological innovation and promote green development. Specifically, we should strengthen the construction of technological innovation platforms and promote green technological innovation; Promote green buildings and green manufacturing technologies to improve energy efficiency; Strengthen talent cultivation and

introduction, and establish a diversified talent team.

#### 4.4 Deepen the reform of institutional mechanisms

The Beijing Tianjin Hebei region should deepen the reform of institutional mechanisms and promote green development. Specifically, we should strengthen the construction of ecological environment protection systems and establish long-term mechanisms for ecological environment protection; Promote energy price reform and establish an energy price mechanism that reflects the scarcity of resources and the cost of environmental damage. Firstly, we can continue to deepen the market-oriented reform of grid electricity prices for hydropower, nuclear power, natural gas power generation, and other industries to promote the development of new energy and related energy storage industries; Secondly, the reform of transmission and distribution electricity prices can be promoted to promote the optimized allocation of power resources on a larger scale. In addition, green electricity pricing policies such as differential electricity prices and tiered electricity prices for high energy consumption and high emission industries can also be improved to promote energy conservation and carbon reduction. At the same time, social participation and public opinion supervision should also be strengthened to create a good atmosphere of green development.

#### 5. Conclusion

The Beijing Tianjin Hebei region can optimize its carbon emissions measures by promoting energy price reform, promoting low-carbon transformation of energy supply structure, optimizing energy consumption structure, and strengthening regulation.

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