Global Scientific JOURNALS

GSJ: Volume 12, Issue 1, January 2024, Online: ISSN 2320-9186
www.globalscientificjournal.com

ENERGY TRADING USING BLOCKCHAIN TECHNOLOGY FOR SOLAR ENERGY

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KeyWords
Blockchain, p2p, Energy trading, solar Energy, Chain connected, ledger-sharing.

ABSTRACT

This paper discusses about the recent technological application of using solar energy to trade with blockchain technology and the applications. The emerging technological application, processes and real time uses of this Technolocy is discussed. The energy market, blockchain technology, p2p energy trading system. This research was able to analyse the peer to peer blockchain technology and the trading mechanisms. It further highlighted how solar energy can be extracted and hannessed into energy trading using these blockchain methodology.

INTRODUCTION

Solar energy, harnessed from the abundant and renewable source of sunlight, has emerged as a promising solution to meet our ever-growing energy demands while reducing our carbon footprint. However, one of the primary challenges associated with solar power is its intermittent nature, as it depends on daylight availability. This is where solar energy storage systems play a pivotal role.

The drawbacks of the centralized energy system, such as the significant energy loss during long-distance transmission and distribution processes and the system's low fault-tolerant capacity, are currently becoming more and more obvious as the environmental pollution issue becomes more and more serious. Although decentralized renewable energy technology is gaining popularity, the current centralized system is unable to accommodate its storage and redistribution needs. Blockchain-based energy trading was proposed by certain academics in the interim (Zhang et al., 2017; Pee et al., 2019), and some projects have already been executed effectively (Laszka et al., 2018b; Mengelkamp et al., 2018). Building a blockchain-based energy trading platform and trading mechanism is currently a popular issue. The studies and projects based on blockchain-based energy trading that have been suggested in papers published in recent years are systematically reviewed in this study. Given that blockchain-based energy trading is still in its infancy, this study categorizes the present research focus into four areas: (1) creation of the trading platform; (2) efficiency, confidentiality, and security of the transaction mechanism; (3) redundancy and scalability of the trading platform; and (4) application of the particular technology of the trading platform (Li et al, 2021).

The remainder of this essay is structured as follows. The backdrop of the research problem and the development process are introduced in section The backdrop and Development Process. Section Application of Blockchain in Energy Trading examines the state of the research on four important areas.

Energy Markets

Renewable energy plays an important role in reshaping the future of energy industry, which can be integrated into power systems, in various forms, such as active distribution networks (Li et al., 2018a), integrated energy systems (Li et al., 2020), and microgrids (Li et al., 2018d). In this context, how to maximize the utilization of renewable energy by managing micro-grid markets is becoming a hot topic from academia to industry. Papaefthymiou and Dragoon (2016) elaborated on how to transform the traditional power systems into systems with 100% renewable energy. Similarly, Hanna et al. (2017) stressed the importance of policy support; to find the optimal operation mode to model the microgrid, Hanna et al. (2017) found that only with the support of policies, the microgrid will be able to achieve the lowest cost operation and environment friendly factors. Li et al. (2018c) presented a scheduling scheme of microgrids with an electric vehicle battery swapping station, taking into consideration, the real-time pricing mechanism. Li et al. (2019) put forward a multi-objective microgrid dispatch strategy considering the user experience. To ensure the benefit of microgrid participants, Kuznetsova et al. (2014) put forward the individual goal of stakeholders to optimize microgrid energy management framework. Furthermore, in terms of economic efficiency optimization, Montuori et al. (2014) proposed the optimization model, hybrid optimization of multiple energy resources (HOMER), to evaluate the economic efficiency of the microgrid with a biomass gasification power plant. Demand response management (DSM) has experienced a renaissance since microgrids require a flexible demand-side to simplify system operations (Palensky and Dietrich, 2011), but the use of DSM in microgrids does not take the advantage of the development of renewable energy sources in the long run, and reflects the needs of socio-economic development. An improved scheme based on the blockchain was put forward by Noor et al. (2018).

Li and Li (2019) proposed a microgrid dispatch strategy taking into account, the demand response of electric vehicles. By combing the advantages of DSM and blockchain technology, Li and Li (2019) presented a game-theoretic model for DSM within microgrid networks that were enhanced by blockchain, and which realized payment mechanisms and intelligent decentralized control.

Blockchain Technology

Blockchain technology provides a powerful tool for implementing energy trading. In 2019, Nakamoto (2019) presented a peer-to-peer (P2P) network, which employed proof-of-work to record a public history of the transaction, and this consensus mechanism can enforce any needed rules and incentives. That was the beginning of the blockchain-based research. Dong et al. (2018) described the blockchain as a distributed, redundant, chain-connected, ledger-sharing database, in which each node in the network is fault-tolerant and can achieve point-to-point communication.

There are four key characters of blockchain:

(1) decentralized distributed nodes and storage;

(2) consensus, smart contract, and asymmetric encryption, which enable it to have huge potential in many domains, such as finance, computer software, and computer applications;

(3) The information economy and postal economy, such as investment and securities;

(4) The shared health-care data framework, generation, and distribution in the citizen-level microgrid which may benefit from the widespread dissemination of blockchain transactions (Giungato et al., 2017).

Andoni et al. (2019) presented an overall review of blockchain technology, which involved 140 blockchain research projects and initiatives. However, most of the related studies are still in their infancy. Some social factors, such as laws and policies will also have an impact on the later development of blockchain technology. More specifically, Ali et al. (2018) presented an extensive survey of the application of blockchain in the internet of things (IoT), demonstrating the potential advantages of blockchain in some aspects, such as privacy, secured communications, identity, and data management as well as monetization of IoT data and resources. Fan et al. (2018) modeled the pricing and transaction of energy-internet electricity, based on the blockchain and big data, which provided a reference for the parties involved, including producers, consumers, and managers.

Blockchain in a P2P Energy Trading System

P2P trading is the direct exchange of surplus electricity between two parties on a connected grid. Blockchain offers a secure platform for P2P trading that tracks the transaction of assets, such as a unit of energy. Blockchain is a distributed ledger system that transparently stores data on a decentralized network. It is used to monitor transactions and track assets. Each block in the chain stores multiple transactions in a way that is easy to audit and verify, but very hard to edit or change. When combined with smart contracts that automate the buying and selling of energy based on supply and demand, blockchain has the potential to be a very attractive solution for distributed energy companies. It could greatly simplify the process of buying and selling power and enable highly localized energy generation. Existing energy companies can participate too, but they would have to adapt their existing technology and business plans. One potential benefit of a P2P trading system is that energy consumers could choose where to buy their power from. For example, they could specify the type of power source (renewable etc) and the type of company they buy from (independent, large, government etc). They can also see real-time prices, allowing them to make informed purchases. Since the system would be largely automated, the cost to the consumer could also be reduced through the elimination of “middle-men” power brokers.

Application of Blockchain for Energy Trading

This study categorizes pertinent studies into the following four areas because, according to various research foci, the majority of studies about energy trading based on blockchain are still in their early stages. Building a trading platform comes first, followed by studies of the economy, privacy, and security of transaction mechanisms, the latency and scalability of the platform, and finally the implementation of the platform's specialized technology.

According to Dr. Hongbiao Li, et al., and their research on blockchain energy solutions, the centralized energy grid has several significant issues. These include its energy loss over long-distance transmissions and its low fault tolerance. The alternative to a traditional centralized system is a decentralized smart grid (Li et al, 2021).

A decentralized smart grid relies on DERs like solar panels, windmills, and combined heat and power systems. DERs generate power at a local level, potentially solving the issues of energy loss and fault tolerance. These technologies are developing rapidly, but they need a reliable platform for energy trading. Like any power generator, DERs would like to sell excess energy and be paid in a timely manner.

Current energy trading systems were not designed for this type of decentralized network made up of small energy providers, so a new system of energy trading is needed (Li et al, 2021).
Blockchain platforms are fault-tolerant, but some blockchains also support so-called "smart contract" technology. This allows a simple buy/sell energy contract to be represented in code, and executed automatically on a blockchain-based trading system. This has the potential to significantly reduce energy trading transaction costs, as well as settlement times. A decentralized smart grid using blockchain technology could dynamically respond to supply and demand in near-real time and deliver payments within minutes. Solving the energy transaction issues can lower the cost of green energy, increase energy efficiency, fight climate change, and measure energy consumption and generation on a far more detailed level than ever before.

Blockchain Trading and Renewable Energy
Solar energy is one of the most common and accessible DERs. In a P2P trading system, people without solar panels could buy surplus renewable energy from their neighbors. A localized microgrid eliminates many of the inefficiencies of a monolithic centralized power generation system since it can respond more dynamically to local needs. Local power generation also reduces the power lost along transmission lines. DERs can lower costs, reduce waste and protect the environment. Renewables are frequently critiqued for their dependency on specific conditions. Solar energy needs daylight and windmills need wind. Blockchain trading provides a solution to these problems by making it far easier for those with surplus power to sell it to those that need it. When renewables are unable to generate power at night, or on a day without wind, microgrid participants can easily purchase power from other sources. Solar and wind are the two most well-known DERs, but biomass, geothermal, and hydropower are also sustainable forms of green energy that could benefit from blockchain trading.

Blockchain and Fossil Fuels
Blockchain has important applications for the renewable technology industry, but it's also applicable in the oil and gas industry. Dr. Hongfang Lu, et al., presented a review of blockchain in the oil and gas industry in 2019. They found that the upstream oil and gas segment suffers from equipment tracking issues and data leakage, the midstream segment suffers from erroneous and delayed transactions, and the downstream segment suffers from integrity and security issues. Hongfang explained how blockchain can improve the upstream segment's data transparency, improve the midstream's transaction efficiency and reduce costs, and improve the downstream's data security. In short, blockchain has significant benefits for the large, established energy generators, as well as newer market participants (Li et al, 2021).

CONCLUSION
As an emerging and powerful technology, energy trading based on blockchain has attracted a growing attention of many scholars. After studying the existing literature, this paper summarizes the key issues into the following four points:
(1) construction of trading platform;
(2) economy, privacy, and security of transaction mechanism;
(3) redundancy and scalability of trading platform;
(4) implementation of the specific technology of trading platform.
Since most studies are in the primary stage, the construction of an energy trading platform and efficient algorithm implementation will be important research directions in the future (Abigo et al 2019). Another interesting topic is to apply machine learning to blockchain-based applications (Shi et al., 2008; Li et al., 2018b; Tanwar et al., 2019; Li et al, 2021).

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