Research of Blockchain in Power Direct Trading Mode

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Abstract: Blockchain technology, as an emerging distributed database technology, decentralized, de-trusted collective maintenance database technology, has a high degree of compatibility with electricity market transactions. This paper first gives a brief introduction to blockchain types, different consensus mechanisms, and smart contracts. Secondly, the necessity of applying the blockchain to the direct electricity trading mode is explained. According to the characteristics of direct power trading, the blockchain technology is combined to design the direct electricity trading mode under the blockchain technology. It is hoped to accelerate the application of blockchain technology in the energy trading industry, deepen the reform of the power system, and promote the rapid development of the power industry.

1. Introduction
At the beginning of 2016, the National Development and Reform Commission, the Energy Bureau and the Ministry of Industry and Information Technology jointly issued the "Guiding Opinions on Promoting the Development of "Internet +" Smart Energy", hoping to develop the emerging forms of the Internet in the production, transmission, storage and consumption of energy, and the deep integration of energy market and multi-energy[1]. The intention is to realize the intelligence of equipment, the synergy of multiple energy sources, the symmetry between information, the flattening of the system structure, and the openness of the power energy trading market[2]. The blockchain technology itself is revolutionizing the traditional Internet landscape and model, and promoting the iteration of the traditional Internet to the value Internet. Blockchain technology is centered on a decentralized trust mechanism, which can promote transactions, provide certification, and improve operational capabilities in energy scenarios [3].

Blockchain technology originates from the financial industry and has its own advantages in conducting market transactions because of its own characteristics. On January 19, 2016, led by Mark Walter, Chief Scientific Adviser of the UK Government

The white paper suggests that the blockchain should be listed as a British national strategy and promoted in the fields of finance and energy [4]. Currently, there are blockchain-based technologies in New York, USA and Busselton, Australia. The electrical energy trading system was put into operation.
Literature [6] introduced blockchain technology as a storage form of transaction information in congestion management. Literature [8] studied the point-to-point virtual trading mode of China's blockchain intelligent contract directly matched power station, and promoted the combination of online blockchain trading and clean energy and blockchain technology.

This paper analyzes the pattern of blockchains in domestic and foreign power trading, combining the characteristics of blockchain technology and direct electricity trading. The power direct transaction mode based on blockchain technology is designed, which has certain feasibility and innovation. This will effectively promote the reform of the power system and the construction of the electricity market, and provide a safe, fast and efficient power trading mode for power producers, electricity sellers and users.

2. blockchain and its technical framework

2.1. Concept and classification of blockchain

In the White Paper on China's Blockchain Technology and Application Development (2016) issued by the Ministry of Industry and Information Technology, the concept of blockchain is a new application mode of computer technology such as distributed data storage, point-to-point transmission, consensus mechanism, and encryption algorithm. According to the specific form of participation of each node in the blockchain, the blockchain can be divided into three types: public chain, alliance chain and private chain. Table 1 compares the public chain, the alliance chain, and the private chain from five aspects.

| Category                        | public chain       | alliance chain    | private chain   |
|---------------------------------|--------------------|-------------------|-----------------|
| Node permissions                | no need            | need              | need            |
| Read and write permissions      | anyone             | alliance decision | private organization decision |
| Anonymity                       | high               | low               | low             |
| Trading speed                   | slow               | fast              | fastest         |
| Degree of decentralization      | fully distributed  | partial           | partial centralization |
|                                 |                    | decentralization  |                 |

2.2. Technical framework of blockchain

The essence of the blockchain is the distributed accounting system, which is decentralized, secure, and programmable. The blockchain system includes the data layer, the network layer, the consensus layer, the incentive layer, the contract layer, and the application layer.

The data layer marks the time stamp on the data block to form a chain structure, and uses the hash function to encode the original data; the network layer, the point-to-point transmission technology (P2P), the data propagation mechanism, and the data verification mechanism jointly form the network layer; Consensus layer, the consensus mechanism of blockchain technology includes POW consensus mechanism, PUS consensus mechanism, DPOS consensus mechanism, Pool verification pool, etc; incentive layer, in order to ensure sufficient computing power, blockchain system introduces corresponding incentive mechanism to Enhance the enthusiasm of the participants; the contract layer, the contract layer encapsulates various script codes and algorithms represented by smart contracts, and the smart contract is the context-corresponding logic rule, which has the characteristics of distributed verification, storage, and unforgeability. After the birth of chain technology, due to its programmable, decentralized, and high transparency, it is regarded as the natural support technology of smart contracts. The decentralized transaction book function of blockchain technology can be used to register, confirm and transfer various functions. Different types of assets.
3. Blockchain-based power direct trading model

3.1. Analysis of blockchain technology applied to direct electricity trading mode

Direct trading in the electricity market has the characteristics of precise measurement, ubiquitous interaction, self-discipline control, and optimization decision-making. Accurate metering is the basis for precise control of power networks. It is not difficult to accurately measure individual individuals. However, at the power level, with the access of various multi-party entities, mutual trust between measurement data between different access subjects is a problem. The problem can be solved by the consensus authentication mechanism of blockchain technology. The core problem solved by the blockchain technology is the mutual trust between the multi-party entities. Under the condition of mutual trust, the multi-party can enhance the ubiquitous interaction, self-discipline control and the ability to optimize decision-making. The wide-area coordination refers to the multi-party competition between the two parties, to realize their own interests, to coordinate with each other and to achieve the role of wide-area coordination. The wide-area coordination is very fragile under the condition of insufficient trust between the various entities, and the blockchain As a technology to solve the trust mechanism, technology can provide a good solution for wide-area coordination of weak trust between multiple subjects. As shown in Figure 1, this decentralized transaction model can also be applied to direct power transactions. The new trading model brought by blockchain technology can bring a new model to electricity market transactions. The application of intelligent contracts makes the blockchain intelligent and contracted. In smart energy systems, it contains a large number of intelligent scheduling and intelligent decision-making behaviors. Smart contracts can be used as ports for information related to the electricity market. Smart contracts are an important application of intelligent trading and intelligent decision-making in the power market at the information layer.

3.2. Blockchain technology applied to the design of electricity directly trading mode

The electricity market includes trading entities such as power plants, power sales companies, power grids, users, and trading centers. These trading entities can freely customize trading smart contracts between the trading blocks, and write clearing and settlement of purchase and sale of electricity transactions in contracts. Rules; use membership system management to judge the market identity of both parties to the transaction, and match the corresponding smart contract; users customize the smart contract through the blockchain platform to achieve efficient power market transactions and settlement.

The purchase and sale of electricity transaction settlement model is represented by a computer code as a smart contract and written into the distributed network system of the blockchain in advance; when
a certain item in the contract occurs, the smart contract is triggered and automatically executed accordingly. The contractual terms; the membership service is responsible for managing the identity, privacy and confidentiality on the network. Before the contract occurs, the membership management first identifies the market identity of both parties and matches the corresponding smart contract; at the same time, the membership mechanism also guarantees Authorized third parties are not informed of confidential information about identity, transaction patterns, transaction content, etc. Thus, the blockchain-based power direct transaction model shown in Fig. 2 is designed.

Taking power generator A selling power to user B as an example, a single-line solid arrow indicates the flow of the contract, and a one-way dotted arrow indicates the flow of the transaction information. Generator A compiles the contract with information on trading volume, price, delivery time, etc. and publishes the contract address and interface to the trading pool; User B selects the contract in the trading pool and selects the contract that meets his needs. The public key address is used as the flow of electricity to the account, signed with the private key and the signed contract is synchronized to the blockchain. Once confirmed, the direct transaction agreement is reached between generator A and user B. The double-headed arrow in the figure indicates that both the generator and the user can initiate the transaction initially, thereby achieving both the two-way quotation and the free choice of price matching, and between the generator and the generator, between the user and the user, at the necessary time. The same process can be used to directly generate electricity generation rights transactions. This trading model design has the following characteristics:

(1) Adopt smart contract to ensure that the transaction process is automatically executed by the computer. Due to the instantaneous nature of energy delivery, the settlement process can be completed within a short period of time when the transaction takes effect. At the same time, what kind of payment method is used? will also be bound in the contract at the outset to ensure that the interests of all parties will not be harmed;

(2) At present, the concept prototype of the intelligent digital ticket system based on blockchain technology has been developed. Once put into practical application, the security of the acceptance bill will be greatly increased, and the human and financial resources consumed by the endorsement, distribution and redemption of the endorsement will also be Will decrease;

Figure 2: Blockchain-based power direct trading model
(3) Blockchain technology Because of its natural design transparency, all information of the transaction will be visible in all nodes in real time, and information disclosure will be more convenient than ever.

4. Conclusion
This paper first analysis the current status of the power trading model. It also introduces the concepts related to blockchain technology, and then makes a theoretical analysis of the necessity of blockchain technology applied to the direct electricity trading mode. A blockchain-based power direct trading system framework was built. More effective market access certification can be achieved to ensure that trading rules are automatically and strictly enforced, and the disclosure of relevant information will be more transparent, which will help to guide the price signal and improve the timeliness of transactions.

In this paper, the discussion on the application of blockchain technology in direct power trading is temporarily at a relatively macro level, and some of the details are still missing. At the same time, blockchain technology really needs to wait for the continuous improvement of technology and the continuous advancement of power market reform. I hope this article will benefit this process.

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