VFAST Transactions on Software Engineering
http://vfast.org/journals/index.php/VTSE@ 2022, ISSN(e): 2309-3978, ISSN(p): 2411-6246
Volume 10, Number 4, July-December 2022 *pp: 145-150*

Comparison of Clean Energy Trading Method in Microgrid by using Blockchain Technique

Manzar Ahmed[1] , Agha Yasir Ali[4], Muhammad Rehan[4], Afsaar Ahmed[2] , Uzma Amin[3], Mishaal Ahmed[2*]

[1]Department of Electrical Engineering, Sir Syed University of Engineering & Technology, Karachi- Pakistan
[2] Department of Software Engineering, University of Engineeering & Technology, Lahore-Pakistan
[3] Department of Electrical Engineering, Computing and Mathematical Sciences, Curtin University, Australia.
[4]Department of Electronic Enginneriing, Sir Syed University of Engineering & Technology, Karachi-Pakistan
[5]Department of Software Engineering, University of South Asia, Lahore-Pakistan
*Corresponding Author: mishaal100@yahoo.com

ABSTRACT
The old conventional energy distriution system cannot fulfill the demand of the prosumers in providing secure energy trading and with minimum losses in energy transmission. Because it is centralized system and user has no freedom to trade energy without involving the third party. In conventional grid there are lot of issues such as controlling the losses and forecasting the demand and reliability. One major issue is theft of electricity and losses. The new blockchain system has potential to provide secure energy trading in network without involvement of third party. The combination of blockchain and Microgrid has all features to resolve the issues related to the current grid such as controlling power, Forecasting the demand and reliability. In this paper the combination of Microgrid and blockchain for trading energy will be analyzed and energy trading method in P2P Network based will be investigated to find best method for trading enegy in network. For the simulation the matlab tool will be used.

KEYWORDS
Clean Energy, Blockchain, storage system, P2P Trading, and Microgrid

JOURNAL INFO
HISTORY: Received: November 19, 2022 Accepted: December 27, 2022 Published: December 31, 2022

INTRODUCTION

The demand of clean energy has been increased rapidly because the pollution and hazard gases produce from these resources are creating health issues such as CO_2 penetrating in environment with high ratio. In future the energy should be clean or Green and it should fulfill the Green energy standards before and after processing. The energy trading in the conventional Grid is not providing any freedom to prosumers to sale or purchase energy with their own choice and rate and system is centralized. In many countries still conventional energy system not upgraded and system is suffering from many losses and all losses are recovering from customer in form of over billing. The total energy mix of Pakistan is as 4% nuclear, 29% hydro, 61% fossil-based fuels, and 6% others. Pakistan has an untapped potential of electricity generation of 100,000 MW (Thar coal), 56,000 MW (hydro), 150,000 MW (wind), and ~50,000 MW (solar). A significant increase in the share of hydro power and local coal are projected with minimal growth in nuclear sector. Hydro 40% of power will be share in main grid in 2040 [2]. The present situation is given in figure 2 and which is worst and cannot fulfill the demand.

The National Electric Power Regulatory Authority claims that high Transmission and Distribution (T&D) losses coupled with low recoveries are reached Rs2, 252,750 million by June 2022. NEPRA saying it is the biggest challenge for the country to overcome the Circular Debt which is hampering the power sector, particularly investors and end-consumers at the same time. Besides losses, recoveries, underutilization of the assets, running defaulters, and delays in payment of subsidies are among the contributory factors towards circular debt. The financial impact of running defaulters is around Rs700 million, which is alarming as these consumers are still connected with the system as shown in, figure 2.

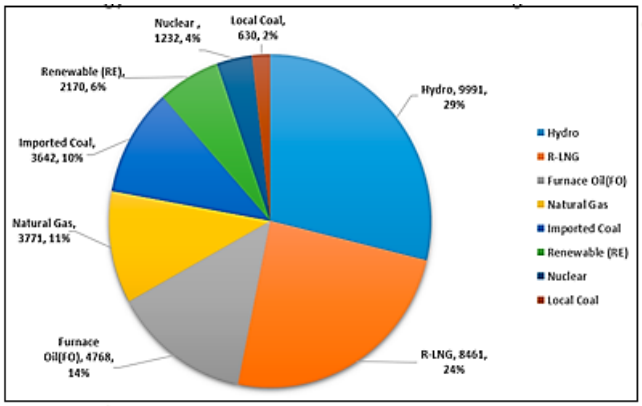

Fig: 1. Energy resources in Pakistan [2]

The National Electric Power Regulatory Authority claims that high Transmission and Distribution (T&D) losses coupled with low recoveries are reached Rs2, 252,750 million by June 2022. NEPRA saying it is the biggest challenge for the country to overcome the Circular Debt which is hampering the power sector, particularly investors and end-consumers at the same time. Besides losses,

recoveries, underutilization of the assets, running defaulters, and delays in payment of subsidies are among the contributory factors towards circular debt. The financial impact of running defaulters is around Rs700 million, which is alarming as these consumers are still connected with the system as shown in, figure 2.

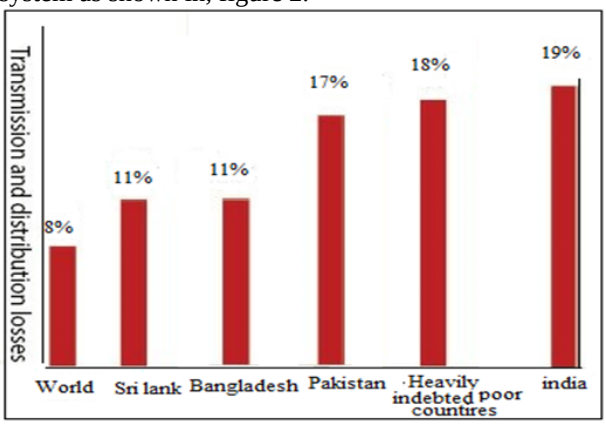

Fig: 2. Electricity losses per year in Pakistan

In Pakistan the old energy system is upgraded but still system suffering from huge losses and poor people bearing the load of overbilling and line losses, in some urban cities new energy meter are installed for trading energy from prosumers but the service provider purchase energy with their own choice rate and meter cost is around 40 thousand which is too high. One issue is that below 10 kW the prosumers cannot install meter and second rate is very low for selling energy. There are so many disadvantages of current centralized power system and still consumers are suffering from many issues in Pakistan. There are some solutions for these issues but government is not taking these issues seriously and the people are suffering from huge financial burden. There are technical solution for these issues such as the in each area, the losses and consumption of electricity must be calculated by using in domestic transformer using wireless mobile terminal and people who theft the electricity must be traced, but this need huge cost and man power to be trusted. Second solution is to use Nano coating to reduce the line losses and using the blockchain to trade energy with security. Both solutions can be used in future to resolve the issues. The combination of blockchain and Smartgrid is best solution for future power system to address these issues. In figure 1, the blockchain based energy trading model is given. There are many issues in current Grid such as energy theft. Losses and freedom. First of all user has no freedom to sale extra generated electricity to grid with own choice rate. Second there is no record and transparency between user and energy providers. The system cannot control new energy resoucrs entering in the system and sufer from huge losses. The blockchain system can resolve all issues present in cuurent centralized grid.

For solar and wind energy system Energy storage system is essential part and in future the energy storage system must be improve to supply electricity all time . After the introduction of the lithium, batteries at commercial and domestic level, the researcher focusing on Nanotechnology to improve the storage system. The unpredictable nature of these systems required efficient energy storage system to provide continuous power such as Super capacitor and lithium batteries.

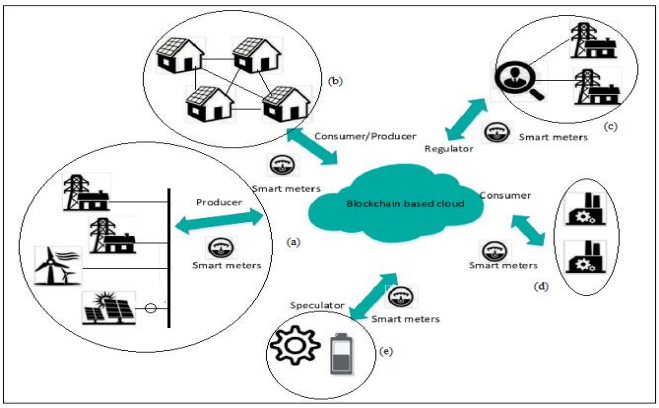

Fig: 3. Blockchain based energy trading system

LITERATURE REVIEW

The green or clean energy is essential parameter for environment and human health. In this paper the author discuss the issues related to the green energy standards and its implementation in the microgrid [1]. In this study the author analyze national policies of Pakistan for electric power generation, growth, and complying with multilateral agreements. Analysis was based on systems architecture to diagnose the system behavior such as falling into the vicious cycle of coal [2]. The blockchain and software define networking topic are main researcher focus in these days because of many applications in enrgy. In this paper the author present the features of Blockchain and software-defined networking leading technologies because it has many applications in several network-related scenarios and have consequently experienced a growing interest in the research community [3]. In the study the author present the features and challenges of Energy Internet and Smart Grid 2.0 The author maily focus on distributed power grid management, the blockchain and smart contracts methods to improve transparency in blockchain and performance including the degree of decentralization, scalability, and device reliability [4]. In this research paper author work on seamlessly engage prosumers to perform P2P trading and financial transactions among themselves need to carry out with high security. Further autor shows the buy/sell orders and price information will be available over a secured platform for the prosumers to incentivized and participate in the trading [5]. In this paper the blockchain-based P2P trading scheme with local energy storage was analyzed and find effective more effective as compared to other trading method. [6]. The sudy describe how prosumers in large

nework like one community in microgrid, which operate in multiple voltage levels can participate to transfer the energy [7]. According to a specialized point of view, the creators executed a secluded blockchain-based programming stage for expanding the elements of digital currency trades to the sustainable power Market, including a robot-counsel, which recommends prosumers the top rated schemes for energy trade. The outcomes of the investigation showed a ton of guarantee [8]. In study the author explains about the non-renewable sources are able to fulfill the energy demand for many but have significantly influenced the worldwide environment and nature in an adverse way. It has estimated that certain types of non-RE sources such as fossil fuel and coal will dried up by the start of twenty second century with respect to the current global energy consumption rate [9]. This study describe the concept of blockchain and its related software application in the business and energy sector [10]. Since 2017, the utilization of blockchain in RESs has become a significant topic for scholars all over the globe from past four years. In this paper the author introduce the concept of DESs and RESs is to develop a sustained global community, which is free from environmental and biological hazards, as well as addresses the energy issues found in previous CESs [11]. In this research paper the author discuss the features DESs system, which offer various features such as energy availability, secondary energy sources, and quality of service, which addresses the gaps previously found in CESs [12]. The study describe the Blockchain features in energy trading in Microgrid. The authors mainly focus the solar system for energy trading using blockchain [13]. In the study the author used the model of distributed generation to analyzing the energy storage system (ESS) capacity; size of the storage system by sung the PV solar system [14]. The storage system capacity and performance depend on the load and the battery construction parameters, materials. In this research article author, calculate the performance of solar power system with battery storage using two modules with standalone mode [15]. Microgrid is taking more attention in recent years due to the many benefits, such as reduction of voltage fluctuations, increasing reliability, power quality improvement, energy cost reduction, and ultimately increasing customer satisfaction. However, some issues are still need to address such as changing the protection setting, power system stability, and working in islanding mode [16]. In this study the author describe the benefits of the Blockchain technology using trading the energy [17]. In this paper the author presents the basic techniques of the energy converting devices and the potential of the system. The impact of the system not affects the marine life or any other issue. It is safe and clean energy and has many benefits [18]. In this paper the author, present the benefits of the blockchain for energy storage system. By using the blockchain, the energy can be trade more efficiently and more profit cab is generated [19]. It is documented in the study there are lot of benefits of the Blockchain technology using for trading the energy [20]. The study describe the benefits of the blockchain for energy storage system. By using the blockchain, the energy can be trade more efficiently and more profit cab is generated [21].

ENERGY TRADING IN MICROGRID AND BLOCKCHAIN

The Researcher are searching new energy alternative energy resources to fulfill the demand of the energy in future such non-conventional clean energy, renewable energy and green energy resources. In Microgrid the energy reached at different recourses and levels from renewable resources such as wind and solar power plants, or nonrenewable resources (conventional methods), but the main issues are changeability and uncontrollability of output power. Microgrid is often propose with Energy storage system (ESS) and it is one of the perfect solutions. In present the conventional grid, the storage system is limited such as pumped hydro-storage, which are mainly in mountainous areas but other storage system such as batteries, electric cars, flywheels, hydrogen, chemical storage implemented in small scale. The figure 4 present the complet model of microgrid using the blaock chain technology for energy trading.

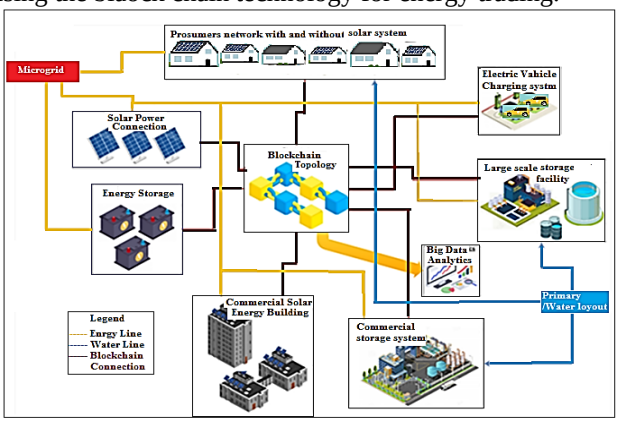

Fig: 4. Blockchain Technology trends

The microgrid model is given in figure 4 for energy trading using the blockchain. There are three methods for trading energy such as Infrastructure based, ad hoc and large energy storage based trading.

ISSUES *AND CHALLEGES*

The followings are many issues in the microgrid for trading energy in p2p network such as;

a. Energy trading system
b. Power Electronics and Energy Storage issues
c. Smart Sensors and Smart meters
d. Prevent from cyber-attacks

Smart sensors and smart meters are required for automated energy systems, to work in real time environment to measure the two-way remote terminal units, energy used, price of energy and total prices of each user. All devices require dual identification numbers, which makes make more difficult to integrate with new devices, appliances, sensors.

Power Electronic components produce harmonic distortion and voltage distortion issues in grid. For interfaces AC transmission and high voltage DC distribution smart high power sustainable components will be required to create smart electric power grids. The numbers of prosumers are increasing and it is difficult to predict or forecast the loads in future. The Smart meters include a modular, interoperable, reliable, scalable and efficient two-way communication backbone that requires long duration and high frequency. The transmission and storage of information should be protected to prevent cyber-attacks. In this research work, three major issues related to the Energy trading in P2P network in blockchain system will be address

PROPOSED METHOLOGY TO ADDRESS ABOVE ISSUES

i. In future Nanotechnology based sensors will be able to auto correction capability and automatically diagnose problems. They will be self-healing or produce alerts call to technicians whenever fault will be encountered. These sensors also used for real time monitoring of remote locations. By using these sensors in transmission lines the data and information can be obtained in real-time. It will help to manage the distribution feeder network operation by providing information about line losses, phase difference between voltage and current, power quality, distribution feeder and speed outage restoration.

ii. Energy Storage System; The required amount of electricity that should be transmitted through transmission lines can be reduced using storage system because it helps to share the peak energy demands. Nanotechnology will play vital role in energy generation system through the development of low cost devices required to store the electrical energy such as fuel cells, batteries and capacitors. The future energy storage devices may be optimized by Nano materials by using Nano scales catalyst particles.

iii. A carbon nanotube has good electrical conductivity and has high surface areas. The surface areas of carbon nanotubes are highly accessible to a battery's electrolyte due to their linear property. Carbon nanotubes based electrodes used this linear property in batteries to get more electricity output than conventional electrodes. It is possible because for a given amount of material, the energy output will be increased due to this linear property sand batteries will become more powerful, as well as size of the batteries will be smaller and weight will reduce for a wider range of applications.

The nanostructured materials will also increase the battery life about 10-20 times than present age lithium batteries and battery will provide good performance over a wide range of temperatures over currently used batteries. Approximately 70% or more power would be available at temperature range of −45° to +152 °F.

The advanced lithium-ion battery are performing good at high temperature, it also has a much longer lifetime no hazardous materials issues. By using these batteries EBP and uninterruptible power supply system's become consistent part of distributed mini-grids. Battery storage is main componenet to maintain Microgrid stability and extra energy return to the grid and stored in system and provide on demand using Blockchain technology. Moreover, provide uninterrupted power supply.

Table:1 the mojor Goals for fututre

1.	Make Solar Energy Economics	(Only a small fraction of output of the sun's power) strikes the earth, but even that provides 10,000 times as much as all the commercial energy That human's use on the planet.
2.	Provide energy from fusion	Lithium is the future element producing power from nuclear fission, the energy Source for sun and hydrogen bonds.
3.	Restore and improve Urban Infrastructure	Urban, The greatest challenge to mankind Includes water, power, sewerage, road and rail network including power and gas grids. The problem is particular to Megacities and peculiar to South Asia. Solutions must be designed to sustainability and promote energy efficient and environmental friendly buildings.
4.	Securing Cyber Space	New methods of security are to be worked out to control the flow of information. The challenges must be fought by new personal, social and political integration.

In table 1, the four major goals are given to focus.

COMPARISON OF ENERGY TRADING METHOD

There are three method of energy trading in blockchain such as Infrastructure based P2P, Ad-hoc P2P and Large scale storage based as given in figure 5. In Microgrid an efficient energy storage system required to provide uninterrupted power supply. There should be no delay between input and output system ideally. The lithium batteries show the best efficiency with minimum cast. It gives surety that energy will be available for the users all the time. In addition, it can reduce carbon footprint. In figure 5, three energy trading systems are given for energy trading in microgrid.

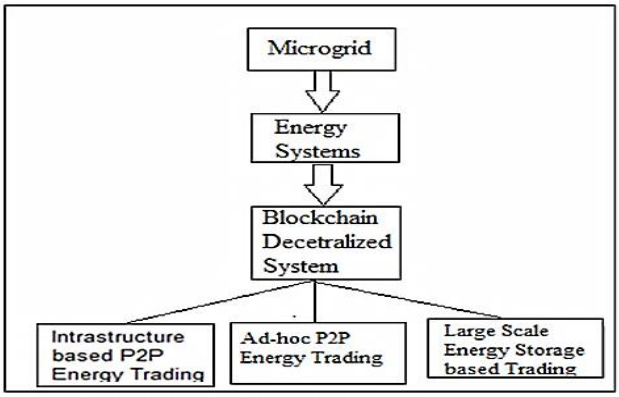

Fig:5. the energy trading system in microgrid

PROPOSED SOLUTION TO P2P ENERGY TRADING

Three types trading system in blockchain system are proposed. The infrastructure based P2P Energy trading depends on existing system and new system and components must be interface properly to avoid the losses and delays in the system as given in figure 6.

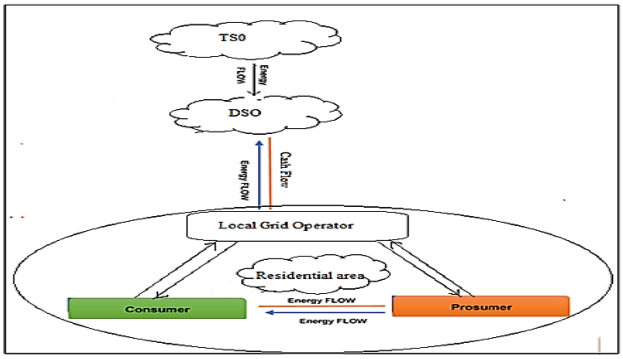

Fig:6. Structure based energy trading

The ad-hoc P2P trading depend on the other network and it is temporary setup and there are many security issues. The ad-hoc based trading is given in figure 7.

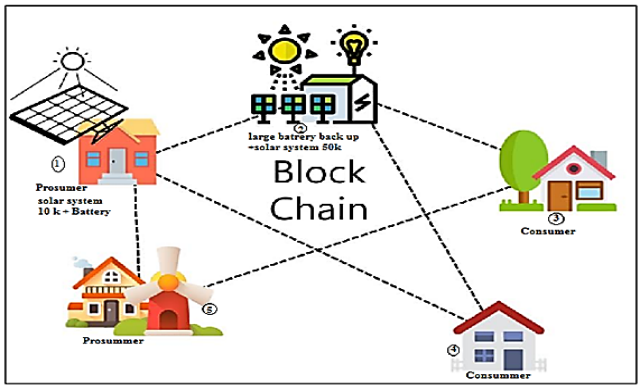

Fig:7. Ad-hoc based Trading [11]

The large energy based energy trading system is suitable for urban areas. The large energy storage based energy trading system is given in figure.8.

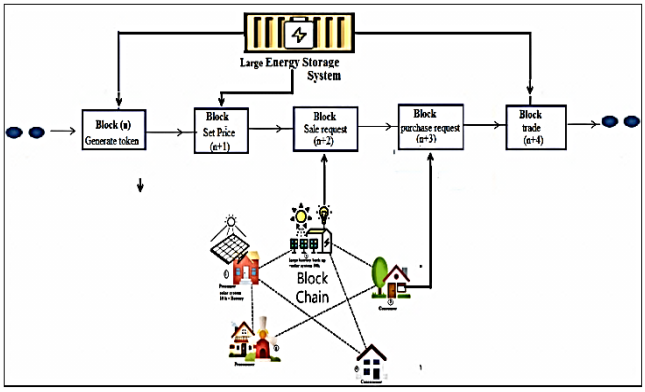

Fig: 8. large scale energy storage based trading

The first method is Peer-to-peer is an independent energy trading platform where individuals generate their own renewable energy and can sell the excesses energy at given price in the local network. The energy is token based and each block/hash on the blockchain keep the record of contract between the producer and the buyer of the energy traded.

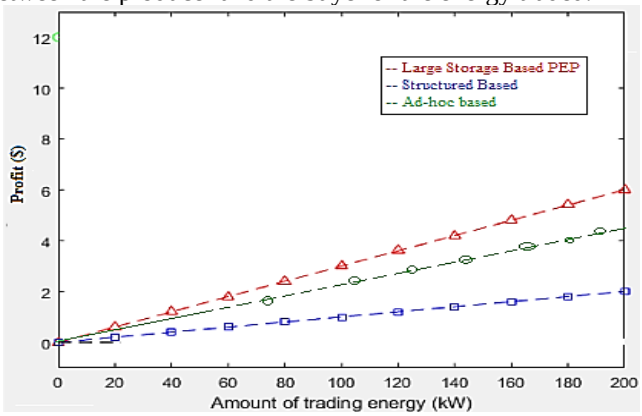

Fig: 9. comparison of Energy trading

The figure 9, present the comparison of the energy trading using three method. The result shows there is more profit with large stoarge system if the efficient energy storage system is installed in the network because more energy can be transmitted in large scale.

CONCLUSIONS

In this paper, comparison of three different energy trading method in p2p network was investigate, the large scale storage based energy system is more reliable and dependable for forecasting future energy requirement There are several of the benefits can be taken by the deployment of this method by using new components in the network. The result shows that by using large scale energy stoarge based trading more profitable as compared to aothers but all components infacing the systems should be efficiency and profit can be increased of new advance storage system. Energy storage capacity can be improve and charging discharging times can be reduce by using efferent, inverters, controller's functions by using Nano electronics in future by using the blockchain.

FUTURE WORK

The present research work was realted to large scale energy storage based system, if future infrastructure based and based system can be focus by using advance components in grid

ACKNOWLEDGEMENT

First it is my great pleasure to say thanks to advisor for his guidance and important time for advising and guiding me. Then I must say thanks to all my friends and colleagues for moral support and time and finally to my family for moral support.

CREDIT AUTHOR STATEMENT

ManzarAhmad*:**Methodology, Conceptualization, ***Agha Ali Yasir:, Software, data curation, Writing-Original, draft preparation. ***Muhummad Rehan***: Visualization,

Investigation. ***Afshaar Ahmed***: Software Supervision**:** ***Uzma Amin***: Software, Validation.: ***Mishaal Ahmed*****:** Writing-Reviewing and Editing

COMPLIANCE WITH ETHICAL STANDARDS

It is declare that all authors don't have any conflict of interest. Furthermore, informed consent was obtained from all individual participants included in the study.

REFRENCES

[1] A. Mishaal, M. S. Farooq, M. I. Haque, A. Manzar, H. Maqbool and A. yousaf," Application of Blockchain in Green Energy for Sustainable Future" ,IEEE Explorer: ISBN 2409-2983, 05 January 12, 2022.

[2] A. A. Durrani, I. A. Khan and M. Imran Ahmad, "Analysis of Electric Power Generation Growth in Pakistan: Falling into the Vicious Cycle of Coal", Engineering journal, vol 2(3), pp 296-311, 2021.

[3] A. Rahman, A. Montieri, D. Kundu, M. R. Karim, M. A. Islam, S. Umme, A. Nascita & A. Pescapé, "On the Integration of Blockchain and SDN: Overview, Applications, and Future Perspectives", Journal of Network and Systems Management . Springer Link, 06 September 2022.

[4] B. Zafar and S. Ben Slama, "Energy Internet Opportunities in Distributed Peer-to-Peer Energy Trading Reveal by Blockchain for Future Smart Grid", sensors journal, 1 November 2022.

[5] S. Noor, W. Yang, M. Guo, K. H. Dam, and X. Wang, "Energy demand side management within micro-grid networks enhanced by blockchain," Applied Energy, vol. 228, pp. 1385–1398, Oct. 2018.

[6] Hou, L. Guo, and Z. Ning, "Local electricity storage for blockchain based energy trading in industrial Internet of Things," IEEE Transactions on Industrial Informatics, vol. 15, no. 6, pp. 3610–3619, 06. 2019.

[7] S. J. Williamson, J. Kitson, A. Griffo, and W. Maccdo, "Universal droop controller for DC–DC converter interfaces onto a modular multi-tiered DC microgrid," The Journal of Engineering, vol. no. 17, pp. 3469–3473, 2019

[8] K. Mannaro, K, Pinna, A. and M. Marchesi, "Crypto-trading: Blockchain-oriented energy market", *International Annual Conference, ,* IEEE, pp. 1-5, 09. 2017 .

[9] Solar Energy Technologies Program Multi-Year Technical Plan 2003-2007 and beyond, DOE Office of Energy Efficiency and RE, 01. 2004.

[10] 6M. S. Farooq, M. Ahmed and M. Emram, "A Survey on Blockchain Acquainted Software Requirements Engineering: Model Opportunities, Challenges, and Future Directions", IEEE Access, 29.04. 2022.

[11] Hu, X.; Shi, F.; Xue, G, "Study on a plug and play control method for RE source", Power and Energy Engineering IEEE, pp. 2137–2142, 12 December 2016.

[12] Zhao, C.; Mallada, E.; Low, S.H, J. Bialek, "Distributed plug-and-play optimal generator and load control for power system frequency regulation", Electrical Power Energy System, vol 101, pp 1–12, 2018.

[13] M. Ahmed, A. M. khan, M. Ahmed, M. Javeed, L. Farhi, I. U. Haque, "Energy Trading and Control in Microgrid Network by using Blockchain Technology", VFAST Transaction on software Engineering, Vol 10, NO, 1, 2022.

[14] P. Cong, N. Truonga, M. Schimpea, U. B. bholger, C. Hessea and A. Jessenia, "Multi-Use of Stationary Battery Storage Systems with Blockchain Based Markets", Science Direct, Energy Procedia, Vol 155, pp 3-16, 2018.

[15] N. Z. Aitzhan and D. Svetinovic, "Security and Privacy in Decentralized Energy Trading through Multi-signatures, Blockchain and Anonymous Messaging Streams," IEEE Trans. Dependable Secure Computer, pp. 1-2, 2016.

[16] A. S. Yahaya, N. Javaid , S. Ullah, R. Khalid, M. U. Javed, R. U. Khan , Z. Wadud, and M. A. Khan, "A Secure and Efficient Energy Trading Model Using Blockchain for a 5G-Deployed Smart Community", Wireless Communications and Mobile Computing, 2022.

[17] M. K. Hasan, A. A. Khalifa, S. Islam, N. B. M. Babiker, A.H. Habib, A. H. M. Aman and M. A. Hossain, "Blockchain Technology on Smart Grid, Energy Trading, and Big Data Security Issues, Challenges, and recommendations", Metaheuristic Algorithms for Big Data Analytics within the Internet of Things, Special Issue, Vol 2022, 2022.

[18] L. Hongbiao, F. Xiao, L. Yin and F. Wu, "Application of Blockchain Technology in Energy Trading", Frontier Energy, 2021.

[19] N. Mhaisena, N. Fetaisa and A. Massoud, "Secure smart contract-enabled control of battery energy storage systems against cyber-attacks",

[20] S. Baily "Hidden Behavior of Supercapacitor Materials Revealed", Journal of AZO Materials, Nov 10 2021.

[21] L. Hang, and D. Hyeun Kim, "Design and Implementation of an Integrated IoT Blockchain Platform for sensing data integrity", sensors, pp 10-19, 2019.