Conceptual characteristics and analysis of typical application scenarios of energy blockchain

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Abstract—In recent years, blockchain has gradually moved from a technical concept to reality, and has increasingly shown its important potential to empower industrial innovation and boost economic construction. Blockchain technology has shown strong application potential in the field of energy and power with its technical characteristics such as traceability and non-tampering. At present, many energy companies at home and abroad have used the energy blockchain to implement various scenarios, but they have not yet formed a target systematic research on energy blockchain. This research deeply analyzes the conceptual and technical characteristics of energy blockchain, proposes a screening model for application scenarios, and analyzes typical application scenarios of energy blockchain based on this, aiming to provide a useful reference for energy companies to develop blockchain applications.

1. Conceptual characteristics of energy blockchain

As an important breakthrough in building a network power, developing a digital economy, and boosting economic and social development, blockchain has rich connotations at two levels: technology and concept. At the technical level, the blockchain is a fusion of computer technologies such as distributed data storage, peer-to-peer transmission, consensus mechanisms, encryption algorithms, which realizes the management of data in the order of recording and guarantees that the data cannot be tampered with; at the conceptual level, the blockchain uses different consensus rules to establish a low-cost cooperation model of mutual trust in an untrustworthy competitive environment, realizing the spontaneous establishment of a trust system among multiple entities.

Energy blockchain is a new concept of energy industry development born out of blockchain. It is a new combination of energy flow, data flow and business flow in the blockchain platform, with very obvious ecological circle attributes. The energy blockchain will reshape the production relationship between the various entities in the energy industry, build an open and cooperative system based on data flow, turn data into mobile assets, give birth to various open and integrated business models, and build a hub economy. Therefore, the energy blockchain has three characteristics: ecosystem, digitalization and hub.
2. The connection and difference between energy blockchain and blockchain

(1) The connection between energy blockchain and blockchain

First, underlying technology implementation of both energy blockchain and blockchain is distributed ledger storage technology. When the energy blockchain is dealing with the trust problem of multi-agent sharing and collaboration, it still needs to store the interactive information between the entities. In other words, both energy blockchain and blockchain need to use similar distributed ledger storage technology.

Second, the core goal of both energy blockchain and blockchain is to solve the trust problem between multiple business entities. The issue of trust between multiple entities often directly determines the cost of business operation and development. It is a basic issue in social and economic development. The premise of the construction of energy blockchain and blockchain is to solve the issue of trust between entities. Therefore, Both energy blockchain and blockchain have the same core goals.

(2) The difference between energy blockchain and blockchain

First, energy blockchain and blockchain face different basic environments. The main bodies involved in the energy industry include the underlying energy producers, demanders, regulatory agencies and even the entire national government, and there is a natural inequality among the various subjects. Therefore, the application of energy blockchain must consider the inequality between subjects, which is fundamentally different from the application of general blockchains. The consensus mechanism of general blockchains needs to make the status of subjects more equal as much as possible.

Second, Energy blockchain is suitable for development using alliance chain. Energy itself is a strategic resource, which is often directly controlled by the state. The public chain reshapes the status of the subjects and operates in the form of anonymity, which is inconsistent with the requirements of national control and cannot support the status of energy as a strategic resource. Therefore, compared with the public chain, the alliance chain is more suitable for the energy field.

Third, the existing consensus mechanism cannot meet the needs of energy scenarios. The design ideas of the existing consensus mechanism often disperse the decision-making power in the system to as many nodes as possible to form a mutually restrictive relationship. The energy industry needs to reduce the cost of energy consumption in the form of hub operation, so the decentralized consensus mechanism cannot meet the needs of promotion in the energy industry.

3. Screening model for typical application scenarios of energy blockchain

With the development of blockchain, its application scope continues to expand. At present, the energy blockchain has a certain number of application scenarios, and has a certain foundation for exploration. However, the current energy blockchain field lacks a systematic application scenario screening method, which causes the energy blockchain to go through a long trial and error cycle when selecting scenarios,
which causes a waste of resources to a certain extent.

This research proposes a screening model for typical application scenarios of energy blockchain, and provides a systematic method for energy companies to select scenarios with development value and potential from the current energy blockchain application pilots. On the one hand, it reduces the trial and error cycle for energy companies to develop energy blockchain applications, and it provides a method basis for energy companies to further carry out mid- and long-term planning of energy blockchain application scenarios. The overall structure of the model is shown in Figure 2.

![Figure 2 Schematic diagram of the application scenario screening model of energy blockchain](image)

The energy blockchain application scenario screening model first judges the availability of the energy blockchain in the application scenario, and analyzes whether the scenario meets the basic conditions of blockchain application. Second, the model judges the efficiency of the application of the blockchain in the scene, and analyzes whether the energy blockchain can improve the efficiency of the actual application in the scene. Finally, the model judges the best suitability of the energy blockchain in the scene, and analyzes whether the energy blockchain plays an indispensable role in the scene.

After the judgment and screening of the model, the application scenarios can be screened into pseudo-demand scenarios, usable scenarios, effective scenarios, and necessity scenarios, which provides a sufficient reference for energy companies to judge and select energy blockchain application scenarios.

### Table 1 Judgment criteria for each stage of screening model

| Usability judgment | National and regional policy support | Network infrastructure situation | Data infrastructure situation |
|--------------------|-------------------------------------|----------------------------------|-----------------------------|
|                    | Consider national and regional regulatory policies to ensure that application scenarios can develop healthily under national regulatory policies. | The communication between each node needs to be realized with the help of network communication facilities. The construction of the network infrastructure is an important factor in determining the availability of the scene. | A relatively sound data infrastructure is required to support the replication and storage of data on the chain, otherwise the blockchain system will not be able to operate completely. |
The frequency of data and transactions is too high, and technical performance will become a factor that restricts the application efficiency of the scene.

The degree of business digitization often reflects the importance of data in the process of business activities.

The greater the number of collaborating parties in the scene, the more prominent the trust problem and the more suitable the use of blockchain.

Business logic refers to whether the scene participants can form a closed loop of value, that is, can create a win-win situation.

Energy blockchain is a kind of trust machine. The premise for its function is that there is no natural trust relationship between application environment subjects.

There is no structured data in a scenario, or the cost of data structure is high, then the application of energy blockchain in this scenario will not be the best choice.

For data that has no value, the demand for authenticity is often not strong, so it does not have the best adaptability for energy blockchain applications.

The need for a unified trust consensus in the whole scene.

The continuous promotion of both parties is a necessary condition to promote the normal operation of energy blockchain application scenarios.

Whether the value incentive model in the scene can really play the role of main motivation is a key factor in judging the best suitability of the scene.

4. Typical application scenarios of energy blockchain

According to the energy blockchain application scenario screening model, the data application scenarios and transaction application scenarios of energy companies are filtered, and the following two scenarios with the best adaptability of the energy blockchain can be obtained:

Reliable collaboration of power data. Firstly, judge the usability. According to the judgment criteria in the usability judgment stage, data collaboration belongs to the scope of blockchain applications allowed by the state, and energy companies have network infrastructure and data storage infrastructure to meet the availability of scenarios. Secondly, the efficiency is judged. According to the criteria of the efficiency judgment stage, energy data is mostly reported in time intervals, and the frequency is not high, and the data application itself has the characteristics of high digitization and multi-party participation. Energy data also has high social value, has authenticity requirements, and satisfies the principle of efficiency. Finally, the best fit is judged. Because energy data has privacy and non-disclosure properties, it has very high requirements for a trusted environment, and the value of energy data can provide incentives to participants in collaboration and meet Requirements for best fit.

Green energy trading ecosystem. First, judge the usability. According to the judgment criteria in the usability judgment stage, green energy transactions such as carbon trading and green points belong to the scope of blockchain applications allowed by the state, and energy companies have network infrastructure and data storage infrastructure to meet scene availability. Secondly, the efficiency is judged. According to the criteria of the efficiency judgment stage, most energy companies currently have a small green energy transaction scale, and the measurement equipment and transaction records
are well stored, and the digital characteristics are obvious. The transaction involves multiple participants, and the transaction information needs to be authentic and traceable, with the demand of information authenticity and meeting the efficiency principle. Finally, the best suitability is judged. Since carbon data and green transaction data need to be strictly non-tamperable, they have very high requirements for a credible environment, and the value of green exchanges can provide incentives to participants in collaboration and meet the requirements of optimal adaptability.

(1) Power data chain: Energy blockchain builds a credible collaboration bridge between internal and external power data

At present, most energy companies still face the following difficulties in implementing data collaboration: First, the diversification and differentiation of data systems hinder the operation of data collaboration. Second, data islands are widespread. Data between different industries, between different entities in the same industry, and even between different business departments of the same enterprise is not easy to get through, resulting in a low degree of data value mining. Third, the core business data is confidential, and it is difficult to ensure the security of the data by directly exchanging data.

Blockchain is decentralized, non-tamperable, anonymous, and open. On the one hand, this can provide consensus security for data exchange and collaboration, and avoid the interference of invalid data at the source of the data, thereby providing stability and valuable data for partners. On the other hand, this can effectively solve the problems of large data differences, high barriers and insecurity in data collaboration, and by establishing a safe and reliable data exchange and collaboration mechanism, it can give full play to the value of the existing large-scale data of energy companies.

![Figure 3 The process of blockchain trusted data collaboration](image)

Figure 3 shows a case of trusted data collaboration between an energy enterprise data center and an external enterprise. First, the enterprise data center builds a trusted data chain and stores data characteristics on the chain through the blockchain. In this process, because there is a one-to-one correspondence between the characteristics and the actual data, the characteristics are stored on the chain and have the trustworthiness that cannot be tampered with, making the original data also trustworthy. Secondly, external companies join the trusted data chain to find the required data through data query on the chain. Since the data stored on the chain is a characteristic of the original data, it prevents external companies from directly browsing internal data. Finally, external companies automatically perform identity authentication and use behavior approval on the blockchain by invoking smart contracts. After the approval is passed, the data call operation is carried out directly on the chain. The whole process will not produce real data transmission behavior, but it can realize the use and value of the data on the chain. For example, if you want to evaluate the operating status of an enterprise through power data, you need to extract the data for separate analysis under the traditional data collaboration model. In the scenario of credible data collaboration, you only need to call the contract to obtain the relevant characteristics of the power data reflecting the business status of the company without extracting the data, which can ensure the security of the power data.
(2) Green energy chain: Energy blockchain drives green power market-oriented ecological operation

After the signing of the "Kyoto Protocol", the country vigorously advocated the use of market-oriented means to build a green energy co-construction ecology covering the entire industrial chain of "production," "transport," "sale," and "consumption", but the overall market response was not as expected. Governments and industry institutions have launched quantitative digital products such as carbon trading and green certificate trading, but they lack operation and market vitality. On the one hand, although carbon trading is in operation, it still focuses on the thermal power sector and is limited to the upstream market for green energy, and has not fully realized the potential of the electricity market. On the other hand, the green certificate is still in the preliminary stage of development due to the lack of a complete commercial value chain design, a lack of transparent and authoritative promotion agencies, and a lack of government supervision and support.

First of all, energy companies connect energy flows with green chain points, and convert them into green chain points through fossil energy. The green chain points are used to attract other market entities to intervene. For example, it can cooperate with the market supervision department to verify the traceability of the green chain points to ensure the source and destination of each kilowatt-hour of electricity, which greatly reduces the market fraudulent behavior, and then builds green chain points into a channel for the regulatory authorities to provide subsidies and policy preferences. Secondly, for financial institutions and insurance companies, the electricity consumption data of each component of the green energy chain ecosystem will be presented in the form of green chain points, providing credible references for financial institutions and insurance companies' loan issuance and credit review. Financial institutions and insurance companies need to pay corresponding fees to obtain this information and release financial service information to various entities, which provides financial support for maintaining the entire green energy chain ecosystem. At the same time, think tank units of energy companies, as the main participants in the ecosystem, can also be deeply integrated into the operation of the ecosystem by analyzing data, interpreting policies, and providing consulting services. Finally, in the form of a side chain, the exchange function is opened up with other points platforms to realize the redeemability and traceability of points.

Further, in accordance with the idea of "blockchain + ecology", the energy blockchain is used to realize the "diversion + empowerment" of energy Internet business. Taking the five sub ecological construction of distributed photovoltaic service, comprehensive energy service, electric vehicle service,
data commercialization service, online industry chain finance as the entry point, aggregate and serve government departments, energy suppliers, energy consumers and other objects, so as to promote the integration of supply and demand of all links and all factors and the optimal allocation of resources, promote the growth of industry aggregation, drive the common development of the upstream and downstream of the industrial chain, and build a new energy ecology for mutual benefit and win-win (See Figure 5).

5. Research conclusions
This research proposes that energy blockchain is a new concept of energy industry development born out of blockchain, a new combination of energy flow, data flow and business flow in the blockchain platform, and proposes energy blockchain and blockchain. There are significant differences in the industrial basic environment, consensus mechanism, etc., making major innovative contributions to the construction of the energy blockchain theoretical system.

This research proposes a multi-dimensional screening and evaluation model for energy blockchain projects to help energy companies screen energy blockchain projects, carefully screen out "false demand" application scenarios, and provide a guarantee for energy companies to grasp the development direction of energy blockchain business.

This research proposes two application scenarios of power data chain and green energy chain, which provides a feasible path for the implementation of blockchain in the energy industry and provides a policy reference for the orderly promotion of energy blockchain projects.

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