ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

Research on China's Carbon Emission Trading Mechanism and Implementation Path under the Dual Carbon Background

Xueer Chen, Chen Chen, Shuting Dai, Shujun Liu

Nanjing Audit University, Nanjing, Jiangsu 211815, China

Abstract

Industrial development is closely linked to human social progress and is a key force driving social progress. However, it cannot be ignored that while the industrial sector continues to expand and evolve, it has also triggered a series of thorny problems, among which global climate change is particularly prominent and poses a serious threat to the future of humanity. In the context of "dual carbon", China's Emissions Trading System (ETS), as a core tool for market-oriented emission reduction, plays a crucial role in promoting low-carbon transformation. This article is based on the framework of the "Management Measures for Carbon Emission Trading", and systematically studies the rules for carbon quota allocation, trading, and verification. It analyzes the operational logic of the "Shanghai Trading+ Hubei Settlement" dual core architecture and explores the optimization direction of industry differentiated quota allocation paths and trading rules. The paper emphasizes that in order to achieve a more effective carbon emission trading mechanism in the context of "dual carbon", it is necessary to adhere to strengthening top-level design and legal protection, optimizing market structure and risk management, deepening industry differentiation policies, improving price regulation and trading mechanisms, strengthening supervision and performance constraints, and promoting international links and coordination. The research provides theoretical and practical basis for the improvement of China's carbon trading mechanism, and helps to systematically achieve the "dual carbon" goal.

Keywords

Carbon Emissions Trading; Dual Carbon Targets; Quota Allocation; Dual Core Architecture; Market Mechanism Optimization.

1. Introduction

The development of human society depends on industry's development constantly. However, the global climate change problem brought by the industrial development is becoming increasingly severe. To further implement the environmental protection strategy and realize the construction of ecological civilization, Chinese government proposed the "Dual Carbon Target" in 2020 ,which strives to achieve carbon peak before 2030 and achieves carbon neutrality by 2060.At the Central Economic Work Conference of the same year, the "Dual Carbon Target" was also listed as one of the eight key tasks for 2021.The 20th National Congress report also pointed out that we must promote the achievement of the "Dual Carbon Target" and improve the carbon emission trading system actively and steadily[1-4].

2. Carbon Emission Trading Mechanism and Implementation Path

2.1. Top-level Design

On January 25,2024, Premier Qiang Li signed State Council Decree No.775, announcing the Interim Regulations on the Management of Carbon Emission Rights. (Hereinafter referred to as the 'Regulations'.)The Regulation shall come into effect on May 1,2024.There are a total of 33

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

regulations, which builds the basic institutional framework for the national carbon market and standardizes the responsibilities of participating entities. What's more, It also clarifies the illegal activities and punishment methods in the carbon market. The issuance of the regulations provides a clear and concise system of rules and a strong legal basis for the subsequent operation and development of the national carbon market. The regulation outlines six key aspects of the carbon emission trading management framework:

①Legal Status and Responsibilities of Registration and Trading Institutions: The registration authority and trading mechanism are designated to manage the registration and settlement of carbon emission trading products and centralized trading respectively.

②Scope, Products, Participants, and Methods of Trading: The types of greenhouse gases and industry sectors covered are determined by the competent ecological and environmental authorities in conjunction with relevant departments. Trading products include carbon emission allowances (CEA), and participants include key emission units and other eligible entities. Trading methods include negotiated transfers.

③Identification of Key Emission Units: Conditions for key emission units are set by the competent ecological and environmental authorities, with provincial authorities compiling the list.

④Allocation of Carbon Emission Allowances: The total quota and allocation plan are formulated by the competent ecological and environmental authorities, with provincial authorities distributing the quotas.

⑤Emission Reporting and Verification: Key emission units compile emission reports, which are verified by provincial authorities to confirm actual emissions.

⑥Quota Clearance and Market Trading: Key emission units must fully surrender their quotas, which can be bought or sold in the market for clearance purposes.

2.2. Dual Core Architecture of "Shanghai Trading+ Hubei Settlement"

As the exclusive trading platform for the national carbon market, the Shanghai Environment and Energy Exchange (SEEE) is responsible for establishing and maintaining a centralized competitive trading system for carbon emission allowances (CEA). It offers various trading mechanisms, such as listing agreements and bulk agreements. Additionally, SEEE provides services like opening trading accounts, fund settlement, and information disclosure. In 2023, it launched a blockchain-based evidence system to enhance transaction transparency. During data synchronization, SEEE transmits trading data in real time to the Hubei registration system, ensuring that trading and settlement information are synchronized with a delay of no more than five minutes.

The Hubei Carbon Emission Rights Registration and Settlement System acts as the sole central registration and settlement entity for the national carbon market. It has established carbon emission allowance accounts for 2,162 controlled emission enterprises, strictly adhering to a real-name policy of "one account, one code." Regarding quota management, the system oversees the entire lifecycle, including allocation, cancellation, and transfer. In 2023 alone, it completed the initial issuance of 4.53 billion tons of quotas. Moreover, the system is directly linked to the central bank's payment infrastructure, enabling DVP (delivery versus payment) settlement and reducing the settlement time for individual transactions to within two hours. To effectively manage risks related to asset registration, fund settlement, and market operations, the Hubei Carbon Emission Rights Registration and Settlement System has implemented a three-tier risk reserve fund system (exchange, settlement institution, and member). By the end of 2023, the scale of the risk reserve fund had reached 1.2 billion yuan.

This dual-core structure separates trading execution from asset registration, successfully avoiding the issue faced by the EU ETS in its early stages, where a single entity monopolized

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

market data and capital flow. The specific operational process is as follows: enterprises place orders on SEEE, and the system matches trades in real time; post-trade, the transaction price, quantity, and buyer/seller codes are encrypted and transmitted to the Hubei system; subsequently, the Hubei system verifies the validity of quotas and funds in the account and completes the transfer of CEA and funds; finally, the result is returned to SEEE to update enterprise holdings, forming an automated closed loop throughout the process.

The establishment of the dual-core architecture has yielded substantial results. On one hand, it has minimized the risk of significant settlement defaults. From 2021 to 2023, there were no major settlement defaults in China's carbon market, whereas the South Korean carbon market experienced four settlement failures during the same period. On the other hand, it has significantly reduced costs. The separation model allows the annual operating cost of the national market to be maintained at 120 million yuan, much lower than the estimated cost of the single-institution model (approximately 200 million yuan). Of course, China's dual-core architecture still requires refinement. Current challenges include the inability to achieve cross-system compatibility (Guangdong uses a different registration system and needs to connect with the national system via an API interface) and difficulties in regulatory coordination (requiring collaboration among multiple departments, such as the Shanghai Municipal Financial Bureau and the Hubei Provincial Department of Ecology and Environment, for joint supervision).

To address these challenges, China plans to integrate CCER registration into the Hubei system by 2025 and explore interconnectivity with green certificate (GEC) accounts to expand functionality. Simultaneously, it will trial quantum encryption communication technology to prevent potential cyberattacks. In terms of international cooperation, it will leverage the Shanghai Free Trade Zone to pilot direct participation of foreign institutions in trading and explore mutual recognition of CEA with the Hong Kong International Carbon Market.

2.3. Industry Differentiation Quota Allocation

In the allocation of carbon emission quotas, China has adopted differentiated path design according to the characteristics of different industries to balance the pressure of emission reduction and the demand for industrial development and promote structural transformation.

High emission industries (such as electricity, steel, cement) usually allocate quotas using baseline or historical emission methods, gradually tightening to promote emission reduction. Among them, the benchmark method sets the quota benchmark based on the advanced value of energy efficiency in the industry, and reduces the benchmark value by 3-5% annually, so as to force the withdrawal of backward production capacity. Taking the power industry as an example, in 2023, the policy of "bottom hunting emission transformation quota reward" was implemented for 100 coal-fired power units, and those enterprises that completed the transformation and met the standards could obtain an additional 2% quota, which effectively encouraged enterprises to actively carry out emission reduction transformation. In the iron and steel industry, the pilot implementation of "hydrogen metallurgy quota deduction" measures, that is, 1.8 tons of quota consumption per ton of hydrogen chloride steelmaking can be reduced, which effectively promotes the exploration and application of green production technology in the iron and steel industry.

Emerging industries (new energy, electric vehicles) may need more flexible policies, such as quota incentives or green financial support. Among the many Z balance measures, the flexible quota mechanism is more commonly used, which mainly includes two parts, one is green power deduction, that is, 0.8 tons of quota can be deducted from renewable energy generation per megawatt hour. This measure encourages enterprises to use more renewable energy and help achieve a green transformation of the energy structure; The second is the reserve of innovation quotas, for which "low-carbon technology reserve" is specially set up. Taking 2023 as an

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

example, 50 million tons of quotas are reserved to support hydrogen energy and CCUs projects, which provides a strong quota guarantee for the research and development and application of emerging low-carbon technologies.

Agriculture and forestry may participate in the market through CCER (national certified voluntary emission reduction) or other carbon sink projects to obtain economic incentives. After the restart of the national CCER mechanism in 2024, the first batch of afforestation, bamboo forest management and other methodologies included clarified the development standards of forestry carbon sinks. For example, through scientific calculation, Guangxi eucalyptus forest project has achieved an average annual certification of 0.8 tons of CCER per mu, which has set up a quantifiable and tradable demonstration model for forestry carbon sequestration development. In the innovation of ecological compensation mechanism promoted simultaneously, Yunnan pilot "forest carbon sink pledge", farmers can apply for low-interest loans with certified carbon sink income in the next five years, and a total of 230 million yuan will be issued in 2023. This model activates ecological assets with green financial tools, which not only alleviates the pressure of early investment in forestry management and protection, but also opens up the transformation channel of "ecological resources carbon assets capital flow" through market-oriented mechanism, promotes the coordinated development of Rural Revitalization and ecological protection, and forms a replicable model for the value realization of ecological products.

2.4. Trading Rules

China's carbon emission trading rules follow a "total control–market regulation–strict supervision" tripartite principle, ensuring market efficiency and emission reduction goals through multi-layered mechanisms. The core framework includes:

①Layered Market Structure:

The national carbon market operates under a "two-tier trading platform + regional supplements" framework. SEEE handles CEA unified trading, while the Beijing Green Exchange manages CCER transactions. After the system upgrade in 2024, blockchain certification will be introduced to achieve traceability of the entire process of CCER issuance, trading, and cancellation. Nine carbon pilot markets, such as Hubei and Guangdong, have been established at the regional level as supplements. Industry such as ceramics and textiles that are not covered by the national market are allowed to be included, forming a differentiated industry coverage system.

②Dynamic Trading Mechanisms:

The market adopts a composite pricing mechanism of “benchmark price fluctuation + circuit breaker protection”. Take the weighted average price of the first ten trading days as the daily opening price, and ensure that the daily fluctuation does not exceed 10% of the benchmark price. When the cumulative fluctuation of the price exceeds 20% for three consecutive trading days, the circuit breaker mechanism was triggered to suspend trading for 1 hour, and a total of 11 circuit breakers were initiated in 2023, effectively suppressing market speculation. The carbon trading methods mainly include listing agreement trading, bulk agreement trading and single bidding. The listing agreement trading is for single transactions of less than 100000 tons, while the bulk agreement trading is for single transactions of more than 100000 tons. The latter is subject to price discount restrictions, and the transaction price shall not be lower than 90% of the daily listing average price. The single item bidding for China’s carbon emission rights focuses on the targeted trading demand for specific quotas, dividing the bidding items into two categories: government reserve quota auctions and CCER targeted bidding. The former is a 5% adjustment of the total national reserved quota, which is regularly organized through the Shanghai Environment Exchange platform for special auctions. The latter is a special procurement channel for key emission control enterprises to apply for CCER, such as the Beijing

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

Green Exchange holding two forestry carbon sequestration sessions every month. Single bidding adopts a tiered pricing constraint mechanism, with three pricing ranges set: safety zone (benchmark price ±10%), waring zone (±10%-20%), and circuit breaker zone (20% or more). The participating entities are stratified. Enterprises that achieve their annual emission reduction targets have priority subscription rights and commercial banks, carbon funds and other investment institutions to participate in price limiting, commercial banks, carbon funds and other investment institutions must follow the “double limit” rule: the single bidding volume shall not exceed 15% of the daily market trading volume, and the quotation shall not exceed 20% of the average price of the previous five days.

③Transparent Verification Management:

Implement a "three-phase verification + double random sampling" regulatory model. Emission control enterprises are required to submit emission reports verified by provincial ecological and environmental departments before the end of March each year, and complete quota collection before the end of June. In 2024, a satellite remote sensing monitoring and energy consumption data direct connection system will be introduced to achieve real-time emission verification for 39 key industries such as steel and cement. The Ministry of Ecology and Environment has established a cross departmental joint punishment mechanism, and enterprises that fail to fulfill their obligations will be fined three times that the market average price of the quota and downgraded in the environmental credit evaluation. Taking 2023 as an example, the compliance rate of 2165 key emission units nationwide reached 99.5%, and a total of 86 million yuan in fines were imposed on 12 noncompliant enterprises.

3. Analysis of Pilot Cities for China's Carbon Emission Trading Mechanism : A Case Study of Shanghai.

As one of the first pilot cities for carbon emissions trading in China (launched in 2013), Shanghai has achieved significant results in the field of carbon trading through institutional innovation and market-oriented means. As of September 30, 2024, the pilot carbon market in Shanghai has achieved 100% compliance for 11 consecutive years, with a cumulative transaction of 256 million tons of carbon emission rights and a transaction amount of 5.081 billion yuan, covering 28 industries including steel, electricity, and chemical industry, and involving 378 enterprises.

3.1. Pilot Achievements

①Increased market activity

Pre quota early issuance mechanism: Shanghai pioneered the pre quota mechanism, where enterprises can obtain the next year's quota in advance at 80% of the approved emissions after completing the previous year's performance and use it for trading. This policy has led to a year-on-year increase of 108% in quota trading volume and 133% in trading volume in 2024, significantly improving market liquidity.

Carbon inclusive and quota market closed-loop consumption: Shanghai has included carbon inclusive emission reductions (such as low-carbon behavior of citizens) in the quota clearing system. In 2023, enterprises will use 9115 tons of carbon inclusive emission reductions to offset quotas, accounting for 88.5% of the total offset amount, achieving a linkage between public participation and market mechanisms.

②Synergistic efficiency in reducing pollution and carbon emissions

The Shanghai pilot carbon market innovatively combines air pollution prevention and carbon reduction, increasing the quota distribution ratio (such as increasing by 0.3% -0.5%) for enterprises with excellent pollution reduction and carbon reduction performance, and

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

incentivizing enterprises to achieve a win-win situation for environmental and economic benefits through technological transformation.

③Strict MRV system and data management

The Shanghai Municipal Ecology and Environment Bureau entrusts a third-party organization to verify the emission data of enterprises through government procurement services, and uses blockchain technology to ensure data traceability. At the same time, companies are required to keep original records for at least 5 years to effectively prevent data fraud.

④Regional cooperation and regulatory safeguards

The Shanghai Carbon Emission Management Measures specify rules for quota allocation and payment, and establish cooperation mechanisms with provinces and cities in the Yangtze River Delta to promote green technology innovation and industrial coordinated development.

3.2. Problems and Challenges

①Insufficient industry coverage and imbalanced quota allocation

Although Shanghai covers 28 industries, the focus is still on traditional high emission industries such as electricity and steel. Emerging industries such as data centers and service industries have not been fully included, and quota allocation needs to be further balanced between emission control efforts and enterprise affordability power.

②Carbon price fluctuations and insufficient market depth

The price of carbon market in Shanghai is greatly affected by policy adjustments, and the trading behavior of enterprises is mainly based on the demand for performance, lacking long-term investors. Due to insufficient market liquidity, the price discovery function has not been fully utilized.

③Data quality and verification pressure

Despite using third-party verification, some companies still have issues with inaccurate data reporting, especially in complex process industries such as chemical engineering, where accounting methods need to be further standardized.

④Insufficient connection between voluntary emission reduction markets

Although the Shanghai carbon inclusive system is linked to the quota market, the development scale and consumption channels of voluntary emission reduction projects (such as forestry carbon sinks) are limited, making it difficult to meet the diversified needs of enterprises.

3.3. Case Enlightenment

①The system design needs to give consideration to rigidity and flexibility

Shanghai has implemented a pre quota mechanism and dynamically adjusted quota allocation, which not only ensures emission control targets but also provides buffer space for enterprises, reflecting the balance of "total quantity control and market incentives".

②Technological innovation drives emission reduction efficiency

Enterprises can convert their emission reduction achievements into carbon asset income by applying technologies such as flue gas waste heat recovery. It has verified the effectiveness of combining technological upgrades with market-oriented mechanisms.

③Regional collaboration and regulatory improvement

The expansion of the national carbon market to industries such as steel and cement (with 1500 new enterprises added by 2025) requires learning from Shanghai's experience, strengthening cross regional cooperation and a unified regulatory framework to avoid market segmentation.

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

4. Conclusion

Under the guidance of the "dual carbon" goal, China has made significant progress in its carbon emissions trading mechanism and implementation path, laying a solid foundation for addressing climate change and promoting sustainable development. The implementation of the Interim Regulations on the Management of Carbon Emission Rights has established a comprehensive and standardized institutional framework, covering key links such as registration, trading mechanisms, and quota allocation, providing strong legal protection for the orderly operation of the carbon market. The dual core architecture of "Shanghai Trading + Hubei Settlement" effectively separates transaction matching and asset registration, and has achieved significant results in reducing settlement default risk and operating costs. Although there are currently issues with cross system compatibility and regulatory coordination, related expansion and improvement plans are underway, which are expected to further enhance its functionality and stability. The industry differentiation quota allocation strategy fully considers the characteristics of different industries, gradually tightening quotas for high emission industries to promote emission reduction, providing flexible support for emerging industries, and agriculture and forestry participating in the market through carbon sequestration projects to achieve a balance between emission reduction and industrial development. The hierarchical market structure, dynamic regulation mechanism, and penetrating verification management in the trading rules ensure the effective operation of the market and the achievement of emission reduction targets.

However, in the development process of the carbon market, there are also challenges such as insufficient functioning of the carbon market, increased burden on enterprises, difficulty in ensuring data authenticity, and policy implementation. In the future, the optimization and innovation of the carbon emission trading system can be carried out around the following aspects:

①Adhere to strengthening top-level design and legal protection

Improve the legal and regulatory system of the carbon market, promote further refinement of the Interim Regulations on the Management of Carbon Emission Rights, and clarify regulatory rules for emerging fields such as carbon finance and cross-border trading. Establish a dynamic adjustment mechanism, regularly evaluate industry coverage, quota allocation methods, and emission reduction targets to ensure alignment with the "dual carbon" process. For example, timely inclusion of high emission industries such as chemical and aviation, and exploration of participation paths for small and medium-sized enterprises.

②Optimize market structure and risk management

Promote the dual core model of "trading + settlement" to avoid the risk of monopoly by a single institution, while strengthening the coordination between regional and national markets. For example, promoting data exchange between pilot markets such as Guangdong and the national system, and exploring cross regional quota transfer mechanisms. Introduce more advanced technological means, such as blockchain, quantum encryption, etc., to enhance transaction transparency and security, prevent data tampering and network attack risks.

③Deepen industry differentiation policies

Continuously tightening quota allocation for traditional high energy consuming industries such as electricity and steel, adopting the "baseline method + technological progress reward" mechanism, and promoting the application of green technologies such as hydrogen metallurgy and CCUS; Implement flexible incentive policies for emerging industries such as new energy and electric vehicles, such as quota reserves and green electricity deductions, to promote low-carbon technology research and industrialization. Expand the CCER development of carbon

ISSN: 2692-7608 DOI: 10.6981/FEM.202507_6(7).0014

sink projects (such as forestry and clothing industry), improve the production mechanism, and promote the "Carbon River Pledge" and "Carbon Finance"

Waiting for innovative tools to be implemented.

④Improve price regulation and trading mechanisms

Dynamically optimize the "benchmark price + circuit breaker" mechanism to prevent severe market fluctuations, while introducing financial instruments such as carbon futures and options to improve market liquidity. Explore the reform of quota auction mechanism, such as expanding the proportion of government reserve quota auctions, or introducing a mixed model of "paid distribution + free distribution", gradually increasing the proportion of paid distribution.

⑤Strengthen supervision and performance constraints

Promote digital regulatory measures (such as satellite remote sensing and direct connection of energy consumption data) to achieve real-time monitoring and verification of emission data, and reduce the risk of human manipulation. Intensify the punishment for breach of contract, establish a cross departmental joint punishment mechanism (such as environmental credit downgrade and financing restrictions), and improve the risk reserve system to prevent systemic risks.

⑥Promote international connectivity and collaboration

Relying on open platforms such as free trade zones, pilot foreign institutions to participate in the domestic carbon market, and explore mutual recognition mechanisms with carbon markets such as Hong Kong and the European Union. Actively participate in the formulation of global carbon market rules, promote the alignment of China's carbon pricing mechanism with international standards, and enhance its voice in international climate governance.

The practical experience of China's carbon market shows that the success of the carbon emission trading mechanism depends on the organic combination of institutional design, technological innovation, and market vitality. In the future, it is necessary to further balance the rigid target of emission reduction with the needs of industrial development, and build a more efficient, fair, and transparent carbon trading system through the path of rule of law, marketization, and internationalization, contributing the "Chinese solution" to the global carbon neutrality process.

Acknowledgments

Fund Project: 2024 Jiangsu Province College Students Innovation and Entrepreneurship Training Project: Research on China's Carbon Emission Trading Mechanism and Realization Path under the Background of "Two-carbon" (2024SX09009).

References

[1] Wu Yihan. Thinking on carbon audit under the target of "double carbon" -- Based on the perspective of carbon emission right trading [J]. Audit and Financial Management, 2024, (01): 57-59.

[2] Yu Fengju. Interpretation of interim Regulations on the Management of Carbon Emission Trading and suggestions on local carbon market [J]. Energy saving and environmental protection, 2024, (03): 11-16.

[3] He Jun. The Interim Regulations on the Management of Carbon Emission Trading announced that carbon trading ushered in a new rule of law situation [N]. Electromechanical Business Daily, 2024-03-04 (A01).

[4] Wen Huiru. Improvement of China's carbon emission right trading system under the goal of "double carbon" [D]. Southwest University of Science and Technology, 2023.