

Application Status and Future Prospect of Blockchain in Energy and Power Industry

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Abstract

Blockchain technology has the characteristics of decentralization, openness, transparency, security and credibility. Because it has a broader commercial application prospect, it began to break away from the previous scenarios, providing an important way to solve the transaction friction in the energy and power system. In the energy industry at home and abroad, public utilities, power agencies and energy companies have explored blockchain projects and achieved good results. Looking forward to the future, if blockchain technology can be well developed and applied, it will certainly play a great role in promoting and transforming the field of energy and power, and make it move steadily in the direction of flexibility, diversification, reasonable balance, clean environmental protection and efficient intelligence.

Keywords

Blockchain; Energy Industry; Power Industry.

1. Introduction

Blockchain is an emerging Internet technology created by applying the principles of cryptography, software engineering and economics [1]. Blockchain technology began to break away from the previous scenario because of its broader commercial application prospects, and received more attention. From the perspective of scientific and technological innovation driving business development, blockchain technology, with its unique technical architecture, can not only provide an effective exploration path to solve the current massive Internet user data security and management, but also reshape the economic relationship between individuals, business organizations and other market players in a more efficient and reasonable way, and solve some problems and pain points for a long time, Therefore, it is generally considered to have great commercial potential. In terms of the development trend and existing problems of the power industry, there are mainly three aspects. At the power generation level, the proportion of renewable energy to chemical energy is growing, and different energy types need to be effectively absorbed. At the same time, a single centralized large-scale power supply can no longer meet the needs of diversification and refinement, which is related to the unreasonable regional layout of power generation installed capacity [2]. At the transmission and distribution level, the property right structure of the power grid tends to be complex, and the dispatching and trading belong to different enterprises. The topology of the coexistence of super large high-voltage network and micro network makes the complementary interconnection between different power grids and the overall coordination between dispatching and trading institutions difficult. At the consumption level, producers are also consumers. How to break the one-way production consumption mode, manage a large number of smart devices in the future, and protect the data privacy of producers / consumers are all worth exploring [3]. Under the macro background that the uneven distribution of global energy often leads to international

conflicts and carbon emission rights have increasingly become an important trend, the application of blockchain technology in the field of energy and power is particularly eye-catching.

2. Application Status of Blockchain in Energy and Power Industry

At present, blockchains are divided into three categories: public blockchain, consortium blockchain and private blockchain [4].

The application and development of blockchain technology in the field of energy and power as early as the beginning of 2016, the British think tank released a research report, suggesting that blockchain should be included in the national strategy and promoted in the field of energy [5]. Samsung group of South Korea has cooperated with IBM, and energy and power enterprises around the world such as BP, Royal Dutch Shell, EDF and Tokyo Electric Power Company of Japan have also begun to invest in and pilot the application of blockchain technology.

The trans active grid project in the United States, in cooperation with the blockchain energy service platform lo3 and Siemens, was tested in Brooklyn, New York [6]. The project aims to enable residents and commercial institutions to share and sell the remaining solar power to other micro grid stakeholders, realize the point-to-point transaction of distributed energy in the region, and restore the power supply capacity in case of emergency. This project positions itself as a distributed power supplier / retailer[7]. The project uses smart meters to help users store and buy and sell electricity, promote users to install and use distributed energy, and squeeze more performance from the existing power grid by designing a more effective accounting system.

The power ledger project being tested in Australia is an ecosystem, which provides a transparent management framework, allows the global energy market to be seamlessly connected with its own ecosystem, and also allows to redefine the relationship between the application trustee (such as power companies, retailers, property managers, etc.) and consumers [8]. The project has tested several blockchain platforms in Australia and New Zealand, and was commercially deployed in the building of Northwestern University in the United States in July 2018.

In 2016, RWE, a German electric power company, began to cooperate with ZF, an automotive technology company, and UBS in the electric vehicle sharing fast charging pile project [9]. Germany's conjoule project has received investment from Tokyo Electric Power Company of Japan, focusing on the development of blockchain point-to-point energy trading solutions to support transactions between roof photovoltaic owners or enterprise buyers purchasing photovoltaic power.

The UK's electron company has established the energy and power ecosystem of the blockchain platform, including asset registration, flexible trading and smart meter data confidentiality system [10]. With the help of Siemens and national grid of the United Kingdom, electron obtained the support of the government and expanded the scale of the platform.

In addition, Austria, northern Europe and other European countries and regions also have public utilities, power agencies, energy companies and so on to explore blockchain projects.

Since the establishment of the world's first energy blockchain laboratory in May 2016, Chinese experts and scholars have achieved fruitful research results in the application analysis of blockchain technology in China's energy field. Based on the matching analysis of the typical characteristics of blockchain and energy Internet, the application mode of blockchain technology in the field of energy Internet is explored, and the application scenarios of blockchain in the fields of demand side management, power metering and market trading, and power market auxiliary services are proposed. In 2018, State Grid announced a patent entitled "power transaction control method and device for blockchain" to conduct research on the

application of blockchain technology to the energy Internet. State Grid Zhejiang electric power company focuses on the application research of electronic data preservation, point exchange, data transaction and other aspects based on blockchain technology [11-12].

China Southern Power Grid Corporation also launched similar research projects in 2018. In addition, Jiangsu Province has also selected several communities in Suzhou, Wuxi and Changzhou to establish smart microgrid systems to carry out the exploration experiment of photovoltaic blockchain and shared household power. At the same time, the smart city construction schemes of some large enterprises also use blockchain technology to empower the energy and power sectors of the city.

At present, the core purpose of blockchain in the construction of China's energy Internet is to build a transparent, widely participated and fully trusted financial trading system between the pan energy physical network and the pan energy information application network. Through such a trading system, a system level solution for green subsidies, green operations and green finance can be made, so as to realize a seamless data link between industry and finance, and realize the physical model of energy The three-dimensional integration between the information model of the Internet and the financial system of blockchain. The brief schematic diagram of blockchain based energy Internet proposed by Chinese experts and scholars is shown in the figure below.

3. Application Trend of Blockchain in Energy and Power Industry

In general, the trends and problems in the field of energy and power can be summarized into four aspects: subject clarification, trust management, price trading and data application. In this regard, the application of blockchain technology in the field of energy and power may have the following directions from the current global development momentum.

First, build a distributed energy trading market. Blockchain can enable distributed energy users to seamlessly sell electricity to nearby consumers, so as to realize real localized energy production and consumption. This may exist in small and localized micro grids as a supplement and coordination for centralized energy production of large institutions, so as to improve the balance of regional layout of capacity. This application may have greater potential outside the grid. For example, grid singularity, an Austrian start-up, is using blockchain technology to explore "pay as you go" solar energy in developing countries, where the power grid infrastructure is relatively simple and there are fewer regulatory barriers [13].

Second, blockchain technology will drive the implementation and popularization of more distributed power grid infrastructures. Being able to conduct safe trading in the energy market as a local producer will attract more resources to invest in the technology of enabling distributed power grids. Specifically, it includes infrastructure such as smart grid equipment, Internet of things equipment and electric vehicles. The more distributed the power grid is, the more reliable and efficient it can match energy supply and demand - including but not limited to sending real-time quotation information and reducing expensive transmission and distribution infrastructure expenses.

Third, the design of distributed energy system. The distributed energy system has four advantages: first, it can reduce the energy loss of long-distance transmission, which can generally reduce the energy loss by 30% [14]; Second, it is not easy to be affected by network attacks; Thirdly, redundancy is created to reduce the impact of natural disasters; The fourth is to realize the refined management of energy consumption. To achieve these four points, it may be necessary to design the control mechanism of distributed energy in production, transmission and consumption, and design the construction of large IOT facilities such as interconnected smart meters, smart street lamps and smart appliances.

Fourth, research and Exploration on various fine applications of blockchain technology. Specifically, it includes: from power generation to operation and transmission, auxiliary services, power production management, safe energy storage, distributed power operation and maintenance management and other applications; From power transmission and distribution to terminal, dispatching automation, multi energy unified measurement, information physical system security and other applications; In terms of load, load fluctuation stability management and carbon market application; In terms of power trading and retail, the trading and settlement of distributed energy power trading system and electric vehicle charging market; In terms of the underlying control of the power grid, the blockchain based power grid distributed regulation technology and community microgrid management [15]; Asset management and data management of intelligent devices of the Internet of things. These fine applications can roughly correspond to the above four aspects: subject clarification, trust management, price transaction and data application, such as smart grid distributed decision-making and collaborative autonomous operation based on blockchain technology, distributed distribution network operation mode, LAN energy storage system, demand side response resource transaction, virtual power plant operation and dispatching, and large user direct power purchase transaction system, And intelligent electricity meter monitoring platform based on blockchain technology and Internet of things.

4. Summary and Outlook

Lack of trust among market players in the energy system is likely to lead to transaction friction, which is generally difficult to avoid in the case of a large number of participants. Blockchain technology has the characteristics of decentralization, openness, transparency, security and credibility, and provides an important way to solve the transaction friction in the energy system. Although blockchain technology has been applied in energy and other industries to varying degrees, it is still in its initial stage, and there are still technical problems such as low efficiency and waste of resources, leading to the fact that blockchain technology has not been widely used. When blockchain is applied to the energy and power industry, there are still many challenges and constraints. First, from the perspective of system construction, blockchain is still an unfinished infrastructure, and it is difficult to achieve the consistency and availability of consensus and efficiency. Secondly, there is still a big gap in the Internet of things system, and there are also problems with the data of many smart meters. Thirdly, policy updating, cross-border coordinated development and unified supervision are also short-term constraints.

However, in the long run, from the perspective of technology driven change, the huge market change and development opportunities in the field of energy and power may be a process of joint participation with emerging technologies such as the Internet of things, artificial intelligence and blockchain. This innovation is not only restructuring, but also will produce major original innovation. Moreover, blockchain is not only a universal technology to improve efficiency, reduce costs and increase security, but also a mechanism technology that can coordinate the market-oriented operation between different entities at the micro level. Looking forward to the future, if blockchain technology can be well developed and applied, it will certainly play a great role in promoting and transforming the field of energy and power, and make it move steadily in the direction of flexibility, diversification, reasonable balance, clean environmental protection and efficient intelligence.

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