

Development And Countermeasures of Carbon Finance in The Construction Industry Under the Background of The Carbon Peaking and Carbon Neutrality

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Abstract. Under the background of the carbon emission peaking and carbon neutrality and the trend of global emission reduction, how to deeply meet China's "3060" carbon target is an important proposition for the development of various industries. As a typical high-carbon emitting traditional industry, China's construction industry has a particularly high demand for energy efficiency and carbon reduction. This paper comprehensively examines a number of papers to explore the issue of the impact of carbon finance on the development of decarbonisation in the construction industry from the current situation, distinguishing between the practical problems posed by each of the influencing factors. This paper delves into the challenges and countermeasures faced by the construction industry itself, the market, and the government in the development of carbon finance. It further explores the carbon finance development model throughout the entire lifecycle of the construction industry. In line with the inherent needs of low-carbon development in the construction industry while promoting the realisation of win-win long-term benefits in terms of both economic and environmental benefits.

Keywords: Carbon finance; carbon emission; carbon market; building industry; ESG.

1. Introduction

Reports released by the United Nations Environment Programme (UNEP) and the Global Alliance for Building and Construction (GlobalABC) show that the energy demand and direct emissions of the buildings and construction sector together account for more than one fifth of global emissions. Meanwhile, a report by the International Energy Research Centre (IERC) shows that the construction sector is responsible for about 40% of the world's annual greenhouse gas (GHG) emissions. As one of China's high-energy-consuming industries, its low-carbon development is the key to advancing the "3060" goal. Carbon finance, as an important financial tool to address climate change, can internalise the external costs of carbon emissions through carbon emissions trading and carbon financing, incentivise enterprises to reduce greenhouse gas emissions and promote green and low-carbon development. At present, China's construction industry has made a series of positive and beneficial new attempts in carbon finance, looking forward to further strong correlation between carbon emission reduction and economic benefits in the construction industry. However, the current development of carbon finance in the construction industry still faces many challenges. The heterogeneity of the construction industry, to a certain extent, constrains the carbon emission reduction effectiveness of existing carbon finance systems. There is an urgent need to develop a new adaptive carbon finance framework and formulate a series of incentive policies to guide its practical application.

In recent years, scholars both domestically and internationally have begun to devote attention to the development of carbon finance in the construction industry. They have embarked on extensive research endeavors to explore the role of carbon financial instruments in facilitating energy conservation, emission reduction, and green transformation within the sector. These studies not only reveal the development trend of the carbon finance market, but also analyse the innovative practices of the construction industry in the field of carbon finance, such as C-ESG framework non-financial indicator evaluation system for the construction sector [1] and an energy enhanced BIM framework incorporating carbon finance theory [2].

This paper will deeply analyse the development of carbon finance in the construction industry under the the background of the carbon peaking and carbon neutrality, discuss the challenges it faces. Specifically, this thesis will explore how the construction industry can achieve carbon reduction and green transformation through carbon trading and carbon financial instruments. However, in this process, the development of carbon finance in the construction industry is still facing problems such as imperfect policy environment, unsound market mechanism and insufficient technical support. Therefore, this thesis will propose a series of targeted countermeasures and recommendations based on the current situation and the characteristics of the industry.

Currently, although there has been some accumulation of research on the application of carbon finance in the construction industry, most of the studies focus mainly on the macro level and the existing implementation standards. On this basis, this study will further refine the analysis and put forward a series of targeted and operable countermeasures through in-depth analysis of the heterogeneity of the construction industry, in anticipation of providing new ideas and directions for the healthy development of carbon finance in China's construction industry.

2. Relevant Background of Carbon Finance in the Construction Industry

2.1. The Evolution of Carbon Finance in the Construction Industry

The concept of carbon finance originated from the international community's concern for environmental protection and climate change. As environmental awareness has increased, the international community has begun to seek solutions to environmental problems through economic means.

In 1997, the Third Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Kyoto Protocol, an international convention that establishes the International Emissions Trading (IET) mechanism, the Joint Implementation (JI) mechanism, and the Clean Development (CDM) mechanism, marking the point where carbon emissions trading enters the stage of practical application.

China, as the world's largest source of carbon emissions, supplies about one-third of the global market's carbon emission reductions. Existing carbon pilot markets in China have successively included the construction industry in the trading system, with the mandatory market as the mainstay and the voluntary market as a supplement to trade carbon emission rights and obtain economic benefits. In terms of the national carbon market, the seven major energy-intensive industries of petrochemicals, chemicals, building materials, iron and steel, non-ferrous metals, paper, and aviation will gradually be included, with the building materials and iron and steel industries being related to carbon emissions during the construction phase of buildings [3]. With the guidance of carbon economy policies, enterprises upstream and downstream of the construction industry chain are beginning to participate in carbon finance activities. Carbon financial assets interacting with the capital market are formed through, for example, the refined management of building energy consumption, breaking the bottleneck of the capital cost of green circular economy in the operation phase of the building.

On 27 December 2023, the China Building Energy Efficiency Association (CBEEA) and Chongqing University jointly released the 2023 China Carbon Emission Research Report on Buildings and Urban Infrastructure. The report shows that in 2021, carbon emissions from the operational phase of buildings will be 2.3 billion tCO₂, accounting for 21.6% of the country's share and 56.6% of the total process carbon emissions. As the carbon emissions from the operation phase of a building have historically accounted for more than half of the carbon emissions from the whole building process, the mainstream carbon finance-related subject at present is the building operator responsible for the operation of the building. At the same time, however, the production and transport phases of construction also account for nearly half of the total carbon emissions, so relevant studies have also included building developers in the carbon finance system for consideration and proposed appropriate mechanisms [4].

2.2. The Importance of Carbon Finance for Low Carbon Development in the Construction Industry

Carbon finance refers to capital financing activities based on carbon emissions trading, using carbon allowances and carbon credits as the medium or subject matter. The two main components of carbon finance are the carbon emission rights trading market and carbon finance-related derivatives, which can play the roles of trading, financing and support to achieve greenhouse gas emission reduction and environmental protection, as well as further complementing the already existing financing mechanism for the construction industry, and even serve to alleviate the existing financing barriers in the industry.

The application of carbon finance to the construction sector can be summarised as the use of financial instruments to indirectly guide the industry in addressing the range of carbon emissions issues it currently faces. Through the use of market mechanisms and stakeholder evaluation perspectives, it can play a role in urging the construction industry to accelerate the low-carbon transformation and add impetus to the promotion of "dual carbon" goals.

2.3. Carbon Finance from Life Cycle Perspective in the Construction Industry

Carbon emissions from buildings have a life cycle character. In the production phase of building materials, the production of building materials consumes a great deal of energy and generates a significant amount of exhaust gases. For example, steel production requires large amounts of electricity and high-temperature gas, while cement production requires high-temperature combustion of coal. Each of these processes releases vast quantities of carbon dioxide and other greenhouse gases. During the construction phase of a building, the use of construction machinery consumes high volumes of energy and generates a lot of exhaust gases and wastewater. During the operational phase of a building, the building's heating, cooling and lighting equipment also consumes substantial amounts of energy and produces considerable quantities of greenhouse gases.

The operational phase of a building and the pre-construction phase of a building each account for nearly half of a building's full-cycle carbon emissions. By solving the problem of how to open up the path from the life cycle management of the building to the corresponding authority and responsibility subjects as well as using carbon finance as a medium to promote the low-carbon development of the relevant links, the overall carbon emissions of the life cycle of the building can be effectively reduced, and further implement the low-carbon transformation of the whole industry.

3. Development Status of Carbon Finance in the Construction Industry

3.1. Status of Carbon Finance Development in China's Construction Industry

With the emergence of the global carbon trading market, China's carbon financial market has also started, but all aspects of the mechanism have not yet formed a special national condition [5]. Although carbon accounting and crediting for buildings is not mandatory in China, the market is already following the practice. There are already three carbon pilot markets in Shenzhen, Shanghai and Beijing that include the construction industry in their trading systems. Although carbon funds, carbon bonds, carbon quota mortgages, carbon quota buyback financing and other businesses have been launched, their business level and degree of innovation are obviously insufficient, and there is a large gap with the increasingly mature international carbon financial market, which has broad development potential and room for upward mobility in the future.

3.2. Current Strategies for Carbon Finance in China's Construction Industry

Using 2020 data as an example, the carbon emissions of China's construction industry at the production stage of building materials, the construction stage and the operation stage accounted for 28.2%, 1% and 21.6% of national carbon emissions, respectively, including carbon emissions from iron and steel and cement accounted for 14.7% and 12.3% of national carbon emissions at the

production stage, respectively. There are appropriate measures to reduce building emissions from all three aspects of building design, construction and operation. For now, the methodology for developing emission reduction credits in the operational phase of a building is more mature.

Carbon emissions from the building sector can be divided into three ranges based on the Greenhouse Gas Protocol (GHG protocol). Scope I is carbon emissions directly generated by construction work, Scope II is indirect emissions of greenhouse gases from energy use and Scope III covers carbon emissions from the whole chain of production of materials and components, planning and design, construction and transport, and operation and maintenance.

There are four methodologies for developing emission credits for construction projects currently in use in China's carbon finance system, including <Energy Efficiency Technologies and Fuel Switching in New Buildings>, <Installation of Energy Efficient Lighting and/or Controls in Buildings>, <Energy Efficiency and Fuel Switching Measures for Buildings> and <Combined heat and power or trigeneration systems for supplying energy to commercial buildings>. Majority of projects developed in line with the methodology of <Energy Efficiency and Fuel Switching Measures for Buildings> [4].

Not only is the programme of action for large-scale retrofitting of building stock being implemented, but some companies in the construction sector are also experimenting with international carbon finance, for example by introducing the implementation of the Verified Carbon Standard (VCS) mechanism for projects. The VCS project was developed under the leadership of the non-profit organization VERRA in conjunction with The Climate Group (CG), the International Emissions Trading Association (IETA) and the World Economic Forum (WEF). Under this mechanism, emission reductions from verification and certification projects can be converted into Verified Carbon Unit (VCU), which is tradable, through their greenhouse gas emission reductions and removals.

3.3. Status of Integration of Carbon Finance in Other Sectors

Currently, the national carbon emissions trading market only includes the power sector, and other emission-control sectors and non-compliant organizations have yet to enter. According to the Ministry of Ecology and Environment's notice on the verification requirements for carbon emission reports of enterprises in the cement, electrolytic aluminium and iron and steel industries, the three industries are expected to be prioritized for inclusion in the national carbon market in the near future.

In the new energy sector, wind power and photovoltaic power producers, companies that study biomass energy, as well as those that contribute to carbon sinks and those that contribute to the circular economy, have gained high returns from the sale of China Certified Emission Reductions (CCERs). Purchasers are often key emission control enterprises in the industrial sector, who reduce their compliance costs by purchasing CCERs from voluntary emission reduction enterprises [6]. Meanwhile, the internet technology industry is also facing the problem of large amounts of electricity consumption in data centers. Many leading companies have also incorporated environmental protection measures such as green power purchasing and other choices of renewable energy sources into their development strategies, in anticipation of further high-quality zero-carbon operations.

4. The Challenges of Carbon Finance for the Construction Sector under the “Dual Carbon” Target

4.1. Heterogeneity in the Construction Industry

4.1.1 multi-agent collaboration

Construction projects have the characteristics of multi-agent collaboration [7], with a multi-level network structure of "developers - design units - construction units - suppliers". And because of the flexibility of the project-based system in the construction industry in terms of collaboration, it makes teams temporary for specific projects. This has led to the introduction of the role of carbon finance in the process, will involve the interests of a number of variable subjects, the concerted efforts of all

parties from different dimensions to reach a comprehensive carbon reduction method is limited, and the lack of relevant standards to promote the reasonable distribution of benefits. To a certain extent, these problems have constrained the development of the carbon finance market.

4.1.2 Limited carbon reductions at the project level

While overall carbon emissions are large at the construction sector level, individual project emissions reductions are relatively limited. As an example, the Chongqing International Bio-city supporting apartment building, which is one of the first batch of green and low-carbon building demonstration projects in Chongqing in 2024 [8], as a near-zero energy building demonstration project, with a construction site of 40,290m² and a total floor area of 159,000m², adopts a variety of near-zero energy building technologies, which saves 32.5kWh/m² of terminal energy consumption per year, and saves electricity during the operation phase of about 16.25 million kWh. For the present, the number of demonstration cases of this kind of near-zero carbon building is very small, and the total carbon emission of the whole process of the national housing construction in 2021 will be 4.07 billion tCO₂, accounting for 38.2% of the national energy-related carbon emission, so the carbon emission reduction of the monolithic building at the present stage is only a very small part of the total amount of carbon emission reduction.

4.1.3 The difficulty of measuring overall risk

Construction enterprises have a larger initial investment scale, longer investment recovery cycle, more complex business risks, and the lack of effective collateral [9], which has more influencing factors leading to more difficult to measure and analyse the risk. For risk-focused financial institutions, whose core business usually revolves around the placement of risk-sensitive funds, the ease of risk measurement can be directly related to the financial institution's drive to conduct its business in order to ensure that these funds can be recovered relatively safely after placement.

4.2. Policy and Institutional Barriers to Carbon Financial Markets in the Construction Sector

At present, the environment, market and policies of China's carbon market are still in a fragmented state, and the fundamental goal of "using market mechanisms to solve environmental problems" has not yet been fully realised [10]. Due to the lack of specific policies on carbon finance for the construction industry, the operation of the construction industry in the field of carbon finance is deeply trapped in the constraints of the lack of property rights system and the unclear responsibility of environmental subjects. At the same time, the carbon trading market also suffers from imperfect system design, non-transparent certification and trading system for carbon emission reductions, and lack of innovation and promotion system for carbon financial products. Previous carbon market pilots incorporating the construction sector covered mainly existing buildings and were small in scope, and the exploration of experience was not yet comprehensive enough to achieve effective coverage of the national carbon market.

4.3. Industry Participation and Carbon Market Activity

Obviously, at this stage, the construction industry pays little attention to the carbon market. The underlying rationale for the "indifference" displayed by the construction industry towards carbon emissions trading is primarily attributed to two factors. One is a lack of awareness surrounding carbon emissions trading, and the other is the relatively low maturity and developmental level of the carbon market within the construction sector itself. As a typical traditional industry, it has been accustomed to the mode of both massive carbon emissions and revenue. However, the issue of balancing economic benefits and environmental sustainability should be a paramount concern for relevant enterprises at this juncture.

At this stage, the national carbon market is relatively single in terms of trading products, industries and participants, and derivative carbon financial products such as carbon forwards, carbon options and carbon swaps have not appeared [11], so the enthusiasm of financial institutions to participate in carbon finance has yet to be improved. Market transactions are also inactive, the carbon price cannot

accurately reflect the cost of social emission reduction, resulting in enterprises cannot accurately measure the benefits of the implementation of emission reduction measures, the role of the carbon market to promote low-cost emission reduction of the whole society cannot be effectively played [3].

4.4. The Need for Improved Risk Management and Regulatory Mechanisms

The carbon financial market in the construction industry is complex and risky, and it is necessary to establish a sound regulatory system to ensure the stable operation of the market. At present, the top-level design of China's carbon finance is not yet perfect, and there is a lack of special laws and regulations for the construction industry, which makes the risk prevention and control system not yet sound, and the technical capacity and risk prevention and control awareness of the various actors involved is also low.

5. Countermeasures and Recommendations for the Development of Carbon Finance in the Construction Industry

5.1. Improving the Policy and Institutional Environment for Carbon Trading Markets

In order to promote environmental sustainability in the construction sector, it is imperative to establish comprehensive and unified accounting standards for carbon emissions from buildings. Additionally, it is crucial to strengthen the energy consumption statistics system and indicator framework within the construction sector, and to foster a cross-sectoral mechanism for sharing building energy usage data. At the same time, it is necessary to accelerate the improvement of the evaluation system related to low-carbon buildings and low-carbon technologies, and to promote the reasonable application of evaluation results in the field of carbon finance. To enhance environmental, social, and governance (ESG) performance in the construction industry, it is crucial to further integrate ESG assessment frameworks. This integration allows for the evaluation of corporate performance beyond financial metrics, encompassing the environmental and social impacts of production and investment activities, as well as the reliability of corporate governance [12].

The government should create an encouraging environment for development and accelerate legislation for carbon reduction and energy efficiency in buildings. The government can also cultivate carbon financial intermediaries to expand market players and enliven carbon trading and investment by exploring and establishing liquidity provider mechanisms. The development of relevant research should also be emphasised by the government, exploring the design of operational and trading mechanisms in the banking, insurance, securities, fund and trust industries under the framework of carbon finance, and seeking the in-depth integration of products and services with the whole life cycle of the green building industry [9].

5.2. Enhancing Risk Management and Regulatory Mechanisms for Carbon Finance

First, the transparency of the carbon financial market can be strengthened by building a comprehensive risk management framework. Secondly, an information disclosure system should be established to reduce the risks brought by information asymmetry to market participants. Furthermore, a unified and transparent carbon accounting and trading platform can be created through the use of the BIM (Building Information Modeling) platform and blockchain technology, which facilitates the recording of emission information, the purchase of carbon offsets, and the access to professional financial services [13]. Finally, the actual carbon reduction should be verified by means of third-party carbon accounting and carbon auditing to ensure the authenticity and accuracy of the data and help the healthy development of carbon finance in the construction industry.

5.3. Promoting Carbon Finance Innovation and Development in the Construction Sector

From the perspective of the whole life cycle of a building, the development of carbon asset development, carbon funds, carbon bonds, carbon benefits and other related mechanisms will be

considered in the four dimensions of the building materials stage, the construction stage, the operation and maintenance stage and the dismantling (recycling) stage. Taking the construction industry stakeholders (government, construction professionals and consumers) as a starting point [14], the government oversees the disclosure of carbon emissions data, which in turn incorporates indicators such as carbon emissions generated by construction projects and the proportion of low-carbon technologies used into consumer considerations.

Innovative forms of carbon finance in the delivery of construction projects to channel funds more easily, for instance, the Sustainable Savings (S2S) novel finance project delivery concept [15]. Attention needs to be paid to the synergy of multiple actors in a construction project, using collective cross-organisational efforts to reduce management costs and increase profits during the period of cooperation.

Pay attention to promoting the diversification of carbon trading products and the flexibility of trading methods, so as to stimulate market vitality and accelerate the construction of the national carbon market, and further lay the foundation of long-term pricing mechanism [3]. While steadily promoting product innovation, derivatives trading such as futures and options in the carbon pricing market should also be promoted in a timely manner to facilitate the formation of a multi-level product market to enhance the liquidity and price discovery function of the trading market.

6. Conclusion

This paper discusses the necessity and methods of integrating the construction industry with carbon finance, and critically discusses the environment for the development of carbon finance in the construction industry. Carbon finance for the construction industry, as a bridge connecting the construction industry and the financial market, can provide the construction industry with financing channels to realise the low-carbon transition through innovative financial instruments and services. This will not only help the construction industry to reduce carbon emissions and improve energy efficiency, but also promote the diversification of the financial market, and better still, provide a concrete path to realise the long-term benefits of a win-win situation in terms of both economic and environmental benefits.

For now, the development of the carbon financial system in China's construction industry is still immature and needs to attract the attention of all parties. With the promotion of various measures and the continuous improvement of China's carbon trading market construction, carbon finance will usher in a good opportunity for development. More research and planning on relevant mechanisms should be carried out to accelerate the integration process between carbon finance and the construction industry.

In the future, carbon finance for the construction industry will play an even more important role in global green development and low-carbon transition. With the continuous progress of technology and the growing maturity of the market, carbon finance products will become more diversified and personalised, providing more flexible and efficient financing solutions for the construction industry. At that point, there will be closer cooperation between governments, financial markets and the construction industry, advancing the concept of zero-carbon buildings in a tangible way while jointly contributing to global climate governance and the achievement of the Sustainable Development Goals (SDGs).

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