Background and Motivation: Existing Solutions and Related Research

I. Introduction

Among the many strategies to address global climate change, the Emission Trading System (ETS) is a market-based mechanism that aims to regulate greenhouse gas emissions by setting emission caps and trading emission permits. However, the traditional carbon emission trading system faces many challenges, including opaque transactions, tamperable data, and high transaction costs. Blockchain technology, with its inherent immutability, transparency, and decentralization, is considered a powerful tool for optimizing carbon emission trading systems.

II. Existing Carbon Trading Solutions and Challenges

According to the research of Richarson and Xu, although the existing EU Emission Trading System (EU ETS) has achieved certain results in controlling greenhouse gas emissions, it still has problems of inefficiency and easy manipulation. In addition, the limitations of the traditional carbon trading market are mainly reflected in the geographical coverage restrictions and high transaction costs.

III. The potential of blockchain technology and application cases

1. The potential of blockchain technology

As described in the article "Blockchain Technology in Carbon Trading Markets", blockchain technology can significantly improve the transparency, security, and efficiency of transactions. For example, in the case study of Shanghai Environment and Energy Exchange, the application of blockchain technology significantly improved the transparency and efficiency of carbon trading prices.

2. Practical application cases

- Northern Trust Carbon Ecosystem: This fully digital platform uses private ledger blockchain technology to provide project developers and buyers with a secure carbon credit trading and retirement platform.

- IBM and Energy Transformation: IBM's case shows how blockchain technology supports the democratization of energy and increases market transparency and fairness by enabling consumers to directly access the market.

- Climate Chain Coalition: This global cooperation network uses blockchain technology to promote cross-regional carbon trading cooperation and promotes the transparency and traceability of carbon reduction projects.

IV. Project Architecture and Technical Implementation

Combined with our project architecture, we designed a blockchain-based carbon trading platform involving four main components: supply chain, AMM market, reward mechanism and voting system. Through smart contracts and blockchain technology, we ensure the immutability and transparency of transactions. Specifically in code implementation, such as the `CarbonCredit.sol` and `CreditManager.sol` smart contracts not only handle the issuance and trading of carbon credits, but also ensure the fairness and efficiency of transactions through algorithms.

V. Integration of blockchain and sustainable development goals

In the document "Blockchain of Carbon Trading for UN Sustainable Development Goals", the authors discuss in detail how blockchain technology can support the carbon trading market by improving the transparency, security and efficiency of transactions, thereby promoting the realization of the United Nations Sustainable Development Goals. Blockchain technology can provide a decentralized verification platform for the trading of carbon emission rights, which can not only reduce fraud, but also reduce transaction costs and time through automated smart contracts, thereby increasing market participation and liquidity.

VI. Sustainability challenges and blockchain solutions

As discussed in "Blockchain of Carbon Trading for UN Sustainable Development Goals", although blockchain technology has potential in environmental protection, it also brings additional energy consumption and complexity. This requires technological innovation and the active participation of policymakers to ensure that the sustainable application of blockchain does not backfire and increase carbon emissions.

By integrating these professional documents and actual case analysis more deeply, we can fully demonstrate the scientific and practical nature of our project, as well as the practical application value of blockchain technology in modern environmental protection and carbon trading markets. This integrated application not only supports technological progress, but also promotes global carbon reduction policy goals, and is a key step towards a cleaner, fairer and more sustainable world.

VII. Conclusion and Outlook

This project uses blockchain technology to solve the problems existing in the traditional carbon emission trading system and improve the transparency and efficiency of the market. In the future, with the further maturity and widespread application of blockchain technology, we expect the carbon trading market to become more active and help achieve carbon reduction goals worldwide. In addition, continued technological innovation and policy support will be key factors in promoting the development of this market.

Why choose permissioned or permissionless blockchain: Why blockchain technology is needed in the project and why a specific type of blockchain is chosen

I. Project requirements and the necessity of blockchain technology

In our project, blockchain technology is used to ensure the transparency, security and immutability of carbon trading. The trading of carbon emission rights involves multiple participants, including governments, enterprises and individuals. The authenticity and accuracy of each transaction are crucial to the trust and efficiency of the entire system.

1. Transparency and traceability: Through blockchain technology, all transaction records are open and transparent and can be traced back to the source, which is essential for building trust among market participants.

2. Security: Smart contracts ensure that transaction rules are automatically executed without the intervention of intermediaries, reducing the possibility of fraud.

3. Efficiency: Blockchain greatly improves processing speed and reduces operational errors by automating transactions and reducing paper processes.

II. Choose permissioned or permissionless blockchain

When considering using permissioned or permissionless blockchain, we need to decide based on the specific needs and goals of the project. The following is an analysis of the type of blockchain to choose based on the structure and functional requirements of our project:

1. Supply Chain Management (`CreditManager.sol`): This module is responsible for recording and verifying the carbon emission data of enterprises. In this case, a permissioned blockchain is more appropriate because the participants are known verification entities, such as government agencies and compliant enterprises.

2. AMM Market (`Exchange.sol`): This module involves the automated market production of carbon credits and currencies, which requires a high degree of transparency and openness. A non-permissioned blockchain can provide barrier-free market participation opportunities for a wider range of participants.

3. Reward Mechanism (`Reward.sol`): The module that rewards enterprises for reducing carbon emissions needs to ensure the immutability of data and transparent and fair reward distribution. Permissioned blockchains can ensure that only qualified enterprises can receive rewards here.

4. Voting System (`Voting.sol`): Decisions used to govern the entire system, including proposals and voting. This part is more suitable for permissioned blockchains because it is necessary to ensure that all voters are certified participants in the system.

III. Combined with the support of literature and cases

1. Literature support: According to "Carbon Trading with Blockchain", the introduction of blockchain can solve multiple problems in the existing carbon trading system, such as fraud, opacity and improper data management.

2. Case analysis: Northern Trust Carbon Ecosystem shows how to use blockchain technology to improve the security and efficiency of carbon credit trading. IBM's energy transformation case further proves the potential of blockchain in improving market transparency and efficiency.

IV. Conclusion

In summary, our project's choice of mixed use of permissioned and permissionless blockchains is based on the specific needs of different modules. Permissioned blockchains provide the necessary security and controllability in supply chain management and reward issuance, while permissionless blockchains promote wider participation and transparency in the AMM market. In addition, our choice is also inspired and verified by relevant literature and actual cases, which demonstrate the effective application and potential advantages of blockchain technology in carbon trading systems.

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