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Application of Blockchain in Carbon Trading

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Abstract

This paper introduces the similarity between the mechanism of carbon trading and blockchain, then it elaborates on the application of blockchain in carbon trading. In corporate carbon trading, blockchain technology can record and transfer information flow reliably, realize point-to-point transactions between suppliers and demanders to achieve "decentralization", help to reduce the entry threshold for the carbon trading market. At the same time, an analysis of social environment for blockchain-based carbon trading on person is made. Finally, the paper confirms the value of "blockchain + carbon trading" and looks forward to the future.

Keywords: Blockchain; Carbon trading; Decentralization; Emission reduction.

1. Introduction

1.1. Carbon trading overview

Carbon trading is a market mechanism adopted to promote emission reduction of global greenhouse gas such as carbon dioxide [1-6]. In December, 1997, the "*Kyoto Protocol*" passed by the UN government in Kyoto, Japan, regards the market mechanism as a new way to solve the greenhouse gas emission reduction problem, that is, the carbon dioxide emission is considered as a commodity, which has formed a carbon trading system [7-8].

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Concretely, the process of carbon trading is shown in Figure.1. Emission has been reduced in the companies which have been devoted to energy-saving transformation or technology and equipment upgrade. Companies whose emission is exceeded should purchase the remaining emission quota from them. In this way, low-carbon awareness will be strengthened. As a result, equipment, technology, structural energy conservation, energy management and other methods will be promoted to heighten effect of energy-saving and emission-reduction.

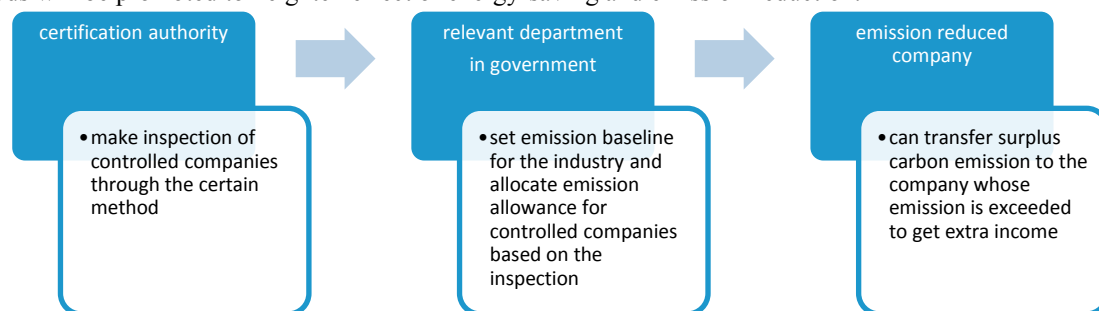| certification authority	relevant department in government	emission reduced company
• make inspection of controlled companies through the certain method	• set emission baseline for the industry and allocate emission allowance for controlled companies based on the inspection	• can transfer surplus carbon emission to the company whose emission is exceeded to get extra income

Fig. 1. Process of carbon trading

1.2. Blockchain overview

In 2008, Bitcoin was issued. At the same time, with the publication of its founder Satoshi Nakamoto's thesis "*Bitcoin: A P2P Electronic Cash System*" [9], blockchain, the underlying core technology of the Bitcoin system, used as a decentralized database technology, came into the public view.

Blockchain is characterized by decentralization, transparency, data security and system autonomy. It has been applied widely in areas such as finance, education and employment, culture and entertainment, public service, information security, healthcare, supply chain and internet of things [10-11].

1.3. The application of blockchain in energy trading

The goal of application of blockchain technology in the energy industry is to provide a fully decentralized energy system that can be communicated directly between producer and consumer. Blockchain technology helps to strengthen influence of individual consumer and producer at the market, which also gives consumer a high degree of autonomy in energy deal directly. In addition to energy supply trade, blockchain technology can also be applied in the process of metering, billing and settlement.

In Germany, a detailed analysis about the prospect of the blockchain in energy trading, proposes that Enercoin, which represents the blockchain transaction currency, can be used as an alternative instead of Eurocurrency for energy trading [12]. The Belgian experts make a tentative plan, that is NRGcoin currency can be used for microgrid power trading after the application of decentralized approach in point-to-point trading [13-14].

Singaporean scholar Khamila Nurul Khaqqi proposes a blockchain-enabled system for emission trade. His paper offers a novel ETS model customised for Industry 4.0 integration. It corporates blockchain technology to address ETS's management and fraud issues whilst it utilizes a reputation system in a new approach to improve ETS efficacy, which would improve management, increase abatement investment, motivate industry participants [15].

Janusz J. Sikorski in Department of Chemical Engineering and Biotechnology explores blockchain technology in relation to Industry 4.0. He presents an example where blockchain is employed to facilitate machine-to-machine (M2M) interactions and establish a M2M electricity market in the context of the chemical industry. This work contributes a proof-of-concept implementation of the scenario [16].

Although blockchain technology shows strong potential in energy application, it has just begun. Only a few high-tech companies in occident have attempted it.

In April 2016, the TransActiveGrid project in Gowanus and Park Slope, Brooklyn, New York, was put into operation successfully [17-18]. It combines blockchain with distributed generation to achieve a point-to-point trading model. Every green energy producer and consumer on the platform can trade freely and directly without third party.

A single household can sell the remaining electricity from solar power to another household. The project is the first energy market based on blockchain technology in the world. It is to be regretted that the project came to an end because New York City does not allow the individual to sell electricity.

2. The application of blockchain in carbon trading

In the world, blockchain research and practical application are in full swing. "Blockchain +" has become a new era of the vane. In China, the cochain of carbon asset has become a hot spot quietly. The Ministry of Industry and Information Technology of the People's Republic of China is formulating national standards for blockchain technology. It can be seen that blockchain application in the carbon industry is inevitable.

Many features of the carbon trading market are really similar to the blockchain mechanism. The essence of blockchain is a decentralized database. The essence of carbon trading is to assess, store, trade and manage carbon emissions. Blockchain is a form of existence of data, while carbon trading is the use of data.

2.1. Blockchain-based carbon trading on corporate

When blockchain is applied to a corporate carbon transaction, the company's production and consumption status will be checked at a specified interval, and the output or reduced carbon emissions corresponding to the status will be stored in the database. Then autonomous trading or block can be performed. The chain arranges the trading route and completes the carbon emission transaction with the other party directly. The following advantages are analyzed for "blockchain + carbon trading".

2.1.1 Safe and reliable

To ensure the safety of carbon emissions in the transaction cycle. The concept of a distributed ledger in blockchain theory requires that transactions between network participants be faithfully recorded in a shared ledger. Each record will have a timestamp and a unique cryptographic signature, which ensures that each transaction can be traced back to the historical record. Any changes in the books will be truly reflected in all copies, usually within a few minutes or even seconds, which prevents anyone from making mistakes or altering them maliciously. Specific to the application of carbon trading, blockchain technology can truly and reliably record and transmit information flow in carbon emissions trading [19]. By creating a consensus network, we can directly locate the problems in the transaction link and ensure the traceability of information, so as to avoid problems such as lost quotas and repeated transactions. Even if an illegal trading activity or fraud occurs, it will be detected and the normative operation of carbon market will be further strengthened.

2.1.2 Efficient and convenient

At present, the general system is divided into three parts. The registration system is mainly responsible for the generation and storage of carbon emission quotas and the management of quota accounts. The carbon emissions trading system completes the carbon emission quota transaction. The corporate carbon emissions management system completes the calculation of corporate carbon emissions and the accounting of third-party. Blockchain technology can load the management system, registration system and trading system into the shared account books in order of occurrence time, and the changes caused by the search, the call and even the modification between systems will occur in the same total books, which will seamlessly connect the corporate platform with the public platform and greatly save the maintenance cost [20].

In addition to the transparency and non tampering of the data mentioned above, the feature of the blockchain also includes the essential feature of decentralization. All enterprise nodes will follow the same protocol, in which it is stipulated that all companies' carbon emission transactions comply with the same consensus algorithm to make all processes consistent. In this way, the carbon emissions trading exchange will be greatly liberated and "decentralization" will be achieved.

The carbon emissions trading exchange will slowly hide behind the scenes in the decentralization process. This weakening trend is actually a relief to itself. In 2011, the State Council promulgated the "Circular on Launching the Pilot Work of Carbon Emissions Trading" and proposed the gradual implementation of a carbon emission trading market pilot. On June 18, 2013, Shenzhen took the lead in establishing a carbon emission trading market, marking the domestic start. The carbon trading fee as the main income of the exchange, varies from 0.08% to 0.7%. However, judging from the current situation of China's carbon emissions trading exchanges, transaction fees can only basically cover the cost of water and electricity. Most exchanges mainly rely on reporting carbon market related research fees and low-carbon project consulting fees and other financing. These have an overlap with the main business of research institutes and consulting companies. Therefore, frankly speaking, the main business of carbon emissions trading can not feed itself, and sideline falls behind others. It is in an awkward situation.

"Decentralization" omits the intermediary structure and enables point-to-point transactions between suppliers and demanders. The blockchain can independently determine transaction, which even can constantly update the best trading route and schedule based on previous trading experience. In this way, the carbon emission quota utilization rate will increase, and the efficiency will be greatly improved.

2.1.3 Open and inclusive

With the consent of the State Council, the National Development and Reform Commission issued the "National Carbon Emission Trading Market Construction Program (Power Generation Industry" on December 18, 2017. This document uses the power industry as a breakthrough in the carbon market construction because of the large carbon emissions of the power industry. It also proposes that companies with an annual energy consumption of 26,000 tons of carbon dioxide equivalent and 10,000 tons of standard coal will be included in the threshold. At the same time, the conference points out that with the maturity and improvement, the carbon market should be further lowered into the threshold and more companies should be included in the management. According to the document, such a signal can be obtained, although many small and medium-size enterprises (SMEs) have not been approved to enter the trading market, their access permission has become a consensus in the plan.

In Canada, the clean energy industry is mainly composed of small and medium-sized enterprises, which are located all over the country and involved in many innovative fields such as power generation, energy infrastructure, energy efficiency, industrial processes, biomass and bio-energy, recycling and reuse and transportation. A large number of policies by the Canadian government, including price subsidization, tax incentive and project support, have become fertile ground for small and medium enterprises to develop clean energy. In contrast, the current level of green development of China's large enterprises and small and medium-sized enterprises is not balanced. In the 12th Five-Year Plan, the industrial energy-saving and emission reduction shows partiality for large enterprises. The level of sustainable development of large enterprises has been significantly improved these days. However, the technological equipment of small and medium-sized enterprises generally lags behind, with relatively high consumption of various pollutants. Whether it is a large enterprise or a small and medium-sized enterprise, they should develop on parallel lines in energy-saving and emission-reduction. This is an issue that needs urgent attention.

Blockchain technology can make each company's emissions have the characteristics of assets. Regardless of the size of the company, as long as there is CER output, it belongs to commodities that can be traded in the carbon market. Blockchain technology will help reduce the entry threshold for carbon trading market and actively mobilize the subjective initiative of small and medium-sized enterprises in energy reform. For them, the flexible and sensitive features can also show an advantage in the tide of low-carbon economy and help them to grasp business opportunities.

2.2. Blockchain-based carbon trading on person

Dieter Helm, a professor of economics at the University of Oxford in England, queried about the problem with the *Kyoto Protocol* in the Energy Review in 2013. The *Kyoto Protocol* does not consider the carbon footprint. It is based on carbon reduction in the production process rather than the consumption process. However, the carbon footprint and carbon consumption is closely related to the consumers. This view is particularly strong in the reality. For the development of the carbon market, there has been an issue that the industry values carbon emission while the public

does not for a long time. The government and financial institutions have been dedicated to the construction of the carbon market eagerly, but the general public is still unfamiliar with this concept.

Similar to the principle of more intense participation from small and medium-size enterprises, the application of blockchain will also accelerate the people's personal involvement in the market of carbon trading, mobilize the user's subjective initiative fully, which will encourage the whole society to unite to change the embarrassing situation.

Based on the characteristic that the blockchain is applicable to the transaction (bitcoin), the application can solve the problems of data ownership, privacy, and permission effectively. Carbon coins are collected by the individual low-carbon behavior to the blockchain account through the technology. A safer, more transparent and efficient blockchain depository model is adopted. The basic data from individual low-carbon behavior will be adapted to carbon coins quickly through a highly intelligent methodology. The public can use carbon coins to consume or even make financial investments in the carbon sector.

For instance, the EU Scanergy project combines blockchain and personal carbon trading to enable direct trading of small users' green energy. The project envisages testing the production and consumption status of the network every 15 minutes in the trading system, and providing energy suppliers with a bitcoin-like NRG currency as incentive for energy production, but the project has not yet been put into practical operation.

In China, the "energy" in the "The Forest of Ants" project has the same effect as the carbon coin. The carbon emissions saved by subway trips, on-line payment for water, electricity and coal, and online ticket purchases by users will be calculated as virtual "energy", which will be used to raise one virtual tree on users' accounts. After the virtual tree grows, the Ant Financial and public welfare partners will plant a real tree on the earth to cultivate and inspire users' low-carbon environmental protection behavior.

Chen Long, Chief Strategy Officer of Ant Forests, mentioned that in the future, if individual carbon emission reduction activities can gain acceptance nationally and be included in China's CCER type, it will be hopeful to become a "carbon account" for future individuals to participate in carbon trading and investment.

It is worth noting that if blockchain technology is applied to personal carbon trading, the shared ledger will also quicken the integration of personal low-carbon behavior with government policy, public service, and corporate good. For example, in 2016, in China's first carbon currency trading platform (Shenzhen), the carbon coin system has secured cooperation with the urban management, traffic police and other departments. User riding can be counted as the corresponding carbon coin.

3. Conclusion and prospect

Combined with the steps of carbon emissions trading, the characteristics of the blockchain are specifically demonstrated to show its own advantages in the enterprises. On the personal front, it has been concluded that carbon market has reached a certain level, which will lay the foundation for blockchain promotion.

However, the technology and application of the energy blockchain are still in the initial stage. On the one hand, the blockchain technology is not mature enough. The computing power and response speed are both bottlenecks. On the other hand, the energy system is so complex that requires a lot of research, policy support and related talents. There is still a long way to go before the energy blockchain can be realized.

Acknowledgements

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