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Design of carbon emission trading system based on blockchain smart contract technology

THESIS WORK OF THE MASTER'S PROGRAM
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ANNOTATION

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In TW the method of effectively mitigate global climate change and fully mobilize the enthusiasm of enterprise is offered (the object of research, for example is specified Blockchain technology). The method is based on modeling (the object of research, for example is specified Smart contract technology based on Solidity software).

TW purpose – to Improve the efficiency of carbon emission trading (the object of research is specified Blockchain smart contract technology) the enterprises of power system with use of a method (the chosen method, for example is specified Establish carbon emission trading market).

TW contains: sections of modeling of processes; Selection of key indicators, Establish a comprehensive evaluation index system; Function debugging of transaction module; key parameter sensitivity analysis; estimates of ecological and economic efficiency of application of methods at the enterprise of power system; The analysis strong an weaknesses of technology of blockchain, opportunities and threats of its application in carbon emission trading system; Gantt's schedule of actions for implementation of technology of carbon emission trading system in power system.

TABLE OF CONTENTS

ABSTRACT

With the international research on global climate, they have launched actions in the face of global climate change. In 2011.11, referring to the experience of the United States regional greenhouse gas action and the construction of the European Union's international carbon market, the National Development and Reform Commission announced that China's carbon trading market has begun, and carbon emissions trading is considered to be an effective mitigation of global climate change and fully motivate enterprises s method. From 2013 to 2016, China has successively established 7 pilot cities for carbon trading markets, laying a solid foundation for the establish of a unified national carbon trading market. Emissions trading is considered as a means to effectively mitigate global climate change and fully motivate companies.

As the carbon trading product is a virtual product, the blockchain as a decentralized database uses transparent mathematical algorithms to ensure that the data stored in the chain is secure and cannot be tampered with. Smart contracts composed of automated script code can perform intelligent transactions on the data in the chain.

The actual review of carbon trading inspection and review was conducted with actual company MRV work. Finally, according to the characteristics and requirements of the construction of China's carbon emissions trading market, starting from the design goals of the trading platform, the overall system design, system implementation, system deployment, and implementation of functional modules are studied. On the Ethereum open source platform, the blockchain is developed. Black box design, writing smart contracts, and deploying smart contracts in private blockchain blockchains to implement the basic functions of a carbon emissions trading system and enable transaction data to be recorded in the blockchain. Realize the specific functions of the registration management module, information module, transaction module, settlement module, and auxiliary module of the trading platform. Complete user login, record query, balance query, release information, matchmaking, risk control, market supervision and other comprehensive functions.Finnally do The analysis strong an weaknesses of technology of blockchain, opportunities and threats of its application in carbon emission trading system,meanwhile da a Gantt's schedule of actions for implementation of technology of carbon emission trading system in power system.

1 INTRODUCTION

1.1 Research background

The consequences of global warming are far faster than experts expect. Potential threats may include rising surface temperatures, changes in global climate, rising sea levels, and even disruption of food production. It is undeniable that many countries still rely mainly on fossil fuels to maintain their energy production and supply, so carbon dioxide emissions will exacerbate global warming and cause environmental damage and health hazards [1].

Due to the harmful effects of excessive carbon dioxide emissions on the global climate each year, regulators have established strict regulations to limit their emissions. Approximately 76% of global emissions in 2010 originated from power generation needs, mainly for electricity and industry [2]. From 2015 to 2040, global CO2 emissions are forecast to increase by 16%. Carbon dioxide was 75% of global greenhouse gas emissions in 2010, with an average annual increase of 0.6% from 2015 to 2040, most of which comes from the burning of fossil fuels. In 2018, CO2 emissions reached 10 billion tons. The world's per capita CO2 emissions in 2010 are shown in table 1.1 [2].

Table 1.1 – World CO2 emissions per capita in 2010

Country	CO2 emissions, 100 million tons	Of global emissions, %	CO2 emissions per capita, tons / person
China	76 871	25.35	5.757
United States	52 996	17.48	17.015
India	19 794	6.53	1.650
Russia	15 774	5.19	11.011
Japan	11 011	3.63	8.691
Germany	7 346	2.42	8.911
Canada	5 139	1.69	15.255

Considering the impact of greenhouse gas emissions on climate change, various studies have been carried out and several solutions have been proposed: including converting CO2 into usable industrial products, applying energy-saving emission reduction technologies to reduce CO2 production, and capturing CO2 for supply storage. However, due to the financial burden of these solutions, they have rarely been implemented proactively [3].

Charging emission products is considered to be an effective way to reduce the passive acceptance of emission reductions. One option is through an emissions trading scheme (ETS) or a cap-and-trade scheme. In 2016, 17 ETS were active globally, and more government agencies are considering implementation [4]. Specific regulations vary from country to country. Although the market mechanism is used as a new way to solve the problem of reducing greenhouse gas emissions represented by carbon dioxide, that is, using carbon dioxide emission rights as a commodity, thereby forming a transaction of carbon dioxide emission rights, referred to as carbon trading [5]. Two recognized methods of producing emissions prices are carbon taxes and carbon trading permits. The difference between the two lies in the method of price generation: in the case of taxation, prices are determined and determined by policy makers; in the carbon trading market, prices are the result of supply and demand. These two policy options have been analyzed and compared many times in different aspects and situations, with mixed results, and some researchers have found that both are equally effective [6].

Carbon trading is also known as ETS or cap-and-trade schemes. It sets limits or limits on the types and amounts of greenhouse gases allowed by its jurisdiction. Then through free allocation or auctions, the same number of permits that allow participants to emit greenhouse gases are created and distributed at the beginning of the participants. At the end of this period, all participants must submit the relevant number of permits and the emissions report generated during that period [1].

Carbon emissions trading is because the cost of reducing emissions varies widely between companies, and this approach provides participants with the flexibility to use the most cost-effective method to fulfill their obligations [7]. The plan also provides an option for relevant parties to achieve economic production by purchasing and abandoning quotas.

In October 2011, referring to the experience of the US regional greenhouse gas action and the construction of the European Union 's international carbon market, the National Development and Reform Commission announced that China 's carbon trading market has begun. From 2013 to 2016, China established Chongqing, Shenzhen, and Tianjin 7 carbon trading market pilot cities in Shanghai, Shanghai, Beijing, Hubei and Guangdong [8]. Taking pilot cities as the first step, gradually explore the national carbon market experience [9] (figure 1.1).

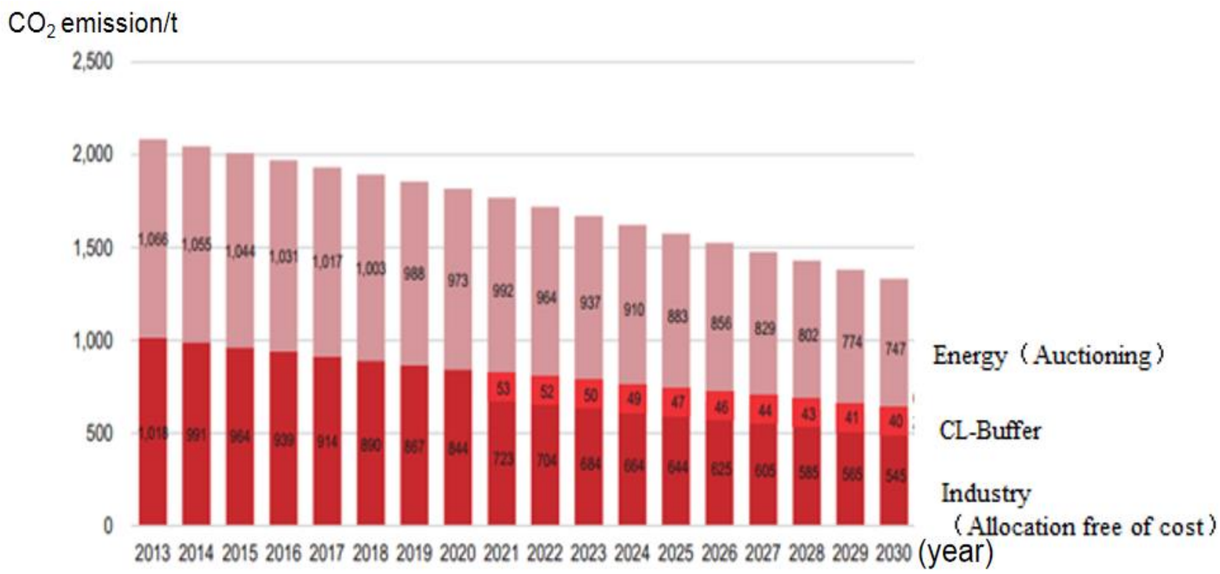

Figure 1.1 – EU emissions trading system-total control
in the third and fourth stages

With the introduction of the concept of blockchain, due to its completely transparent mathematical algorithms: asymmetric encryption and consensus algorithms, maliciously changing the data stored in the chain requires a lot of computing power. The application has attracted wide attention [10]. Due to the decentralized nature of blockchain technology, it can be well applied to existing applications that require third-party regulatory agencies to reduce regulatory expenditures. The main difference between carbon emissions trading and other physical transactions is that the "quota" of the transaction object is an electronic agreement and a virtual product. Since the blockchain stores electronic information that cannot be tampered with, the blockchain technology can be well applied to the design of carbon trading systems.

1.2 Status of research at home and abroad

The application of blockchain has gone through the following three historical processes:

Blockchain 1.0-Virtual Digital Currency (Bitcoin)

Blockchain 2.0-smart contracts (financial transactions, smart assets)

Blockchain 3.0-Beyond Money and Financial Markets (Internet of Things, Supply Chain, Healthcare).

Figure 1.2 provides an illustration of the blockchain structure.

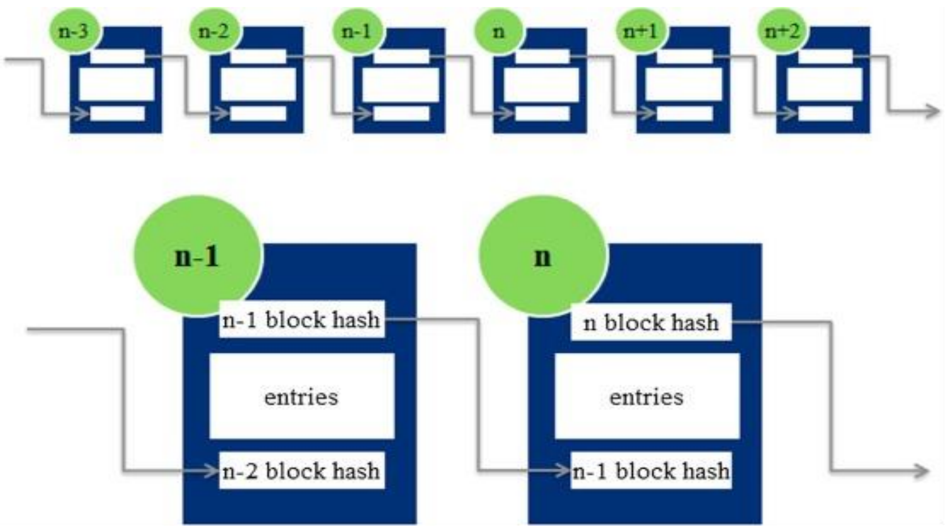

Figure 1.2 – Blockchain structure

With the public's in-depth understanding of the blockchain, more applications of blockchain applications have been developed. There are a large number of cases in the fields of finance, logistics, and public services.

Examples of the application of blockchain in the energy industry include: Drift applied the blockchain to the New York retail electricity market, fully discovered and utilized distributed new energy, realized effective docking of supply and demand, improved electricity efficiency, and reduced electricity costs [11] Greeneum uses artificial intelligence and blockchain to build a virtual power plant. The Greeneum Network is a global community that connects all entities in the energy supply chain. Based on smart contracts and artificial intelligence, it creates a decentralized and sustainable energy market. Provide intelligent monetization for real-time energy transactions, using blockchain technology, smart contracts, and artificial intelligence (AI) to stimulate and decentralize the energy market so that all stakeholders can reliably produce, trade, and consume energy. In the end, the world 's carbon footprint was reduced [12]; Electron developed a distributed natural gas and electricity metering system that interacts with smart meters through smart contracts and can only read meter data to issue energy demand instructions quickly and accurately [13]; LO3 Energy established the world's first blockchain microgrid, proving that a distributed smart microgrid has a higher energy utilization rate than a large grid with unified dispatch in the traditional sense. The potential of Xiaoyan [14].

1.3 Main research content

First, the experience of coping with international climate change, global greenhouse gas reduction targets, and the construction of an international carbon market was studied. Then it analyzes China's strategy to address climate change, including the situation it faces, its strategic requirements, its guiding ideology, its goals, and the construction of its carbon trading market. Then introduced the blockchain technology, and carried out a panoramic analysis to explain the underlying technology of the blockchain from the perspective of the basic knowledge, development history, key technologies, industry status, scene models, and mainstream platforms of the blockchain. Finally, according to the characteristics and requirements of the construction of China's carbon emissions trading market, a carbon emissions trading system platform was built based on the Ethereum smart contract technology. Ethereum is an open source platform for Turing complete construction of decentralized applications, which is equivalent to black box design of the blockchain. Based on Ethereum smart contract technology, it provides a more convenient and quick tool for building blockchain applications. By writing smart contracts and deploying smart contracts in the private chain of the blockchain, the basic functions of the carbon emissions trading system are realized, and transaction data can be recorded in the blockchain. User and regulatory department application platforms are established separately. The user platform can query the system to store data and conduct transactions through the platform, and the supervisory department application supervises and manages users on the platform.

The chapters of this article are arranged as follows:

Chapter 1: Mainly introduces the background of the topic selection and its research significance. Since the Industrial Revolution, human beings have played a leading role in earth activities, and humans have been living in harmony with the earth. Due to the blind pursuit of economic development, excessive emissions of greenhouse gases, Is a major factor in current global climate change. Carbon emissions trading is an effective way to give full play to the role of the market and mobilize emission actors to actively participate in emission reduction activities, which can effectively reduce greenhouse gas emissions.

The second chapter introduces the blockchain in detail from the technical foundation, development history, key technologies, and smart contract technology, and proposes a design scheme of a carbon emission trading system based on smart contract technology.

The third chapter focuses on the key links in the design of the carbon emissions trading system, starting from carbon emissions trading, MRV, and initial allocation of quotas.

Chapter 4 introduces the design and implementation of a carbon trading system based on smart contract technology. The overall design goals, scheme selection, overall architecture, smart contract writing, and deployment are introduced in detail. Finally, the trading platform registration management module, information module, transaction module, fund settlement module, and auxiliary module were demonstrated.

Chapter 5 Analysis strong an weaknesses of technology of blockchain, opportunities and threats of its application in carbon emission trading system,meanwhile da a Gantt's schedule of actions for implementation of technology of carbon emission trading system in power system

2 BLOCKCHAIN TECHNOLOGY

2.1 Blockchain technology foundation

2.1.1 Blockchain origin

At present, Bitcoin is one of the most successful applications of blockchain technology to date. Blockchain technology originally appeared as the underlying framework technology for Bitcoin. Therefore, to understand the blockchain technology, we can first briefly understand the origin of the blockchain-Bitcoin [17].

"Digital currency" has been researched and explored by countless scientists. Bitcoin has made "digital cryptocurrency" a reality. As the first blockchain application, Bitcoin is also the largest, most widely used and most mature application in the world [18].

In November 2008, a Japanese scientist with a net name of Satoshi Nakamoto published an online post entitled "Bitcoin: A Peer-to-Peer Electronic Cash System", which has been issued, causing widespread concern and heated discussion. The concept of bitcoin was first proposed, describing how to build a new, decentralized, peer-to-peer trading system. As of May 2019, the daily confirmed transaction volume of the token has reached the highest level in 16 months, and the maximum number of transactions confirmed in a day is nearly 440,000-exceeding the daily confirmed transaction volume in January last year [15].

Compared with the traditional currency and the "digital currency" before the birth of Bitcoin, the biggest difference of Bitcoin is that it does not rely on any centralized organization, but only on the mathematical principles of encryption and consensus algorithms in its system. This is the convenience brought by technological innovation, and it no longer requires a series of protection measures to trust an institution. This feature has caused bitcoin and blockchain to attract outside attention [19].

2.1.2 Blockchain definition

Blockchain technology is essentially a decentralized database. It is a new application model of computer technologies such as distributed data storage, peer-to-peer networks, high-efficiency consensus mechanisms, and hash encryption algorithms. Generally speaking, the blockchain stores time in the block, a chain data structure that connects the blocks in order according to the order of events. From a technical point of view, the blockchain uses a consensus algorithm to update data, store data in a chain structure, verify data with asymmetric encryption algorithms, and use a distributed infrastructure and computing paradigm for processing data based on open source platform smart contract technology.

The data stored in the blockchain is jointly maintained by the entire network of nodes, and each node participates in the generation and dissemination of data. Its applications have multi-center, automated, and trusted functional characteristics. Since all nodes in the blockchain network participate in bookkeeping and real-time reconciliation, each node is equal in position. Once a smart contract in the blockchain is deployed and executed automatically, the smart contract simplifies the overall process and is enforced through a programming language. The transaction records and other data stored on the blockchain are immutable and traceable, so they can solve the problem of mistrust between parties without the need of a trusted third party intermediary [21].

2.2 Development history of blockchain

Since the birth of blockchain technology, the development process is roughly divided into 4 stages: the origin of technology, the blockchain1.0, Blockchain 2.0, Blockchain 3.0 [28]. Blockchain technology is rapidly heating up in China, and more and more scholars, companies, and research institutes are beginning to pay attention to this emerging technology, and the development of blockchain has reached unprecedented fever. It has become one of the most revolutionary emerging technologies in recent years.

2.3 Blockchain key technologies

The basic architecture of the blockchain is summarized as follows: data layer, network layer, consensus layer, incentive layer, contract layer and application layer [29]. As shown in Figure 2.1.

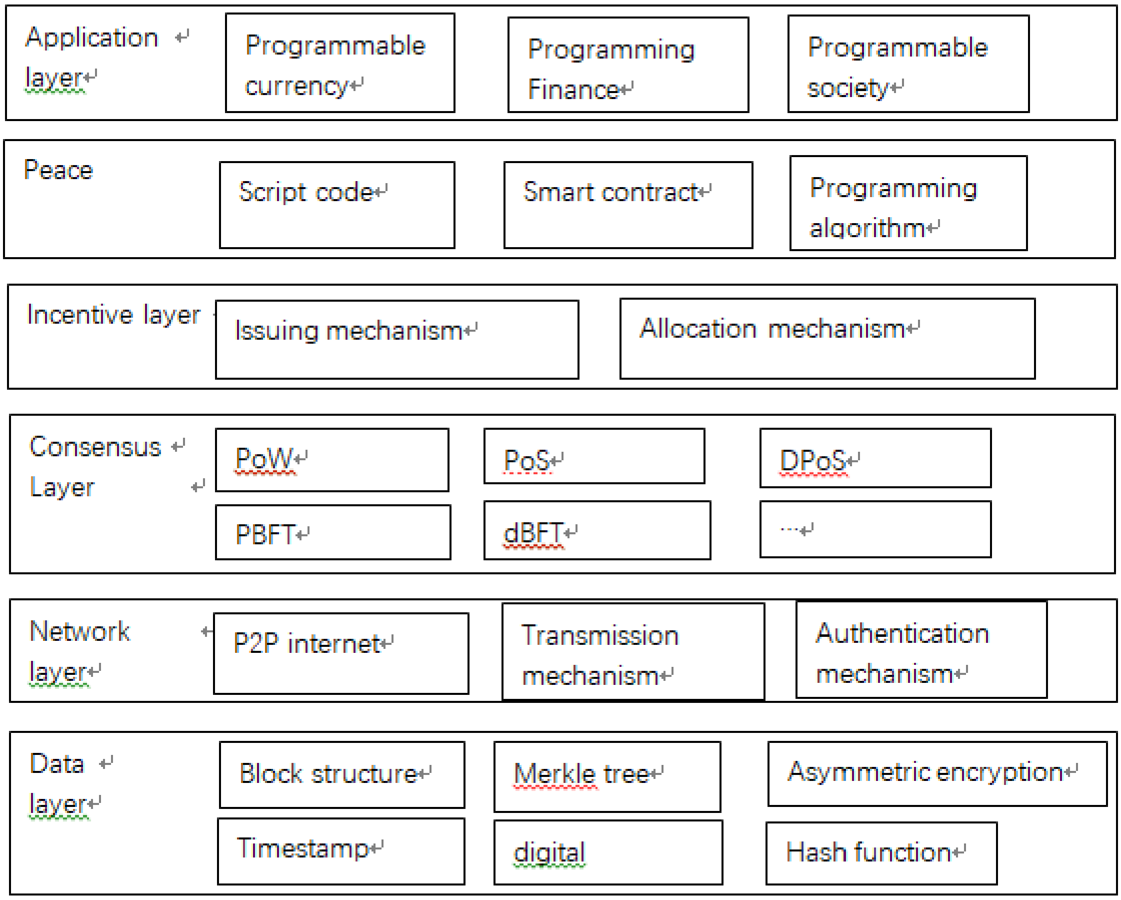

Figure 2.1 – Blockchain basic architecture

2.4 Ethereum smart contract

Ethereum, as a more mature platform for blockchain, is trusted by many developers and companies for its security, reliability and ease of use [38]. The overall architecture of Ethereum is shown in Figure 2.2.

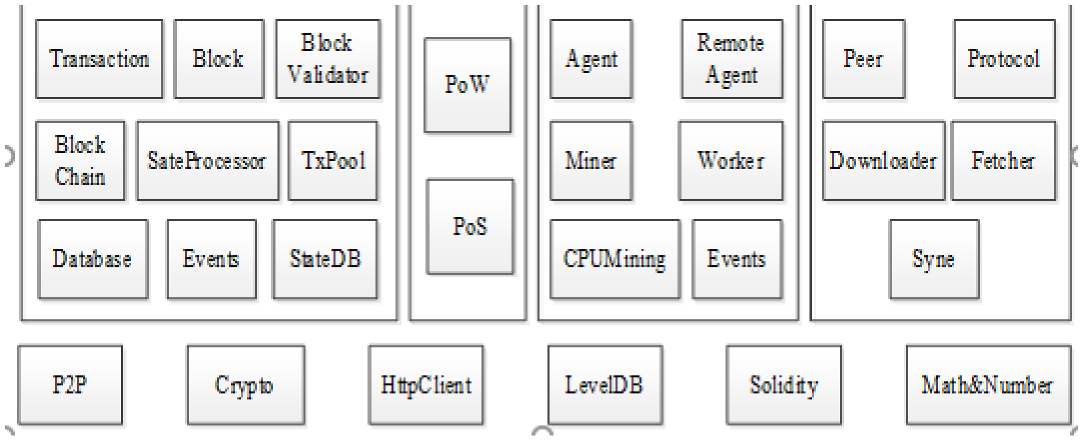

Figure 2.2 – Ethereum basic architecture

The bottom layer of Ethereum mainly includes the P2P protocol, which is a protocol that does not have a central server and directly communicates between two nodes. Only based on P2P, the blockchain can provide decentralized services. Consensus algorithms are the core components of a blockchain platform. They are algorithms and strategies for achieving consensus between different nodes. At present, the two most important consensus algorithms of Ethereum are PoW and PoS. EVM is an Ethereum virtual machine, a container for running decentralized applications. Smart contracts can be compiled into bytecode and run in EVM.

The Ethereum Virtual Machine (EVM) is an environment for running smart contracts. It runs on each node and is similar to an independent sandbox. It strictly controls access permissions; that is, the contract code cannot access the network when running in the EVM. Files, or other processes [33]. The EVM module is mainly divided into three major modules: the compilation contract module, the Ledger module, and the EVM execution module.

A smart contract is a collection of code (logical description) and data (state representation). When a predetermined condition occurs, a transaction will be sent to the contract address, and the entire network node will execute the operation code compiled by the contract script, and finally write the execution result into the blockchain. Therefore, smart contracts can be understood as all business logic code that performs operations on the blockchain [25].

An important feature of smart contracts is Turing completeness. Empower the scripting system to solve all computable problems. Smart contracts are Turing-complete, that is, they can achieve everything that Turing machines can do. In other words, all logical operations that a general programming language can do can be implemented in a smart contract. Another important feature of smart contracts is sandbox isolation. Limits on I / O, network operations, access to other processes, etc. are actually completely isolated. Therefore, currently implemented smart contracts cannot read and write files, nor can they access network resources or directly provide network services. Smart contracts can only use the interface provided by the blockchain platform to access contract data after it is deployed on the blockchain platform.

At present, smart contracts can be written in languages such as Solidity, Serpent, LLL, and Mutan, but the most widely used and most popular is Solidity.

Solidity is a high-level object-oriented language with a syntax similar to JavaScript. It is also a statically typed language. It is designed to write smart contracts and run on the Ethereum virtual machine. Solidity supports inheritance, libraries, and complex custom types. It is a decentralized contract that runs on the network in a real sense. At present, Solidity has an online real-time compiler, which is convenient for developers to use. It also supports a variety of standard library functions.

3 CARBON EMISSION TRADING SYSTEM

Both theory and practice have fully demonstrated that carbon emissions trading plays an efficient role in controlling greenhouse gas emissions [5]. Environmental economic policy tools are simply divided into two categories: "market incentive" and "command and control" in basic environmental theory. In people's opinion, command-and-control policies are compulsory, relatively reliable, and low in uncertainty, but they are not efficient enough to increase enterprises' active participation in energy conservation and emissions reduction, so they do not have continuous improvement and can reduce overall. The purpose of carbon emissions, but not conducive to further implementation of emission reduction measures; market incentive policies are different from high efficiency, continuous improvement, but high uncertainty, can achieve carbon reduction and promote continuous emission reduction technology The dual goal of advancement [39].

In the initial stage of emission reduction actions, the “command-and-control” type can achieve good energy conservation and emission reduction effects through compulsory measures and severe punishment. However, with the development of the economy, the requirements for emission reductions have gradually increased, and the cost of emission reductions has increased. The cost of penalties for enterprises is far lower than the economic benefits of superemissions. Participation in emission reduction is not high, and companies would rather accept penalties or fraud, rather than bear the cost of emission reduction. The “market incentive” policy tools fully play the role of the market in energy conservation and emission reduction, which can not only achieve the purpose of energy conservation and emission reduction, but also promote enterprises to participate more actively in energy conservation and emission reduction. Therefore, with the cost of emission reductions and economic development, market mechanisms have replaced administrative regulations more efficiently [40].

3.1 Overview of carbon emissions trading

3.1.1 Connotation of carbon trading

In the late 1970s, the EPA first proposed an emissions trading system [31]. Given the constraint conditions, the amount of pollutants discharged and the number of individuals who discharge pollutants are determined. The right to discharge pollutants has become a scarce resource. Different individuals have different permitted emissions. In this context, the government allows this right to be like a commodity under government supervision. Free trade between polluters as well.

Carbon emission rights are defined as the legal rights of all units and individuals involved in carbon emission trading to emit greenhouse gases to the atmosphere [53]. Carbon emissions trading is also known as “cap-and-trade, or“cap-and-trade ” mechanism. In the area where carbon trading is conducted, the total amount that can be emitted by trading individuals over a period of time is established, and the total amount is distributed to individuals or organizations in the form of initial quotas so that they have legal carbon (greenhouse gas) emission rights, It also allows this right to be traded between participants in the trading market like a commodity. Under the condition of a certain amount of carbon emissions, the market mechanism that can achieve the carbon emission control target in a cost-effective manner [54].

The main difference between carbon emissions trading and other physical transactions is that the "quota" of the transaction object is a "license" and a virtual product. And it happens that the blockchain can store digital information very well. The "license" digital information can be encrypted and stored in the chain to ensure the security, privacy and immutability of the data, and then conduct transactions in the chain. [55]. The basic elements of carbon emissions trading include: trading objects and organizational boundaries, time scales, total targets, corporate (organizational) quotas, transactions, accounting, quota settlement (performance), and a support system built around the above elements. The successful operation of the carbon market requires the joint efforts of governments and enterprises [56].

From the perspective of the government, first of all, a scientific method for determining the total amount of carbon emission quotas should be established. This involves various aspects such as economic development, energy structure, consumption orientation, etc. The total carbon emission quota control should not be too strict or too wide [57]. In 2017, the National Development and Reform Commission issued the "Carbon Market Construction Plan". In principle, without affecting the stable and healthy development of the economy, the construction of the carbon market was promoted in stages and steps, and the total quota was moderately tight. However, how to grasp the "degree" in specific operations is a huge difficulty. The second is the size of the (organizational) boundaries of companies involved in carbon trading. The size of the organization boundary determines the size and complexity of the carbon emissions trading market, and increases the difficulty of multi-objective decision-making. The plan puts forward the principle of “easy first, then difficult, and gradually promoted”. The first choice for reform is the power generation industry, and the power generation industry is the first to hit the thermal power industry. Positioning the country boldly in terms of trading scope is not a certain region, reflecting the urgent need to build a carbon trading market, and the carbon trading market share of the power generation industry occupies a large proportion throughout the country and is an important part of the national carbon market. The plan stipulates that the products initially traded in the carbon trading market are quota spot. After gaining experience in the construction of the carbon market, the country will increase the country's certified voluntary emission reductions and other trading products that meet the trading rules after the conditions are mature. The above regulations provide unique conditions and a continuous stream of motivation for the construction of the carbon market. The third is to determine a scientific, reasonable and fair quota allocation method. In terms of quota allocation, the plan dares to decentralize, give full play to the role of provincial units in the construction of the carbon market, and clearly point out that the provincial and municipal departments in charge of planning have the power to determine the initial unit allocation quota. "Allocation of quotas" is a powerful means for the government in the construction of the carbon market. It is guided by market demand and guides the market to mobilize market activity and effectively affect carbon prices. At the same time, by formulating a fair and transparent distribution method, conflicts between different enterprises can be coordinated. The fourth is coordination between policies. China's carbon market construction is in its infancy, and various policies and standards are not yet perfect. With the operation of the carbon market, the current policies will inevitably expose their shortcomings and disadvantages. Therefore, there will inevitably be conflicts between the current policies and the latest policies to be launched. Coordination between policies is the key to the success of the carbon market construction [58].

From an enterprise perspective, we must first have a clear and correct understanding of the direction of low-carbon development. Low-carbon development is a necessity of history and one of the key issues in the energy transition. Regardless of carbon emissions trading or carbon tax, total carbon control, carbon intensity control and other compulsory measures, all are market-oriented policy tools that can be used in low-carbon developing countries. Both carbon trading and carbon tax are designed to internalize the social cost of carbon emissions by setting carbon emission prices. Taking full advantage of the market's function of optimizing resource allocation, the impact on enterprise production and operation is relatively small. Total carbon control and carbon intensity control are two technical routes to control carbon emissions. Intensity control has less constraints on social and economic development than total control. The national independent contribution goals are consistent and adopted by the initial national carbon market. To support and actively participate in the national carbon market, enterprises must first be familiar with the basic requirements of national carbon market construction, look for methods and measures for low-cost carbon reduction by enterprises, make corresponding adjustments to development strategies in advance, and prevent possible major developments in low-carbon development Business risk. Then, while continuing to carry out technological innovation, attach great importance to the use of carbon market mechanisms for management innovation, shift from the traditional production and operation model to a new model under the carbon market mechanism, and strive to obtain benefits from comparative advantages.

3.1.2 How carbon trading works

Before introducing the principle of carbon trading, it is necessary to briefly introduce Coase's theorem. Coase's theorem is an important theoretical basis for carbon emission trading mechanism [60]. In the current actual market activities, the conditions for fully satisfying the Coase theorem do not exist, and transaction costs cannot be zero. The specific transaction method is that the government department determines the total amount of carbon emission rights in the country and allocates the carbon emission rights to each emission control enterprise within the total amount. Each emission control enterprise can decide whether to transfer or enter the market according to its actual situation. Transactions, etc., to achieve the goal of controlling carbon emissions and achieving economic benefits. In China, although the nature of the property rights of carbon emission rights has not been legally defined, the allocation of quotas through the government's administrative system can still play the role of a market mechanism.

3.2 Review of monitoring reports

3.2.1 MRV Concept

MRV refers to the process of quantifying carbon emissions and data quality assurance, including monitoring (Monitoring), reporting (Reporing), and verification (Verification). Monitoring refers to the evaluation of the continuity of greenhouse gas emission data; reports refer to the relevant departments or institutions to submit data on greenhouse gas emissions; and verification refers to the relevant agencies to verify the greenhouse gas emissions data of enterprises according to the verification guidelines. A scientific and complete MRV system is the basic element for the construction and operation of carbon emission trading mechanisms, and it is also an important support for low-carbon transformation of enterprises and regional low-carbon decisions [59].

3.2.2 MRV requirements

In the initial stage of the construction of the national carbon market, the monitoring, reporting, and verification system mainly includes the selection of applicable accounting and reporting guidelines, the formulation of monitoring plans, monitoring plan review, emission reports, and third-party verification and spot checks of Monitoring, reporting, and verification systems need to use quantitative accounting standards or guidelines that are clearly related to the allocation and compliance of carbon emission quotas. According to the given accounting method, monitoring work on different activity level data, emission factors, etc. is required. For the same industry, the development of a suitable monitoring plan that meets the accounting method and meets the quota allocation and compliance control of emission-controlling enterprises can enable similar enterprises to obtain corresponding fair opportunities [62].

3.2.3 Case study

The Next, we will introduce the MRV work in detail with specific cases, and take the 2018 greenhouse gas verification of a power plant in North China as an example. Confirm whether the carbon dioxide emission report and supporting documents provided by the inspected party are complete and credible, and whether they meet the requirements of the "Guidelines for Accounting Methods and Reports of Greenhouse Gas Emissions of Chinese Power Generation Enterprises (Trial)".

The verification scope includes two parts:

1. Legal person boundary: Regarding the inspected party as the inspected party as an independent legal person accounting unit, the greenhouse gas emissions generated in 2018 within the scope of its administrative area: emissions from the combustion of fossil fuels, emissions from the desulfurization process; net Emissions from the purchase of electricity;

2. Supplementary data sheet boundary: 2018 annual report information stipulated in the supplementary data sheet of the greenhouse gas emission report of power generation

companies: only includes emissions from the combustion of fossil fuels consumed by major production systems such as power generation boilers and gas turbines; consumption from net purchase of electricity Emissions; the main product output (power supply, heat supply) and production indicators included in carbon trading.

The inspected two existing units are dual extraction condensing steam heating units with a total installed capacity of 2 × 200MW, equipped with 670t / h pulverized coal furnace, equipped with limestone-gypsum wet desulfurization, SNCR-SCR urea method denitration system and Environmental protection facilities such as electric bag filter.

Figure 3.7 Flow chart of power generation and heating production process

The details of the main energy-consuming equipment and emission facilities of the party being verified are shown in Table 3.2 below.

Table 3.2- Main energy-using equipment

Device name	Equipment model	Quantity	Carbon source type	Operation
boiler	DG670/13.7-19	2	Fossil fuels	Normal
Desulfurization tower	-	2	Nitrate	normal
Steam turbine	N200/CC144-12.75/535/535/0.981/0.245	2	electric power	normal
generator	QFSN3-200-2	2	electric power	normal

Greenhouse gas emissions are calculated using the following methods (3.1):

$$E = E_{\text{h}} + E_{\text{s}} + E_{\text{e}} \tag{3.1}$$

The following methods are used to calculate the above-mentioned greenhouse gas emissions.

CO_2 emissions from fossil fuel combustion (3.2):

$$E_{燃烧} = \sum_{i=1}^{n} (AD_{\text{i}} \times EF_i) \tag{3.2}$$

The activity level of fuel combustion is the product of the consumption of various fuels and the average low calorific value in the accounting and reporting year, and is calculated according to formula (3.3):

$$AD_{\text{i}} = NCV_i \times FC_i \tag{3.3}$$

The carbon dioxide emission factor for fuel combustion is calculated according to formula (3.4):

$$EF_i = CC_i \times OF_i \times \frac{44}{12} \tag{3.4}$$

The discharged party's emissions from the desulfurization process shall adopt the following accounting methods in the Accounting Guide (3.5，3.6，3.7):

$$E_s = \sum_k CAL_k \times EF_k \tag{3.5}$$

$$CAL_{k,y} = \sum_m B_{k,m} \times I_k \tag{3.6}$$

$$EF_k = EF_{k.t} \times TR \tag{3.7}$$

The carbon dioxide emissions generated by the electricity corresponding to the electricity purchased by the enterprise are calculated according to formula (3.8):

$$E_e = AD_e \times EF_e \tag{3.8}$$

The inspection team checked the units, data sources, measurement methods, measurement frequencies, recording frequencies, missing treatments were checked.

Through calculation, the carbon emission values can be calculated, it’s shown as table 3.3 below.

Table 3.3 – Activity levels of energy varieties

data item	Check value	unit	Unit inspection conclusion
Bituminous coal consumption	1281355	t	Accurate and credible
Average low calorific value	19.136	GJ/t	Accurate and credible
Diesel consumption	398.23	t	Accurate and credible
Diesel average low calorific value	43.512	GJ/t	Accurate and credible
Desulfurizer consumption	49899.81	t	Accurate and credible
Carbonate content in desulfurizer	90	%	Accurate and credible
Net purchased electricity	0	KWh	Accurate and credible

Determine the emission factors (bituminous coal emission factors, bituminous coal carbon oxidation rate, diesel unit heat value carbon content, diesel carbon oxidation rate) during the combustion of fossil fuels, and the emission factors (carbonate emission factors) during desulfurization Emission factors for net purchased electricity consumption.

purpose of privacy-protected data mining [40] is to extract valuable information from large amounts of data while protecting the data privacy of users or devices. In order to better protect the privacy of electric vehicle users, this chapter uses the improved k-means clustering algorithm under differential privacy protection to ensure the availability of clustering results while protecting data privacy.

The input data of the algorithm is the data of the number of charging times of the 24-dimensional electric vehicle after data preprocessing. The output clustering result is k charging modes of electric vehicle users. The specific steps of the clustering algorithm are as follows:

1. Traverse all data points and calculate the distance from the current data point to other data points.
2. Calculate the density of data points.
3. Sort the density values of all data points in order from large to small.
4. Mark the data points at the end of the queue where density values are sorted as outliers.
5. The data points except the outliers are divided into k clusters in sorted order.
6. Calculate the initial cluster center point.
7. Calculate the distance from each point to each center point.
8. Compare the size to get the minimum distance corresponding to each point, and divide it to the corresponding center point.
9. Calculate the sum of the dimensions of the data points and the total number of data points, plus noise. Then calculate and update the center point of each cluster.
10. If the convergence condition is not satisfied, repeat steps7 to 9; otherwise, output the clustering result.

3.3 Chapter Summary

This paper analyzes the construction of China's carbon market in detail from its connotation, working principle and participants. Next, MRV and quota allocation are studied. Take a power plant in North China as an example to determine fossil fuel Emission factors during combustion (emission factor number of bituminous coal, carbon oxidation rate of bituminous coal, unit calorific value of diesel oil). Carbon content, carbon oxidation rate of diesel oil), emission factors (carbonate emission factors) in desulfurization process, net power purchase. Emission factors of consumption. Checked the greenhouse gas emissions of the inspected party in 2018. Research on carbon quota. The index allocation method is used to calculate the carbon quota. Seven pilot cities in China that have started carbon trading. Taking the city as the analysis object and selecting five indicators of population, cumulative emissions, GDP, carbon intensity and emission reduction cost.

4 DESIGN OF BLOCKCHAIN TRADING PLATFORM

4.1 Platform design goals

According to the national carbon market construction requirements, the design platform of this article should be able to meet the following functions: to provide services such as carbon emissions trading and infrastructure for comprehensive information services. The trading system should be able to complete the comprehensive functions of online account opening, customer management, transaction management, pending order declaration, combined trading, market release, risk control, market supervision, etc. The ultimate goal is to achieve carbon emissions trading efficiently, safely and conveniently [64].

Therefore, the carbon emissions trading platform designed in this article includes the following functional modules: trading entity registration and management module, carbon trading information module, trading module, fund settlement module and other related auxiliary modules. Five functional modules constitute the most important part of the trading system [18]. Through the use of blockchain technology to solve the problem of carbon emissions trading management and fraud, the use of efficient and convenient trading and trading platforms to improve the participation of enterprises.

4.2 Overall system design

4.2.1 Scheme Selection

Scheme selection mainly includes Ethereum client, development framework and interface types. In the development of decentralized applications (DApps), Test RPC and Geth are two types of mainstream Ethereum client usage. The carbon trading platform is designed to run in both Test RPC and Geth. However, the test process of the system uses Test RPC more.

Development framework: This trading platform uses Truffle development tools. Truffle is a development tool based on Ethereum smart contracts, which can unit test contract code, which is very suitable for test-driven development. At the same time, a smart contract compiler is built in. As long as script commands can be used to complete the contract compilation, deployment, and testing, the contract development life cycle is greatly simplified.

Ethereum interface: Ethereum currently provides two interfaces: JSON-RPC and web3.js. Because the Truffle framework is used, the web3.js interface is used by default. Because Truffle wraps web3.js, a JavaScript Promise framework for etherpudding, it is very convenient to use JavaScript code to asynchronously call methods in smart contracts. This interface can be easily switched between the front end and the background Now most decentralized applications use this interface. Therefore, the carbon emission trading platform designed in this paper also uses this excuse, and the specific implementation method is reflected in the code later

4.2.2 Overall architecture

The he carbon trading platform system architecture is shown in Figure 4-2. The bottom layer uses the Ethereum blockchain, and Test RPC is used locally to open Ethereum. Truffle tools are used to deploy smart contracts on Ethereum. The trading system uses the web3.js interface to call methods in smart contracts. Users can use the front-end page to easily use the functions in the trading system.

4.2.3 Smart Contract Design

Ethereum smart contracts can be written in multiple languages, such as Solidity, Serpent, LLL, etc. Among them, Solidity Solidity is a contract-oriented high-level programming language created to implement smart contracts. This language is influenced by the C ++, Python, and Javascript languages, and is designed to run on the Ethereum Virtual Machine (EVM). Solidity is a statically typed language that supports features such as inheritance, libraries, and complex user-defined types. When deploying a contract, you should try to use the latest version.

Smart contract design generally has two schemes: the first is that an entity in the project corresponds to a contract, so there may be multiple contracts in the project, which is more in line with the object-oriented idea; the other scheme is to design only one contract Different objects are stored in a contract through structure and mapping. Relatively speaking, the second scheme is easier to understand, the test is simpler, and subsequent extended maintenance is also more convenient. This system uses the second scheme.

1 instrument contract

In this case, because the contract will continue to interact with the front-end page, which involves some data type conversion, the front-end often comes in the string type, and the bytes32 are used in the contract. Conversion. Here we create a tool contract, and the subsequent tool methods can directly join the contract, and then let the real main contract inherit this tool contract:

```
contract Utils {
// String type is converted to bytes32 type
function stringToBytes32 (string memory source) constant
internal returns (bytes32 result) {
assembly {
result: = mload (add (source, 32))
}
}
// bytes32 type is converted to string type
function bytes32ToString (bytes x) constant internal returns
(string) {
bytes memory bytes String = new bytes (32)
unit char Count = 0;
for (unit j = 0; j <32; j ++) {
```

```
byte char = byte (bytes32 (unit (x) * 2 ** (8 * j)))
if (char! = 0) {
bytesString [charCount] = char;
charCount ++;
}
}
bytes memory bytesStringTrimmed = new bytes (charCount);
for (j = 0; j <charCount; j ++) {
bytesStringTrimmed [j] = bytesString [j];
}
return string (bytesStringTrimmed [j] = bytesString [j];
}
return string (bytesStringTrimmed);
}
}
```

2. Contract status design

The current contract targets government authorities, sellers of carbon emission rights, buyers of carbon emission rights, and carbon emission rights. Since there is only one main contract, we take the competent department as the "owner" of the main contract and the status of the administrator as the public state of this contract:

```
address owner; // The owner of the contract, the carbon emission authority
unit issuedCarbonAmount; // This year's carbon emission quota
unit settledCarbonAmount; // Remaining tradable carbon emission quota
```

Carbon emission rights sellers, purchasers, and carbon emission rights are encapsulated using a struct structure. Next, the attributes of these objects are added to the structure. Carbon emission sellers have four attributes: carbon asset account address, password, carbon emission quota, and sold carbon emission rights; carbon emission buyers have carbon asset account address, password, carbon emission quota, and purchased carbon emissions. 4 types of attributes; carbon emission rights have 3 types of attributes: ID, price, and business address.

```
struct Customer ｛
address customerAddr; // Carbon emission buyer address
bytes32 password; // Buyer password
uint CarbonAmout; // carbon emission quota
bytes32 [] buyCarbon; // carbon credits purchased
}
struct Seller ｛
address sellerAddr; // carbon emission rights seller address
bytes32 password; // Vendor password
uint CarbonAmout; // carbon emission quota
bytes32 [] sellCarbon; // carbon credits for sale
}
struct Carbon ｛
```

bytes32 CarbonID; // carbon emission quota ID
uint Carbonprice; // carbon emission price
address belong;
}

A mapping should be established in the contract. Buyers and sellers can be found through account addresses, or carbon credits can be found through IDs. Solidity provides a way to find the key-value pairs of this mapping:

mapping (address => Customer) customer; // Find the specific buyer based on the buyer's address

mapiing (address => Seller) seller; // Find the specific seller based on the seller's address

mapping (bytes32 => Carbon) carbon; // Find specific rights based on the carbon emission rights ID

At the same time, an array of buyers, sellers, and carbon emissions is established to store all registered or added objects:

address [] customer; // Array of registered buyers
address [] seller; // Array of registered sellers
bytes32 [] carbongoods; // Array of goods that are already online

Contract method design

The method design of the contract is mainly designed for the externally provided methods in each functional module, including the buyer / seller registration method, the method to determine whether to register, the buyer / seller registration method, and the carbon emission trading method.

Construction method

Each contract will have a default constructor, which will be called when the contract is initialized. We can also rewrite the construction method and initialize the parameters. In the design of the carbon emission trading platform, we need to use the caller of the contract as the account address of the competent department. The rewriting construction method is as follows:

//Constructor
function Carbon () {
owner = msg.sender
}

Buyer / Seller Registration

There are two types of methods in smart contracts: transaction methods and constant methods. The transaction method will modify the state variables on the blockchain and will generate a real transaction record on the block. The constant method is generally used to obtain variables. It does not modify the variables and does not generate transaction records on the block. Generally, the geth methods are constant methods. The registered client method should be a transaction method and use the event event to return the value. When using the web3.js interface, the transaction method cannot directly use returns to return data values. The default return value is the transaction hash, so we can only use the event to send the event return value. In contrast, the constant method can directly return data using returns, so constant

Methods generally do not write event events.

Buyer / seller registration is implemented as follows:

```
// Register a customer
event NewCustomer (address sender, bool isSuccess, string message);
functiong newcustomer (address _customerAddr, string _password) {
// judge whether it is registered
if (liscustomer already register (_customeraddr)) {
// Not yet registered
customer [_customerAddr] .customerAddr = _customerAddr
customer [_customerAddr] .password = _stringto bytes32 (_password);
customer.push (_customeraddr);
newcustomer (msg.sender, true, "Registration succeeded");
return;
} else {
Newcustomer (msg.sender, false, "This account is already registered");
return;
}
}
// Register a merchant
event NewSeller (address sender, bool isSuccess, string message);
functiong newseller (address _sellerAddr, string _password) {
// judge whether it is registered
if (lisseller already register (_selleraddr)) {
// Not yet registered
seller [_sellerAddr] .sellerAddr = _sellerAddr
seller [_sellerAddr] .password = _stringto bytes32 (_password);
seller.push (_selleraddr);
newseller (msg.sender, true, “Successfully registered”);
return;
} else {
Newsellerr (msg.sender, false, "This account is already registered");
return;
}
}
```

Seller / Buyer Login

In this contract case, use the smart contract method to obtain the password of the login object and determine whether the login is successful

The logic is carried out in JavaScript code. You can use return directly to return multiple values in Solidity's methods. The method for obtaining the login password in the contract is as follows:

```
// Query user password
function getcustomer password (address _customerAddr) constant
returns (bool, bytes32) {
// First determine whether the user is registered
```

```
if (iscustomer already register (_selleraddr)) {
   return (true, seller [_selleraddr], password);
} else {
   return (false, "");
}
}
```

Carbon quota allocation

In this case, the government authority allocates a carbon credit to each participant. The participant 's carbon credit issuanceCarbonAmount is recorded in the contract. The corresponding changes in the carbon emission credit are implemented as follows:

```
// Government authorities allocate quota to participants
event SendCarbontocustomer (address _sender, string message);
function sendCarbontocustomer (address _receiver, unit _amount) {
if (iscustomeralreadyregister (_receiver)) {
      // Already registered
      issuedCarbonamount + = _amount;
      customer [_receiver]. Carbonamount + = _amount;
      sendcarbontocustomer (msg.sender, "Successfully issued quota");
      return;
   } else {
      // Not yet registered
      sendcarbontocustomer (msg. sender, "This account has not been registered, and the distribution failed")
      return
   }
}
```

Release of carbon emissions information

The trading entity adds a carbon emission quota to the contract, and uses ID to identify each carbon emission quota, and the same ID cannot be added repeatedly. The added carbon credits will be added using mapping mapping objects and added to the sellcarbon array of merchant attributes. The method is implemented as follows:

```
// Add carbon credits
event addcarbon (address sender, bool issuccess, string message);
function addcarbon (address _selleraddr, string _carbonID, unit _price) {
bytes32 tempID = stringtobytes32 (_carbonID);
// First determine whether the quota ID already exists
if (lisCarbonalreadyadd (tempID)) {
   carbon [tempID]. carbonID = tempID;
   carbon [tempID]. belong = _ sellerAddr;
   carbon. push (tempID);
   seller [_ sellerAddr]. sellcarbon. push (tempID);
   addcarbon (msg. sender, true, "Successfully created quota");
   return;
} else {
```

```
    Addcarbon (msg .sender, false, “The quota has been added”);
    return;
}
}
```

Purchase quota

The method is implemented as follows:

```
// Buy carbon credits
event buygood (address sender, bool issuccess, string message);
funtion buycarbon (address _customeraddr, string _carbongID) {
    // Determine if the input quota ID exists
bytes32 tempID = stringtobytes32 (_carbonID);
if (isCarbonalreadyadd (tempID)) {
        // has been added and can be purchased
        if (customer [_customeraddr]. carbonamount <carbon [temID] .price) {
            buyCarbon (msg. sender, false, “Buy failed”);
            return;
} else {
    customer [_customeraddr]. carbonamount-=
    carbon [tempID]. price;
    seller [carbon [tempID]. belong]. carbonamount + =
    carbon [tempID]. price;
    customer [_customeraddr]. buycarbon. push (tempID);
    buycarbon (msg.sender, true, "Buy successfully");
    return;
}
} else {
        buycarbon (msg.sender, false, "The product does not exist"
        return;
}
}
```

4.3 Chapter summary

Starting from the design goal of carbon trading platform, the mainstream Ethereum client of testrpc is selected for development Using truffle development tools, the development framework can unit test contract code, which is very suitable for test drive Dynamic development. At the same time, the built-in smart contract compiler can complete the contract compilation as long as the script command is used Deployment, testing and other work greatly simplifies the development life cycle of the contract. Because of the truffle framework,The web3.js interface is used by default, because truffle wraps a JavaScript promise of web3.js.With the framework of ether pushing, it is very convenient to use JavaScript code to asynchronously call themethod. Then it introduces the system implementation and system deployment with specific code.

5 USE OF TECHNOLOGY OF CARBON EMISSION TRADING SYSTEM IN POWER SYSTEM

5.1 The analysis strong and weaknesses of technology of blockchain, opportunities and threats of its application in carbon emission trading system

SWOT matrix principle. SWOT is composed of the first four letters of Strengths, Weaknesses, Opportunities, and Threats. The guiding principle is: First, the formulation and selection strategy should make full use of its opportunities and advantages, and strive to avoid threats and disadvantages; second, the formulation and selection strategy can be long-term, attacking opponents, and can attack and effectively defend. Third, the formulation and selection strategy can make full use of its own opportunities, play its own advantages, overcome disadvantages and avoid external or internal threats.

Combining the opportunities and threats of the external environment of the enterprise with the advantages and disadvantages of the internal conditions of the enterprise can form four alternative strategies, namely, SO strategy, WO strategy, ST strategy, and WT strategy.

1.Strengths - Opportunity (SO) strategy. This is a strategy for business decision makers to leverage their internal strengths and leverage external opportunities. Enterprise decision makers very much hope that enterprises are in this state, the external environment provides a good opportunity for enterprise development, and enterprises also have the internal advantages of making full use of external opportunities, so that enterprises can conditionally develop development or enhanced strategies. In general, before implementing the SO strategy, companies can first use the WO, ST or WT strat-egy to overcome the disadvantages of the enterprise, avoid threats, and create conditions for implementing the SO strategy.

2.Weaknesses - Opportunity (WO) Strategy. Companies can take advantage of external opportunities to reduce internal weakness strategies.

3.Strengths -Threats (ST) strategy. Companies use their strengths to evade and reduce external threats.

4.Weaknesses - threat (WT) strategy. A strategy for companies to overcome internal weaknesses and heat up external threats. Designed to weaken disadvantages and threats, it is a defensive strategy. In this situation, the survival of enterprises faces a serious threat, and only major changes, contractions, and even bankruptcies and liquidation strategies are adopted.

SWOT matrix application steps:

1.Analyze key external opportunities for your business (O);

2.Analyze the company's key external threats (T);

3.Analyze the key internal strengths of the company (S);

4.Analyze the key internal threats of the enterprise (W);

5.Develop an SO strategy by rationally combining internal strengths with external opportunities;

6.Develop a WO strategy by rationally combining internal disadvantages with external opportunities;

7.Develop an ST strategy by rationally combining internal strengths with external threats;

8.Develop a WT strategy by rationally combining internal weaknesses with external threats. Specifically, as shown in table 5.1.

Table 5.1 – SWOT matrix analysis of the blockchain on emission carbon trading

Internal factor external factor	Strength	Weaknes
	1.Transparent trading information safe trading, high efficiency 2.improving the enthusiasm of enterprises to participate in energy conservation 3.emission reduction tasks 4.reducing regulatory capital, 5.establishing a unified trading market 6.more transparent monitoring of enterprises' emission behavior 7.Storage data is secure and cannot be tampered with maliciously	1.Poor computing power 2.Consume a lot of computing resources 3.Fixed time for block generation
Opportunities	SO	WO
1.China's carbon trading market construction is imperative 2.Global anecdotes are getting more and more serious 3.Citizens' awareness of environmental protection enhanced	1.Using blockchain technology to reduce the cost of government supervision 2.Strictly record the emission history of enterprises 3.Scientific quota model fair distribution of carbon emission trading quota	1.Ensure the scientific planning of annual emission reduction plan 2.enhance the enthusiasm of enterprises to participate in carbon emission reduction
Threats	ST	WT
1.Blockchain technology is still in the early stage of research 2.The function of carbon trading platform is not comprehensive and the system is not perfect. 3.Number enterprises carbon emission trading	1.Accelerate research on blockchain technology. 2.Improve the function of carbon trading platform. 3.Encourage more enterprises to participate in carbon trading	1.Set stricter emission standards 2.Expand the scope of carbon trading enterprises 3.Increase illegal punishment

In the early stage of emission reduction, "command control" can play a good role in energy conservation and emission reduction [1]. However, with the development of economy, the requirements of emission reduction are increasing gradually, the cost of emission reduction is increasing, the resistance of enforcement of compulsory orders is also increasing, the enthusiasm of enterprises to participate in energy conservation and emission reduction is not high, and enterprises are willing to accept punishment or fraud [5], and are not willing to bear the cost of emission reduction [6]. "Market incentive" policy tools give full play to the role of the market in energy conservation and emission reduction, which can not only achieve the purpose of energy conservation and emission reduction, but also promote enterprises to participate in energy conservation and emission reduction more actively. Therefore, with the cost of emission reduction and economic development, it is more efficient for market mechanism to replace administrative regulation.

5.2 Gantt’s schedule of actions for implementation of technology of carbon emission trading system in power system

From the beginning of the preparation of the paper, I divided my research into: determine the total target pre-coverage [8], allocation and management of quotas [3], development of a verification system for monitoring reports, to formulate a system for the performance of contracts by enterprises, establish a trading system, perfecting the system. Each part is completed in strict accordance with the schedule.

Table 6.2 –Gantt’s schedule of actions for implementation of technology of carbon emission trading system in power system

Research and Project stages	Performers	Period of implementation of the project 2019 - 2020, month								
		9	10	11	12	1	2	3	4	5
1	2	3								
Development of introduction	student Z. Zhang									
Research status at home and abroad	student Z. Zhang									
Main research content	student Z. Zhang									
Determine the total target pre-coverage	student Z. Zhang									
Allocation and management of quotas	student Z. Zhang									
Development of a verification system	student Z. Zhang									
Formulate a system for the performance	student Z. Zhang									
Establish a trading system	student Z. Zhang									
SWOT-analysis	student Z. Zhang and Senior Lecturer R. Alabugina									
Gant's schedule	student Z. Zhang and Senior Lecturer R. Alabugina									

6 SUMMARY

The consequences of global warming are far faster than experts expect. Potential threats may include rising surface temperatures, changes in global climate, rising sea levels, and even disruption of food production. It is undeniable that many countries still rely mainly on fossil fuels to maintain their energy production and supply, so carbon dioxide emissions will exacerbate global warming and cause environmental damage and health The main work completed is as follows:

1. The origin, definition and classification of blockchain are briefly introduced. Next, the key technologies of blockchain are introduced from data layer, network layer, consensus layer, incentive layer and contract layer. This paper introduces the design method and concept of smart contract based on Ethereum smart contract technology.

2. Determine the design objectives of carbon trading platform. An electronic system supporting the integrated functions of online account opening, customer management, transaction management, registration, transaction matching, market release, risk control, market supervision, etc. of the whole carbon emission trading. The goal of trading system is to realize carbon emission trading efficiently, safely and conveniently.

3. The function display and application of registration management module, information module, transaction module, settlement module and auxiliary module are introduced.

4. SWOT matrix analysis was carried out, which list the strengths, weaknesses, opportunities and threats. Moreover, according to the paper completion process, the Gantt timetable was established.

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