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AN OVERVIEW ON THE ADOPTION OF BLOCKCHAIN TECHNOLOGY IN THE TRADING OF ENERGY

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Abstract— Blockchain based energy trading have gained popularity in academia and business, this study provides a literature analysis of Energy trading based on Blockchain in the possible areas. The background and development process are presented, and then a review and analysis of block-chain applications in the area of energy trading is done. Final thoughts are summarized, and significant future opportunities in this field are highlighted.

Keywords— *Ethereum, Energy trading, Blockchain, Incentivization, Smart contract*

I. INTRODUCTION

Interconnected micro grids' (IMGs') energy management and trading has lately received attention [1]. To provide local players, including residential, commercial, and industrial clients with sustainable, clean, and affordable energy, a market integration across diverse micro grids is being built [2]. Energy infrastructure is progressively incorporating renewable energy, notably solar energy, thanks in part to financial incentives from the government and the money saved on energy bills as well as growing environmental consciousness [3]. Prosumers are a category of consumers who generate a portion of their energy requirements on-site using microgeneration equipment and supplement that with grid purchases as necessary [4]. Multiple prosumers living close to one another can create prosumer communities or micro grids [5]. Prosumers can either use the solar energy they produce for their own needs or sell any excess to the grid or other consumers. As a result, energy trading is a popular form of practical energy sharing in everyday life [6].

However, in conventional P2P energy trading systems, it is impossible or difficult to ensure participant trust, set the energy trading price, or enforce agreement fulfilment without the help of a reliable third party [7]. Additionally, because RESs are sporadic, some persons struggle to meet their energy needs while others are in excess [8]. Due to DG's efficient energy trading system, small-scale energy providers can now exchange and preserve energy in decentralized manner. The implementation of blockchain, which has been used successfully in many industries due to its well-known advantages, is being used to address the issues that have limited the effectiveness of conventional energy trading methods, such as security, privacy, trust, and the determination of energy pricing [9].

Numerous research has been undertaken on the subject [10], but the usage of blockchain technology in energy trading industry is particularly interesting and promising one. Customers can choose suppliers in a scheme based on the blockchain for energy trading on their own deciding factors, like

dealing with nearby providers or utilization of clean energy, to reduce their electrical energy costs and enhance their distributed renewable energy return on investment. Some experts looked into the viability of using distributed technology to the energy market before formally attempting to integrate blockchain with the energy trading paradigm [11]. The P2P (Peer to peer) framework, which is supported by data, supports the participation of so-called "prosumers" and permits the market for trding of energy to operate in an user centric way, greatly expanding the flexibility of the traditional energy market mode [12–14]. In order to address the issues of users' privacy, security, resource management, and price termination in smart grids, effective and efficient solutions are needed. Sustainable cities and communities depend on the solutions.

II. Literature survey

BEST, a secure platform for trading of energy for EV application using Blockchain, was created by Rajat et al. [15] for their study (EV). In particular, BEST leverages distributed blockchain to validate EV requests, ensuring robustness against single point of concern. The nodes chosen by miner are nominated to authenticate the requests in accordance with the energy requirements, length of stay, dynamic pricing, connectivity history, and additional factors that are significant at the time of operation. Additionally, s/w-defined interaction is used as the backbone of the system to allocate requests from EVs to a worldwide software-based network controller in order to give real-time services. Finally, BEST is evaluated based on the expenses associated with various communications and computation costs between EVs and the smart grid. In order to boost network throughput, it will be necessary to look at the SDN's flow management method in the future.

Esmat et al. developed a novel market and decentralized P2P energy trading platform based on Blockchain [16]. A simultaneous, pool-structured auction for a brief period of time and a ground-breaking, distributed Ant-Colony Optimization clearance mechanism are also included in the market layer. This market structure ensures a close to ideal market outcome, protects players' anonymity, and permits trade of market goods throughout time. The blockchain layer's significant level of automation, security, and efficient real-time settlements are made possible by the usage of smart contracts. The platform's capabilities for energy trading, market clearing, smart contract operations, and blockchain-based settlement are then simulated using real data. One of the limitations of this approach is that it fails to take into account the prosumer's ambiguous commitment and the intermittent nature of RES.

SURVIVOR: Jindal et al. [17] introduced a Blockchain-based on Edge-as-a-Service is basis for safe and Secure Energy Trading in a V2G environment using (SDN) Software Defined Networking. To make energy trading decisions near the EVs, the suggested system employs edge nodes. Additionally, all currently active nodes are used to choose approver nodes, based on a utility function to be in charge of validating transactions, and blockchain is used for safe energy trading. As soon as such nodes have been chosen, a consent-based blockchain technique for secure trading of energy in an S/W Defined Network-permitted V2G environment is next given. Future performance assessments of the proposed work can be made via the consortium blockchain system.

Zhou et al[18] .'s improvements to the decision-making trial and evaluation laboratory (DEMATEL) method include the construction of an obstacle analysis model for the relevant scenario and the use of a hesitant fuzzy linguistic word set and K-mediods clustering algorithm. In comparison to the conventional DEMATEL method, the assessment data collection is more precise and adaptable. Additionally, there may be more than two categories for the severity of an

effect, and the classification of obstruction factors is more precise. Prior to providing an overview and analysis of six specific application cases, thirteen barriers to its implementation in power trading are first mentioned. Following that, each possibility is thoroughly examined, including the causal process, impact degree classification, and quantification of influence among obstacles. In the upcoming work, the design and architecture of the blockchain trading platform in each application scenario will be more thoroughly investigated.

For the autonomous usage of Micro Grids with (PEJ) power electronic jointing based on (M-S) master-slave that is created in the Industrial Internet of Things environment and carried out by a superior array while a inferior array calculates the appropriate control procedures for the Power Electronic Jointing, by Xu et al. presented a brand-new load-sharing method for renewable MGs and a secure energy policy. A superior layer of intelligent control is accomplished via a (DMAS) decentralized multi-agent system on the basis of communication. MAS balance of power control and economic load dispatch are the two different control techniques used by the layer. Many people who work in, manage, or plan to work in the energy sector are very interested in the subject of blockchain technology. A shared and distributed database is made possible by blockchain technology (B.CT), which also delivers secure, transparent, automatic, and reasonable priced operations in power distribution networks. In forthcoming work, the authors will carefully review and discuss recent suggestions for remedies to the blockchain scale problem, like decentralized storage and plasma. Cryptographic system concept for use in scenarios involving the Smart Grid was shown by Skowronski et al. [20]. In addition to handling and encouraging the necessary data transmission and storage, the strategy aims to promote the spread of green field energy. Supply and demand dynamics entirely determine the value of both the cryptocurrency and the energy itself. In the design, Smart Meters are the sole reliable actors. They also emphasize the significance of structures required by a system, such as being regarded secure, dispersed, and in fact, decentralized, with a improved level of safety provided by end-to-end encoding and secrecy provided by unspecified identities. However, owing to the platform's openness, there are numerous ways to ensure legal compliance in every nation.

III. Problem addressing using Optimization technique

A micro grid within the traditional energy trading system will assist buyers and users in trading small expanses of energy during each short-term trading time period. On the basis of this supposition, Prosumers and consumers would find it challenging to inquire or bid in each trade for each period. It is vital to set a single price for each period based on the overall supply and demand offered in order to reduce this difficulty. Since energy is exchanged online, it is critical to prevent the sale of the same energy more than once. As a result, it's required to construct an energy possession structure inside of a smart contract. Unless expensive firewalls are installed, systems based on server are similarly susceptible to hackers and manipulation. The rate and maintenance expenses brought on by the secure implementation may be too expensive for micro grid-based P2P trade on a small scale.

IV. Methodology

In order to create a dynamic rating function to set equilibrium in supply and demand among buyers and users and carry out secure trading within a microgrid, this proposal suggests a novel Smart contract-based block chain framework-based peer-to-peer(P2P) secure trading of energy system. The suggested system is based on a dynamic rating function that balances supply and demand within a micro grid and is based on block chain technology. The ratio of total supply to total demand determines whether prices go up or down each time. Prosumer (consumer) supply and demand will be encouraged or discouraged by the higher or lower price during the necessary

trading period. In order to resolve any disagreements and carry out energy trade processes automatically, a smart contract built on the blockchain is used.

The private block chain linked to the micro grid must first get registration information from each prosumer or consumer planning to trade energy, according to the suggested structure. A digital signature (DG) from the account owner is included in each transaction that includes an externally held account. For the choosing a miners and creation of blocks, this framework uses a proof-of-closeness (PoC) consensus process. The transaction it delivers is the owner's responsibility, and the digital signature ensures validation and nonrepudiation. The transaction gets mined into a block once it has been confirmed to be genuine. Participating nodes transmit transactions that contain information on which functions should be executed, the parameters needed to perform those functions, the smart contract's compiled byte code, and the smart contract with the relevant address. As soon as the transactions of energy are injected into a block, all nodes implement the smart contract (SC) functionalities according to the defined parameters. When a prosumer injects the surplus energy, notification in form of message is employed to create an element with the updated status showing "Injected Energy." Energy transmission between participants is handled by the DSO, a block chain network operator. In addition, it runs the blockchain network and develops or updates smart contracts for the exchange of energy. By avoiding the lengthy consensus process, it enables a node to communicate with other nodes directly rather than through the block chain. Accordingly, only the qualified node's private key(s) can be used to update the states (s). There is no possible method for hackers to alter these conditions without exposing the necessary private key (s). The variations in energy possession that occur while transaction of energy are kept inside a structural arrangement that is included in the smart contract and is therefore secure, which also prevents the double sale issues. The suggested (P2P) secure trading of energy system built via a block chain framework is crucial for creating sustainable cities and societies.

V. Architecture Diagram

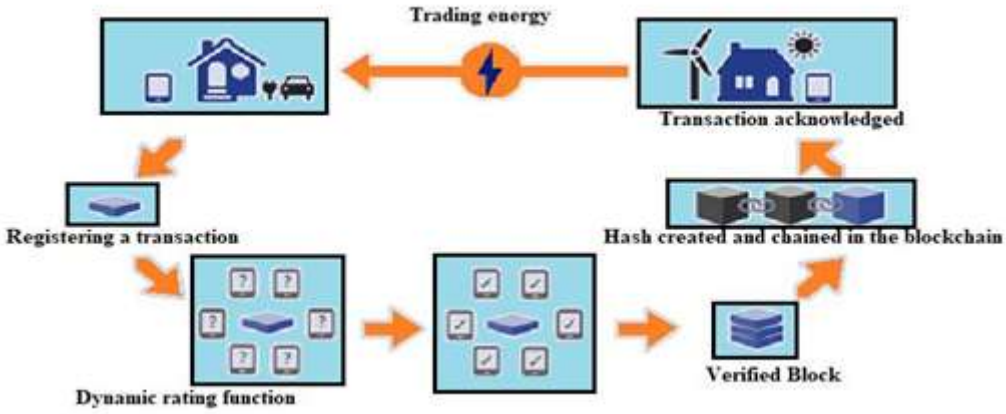

Fig1: Architecture of Authentication by Smart Contract

Conclusion

Many scholars are interested in blockchain-based energy trading as a powerful and developing technology. This essay reviews the main problems into the subsequent four points after reviewing the literature: (1) creation of the trading platform; (2) considerations regarding the operation mechanism's; (3) redundancy, economics, privacy, security and scalability of the trading platform; and (4) use of the novel technology of the platform used for trading. The majority of research are still in the initial stages, the creation of a platform that will be utilized for Energy trading and the application of effective algorithms will be substantial research in the future.

References

1. Hamouda, Mohamed R., Mohammed E. Nassar, and Magdy MA Salama. "Centralized Blockchain-Based Energy Trading Platform for Interconnected Microgrids." *IEEE Access* 9 (2021): 95539-95550.
2. Williams, Nathaniel J., et al. "Enabling private sector investment in microgrid-based rural electrification in developing countries: A review." *Renewable and Sustainable Energy Reviews* 52 (2015): 1268-1281.
3. Shahsavari, Amir, and Morteza Akbari. "Potential of solar energy in developing countries for reducing energy-related emissions." *Renewable and Sustainable Energy Reviews* 90 (2018): 275-291.
4. Oberst, Christian, and Reinhard Madlener. "Prosumer preferences regarding the adoption of micro-generation technologies: Empirical evidence for German homeowners." (2014).
5. Sousa, Tiago, et al. "Peer-to-peer and community-based markets: A comprehensive review." *Renewable and Sustainable Energy Reviews* 104 (2019): 367-378.
6. Okoye, Martin Onyeka, et al. "A blockchain-enhanced transaction model for microgrid energy trading." *IEEE Access* 8 (2020): 143777-143786.
7. Wang, Naiyu, et al. "When energy trading meets blockchain in electrical power system: The state of the art." *Applied Sciences* 9.8 (2019): 1561.
8. Bhandari, Binayak, et al. "Mathematical modeling of hybrid renewable energy system: A review on small hydro-solar-wind power generation." *international journal of precision engineering and manufacturing-green technology* 1.2 (2014): 157-173.
9. Khan, Minhaj Ahmad, and Khaled Salah. "IoT security: Review, blockchain solutions, and open challenges." *Future generation computer systems* 82 (2018): 395-411.
10. Andoni, Merlinda, et al. "Blockchain technology in the energy sector: A systematic review of challenges and opportunities." *Renewable and sustainable energy reviews* 100 (2019): 143-174.
11. Wang, Qiang, and Min Su. "Integrating blockchain technology into the energy sector—from theory of blockchain to research and application of energy blockchain." *Computer Science Review* 37 (2020): 100275.
12. Kahn, M. T. E. "DIGITAL BLOCKCHAIN TECHNOLOGY IN ENERGY: A TECHNICAL REPORT FOR SMART TRANSACTIONS IN THE AGE OF SOCIAL DISTANCING."
13. Mengelkamp, Esther, et al. "Designing microgrid energy markets: A case study: The Brooklyn Microgrid." *Applied Energy* 210 (2018): 870-880.
14. Zhou, Yue, Jianzhong Wu, and Chao Long. "Evaluation of peer-to-peer energy sharing mechanisms based on a multiagent simulation framework." *Applied energy* 222 (2018): 993-1022.
15. Chaudhary, Rajat, et al. "BEST: Blockchain-based secure energy trading in SDN-enabled intelligent transportation system." *Computers & Security* 85 (2019): 288-299.
16. Esmat, Ayman, et al. "A novel decentralized platform for peer-to-peer energy trading market with blockchain technology." *Applied Energy* 282 (2021): 116123.
17. Jindal, Anish, Gagangeet Singh Aujla, and Neeraj Kumar. "SURVIVOR: A blockchain based edge-as-a-service framework for secure energy trading in SDN-enabled vehicle-to-grid environment." *Computer Networks* 153 (2019): 36-48.
18. Zhou, Jianli, et al. "Prospects and obstacles analysis of applying blockchain technology to power trading using a deeply improved model based on the DEMATEL approach." *Sustainable Cities and Society* 70 (2021): 102910.
19. Xu, Weicheng, et al. "Blockchain-based secure energy policy and management of renewable-based smart microgrids." *Sustainable Cities and Society* 72 (2021): 103010.
20. Skowronski, Rafal. "On the applicability of the GRIDNET protocol to Smart Grid environments." *2017 IEEE International Conference on Smart Grid Communications (SmartGridComm)*. IEEE, 2017.