

Innovative Mechanisms in Carbon Emission Issues Based on Blockchain Technology

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Keywords: Blockchain technology, Carbon emissions, Distributed ledger, Consensus mechanism, Smart contracts, Asymmetric encryption

Abstract: By exploring the characteristics of blockchain technology and the characteristics of the carbon emission problem, this paper proposes an innovative mechanism of blockchain technology in solving the carbon emission issues. Blockchain technology has the characteristics of decentralization, time-series data, collective maintenance, programmability, openness, independence, security, anonymity, etc. With the help of blockchain technology, under the premise of mutual supervision and constraint of each node through smart contracts, the carbon emission behaviour of steel companies can be regulated and the industrial structure can be optimized through the restriction of "bank loans" and the floating-control of the "tax rate" of the taxation bureau, so as to effectively promote the goal of carbon neutrality in China.

1. Introduction

With the development of national economy, especially the development of heavy industry, carbon emission exceeds the capacity of ecosystem and has a series of impacts on global climate, etc. Since 2005, China is the world's largest energy consumer and carbon emitter, and the carbon emission is increasing year by year, especially the carbon emission of steel industry accounts for a large proportion of the national carbon emission. Based on the above facts, this paper focuses on the carbon emission problem of China's iron and steel industry, and through the exploration of blockchain technology, we search for the innovative mechanism of blockchain in solving the carbon emission problem in view of the characteristics of blockchain technology.

2. Research Background

2.1. Environmental Status

In the last 20 years, a series of phenomena such as global warming, glacier melting, sea level rise and hazy weather indicate that climate change brought about by the greenhouse effect is seriously affecting the future survival of human beings. Since the 21st century, global carbon emissions have grown rapidly, and from 2000 to 2019, global carbon dioxide emissions increased by 40%. According to the International Energy Agency, global energy-related carbon dioxide emissions decline by 5.8% in 2020 due to the impact of the new crown epidemic, but the economic recovery has raised energy demand, and in December 2020, global carbon dioxide emissions are 2% higher than the same month last year, and the world still faces the challenge of growing carbon dioxide emissions. China's carbon emissions to account for up to 28.8% of world total in 2019. Meanwhile, China's steel industry has large annual carbon dioxide emissions, accounting for more than 18% of the country's total carbon emissions, making it the non-electric industry with the highest carbon emissions. Reducing carbon emissions have become a challenge in the world today.

2.2. Policy Support

China attaches great importance to ecological environmental protection, upholds the important concept of "Lucid waters and lush mountains are invaluable assets", advocates the harmonious coexistence of man and nature, and incorporates the construction of ecological civilization into the overall layout of national development. "China will increase its independent national contribution, adopt more vigorous policies and measures, strive to peak carbon dioxide emissions by 2030, and work towards achieving carbon neutrality by 2060." Achieving the goal of carbon neutrality by 2060 has become the most urgent mission for China and the world today. As a participant, contributor and leader in the construction of global ecological civilization, China insists on the development concept of "community of life between human beings and nature" and makes unremitting efforts to build a community of life between human beings and nature with practical actions. Local governments are actively responding to the national policy, and are also strengthening the construction of green financial system.

2.3. Existing Problems

2.3.1. Disregard for Environmental Protection

Normal production activities in the steel industry cause a large amounts of carbon emissions, which can have unimaginable consequences if left unchecked. According to *the Third Party Observation Report on Ultra-Low Emission in the Iron and Steel Industry*, the attainment rate and ultra-low emission achievement rate of emission permits in terms of the number of enterprises is only 14% and 3.5%. This shows that many domestic small and medium-sized iron and steel enterprises only focus on economic efficiency, the pursuit of low cost, ignore energy saving and emission reduction, as well as will not have extra control on carbon emission.

2.3.2. Challenges of Industrial Upgrading

China's iron and steel industry has focused on scale expansion for many years, and energy saving and emission reduction technologies are more focused on the introduction of lower cost technologies. Most of the enterprises in China are in the early stage of "carbon neutral", and the measures taken are only on the planning of "double carbon" target. How to combine their own production and carbon

reduction, balancing economic and social benefits, has become an important part of enterprise development. Enterprises themselves are facing the challenge of industrial upgrading.

2.3.3. Authenticity of Data

With the introduction of the national green development policy, China's environmental regulations have become stricter, and the supervision and verification of carbon emission data are also increasing, and enterprises are being challenged. Since carbon emission data verification is closely related to the interests of enterprises, enterprises have the subjective will to falsify data when providing relevant data, and the collection of carbon emission data faces problems such as data falsification and irregular data collection, and the authenticity of data cannot be guaranteed.

2.3.4. Protection of Corporate Privacy

Carbon emission data will directly or indirectly reflect the production status of enterprises, and if carbon emission data is circulated among enterprises, industries, third-party enterprises and carbon trading market, there may be privacy issues such as illegal use and leakage of enterprise information. How to protect the privacy of enterprises and build a safe, open and reliable carbon trading market has become a key and difficult point in promoting low carbon economy.

3. Research Content

3.1. Blockchain Technology Analysis

Blockchain technology is a new distributed infrastructure and computing paradigm that uses blockchain data structure to verify and store data, distributed node consensus algorithms to generate and update data, cryptography to secure data transmission and access, and smart contracts composed of automated scripting code to program and manipulate data 0. It is a collection of various technologies such as distributed system, cryptographic algorithm, digital signature, consensus mechanism, smart contract, etc. Blockchain technology serves various industries with its characteristics of decentralization, time-series data, collective maintenance, programmability, openness, independence, security, anonymity 0, etc.

Based on its characteristics, blockchain technology can effectively monitor data such as carbon emission, tax rate, bank lending amount, etc. and ensure the accuracy of data. It can make the data monitored by the public and make the information of the whole system highly transparent, which is conducive to the formation of collective supervision. Moreover, blockchain technology is based on consensus specifications and protocols. The whole blockchain system does not depend on other third parties, and all nodes can automatically and safely verify and exchange data within the system without any human intervention.

3.1.1. Distributed Ledger

A distributed ledger 0, also known as a shared ledger, is a database that can be shared, replicated and synchronized among network members. Traditional carbon tracking process data is often stored in a central institution, which is not transparent enough, while distributed ledger-based carbon emissions tracking can be stored in a distributed form to each coalition node, which helps to prevent irregular disclosure of information; each market member node can continuously track and monitor any public information on carbon emissions calculation and tracking, which makes the overall steel market information transaction declaration process more This will make the process of reporting the overall steel market information more fair, just and open.

By analyzing the carbon emission demand, process and up-chain data, we can study the secure storage, sensitive data protection and credible sharing technology of the data adapted to the carbon emission demand through the on-chain and off-chain data collaboration, so as to realize the openness, transparency, credibility and accuracy of carbon emission measurement.

3.1.2. Consensus Mechanism

For the consensus mechanism of the coalition chain of carbon tracking, the public data declared by the participating market members to the central institution through the coalition chain, or the public data released by the central institution to each market member through the coalition chain, will be created by the nodes of the central institution within a specified period of time. According to this technology, a blockchain carbon emission data information authentication system can be built, which needs to be approved by more than half of the nodes before it can be entered into the system, so as to continuously improve the authenticity of carbon emission data and establish a mutual trust mechanism. In addition, by building a carbon emission management platform through blockchain technology, the carbon emission data database of steel companies, environmental protection departments and lending institutions can be linked, and the carbon emission data of steel companies can be updated and broadcasted in a timely manner to effectively eliminate the phenomenon of "carbon emission exceeding the standard". The lenders themselves can also access external data, including Environmental Protection Bureau regulation, carbon emission data, and credit reference indicators, and adjust their lending strategies in a timely manner.

3.1.3. Smart Contracts

A "smart contract 0" is a computer protocol that digitally facilitates, validates or enforces the negotiation or performance of a contract. Smart contracts allow for trusted transactions to take place without a third party. Smart contracts should be designed to meet the following principles.

- (1) Steel companies actively submit carbon emission data to the federated chain.
- (2) The smart contract uses the data on the chain to automatically calculate the corresponding credit reference index for each company.
- (3) Banks set the corresponding deposit and lending terms according to the indicators.
- (4) The taxation bureau floats the tax rate of steel companies according to the indicators.

3.1.4. Asymmetric Encryption

The security of data is ensured by asymmetric encryption algorithm 0 and digital signature technology, and the "consensus" and "storage" of data are realized through the "chain" of data, and the decentralized multi-subject data redundancy storage, exchange and operation and maintenance incentive mechanism is built. The data redundancy storage, exchange and operation and maintenance incentive mechanism of decentralized multi-subjects, data dependency description and verification, distributed and credible data storage and sharing management, ensuring credible collection and non-tampering of elemental data, realizing the authenticity and credibility of carbon emission data, source traceability and efficient sharing.

3.2. Process of Innovative Mechanism

Through blockchain technology, banks, environmental protection bureaus, taxation bureaus, and listed steel companies are set up as major category (because listed companies are generally units with large carbon emissions and have a greater impact on the environment, the subject of this project is listed steel companies).

The carbon emission data of all companies are endorsed by environmental protection bureaus, which supervise the carbon emission of steel companies to ensure the authority and credibility of the data on the chain. At the same time, banks and taxation bureaus can participate in the process of uploading every carbon emission detail of listed companies on the chain in real time.

Based on the carbon emission data of the company on the blockchain, banks use smart contracts to automatically calculate the indicators that can be used as a reference for granting credit to steel companies, and use this as a basis to reconstruct the credit business system and control the loan financing requests of steel companies.

Taxation bureaus can use smart contracts to float the tax rate of steel companies based on the carbon emission data of the companies on the blockchain. The size of carbon emission to the rated emission of the company will affect the tax rate paid by the steel company, and the company with less carbon emission to the rated emission of the company will have lower tax rate.

Using blockchain technology to build a platform for industry information and resource exchange can strengthen the communication and cooperation between steel enterprises and upstream and downstream industry chain enterprises, certification or consulting institutions, banks or other financial service institutions, logistics service enterprises and other related enterprises and institutions, thus creating a better business environment on the basis of mutual benefit and win-win situation. This paper intends to urge steel enterprises to save energy and reduce emissions through this approach, and jointly create a good ecological environment.

The specific flow of the mechanism is shown in Figure 1.

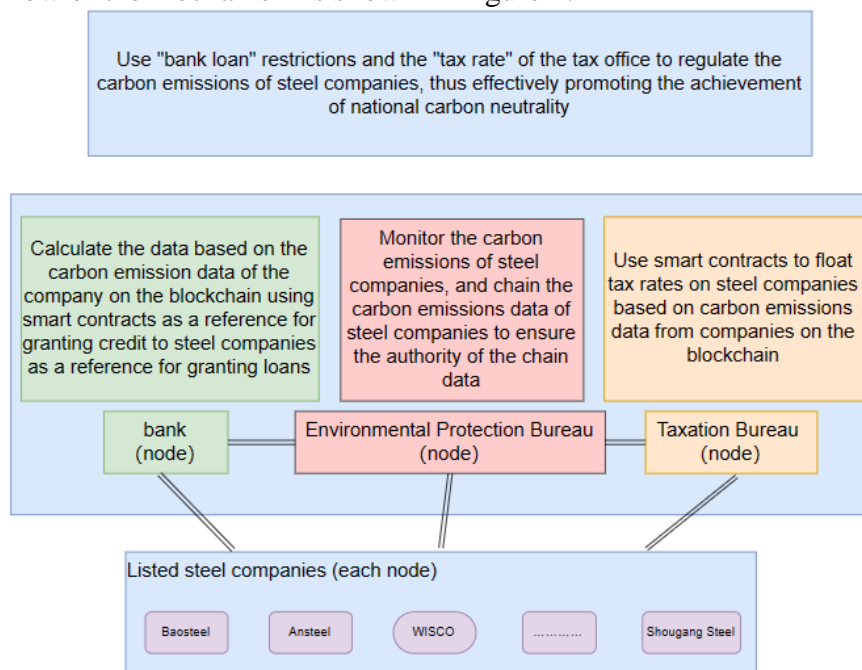


Figure 1: Blockchain-based carbon emission management flow chart for the steel industry

3.3. Analysis of Each Node

Banks: Based on the carbon emission data of steel companies on the blockchain, the corresponding index is calculated using smart contracts as a reference for granting credit to each steel company and as a reference for issuing loans.

After research and investigation, the People's Bank of China and China Construction Bank have launched relevant policies to support.

The policy of the People's Bank of China is to provide low-cost funds to financial institutions

through the Carbon Emission Reduction Support Instrument, and to guide financial institutions to provide carbon emission reduction loans to all types of enterprises in the key areas of carbon emission reduction on the premise of independent decision-making and risk-bearing, with the loan interest rate roughly equal to the market quoted rate for loans of the same maturity class. The People's Bank of China will provide financial support to eligible carbon emission reduction loans issued by financial institutions to enterprises in the key areas of carbon emission reduction through the direct mechanism of "lending before borrowing" at 60% of the principal amount of the loan, with an interest rate of 1.75%. To ensure the accuracy and direct access of the carbon emission reduction support tool, PBoC requires financial institutions to publicly disclose information on the issuance of carbon emission reduction loans and the amount of carbon emission reduction driven by the loans, and to have information verified by a third-party professional organization, and accept subject to public supervision.

China Construction Bank has been actively implementing major national decisions and deployments, incorporating green finance into its bank-wide strategy, and doing its utmost to ensure the adaptation and synchronization of green finance development with the green and low-carbon transformation of the national economy and society. In 2021, the balance of green loans of CCB's relevant regulatory authority caliber reached 1.95 trillion yuan, with a record high growth rate of 45.67%; 25 green bonds were underwritten in the year, with an issue size of 28.55 billion yuan. In 2020 and 2021, CCB's ESG rating was rated A for two consecutive years, ranking among the top in the industry.

The above lending policies of these banks are only supportive measures for carbon emission reduction, but it is only a general concept whether to give loans to them or not. For example, China Construction Bank only says that it refuses to grant loans to high energy-consuming and high-polluting enterprises, and does not give a relatively precise value. For carbon emission in the steel industry, banks, as an important capital node, should clarify the restrictions on carbon emission, find the carbon emission data of corresponding companies through blockchain and give corresponding loan restrictions to effectively guarantee the carbon emission reduction of listed steel companies.

Environmental Protection Bureau: Supervise the carbon emissions of listed steel companies and chain their carbon emission data to ensure the authority and credibility of the data in the chain.

Taxation Bureau: Floating control over the tax rates for steel companies using smart contracts based on carbon emission data from companies on the blockchain.

The Taxation Bureau also provides many preferential policies for energy conservation, such as the State Administration of Taxation in the article "Guidelines for Tax Preferences to Support Green Development", which states that "Energy production and consumption-related activities are the most important source of carbon dioxide emissions, and vigorously promoting carbon emission reduction in the energy sector is an important measure to do a good job of carbon peaking and carbon neutralization, as well as to accelerate the construction of a modern energy system. By increasing the policy support for the development and utilization of solar energy, wind energy, hydro energy, nuclear energy, etc., we can provide a guarantee for the scientific and orderly promotion of the timely achievement of carbon peak, carbon neutral goals and the construction of a modern economic system."

However, currently the tax office does not provide policies on carbon emission reduction for steel companies, which will reduce the enthusiasm of steel companies to reduce carbon emissions. If the taxation bureau floats and controls the tax rate of steel companies every month based on their carbon emission data on the blockchain, it can effectively reduce carbon emissions.

Listed steel companies: truthfully provide our monthly carbon emission data and optimize our industrial structure and regulate carbon emission behavior according to the restrictions of bank credit loans and tax rate restrictions of the tax bureau.

Take Baosteel as an example:

The company actively benchmarked with international standards such as ISO14065 and ISO14067 and organized the first quantitative assessment of the carbon footprint of its products and passed the third-party company verification. Besides, they established the base year and organized the preparation of the carbon peak and carbon neutral action plan and green low-carbon special planning. Their development goals are "to reach the peak by 2023, to reduce carbon by 30% by 2035 and to achieve carbon neutrality by 2050" and "to achieve ultra-low waste discharge, zero waste water discharge and no solid waste discharge by 2025, and to build a global green waste-free steel mill".

However, due to the lack of relevant policies and financial support, they cannot optimize the industrial structure in time, but only do what the company can do spontaneously, so the effect is not significant. If the carbon emission data of these steel companies are put on the chain, as an executive node on the chain, they can optimize the industrial structure in real time and strive to gradually reduce carbon emissions, thus effectively promoting the achievement of China's carbon neutrality target.

Set up four major types of nodes: listed banks, environmental protection bureaus, tax bureaus, and steel companies, and upload the data of each node onto the chain to ensure the reliability of the data. The nodes are then linked with each other through smart contracts, cooperating with each other and constraining each other to precisely control carbon emissions, so as to achieve the neutralization of carbon emissions.

4. Feasibility Analysis

4.1. Technical Feasibility

Blockchain technology has developed to a more complete technology at this stage. In terms of data storage, relational databases such as SQLite network, MySQL, or cloud databases are available; in terms of protocols. On the protocol side, there are multiple consensus mechanisms (e.g., POW, POS, DPOS, BFT, etc.) and multiple security mechanisms (e.g., hash algorithms, digital signatures, zero-knowledge proofs, etc.) to choose from. In the extension layer, smart contracts, reward mechanisms, and penalty mechanisms can be used to improve the underlying platform.

The smart contract connects the listed steel company, banks, environmental protection bureaus, taxation bureaus and other major types of nodes. The environmental protection bureaus endorse the listed steel company to ensure the authenticity and credibility of the data, which convinces the banks and tax bureaus to make dynamic adjustments to the company's bank loan credit and tax rate.

4.2. Organizational Feasibility

As national organizations, banks, environmental protection bureaus and tax bureaus will respond positively to the national call for energy saving and emission reduction for the sake of national interests, and have the right to audit listed companies. While each enterprise will further integrate steel production capacity, optimize product structure, improve the energy-saving process of steel industry, protect the ecological environment and make contributions to society in order to ensure the interests of the company and establish a good corporate image at the same time.

4.3. Time Feasibility

Because of the long time required for the project, the project can be implemented in one city first, and if the progress is smooth and all parties actively cooperate and coordinate, the project can be extended to all cities nationwide.

4.4. Economic Feasibility

The lending quota and tax rate have produced certain restrictions on the economic development of enterprises, which will be pressured to further integrate steel production capacity, optimize product structure and improve energy-saving processes, thus promoting the achievement of carbon neutrality and bringing economic and ecological benefits to the whole society.

5. Innovative Analysis

Most of the solutions to the carbon emission problem so far have been focused on signing climate agreements to establish a carbon compliance market. But this mechanism breaks the traditional way of the past, using blockchain technology to set up four kinds of nodes: listed companies, banks, environmental protection bureaus and taxation bureaus to upload the data of each node to ensure the reliability of the data, and then the nodes are connected to each other through smart contracts to achieve openness and transparency of information. Then, through the "bank loan" restriction and the "tax rate", we can regulate the carbon emission behavior of steel companies, optimize the industrial structure, and control the carbon emission, so as to achieve the neutralization of carbon emission.

The use of blockchain technology can effectively monitor data such as carbon emission and tax rate to ensure the accuracy. Moreover, the data can be monitored by the public, making the information highly transparent and conducive to the formation of collective supervision. Besides, blockchain technology is based on consensus norms and protocols. With the help of smart contracts, the whole blockchain system does not depend on other third parties, and all nodes can automatically and safely verify and exchange data within the system without any human intervention.

6. Conclusion

As there are problems in the steel industry such as unrealistic carbon emission data, lack of attention to environmental protection by enterprises, and difficulty in protecting enterprise privacy, and blockchain technology has the characteristics of decentralization, collective maintenance, openness, independence, security, and anonymity, etc. this paper proposes an innovative mechanism based on blockchain technology.

Through blockchain technology, banks, environmental protection bureaus, taxation bureaus, and listed steel companies are set as major class nodes. The carbon emission data of all companies are endorsed by environmental protection bureaus, which supervise the carbon emission of steel companies to ensure the authority and credibility of the data on the chain. At the same time, banks and taxation bureaus can participate in the process of uploading every carbon emission detail of listed companies on the chain in real time. Under the premise of mutual supervision and constraint of each node through smart contracts, the carbon emission behaviour of steel companies can be regulated and the industrial structure can be optimized through the restriction of "bank loans" and the floating-control of the "tax rate" of the taxation bureau, so as to effectively promote the goal of carbon neutrality in China.

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