Study on the Impact Mechanism of China's Carbon Emission Trading on Cities' Sustainable Development

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Abstract. As an important tool for global climate governance, carbon emissions trading systems have received a lot of attention. Rising carbon emissions do lead to 'non-linear' shocks to the global climate and the economy-society-region. The greenhouse effect of carbon emissions may generate new economic costs and the Chinese government nowadays has attached great importance to low carbon sustainable development as well. This article presents the background of China's carbon emissions trading on sustainable urban development and the countermeasures taken by the Chinese government. By examining the current combination of China's economic and policy goals for carbon neutrality, it provides an in-depth analysis of the implications of the establishment of carbon markets for sustainable development and concludes the article with policy responses and recommendations for the early achievement of climate change goals. To this point, the implementation of carbon emissions in China offers a diverse and attractive sustainable development opportunity for all players in the ecosystem.

Keywords: Carbon Peak; Carbon Neutralization; China's Sustainable Development; Greenhouse Gas Emissions.

1. Introduction

The issue of climate change is a huge challenge for mankind. The massive emission of greenhouse gases, mainly carbon dioxide, has led to global warming, which seriously threatens people's normal production and living activities. In response to the increasingly serious climate change problem, the Paris Agreement has set out a global temperature control target. This not only puts forward new requirements for China's carbon dioxide emission reduction process, but also provides an important opportunity to promote a comprehensive green transformation of China's economy [1]. The coal-based energy consumption structure is difficult to be substitute ed within the short term, which puts pressure on China to reduce carbon emissions. Therefore, how to promote carbon emission reduction and achieve sustainable development of the economy and the environment has become an urgent task to be solved at present.

Carbon neutrality refers to an enterprise, group or individual measuring the total amount of greenhouse gas emissions produced directly or indirectly within a certain period of time, and offsetting their own carbon dioxide emissions by planting trees, saving energy and reducing emissions, so as to achieve "zero" carbon dioxide emissions. However, the carbon neutrality for China is not to achieve "absolute zero emissions", but to reduce the impact of man-made emissions on nature to an almost negligible level by 2060 through technological innovation, to achieve a new balance between man-made emission sources and nature, and to truly achieve a harmonious coexistence between man and nature [1-2].

On September 22, 2020, China's President Xi Jinping announced at the general debate of *the 75th Session of the United Nations General Assembly* that China will increase its autonomous national contribution, adopt stronger policies and measures, strive to peak carbon dioxide (CO_2) emissions by 2030, and strive to achieve carbon neutrality by 2060. This is a great and visionary declaration that has generated tremendous positive reactions around the world. The new peak target and carbon neutral vision is a major strategic decision made by the State Council to coordinate the international and domestic situations, with far-reaching implications and great significance. This important

declaration has set higher requirements, drawn a grand blueprint, and pointed out the direction and path for China's current and future period, and even for the construction of green low-carbon development and ecological civilization in the middle of this century [2]. From the international perspective, this important declaration demonstrates China's new efforts and contributions to address global climate change, reflects China's firm support for multilateralism, and fully demonstrates China's role as a responsible power to promote the building of a community of human destiny, which is widely recognized and highly praised by the international community.

From China's carbon trading market turnover from 2014 to 2020, the overall turnover showed a fluctuating trend: in 2017, China's carbon trading turnover was the largest, at 49.031 million tonnes of carbon dioxide equivalent; in 2020, China's carbon trading market turnover was 43.409 million tonnes with an increase of 40.85 %. From the change of the turnover amount of China's carbon trading market, the overall turnover from 2014 to 2020 showed an increasing trend, with only a small decrease in 2017 and 2018. 2020, the turnover amount of China's carbon trading market reached RMB 1.267 billion, an increase of 33.49 % year-on-year, setting a new high in the turnover amount of the carbon trading market. At the same time, China established eight carbon markets pilot in Beijing, Shenzhen, Hubei, Guangdong, Shanghai, Tianjin, Chongqing and Fujian in response to the country's ambition to address climate change. With the advancement of China's carbon trading pilots and voluntary emission reduction projects, establishing a carbon trading market that can connect and integrate across regions has become the focus of future development [3]. Clarifying the role of the carbon trading market and its impact mechanism is of great policy and practical importance to effectively respond to extreme climate change and achieve China's "peak" and "carbon neutral" goals as soon as possible [4].

In this paper, the background of China’s carbon emission trading on cities’ sustainable development as well as the countermeasure taken by Chinese government are introduced. Through the study on carbon neutral targets via the combination of the current China’s economy and policy, the impact of carbon market establishment on sustainable development are analysed in depth. The countermeasures and recommendations for the early achievement of climate change goals are proposed in the final section of the paper. At this point, the implementation of carbon emissions in China offers a diverse and attractive sustainable development opportunity for all players in the ecosystem [5].

2. Importance of Study on Carbon Neutral Targets

China's carbon neutrality target at this time is not only about environmental protection and green development, but also implicates a series of areas for transformation and upgrading.

2.1 International Carbon Trading Framework and Chinese Entreprenship Practice

In 1997, the Kyoto Protocol was formed on the basis of the United Nations Framework Convention on Climate Change, which innovatively addressed the issue of optimal allocation of global climate resources by introducing market mechanisms. The Kyoto Protocol provides for three complementary carbon trading market mechanisms to reduce the cost to countries of achieving their emission reduction targets. First one is the International Emissions Trading Mechanism (IET), which allows developed countries to trade or transfer emission credits (AAUs) among themselves, enabling countries with excess emissions to meet their emission reduction obligations by purchasing excess emission credits from countries with savings. Secondly, the Joint Implementation Mechanism (JI), which helps countries with excess emissions to meet their compliance obligations through the trading and transfer of project-generated emission reduction units (ERUs) between developed countries [6]. Thirdly, the Clean Development Mechanism (CDM), in which developed countries develop and cooperate with developing countries to reduce greenhouse gas emissions through financial support or technical assistance, and obtain corresponding emission reductions, which are verified and certified as Certified Emission Reductions (CERs) and can be used for compliance by developed countries [7].

Over the past decade, more and more countries have put emphasis on the green development and proposed emission reduction targets, and some large enterprises with responsibility or seeking global development have also proposed "zero carbon" targets. For example, Unilever, IKEA, Mercedes-Benz, and Volkswagen have all set explicit "zero carbon" or "halve" targets. China's carbon neutrality target means that another huge market will raise the level of green development and green development standards. Domestic enterprises, in particular, must not shirk their responsibilities on environmental issues [6]. Only by planning ahead and preparing for policy changes can it achieve sustainable development of the enterprises themselves [8].

On the basis of the international framework, China has adopted the practice of CDM. By eliminating outdated production capacity and promoting carbon emissions trading, China has moved from a concern for "pollution" to "carbon emissions trading". Carbon emissions trading is led by the power sector [7]. China's carbon market is divided into three main phases: the first phase from 2002 to 2011, mainly participating in international CDM projects; the second phase from 2011 to 2020, in Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, Fujian and Shenzhen to carry out carbon emissions trading pilot; the third phase from 2021 to establish a national carbon trading market. In 2020, with the goal of "carbon peaking and carbon neutrality" being mentioned several times, the construction of a national carbon trading market is accelerated, the "Carbon Emissions Trading Management Measures" is released in January 2021 for trial implementation, and the power industry officially starts the first compliance round in 2021.

2.2 Carbon Neutral Mechanisms and Green Finance

On September 19, Wang Xin, Director of the Research Bureau of the People's Bank of China, said that it is important to pay attention to climate-related risks at the *2020 China Finance Society Green Finance Professional Committee Annual Meeting* and *China Green Finance Forum*. According to his speech, a large number of financial assets may become stranded when the big climate and environmental policies get changed. For example, with policy changes, coal power investments and coal power loans will be affected [9]. With the establishment of carbon neutrality targets, related policies may already be under intensive study. Financial institutions must strengthen relevant research capabilities and conduct stress tests in advance to prepare for them [5]. As defined in the "Guiding Opinions on Building a Green Financial System" jointly issued by seven ministries and commissions in 2016, green finance refers to economic activities that support environmental improvement, climate change, and the economical and efficient use of resources, i.e. financial services provided for project investment and financing, project operation and risk management in the fields of energy conservation and environmental protection, clean energy, green infrastructure, etc. From the domestic status quo, by the end of 2020, China's green credit balance reached RMB 12 trillion, the world's largest stock size, with funds mainly invested in the clean energy and transportation sectors, and commercial banks becoming important participants in green credit and green industry funds. 18 March 2021, Shanghai Clearing House released the Green Bond Index.

China's green finance has started since 2005, with top-level design documents issued in 2016, new versions of standards such as *the Green Industry Guidance Catalogue* and *the Catalogue of Green Bond Support Projects* issued since 2019, and *the Green Finance Performance Evaluation Programme* for Depository Financial Institutions in the Banking Sector issued in 2020, and a multi-level market for green credit, bonds and insurance has been initially formed [4]. Specifically, a policy system including a classification and statistical system, an assessment and evaluation system and a reward and incentive mechanism has been established for green credit; a differentiated policy system including issuance criteria recognition, information disclosure and renewal period management has been gradually formed for green bonds according to different bond categories; policy construction for green securities index, green insurance and environmental equity trading market is still in progress.

Besides, China may also need to invest in large-scale green renewal in the near future. Since 2013, China's industrialisation has entered a plateau and urbanisation has become the key to new carbon emissions. New and stock transport, buildings and infrastructure renovation have been becoming

areas for significant investment and green financial support. According to CICC's estimates, the cumulative green investment and financing gap from 2021-2030 is approximately RMB 5.4 trillion, or RMB 0.54 trillion per year on average [6]. This gap may widen further as investment demand takes a back seat, and without policy intervention, the green investment and financing gap could rise rapidly to over RMB1.3 trillion per year after 2031.

3. China's Path to "Carbon Neutrality" by 2060 and Challenges

According to the greenhouse gas abatement cost curve introduced by McKinsey, the order of various greenhouse gas saving technologies and means can be ranked accordingly. There are many ways to reduce emissions at different stage, and this order should be determined by considering the cost-effectiveness and ease of implementation of various mitigation measures [10]. The "Carbon Neutrality" pathway can be broadly divided into three phases as follows.

Phase I (2020-2030) - To reach the peak of carbon emissions. Under the basic task of reaching the peak in 2030, the main tasks are to reduce energy consumption intensity, reduce carbon emission intensity, control coal consumption, develop clean energy on a large scale, continue to promote the replacement of traditional fuel vehicles by electric vehicles, promote energy conservation (improve energy efficiency of industry and residents) and guide consumer behavior.

Phase II (2030-2045) - To rapidly reduce carbon emissions. The main emission reduction pathway after reaching the peak is shifted to renewable energy as the main source, and the replacement of traditional fuel vehicles by electric vehicles is completed on a large scale, while the transformation of emission reduction in primary industries is completed, supplemented by the process of CCUS and other technologies.

In Phase III (2045-2060) - To achieve deep decarbonization, participate in carbon sinks, and complete the goal of "carbon neutrality". During the period from deep decarbonization to the completion of the "carbon neutral" target, the potential for efficient and clean utilization in industry, power generation, transportation and residential side has been basically developed, and carbon sink technologies should be considered at this time, such as carbon capture, utilization and storage (CCUS), biomass carbon capture and storage (BECCS), and other negative emission technologies that balance economic development and environmental issues. Emission reduction technologies are the main focus.

An effective emission reduction path must start from the direction of the lowest cost of emission reduction and the easiest to operate [11]. For the time being, China's energy use efficiency is still relatively low, and the payback period for energy-saving projects in most factories is short compared to the life of the factory equipment, which makes many energy-saving projects economically profitable in themselves. The only thing to consider is to reduce information asymmetry and regulate the energy-saving market, and the new energy segment, whether it is new energy generation or electric and hybrid vehicles, its cost of power generation costs and whole life cycle costs are rapidly declining due to the market competitiveness [4]. As a result, new energy projects in the last two decades will perhaps show exponential growth.

When China's carbon emissions peak and begin to decline, there will be few energy-saving and emission reduction projects that are economically beneficial in their own right, resulting in less room for emission reduction due to energy efficiency, and at this point it is the replacement process between new and traditional energy sources. Therefore, in the process of carbon emissions from the peak to the gradual decline, the main force of emission reduction of new energy to traditional primary fossil energy replacement technology [12]. Since thermal power plants generally have a life cycle of 50 years or more, even if no new thermal power plants are built, those already built will continue to play a role in supplying energy, at which point most emissions still come from coal-fired power plants, as well as process emissions from some industrial/civil gas and cement plants.

In the process of deep decarbonization, additional capital is needed for the huge investments and subsidies of new energy sources. To ensure "carbon neutrality", carbon emissions from power generation must be addressed. Hence, the CCUS technology must expand rapidly at this time.

However, the process of deep decarbonization should begin around 2045-2050, when the cost per unit of CCUS emissions reduction should be significantly reduced based on prior technology accumulation and innovation.

4. Carbon Markets and Trading: How Do They Work?

After a decade of piloting, the national carbon market was officially launched. On July 16, 2021, the Shanghai Environmental Energy Exchange, the first national carbon transaction was successful, with a price of RMB 52.78 per ton, a total transaction of 160,000 tonnes, and a transaction amount of RMB 7.9 million. The so-called carbon trading is to buy and sell carbon dioxide emission rights as a commodity. The enterprises that need to reduce emissions will get a certain amount of carbon emission quotas, and they can sell the excess quotas for successful emission reduction, while the excess emissions will have to buy quotas in the carbon market [13]. The purpose is to control the total amount of carbon emissions through the trading of carbon emission rights. How will the national carbon market work? How to form a reasonable carbon price to guide enterprises to reduce emissions? Will a carbon tax be introduced in the future? How will the dual carbon targets affect China's economy?

At present, China's carbon market is still mainly the spot trading of quotas, and neither the trading volume nor the market value is high enough. In the future, the carbon financial market should be developed simultaneously, i.e., the futures and options carbon financial market based on quotas, and even some guarantee and financing products will be further developed. With the leverage of such a carbon financial market, the trading volume and market value of the carbon market can be multiplied, the market liquidity can be increased, and the carbon pricing can be more objective [3]. The carbon market and the carbon financial market are one and the same, and we expect investment institutions and investors to participate in the carbon market in the future. The importance of the carbon market is also reflected in the role of resource allocation through the formation of carbon prices. For enterprises, with carbon pricing, the carbon dioxide emitted by an enterprise has to enter its cost, and if it can reduce emissions through technological progress, the excess quota can be sold, which changes the traditional cost-benefit analysis. At the same time, it may become possible to attract more capital flow to low-carbon energy-saving emission reduction industries through the carbon market, thus the development of China's carbon market may also play a significant role in the resource allocation.

The carbon market also needs to solve a difficult problem, the verification of carbon data, and the carbon market will promote the construction of infrastructure. In the future, as technology advances, it may be possible to quickly measure the carbon emissions of each enterprise and individual, which will reset the cost-benefit analysis framework for the whole market [7]. The most important role of carbon markets is to provide carbon pricing. With carbon pricing, it will change the behavior pattern of every market player and change the profit view of enterprises, which may produce green products in the future.

5. Counter Measure for Chinese Cities' Sustainable Development

5.1 Establish Flexible Mechanism with Dual Targets for Carbon Intensity

The carbon trading system in Chinese cities is different from the existing systems in the world, as it is based on emission intensity control, and the total amount of carbon can be regulated on a regular basis. Under this mechanism, if the industrial value added of enterprises keeps getting larger, the total amount of carbon will also increase as long as the carbon target intensity is determined. But this does not correlate with the effectiveness of energy saving and emission reduction of enterprises. Such inflexible system has been described in detail in the preceding section as a manifestation of the uncertainty surrounding the target and the effectiveness of implementation [10]. To address this issue, it is recommended that the authorities establish a flexible mechanism for controlling carbon intensity and total amount of carbon with dual targets in the next compliance period. Specifically, before making decisions on the allocation of allowances, the competent authorities should conduct in-depth

analyses of the production, operation and emission data of the regulated industries and enterprises, paying particular attention to the changes in the industry's prosperity, profitability, market space, absolute value of the enterprises' main business income, the structure of their main business, mergers and acquisitions, restructuring and disintegration, etc. Based on the actual situation in the current year and rational forecasts for the future, the industry and enterprises are accurately categorised and measured, and fair and reasonable dual targets for total volume and intensity are set. In each compliance period, the total volume and intensity targets of enterprises are double-assessed. Only enterprises with a decrease in both total volume and intensity are directly judged to have achieved their targets. Whereas, in all other cases, enterprises are required to submit a certain amount of additional quota. The participation and contribution of all stakeholders are paramount to the successful achievement of the green transition.

5.2 Redraw the Industry Baseline

Correct industry classification is key to the smooth and healthy operation of carbon trading. At present, the classification of industries for carbon trading is too superficial, and the existing allocation method takes into account the influence of enterprise size on carbon intensity, but does not take into account the differences in enterprise business. The existing allocation takes into account the impact of enterprise size on carbon intensity, rather than the differences in business or type of carbon emissions [7,9]. For example, in the circuit board industry, different classification methods lead to different groups of similar enterprises, resulting in similar production processes; in the circuit board industry, the different classification of similar enterprises has led to different groupings, resulting in a huge difference in carbon intensity targets for enterprises with similar production processes and similar energy emissions. The fairness of the carbon trading system has been undermined. Therefore, on the basis of the original model, it is necessary to combine the specific technology, energy consumption level and carbon emissions of the industry. Moreover, the carbon intensity targets should be adjusted and refined on the basis of the original model, taking into account the specific technology, energy consumption level and carbon emission intensity of the industry, so as to ensure the consistency and fairness of the carbon intensity targets within the industry. Specifically, from the perspective of enterprises, each case should be analysed on its own merits. The company's total business volume and business structure should be tracked. Once the changes exceed the corresponding threshold values, it will enable the industry to be adjusted, which will also ensure that the carbon intensity target is set fairly.

5.3 Enhance the Internationalization and Standardization of China‘s Carbon Market

Under the general direction of establishing a national unified carbon market, the internationalisation and standardisation of China's carbon market will be enhanced. The basic principles, technical standards and operational specifications for regional links will be established, and possible ways of cooperation with other regions will be explored, contributing to the gradual improvement and long-term sustainable development of the carbon emissions trading system. Thereby promoting the construction of regional carbon markets can maintain a good development of China’s future carbon market. To identify the problems of the carbon trading system in the light of the practical experience and development needs since the carbon market has been operating for one year, so as to lay the foundation for the establishment of the market operation after 2016. To systematically sort out, there is still in need to improve the design of the mechanisms for China's carbon emission management system framework, carbon trading control scope, total volume control, allowance allocation, MRV, carbon offset, compliance rewards and penalties during the current pilot period, draw on good experiences of carbon trading systems at home and abroad, combine the common conditions required by regional linked markets, and focus on developing carbon emission management, total volume control, allowance allocation and carbon offset mechanisms technical standards and specifications, to form a set of carbon emissions trading systems that are developmental, international and standardized [7,13]. The China’s regional cooperation on carbon emissions trading

should take into account the different industrial and energy structures, emission reduction technologies, and actual conditions of different regions. In order to achieve the carbon market integration in different contexts, it is necessary to establish uniform norms and standards, so as to ensure the achievement of regional control targets, control carbon leakage between regions and reduce unreasonable capital flows between regions.

6. Conclusion

Climate change, mainly characterized by global warming, has become one of the major environmental and development challenges common to human society. China's current commitment to achieve carbon neutrality by 2060 is ahead of the global requirement of achieving carbon neutrality around 2065-2070 under the IPCC 1.5-degree Celsius Agreement regarding the temperature rise control target, and China will make a greater contribution to mitigating global warming in order to address the adverse effects of climate change on human society. To achieve a win-win situation between the dual carbon goal and the economic growth goal, China must rely on technological progress and policy support, and these may imply a very dramatic change in its economic structure, carbon emission structure, and energy structure.

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