

Optimal Deployment of Energy Based on Blockchain

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Abstract: With the increasing environmental problems, smart grid has become the consensus of the world to improve sustainable energy systems. Smart grid emphasizes the full interactive link between the elements of the network to improve a fully autonomous and intelligent energy network. One of the key ideas behind this is sharing energy and information. But this brings many problems to the traditional centralized power system. As an emerging information technology, blockchain is one of the ideas to solve problems such as distributed network and network security. The purpose of this paper is to optimize the deployment of energy based on blockchain, and to compare and analyze Ethereum and Hyperledger Fabric technologies in the experiment. The experimental results show that in order to achieve optimal energy deployment, the Hyperledger Fabric platform is more suitable for deployment as an energy trading network and platform.

1. Introduction

In the information age, more and more organizations conduct business collaboration with other organizations through information systems. Since some institutions will falsify and deny the cooperation activities during the cooperation between institutions, which will have a negative impact on the trust between institutions, so improving the security during the cooperation between institutions is an important research content in the field of network security. The traditional approach is to introduce a third-party agency for supervision, but this model has the risk of single-point problems. As a technology with the characteristics of decentralization and data immutability, blockchain technology can greatly alleviate the problems existing in traditional practices [1].

With the improvement of Internet information technology, my country's energy structure has shown a new improvement trend. The decentralized nature of blockchain technology will generate many new economic forms and business models, which are considered to be a kind of energy

distribution that can be applied to the Internet of Energy. A solution for on-site consumption of electric energy. Miraz MH believes that blockchain is considered important for ensuring enhanced security in many fields, IoT ecosystem. Both academia and industry are conducting intensive research to apply blockchain technology to various applications. Additionally, BC provides a private level of privacy. BC has been successfully adopted not only in cryptocurrencies, but also in many non-financial systems [2]. According to Puthal D, blockchain is improving as beneficial and understandable cybersecurity technologies. In its decline, technology has successfully replaced economic business systems in many organizations and has the potential to transform different business models in different industries. Planners and decision makers must deeply analyze its suitability for corporate. If it is useful and provides better opportunities for increasing revenue and reduce costs [3]. At present, the application of energy blockchain is still in the proof-of-concept stage, and most of them stay in the discussion of business models. There is a lack of in-depth research on the combination of blockchain and the nature of the energy Internet itself.

This paper studies the definition of blockchain, an overview of Bitcoin, and the execution steps of energy trading contracts based on blockchain, and discusses the key technologies of blockchain, including cryptography, consensus mechanisms, and smart contracts. In the experiment, the Ethereum and Hyperledger Fabric experimental platforms are used to analyze and compare the energy trading contract deployment on the Ethereum platform and the energy trading contract deployment on the Hyperledger Fabric platform. The experimental results show that the Hyperledger Fabric performs more prominently. On the other hand, the efficiency is greatly improved, so it is more suitable for the optimal deployment of energy.

2. Research on the Optimal Deployment of Energy Based on Blockchain

2.1. Blockchain Definition

Blockchain is an irreversible distributed ledger. The ledger consists of two sets of blocks, and a block can be simply divided into a block header and a block body. Aside from financial factors, from a technical point of view, the blockchain is essentially a database. Unlike other databases, the data stored in the blockchain is recognized by all nodes in the blockchain network and cannot be changed. data in the library, so it is also a reliable and immutable database [4]. From another point of view, the blockchain is a chained data structure. Each block in network relies on the hash and the parent hash to connect in series, distributed storage, common maintenance and chain structure guarantee security. On the blockchain platform, each node stores a complete blockchain, which is also a feature of blockchain [5]. A blockchain consists of blocks, and many blocks form a chain with a time sequence. In addition, the first block of each blockchain is called the "genesis block". A small amount of information is stored to facilitate the verification of the block as it is passed by the nodes. It mainly includes: the hash of the current block, the parent hash, and the timestamp and Merkle root when the block was generated [6].

2.2. Overview of Bitcoin

Bitcoin (Hyperledger Fabric), as the first and most widely circulated cryptocurrency, brought blockchain to the public eye. After Bitcoin, more and more cryptocurrencies and blockchain applications have emerged. If Bitcoin represents Blockchain 1.0, then Ethereum opens Blockchain 2.0 [7]. Ethereum has absorbed many of the same qualities as Bitcoin, but also made some updates and reforms on the basis of Bitcoin. Both Bitcoin and Ethereum belong to the public chains

mentioned earlier, and any node does not need permission to join the network [8]. However, this completely public, authorization-free network participation model cannot meet some performance customizations required by enterprise-level applications.

The requirements for scalability, privacy, security, workflow complexity, etc. of blockchain networks vary widely across industries and uses. These diverse requirements cannot be met by the public chain [9]. Hyperledger encourages reuse of common functions or blocks through a modular architecture. The modular architecture design makes the system more flexible and extensible, and supports individual modification of a component without affecting other parts of the system. Projects framed in Hyperledger include Hyperledger Fabric, Hyperledger Indy, Hyperledger Iroha, Hyperledger Sawtooth, and Hyperledger Burrow [10]. Among them, Hyperledger Fabric is the most popular and has the longest launch time. Hyperledger Fabric is the first distributed platform capable of writing smart contracts using general-purpose programming languages such as Java, and at the same time, it provides enterprise-level users with some key features that are different from other popular blockchain platforms [11].

2.3. Blockchain Technology

Blockchain was originally as a ledger to solve the dual funding problem of cryptocurrencies. The main advantage is that it allows business groups and stakeholders to build trust between untrusted entities in a reproducible way due to the inefficiencies of distributed ledgers [12]. Due to the huge success of Bitcoin, blockchain as an emerging technology has received a lot of attention from the research community. The structure is open because it is implemented by many shared parts, each of which has a copy of the encrypted chain's bitcoin transaction records, in blocks, arranged by the community. Some consensus requests are signed between blockchains. Encrypted blockchains and mechanisms ensure it [13]. The openness of it allows everyone to Bitcoin's transaction, preventing anyone from trying to manipulate the history without revealing it. In this way, unbreakable trust can be set up between things we don't trust. This means that the registry cannot be fixed. Its decentralized, open and immutable nature makes it a architecture. The architecture inherently solves the single point of failure problem as records are replicated across multiple distributed nodes. The key technologies of it mainly include cryptography, consensus mechanism and smart contracts. The following will briefly discuss the application of these key technologies in the energy trading system of the Internet of Vehicles [15].

(1) Fundamentals of Cryptography

In a system where blockchain is the underlying technical framework, the use of encryption technology can ensure it. The use of functions in blockchains is common. A block uses a hash value as its unique identifier, and each of it records the hash value of the parent block. Thus forming a chained data structure. Once blocks are linked together, it becomes immutable because the hash value is unique. Also, another application of hashing is the Merkle hash tree, which is used to aggregate in a block. Merkle hash trees can reduce storage overhead and can be used by lightweight entities to quickly check integrity [15].

(2) Consensus mechanism

Blockchain technology is accepted as a secure and scalable technology. It is a database that occur and makes them on each node [16]. It also lacks trust between the departments. On the one hand, blockchain means enabling trusted computing among a group of untrusted participants. On the other hand, it is also known for providing services. The block data set obtained by the blockchain includes the hash in the next block. Using a hash chain realizes that data cannot be modified without

modifying subsequent blocks. Public systems support users can perform online transactions using pseudonyms without their true identities. The security features that blockchain promises are unprecedented and are the technology that really attracts users. The pioneers of systems have greatly influenced the world of digital payments. Blockchain-based technologies and applications are predicted to revolutionize a range of financial services industries and non-financial sectors.

(3) Smart contracts

A smart contract is a piece of code deployed in the blockchain network. The blockchain platform cannot compile and execute the code. The execution of the code is in the local EVM. In fact, the code deployed on the blockchain can be executed on the client side. On the basis of the original smart contract for improvement, the code is modified according to the needs [17].

The transaction rules based on the smart contract jointly formulated by the participants ensure trust and notarization, the public and private keys confirm the access rights of the transaction contract, and protect the privacy characteristics of users. The point-to-point interactive decision-making between devices based on blockchain deployment does not require trust and trust. It can make decisions on behalf of the centralized platform, and at the same time, a game algorithm can be added to the smart contract to improve the coordination of transactions, and constantly improve the transaction method of smart contracts [18]. In Hyperledger Fabric, the chaincode runs in the container, provides external interfaces and corresponding functions, and calls the contract completely free of charge.

2.4. Execution Steps of Energy Trading Contracts Based on Blockchain

When the user initiates a request when there is electricity, it includes information such as price and usage. Then enter the network to see if the transaction meets the conditions of the transaction agreement and whether it is legal. The end user signs the contract and completes the transaction according to the hospitals of both parties [19]. The specific process is shown in Figure 1:

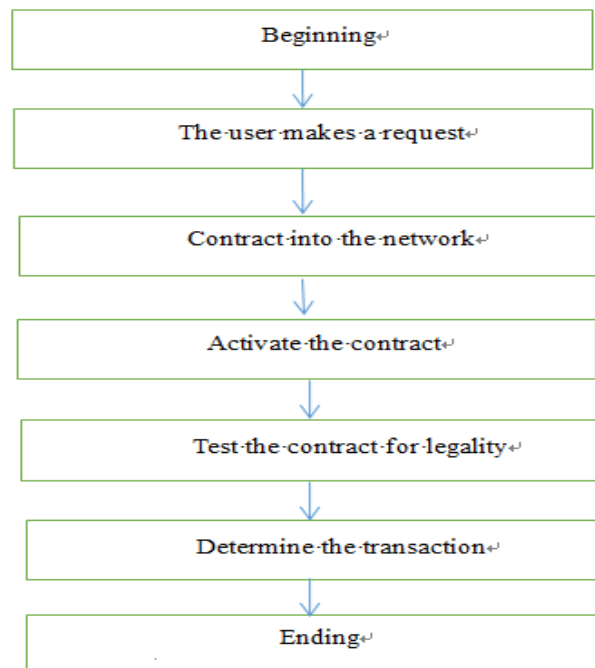


Figure 1. Energy trading contract execution steps

3. Investigation and Research on Optimal Deployment of Energy Based on Blockchain

3.1. Energy Deployment Experimental Platform

In view of the problems of low efficiency and low security in energy transactions based on blockchain, we use blockchain technology to improve, design and experiment on energy transactions, and verify the feasibility of this transaction method through smart contracts. By comparing and analyzing the deployment of energy trading contracts on Ethereum and Hyperledger Fabric platforms, the optimal deployment of energy can be achieved.

3.2. Experimental Method

In regional energy trading, if all buyers and sellers whose bids are equal to P are i , $i \in [k, l]$, then $k \leq t \leq l$, the formula is:

$$M \leq \sum_{i=1}^i \leq x_i \sum_{i=1}^l x_i = \sum_{p_i \geq p_i} x_i \quad (1)$$

Consumers need to buy z_1 kWh and the purchase price is greater than p , and producer z_2 has kWh to sell and the price is less than p , then the formula is:

$$\sum_{i=1}^{k-1} x_i \pi \sum_{i=1}^t x_i = y_t \leq M \quad (2)$$

4. Analysis and Research on Optimal Deployment of Energy Based on Blockchain

4.1. Deployment of energy trading contracts on the Ethereum platform

Before the transaction starts, an appropriate contract should be selected according to the actual situation and the amount of electricity. The content of the contract includes the balance of consumption before and after, the transaction address and time, etc., and finally the purchase price is determined. The node information before and after the Ethereum account transaction is shown in Table 1 and Figure 2:

Table 1. Node Information for Ethereum Account Transactions (ether in Etherian Units)

Transaction node (address)	Pre-transaction balance (ether)	Post-transaction balance (ether)	Transaction completion time/s
192.168.0.115	1.1	0.98	469
192.168.0.116	1.3	0.95	574
192.168.0.117	1.0	0.84	481

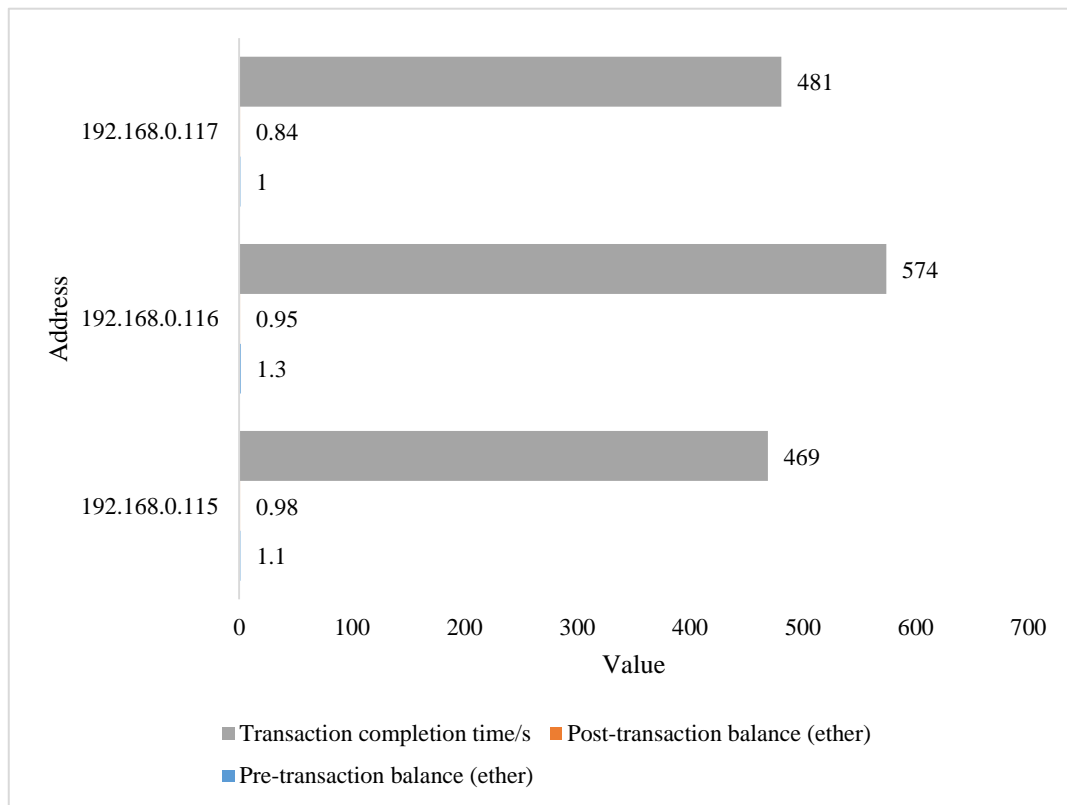


Figure 2. Statistics of the balance and time before and after Ethereum account transactions

Ethereum takes about 5 minutes to 6 minutes from the beginning of the transaction process to the submission time; Ethereum can deploy the public or private chain of the blockchain, once the private key is lost, it may affect the economy of the account.

4.2. Hyperledger Fabric platform energy trading contract deployment

The energy transaction time of Hyperledger Fabric platform is about 3min to 4min. Therefore, Hyperledger has more advantages in time; Hyperledger Fabric has higher security in the transaction process. It can not only automatically checkout, but also realize transaction liberalization. The transaction information of Hyperledger Fabric network nodes is shown in Table 2 and Figure 3:

Table 2. Hyperledger, fabric network node transaction information

Transaction node (address)	Pre-transaction balance (ether)	Post-transaction balance (ether)	Transaction completion time/s
10.113.144..154	500	200	183
10.113.144..104	200	100	194
10.113.144..113	300	110	252

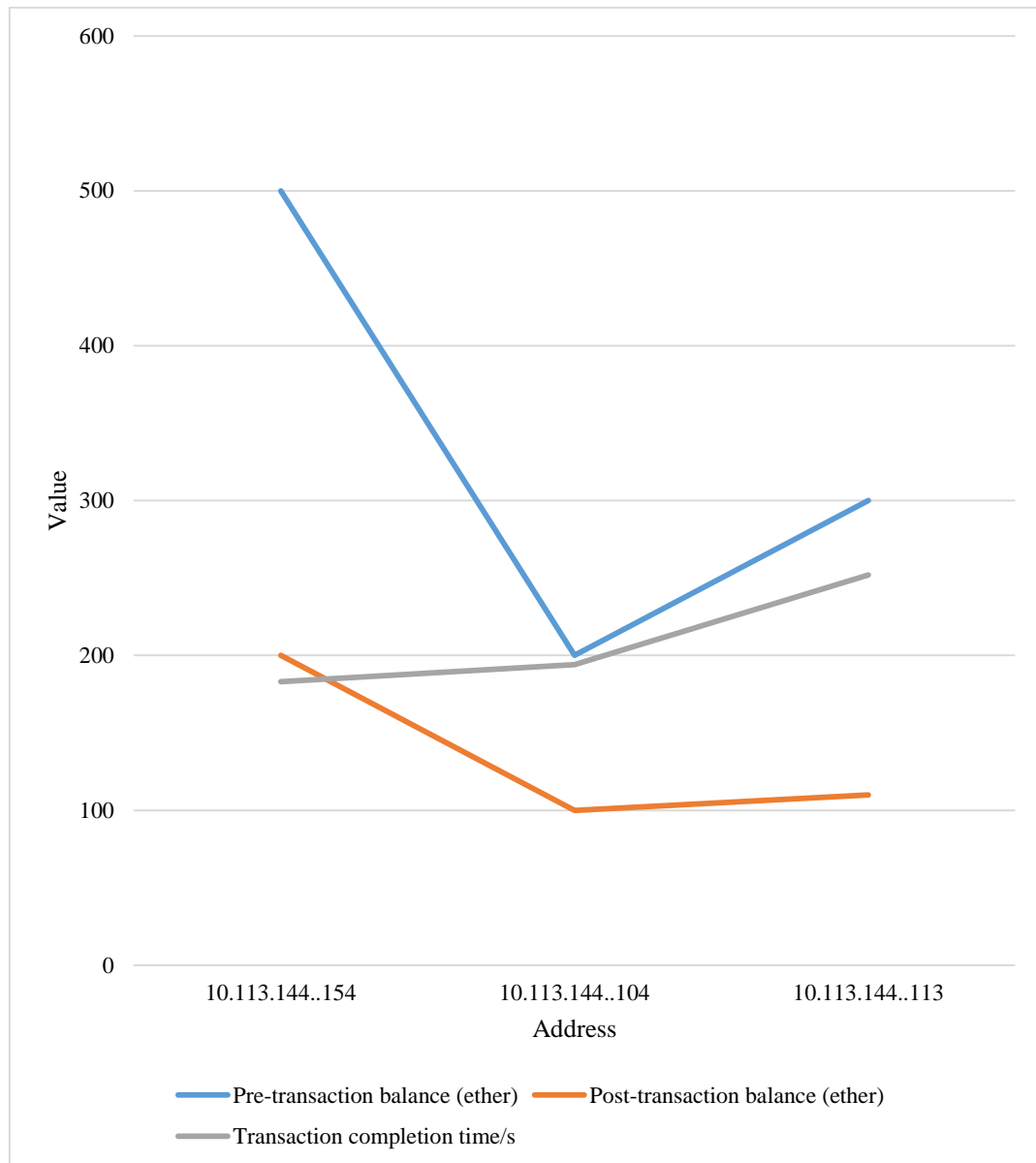


Figure 3. Statistical chart of the balance and time before and after Hyperledger Fabric account transactions

To sum up, although Ethereum is more convenient and the technology is more mature, Hyperledger Fabric performs more prominently in terms of efficiency, time, security and other issues in energy contract deployment. Increased efficiency and therefore more suitable for optimal deployment of energy.

5. Conclusion

The optimal deployment of energy based on blockchain is the key of this research, and the energy deployment scheme will affect the time and efficiency between energy transactions. There are many studies on blockchain-based optimal deployment of energy. This paper establishes an

experimental platform for Ethereum and Hyperledger Fabric, compares the differences between the two, and chooses the optimal smart contract deployment. Due to limited personal knowledge, there are still many deficiencies in the research of energy based on blockchain.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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