Research on Key Technologies of Demand Response Based on Blockchain

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Abstract: At present, the number of potential users involved in the demand response project is huge and the scale is different. In the process of transaction implementation, there is a lack of trusted demand response transaction mechanism and market-oriented transaction platform. The transaction security and reasonable pricing mechanism need to be studied. This paper focuses on the key technologies of demand response blockchain, and proposes a design scheme of demand response platform based on blockchain.

1. Introduction

China's electricity market has been gradually liberalized, and there are many kinds of transaction subjects in the electricity market, such as power grid enterprises, load integrators, service providers, third-party institutions, etc., and the number of potential users involved in the project is huge and the scale is different. The diversity of users leads to the multi scenario, multi mechanism and multi-mode of power market transactions. However, in the actual operation and implementation process of demand response business in the existing market mechanism, there are still regulatory problems in the aspects of supervision and accounting, such as service pricing, use of special subsidy funds, attribution of fines, etc., which need to put forward updated solutions in terms of future energy service transaction mode, scheduling mode, pricing mechanism, etc.

In the current demand response transaction implementation process, the demand side response model has strong planning attribute, weak market attribute, relatively single transaction mechanism, lack of trusted demand response transaction mechanism and market-oriented transaction platform, and the number of user participation, response speed, incentive mechanism and other aspects are not perfect. When the demand response business is implemented on a large scale, if it is still fully centralized It is difficult to achieve low-cost and large-scale user interaction through the centralized management and control method. Further research is needed in transaction security and reasonable pricing mechanism.

This paper studies the integration scheme of blockchain technology and demand response business, excavates the combination point of blockchain and demand response work, and designs a demand response platform based on blockchain, which provides new ideas and references for future demand response work.

2. Research on Key Technologies of blockchain for demand response

With the development of energy Internet and power market, ADR without manual intervention and spontaneous load regulation is the main development trend of energy management and control in energy LAN system. Its consistency with blockchain concept is mainly reflected in the following three aspects:

The embodiment of decentralization. Blockchain technology supports massive users' point-to-point direct transactions, information is open and transparent, and relies on distributed bookkeeping, dissemination, storage and other technologies to form a trusted distributed system without a center. Blockchain, as a kind of peer-to-peer and decentralized characteristic, can provide

important technical support for the response subject to make the optimal decision independently and realize the efficient use of energy.

It emphasizes the development of marketization. As a new generation of information technology, blockchain technology may fundamentally change the behavior of market transactions. Its openness and decentralization are conducive to the formation of a transparent market pattern. The advantages of blockchain in market transaction can promote the demand side to participate in the transaction and interaction of energy system in multiple directions. Combined with the transparency, symmetry and credibility of its information, it is conducive to improving the level of independent supply and demand balance of ADR projects and playing the role of market mechanism.

Pay attention to intelligence and contract. Smart contract is a decentralized and trusted shared program code deployed on the blockchain. Based on this, all kinds of social system functions can be encapsulated and automatically executed on the decentralized and trusted blockchain. The decision-making and transaction behavior in ADR project have the trend of intelligent development. The smart contract based on blockchain can regulate the power transaction behavior of energy storage system, and automatically guarantee the fair and efficient implementation of transaction and benefit distribution.

2.1 Technical Architecture Design Based On The Integration Of Blockchain And Demand Response Service

According to the different development objects of blockchain, blockchain can be divided into three categories: public chain, private chain and alliance chain. The public chain is open to all, and nodes can be joined at will; the private chain branches are open to individual entities, such as within the company; the alliance chain is open to a specific organization.

The alliance chain is controlled by multiple centers, and the system is distributed by several authoritative organizations. These nodes coordinate their work according to the consensus mechanism. This is a partially decentralized blockchain. Users can view and trade. However, to verify the transaction, internal decisions of the alliance are needed. One of the most significant characteristics of the alliance chain is that each node corresponds to an entity. If any entity node wants to join the alliance, it needs to obtain the permission of the alliance. These organizations jointly maintain the stable development of the system.

As the demand response business involves the power grid and user power operation data, it has strict requirements on data privacy, security, supervision and other issues, so it is recommended to carry out pilot project verification in the way of alliance chain. As shown in Figure 1, in the demand response architecture based on the blockchain, grid companies, power sales companies, load aggregators, integrated energy service companies and some large users can join the alliance chain, while power research institutions, as the third-party consulting institutions and governments, also join the alliance chain. Other users participating in the response are connected to the load aggregator, or are hosted by an integrated energy service company and then joined.
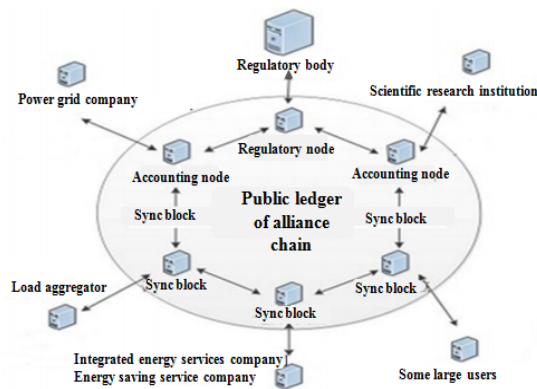
Figure 1: Blockchain Technology Architecture.

2.2 Improve Real-time Transaction Capability

Blockchain technology supports dynamic power P2P transactions. The potential benefit of adopting blockchain technology is to support the direct transaction of decentralized P2P energy, which can ensure the security of users at the same time. The system supports the sale of electricity by the self built solar power generation, charging piles and other assets of users and effectively supervises and urges them to execute the contracts of energy service providers; allows consumers and producers to exchange energy in the network based on the point-to-point blockchain, and the demand and production of electricity are matched through the distribution system; allows dynamic negotiation of energy prices, The negotiation application is proposed in the demand response system based on dynamic power price. Based on the predicted "production / demand" of electric energy and the willingness of users in the electric energy trading area to provide load transfer on demand, the dynamic price is calculated iteratively.

2.3 Establish User Reputation Mchanism

The reputation mechanism of blockchain is to increase the reputation score of each node, so that when a node makes a mistake, its reputation value will be correspondingly reduced, and cheating will also be punished more strictly. In the multi node autonomous system, find out the wrong node and cheating node, such as the situation of being attacked by hackers. When the reputation score is lower than a certain threshold, these wrong nodes and cheating nodes will be removed from the system Except in, wait until these nodes return to normal, and then return to the system. This makes the operation of the whole system more reliable.

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3. Design of demand response platform based on blockchain

The demand side response platform based on blockchain technology uses Ethernet, wireless private network and other modes to connect with the system through the network layer, forming an information interaction channel. According to the multi-layer architecture, the system separates the interface control, business logic and data mapping, and realizes the loose coupling within the system, so as to respond to the system requirements of business changes flexibly and quickly.

The physical architecture design of the platform focuses on the hardware support of the system. According to the application architecture, data architecture and technical architecture, it puts forward requirements for the interface and communication protocol of the system, which provides reference for the system construction and equipment selection of the demand side response platform based on

blockchain technology. As shown in Figure 2, the architecture of the demand side response platform based on blockchain technology is composed of five layers, i.e. device layer, perception layer, measurement layer, network layer and master station layer.
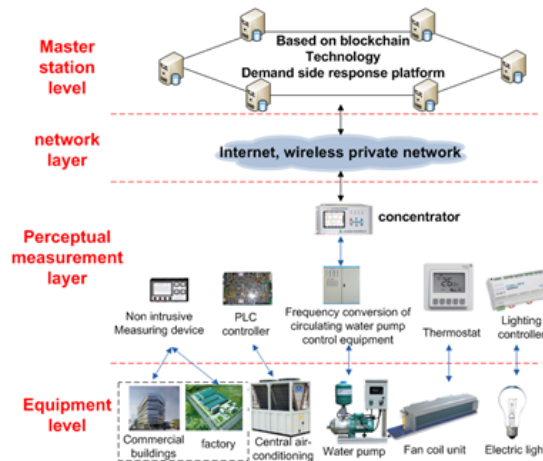

Figure 2: Platform Architecture.

The platform application architecture integrates unilateral dominant transaction and market-oriented bilateral transaction mode, and uses the advantages of blockchain technology, such as data tamperability, smart contract, anonymous transaction, openness, transparency and trust removal, to create a hybrid architecture based on blockchain distributed technology and B / S mode.

4. Conclusion

In this paper, we study the trusted, efficient, node authentication and authorization alliance chain technology, explore the transaction mode of data security and the participation of all parties, and establish the user reputation system, further build the integration scheme of blockchain technology and demand response business, mine the combination point of blockchain and demand response work, and design a demand response platform based on blockchain for the future The work of requirement response provides new ideas and references.

Acknowledgements

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