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Blockchain -based approach for consumption of residual for smart cities

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Abstract

Increasing demand for electricity necessitates the use of efficient mechanisms for demand response management (DRM) in the existing smart grid (SG) system.In this paper, we propose a block chain basedenergy saver mechanism which reuses the electricity residual or waste in smart cities by usingsmart contracts. Block-chain is the technology that enables us to write smart contracts which is a self-executing computer codes that take specified actions under certain conditions. In this proposed model, Information related to amount of energyproduced to the amount of e-waste generated are all saved on the network. E-Waste Management (EWM) using smart contracts will bring more coordination among producers, importers, retailers and recyclers of electricity e-waste.The proposed model saves the electricity being transmitted from power grids to smart cities using block-chain and then convert this residual into source of energy that is being used by another consumer. It will enable the government to regulate e-waste collection and reusing it.

Keywords: Block-chain, E-waste, EWM, Smart Contract, smart grids

Introduction

The Second Industrial Revolution was a historical period that saw advances in different technologies such as electricity, petroleum, and steel. The discovery of electricity marked the beginning of the second industrial revolution. For nearly, 200 years the industry has been growing rapidly, along with the need of electricity. According to the survey done by The India Residential Energy Survey (IRES) 2020, in the few years the consumption of electricity reached to 1,208 kWh per capita. The demand for electricity increases rapidly along with the advancement of the industrial age. Since the twenty first century, global electricity consumption has seen even faster growth, as evidenced by an average annual increase of 3.4%, 1.2 percentage points higher than average annual growth of energy consumption. Fig. 1.1 shows the global electricity consumption during the year 1980–2013.

In India, generation of electricity is a de-licensed activity. There are limited sources to generate electricity. Customers bought their electricity from power plants, have their electricity delivered by the power grid and pay for what they consume. However, advancement in technology has changed the way people generate and distribute electricity. As the world's population is drastically growing, the corresponding additional energy demand should to be continuously supplied in order to sustain the economic development. Thusend usersmade it possible to generate electricity on its own through different resources in order to cope up the increasing demand and becoming a profit making option via energy trading.

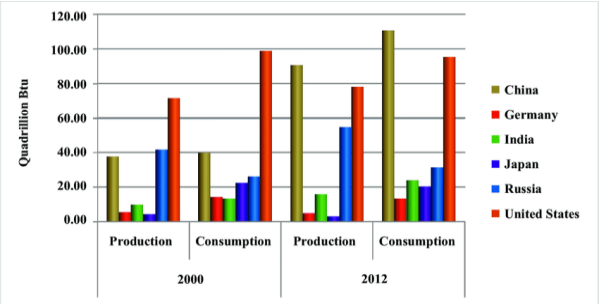


Fig. 1.1 Global Electricity Consumption and Production

Therefore, our major concern in this rapidly increasing electricity demand is to save the electricity being wasted or remain unused and transmitted this e –waste in some other areas as required. This concept is implemented with smart contracts in block chain where transactions are managed using smart grids.

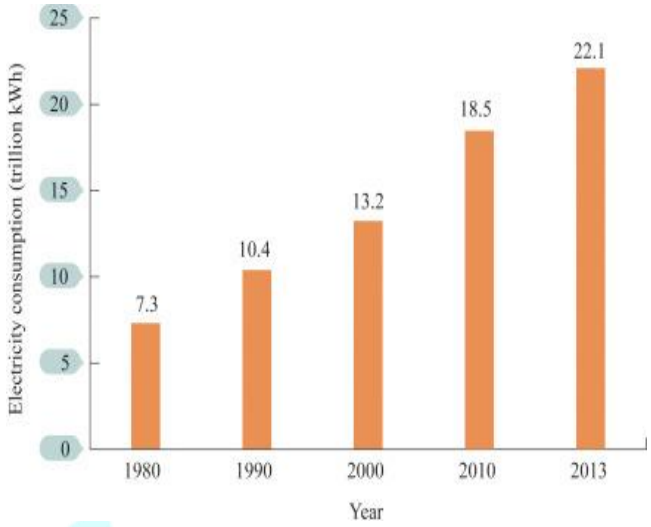


Fig. 1.2 Graph shows the electricity consumption in last decades

Blockchain

A blockchain is a decentralized, distributed, and oftentimes public, digital ledger consisting of records called blocks that is used to record transactions across many computers so that any involved block cannot be altered retroactively, without the alteration of all subsequent block. This allows the participants to verify and audit transactions independently and relatively inexpensively. A blockchain database is managed autonomously using a peer-to-peer network and a distributed time stamping server. They are authenticated by a mass collaboration powered by the collective self-interests. Such a design facilitates the robust workflow where the participants uncertainty regarding data security is marginal. The use of a blockchain removes the characteristic of an infinite reproducibility from a digital asset. It confirms that each unit of value was transferred only once, solving the long-standing problem of double spending. A blockchain has been described as a value-exchange protocol. A blockchain can maintain title rights because, when properly set up to

detail the exchange agreement, it provides a record that compels offer and acceptance.

A blockchain is a growing list of records, called blocks that are linked together using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data generally represented as a Merkle tree. The timestamp proves that the transaction data existed when the block was published in order to get into its hash. As blocks each contain information about the block previous to it, they form a chain, with each additional block reinforcing the ones before it. Therefore, blockchains are resistant to modification of their data because once recorded, the data in any given block cannot be altered retroactively without altering all subsequent blocks.

The first decentralized blockchain was conceptualized by a person (or group of people) known as Satoshi Nakamoto in 2008. Nakamoto improved the design in an important way using a Hashcash-like method to timestamp blocks without requiring them to be signed by a trusted party and introducing a difficulty parameter to stabilize the rate at which blocks are added to the chain.[4] The design was implemented the following year by Nakamoto as a core component of the cryptocurrency bitcoin, where it serves as the public ledger for all transactions on the network.[3]

To ensure efficient distribution of the electricity, maintain low losses and high level of quality, and the security of electricity supply, the smart grid concept was proposed. The concept enables a small, individual scale to generate electricity and sell it to the grid. However, the concept adds complexity to the existing system, such as how a transaction between these generators and consumers are conducted, verified and recorded. This paper proposes the blockchain as a tool to manage transactions in the smart grid. Transactions are performed with smart contracts, and the network acts as a transaction verifier. The blockchain provides immutability of the transactions, which ensure every transaction between generators and consumers will always be executed. It also provides immutability to transaction history, which can be used for audit or solving a transaction dispute.

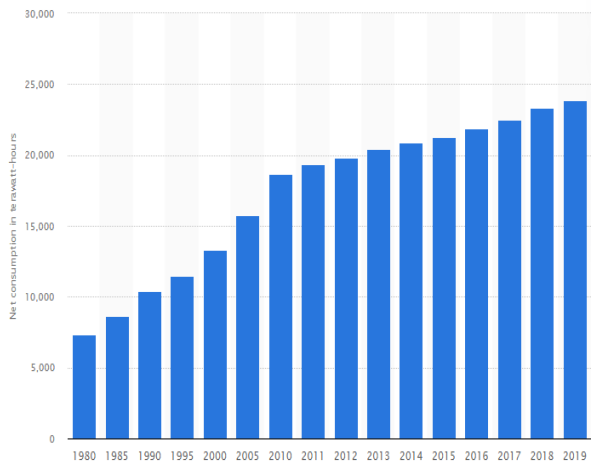


Fig.1.3 Net Consumption of E-Waste

Related Work

As in recent years, energy has become the main driving force in various applications such as smart device management and without it the technology becomes restricted or unusable. Different researchers have worked on the block - chain based E-waste management. Early research initiatives and startups indicate that blockchain technology could potentially provide solutions to some of the challenges faced by the energy industry [1]. A report by UK Government states that blockchains might have the capacity to

reform our supply chains, consumers and business to business services [2]. However current structure of energy and electricity markets is inadequate to achieving this vision, as small players participation in the markets is practically excluded and incentives for active consumer participation have so far proved not sufficient. [3]. According to Price Waterhouse Coopers (PwC), energy firms are increasingly reporting higher energy costs and lower revenues whereas on the other hand, at the same time utilities face demands for increasing transparency by the regulatory authorities [4]. Due to which this research focus on some aspects of any possibility of cost saving and efficiency improvement in the operation of energy systems.

Blockchain technology provides a powerful tool for implementing energy trading. In the year 2019, Nakamoto 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 [5]. That was the beginning of the blockchain-based research. Dong et al. 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 [6].

There are four key characters of blockchain: (I) decentralized distributed nodes and storage; (II) consensus, smart contract, and asymmetric encryption, which enable it to have huge potential in many domains, such as finance, computer software, and computer applications; (III) the information economy and postal economy, such as investment and securities; (IV) the shared health-care data framework, generation, and distribution in the citizen-level microgrid which may benefit from the widespread dissemination of blockchain transactions as described by Giungato et al [7]. Andoni et al. 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 the blockchain technology [8]. More specifically, Ali et al. 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 [9]. Fan et al. 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 [10].

Moreover, potential gains in transparency and competition could benefit other key policy targets related to energy affordability and fuel poverty [11].

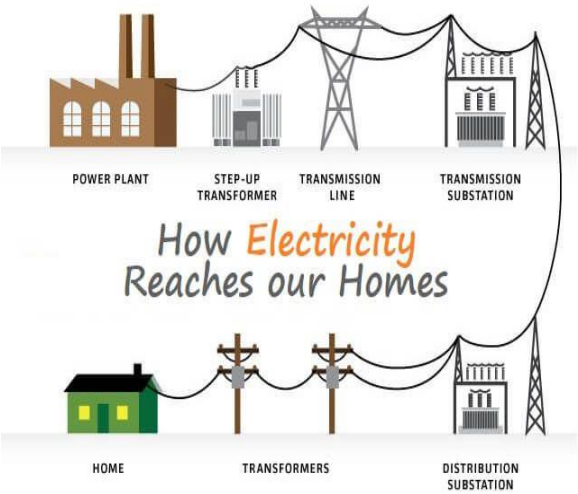


Fig. 1.4 Transmission of Electricity from Power Plant to Public

According to a UK government report by the Competition and Markets Authority [12], poorly designed tariff prices and lack of mobility in the market place have led electricity consumers to pay £1.4 billion on average a year in excessive prices for the period 2012–2015. We note that UK retail electricity prices have increased in recent years irrespectively of whole sale electricity prices [13], indicating that there is significant room for improvement. A commercial report by Deloitte [14] states that blockchain-enabled transactional digital platforms could offer operational cost reductions, increased efficiency, fast and automated processes, transparency and the possibility of reducing capital requirements for energy firms. Cost savings potential is not restricted to utilities and can be relevant to energy consumers and prosumers [15], who are facing increasing energy prices and removal of RES incentives, respectively. Solutions promised by blockchains, such as P2P trading in local or consumer-centric marketplaces could potentially lead to cost savings for energy consumers. [16]

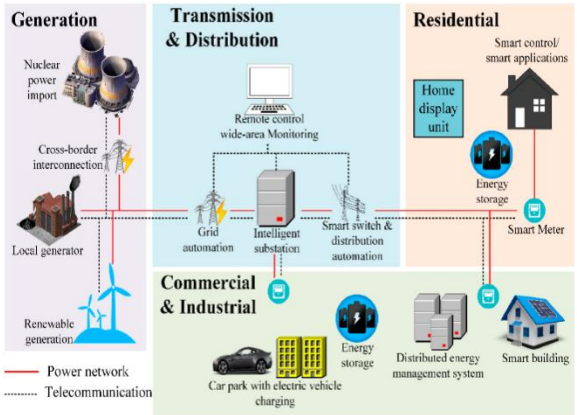


Fig. 1.5 Overall generation and transmission process

Blockchain technologies need to address several issues.Our primarily goal is to manage the e-waste which is being wasted while transmitting from smart grids to our destination. Thus, our primarily focus challenge is to frame a paradigm which collects the energy being wasted and distribute it further being maintaining the security and scalability and then sell to the merchants at reasonable digital money.

Methodology

A blockchain network or system can follow different rules and system architectures depending on desired operation. The blockchain concept originally proposed as a solution for the maintenance of energy trading. Electricity generated at the power plant reaches our homes through multiple substations, transmission and distribution lines, and transformers. The smart grid uses computer technology to improve the communication, automation, and connectivity of the various components of the power network. This allowsas an example for bulk transmission of power gathered from multiple generation plants. Smart grids are fitted with sensorsthat gather and transmit data.

This information makes it possible to automatically adjust electricity flows. Grid managers, who are located remotely, are informed of the situation in real time and can act immediately if there is a problem. The electricity that flows to our homes is generated in power stations. From here, it flows through large transmission lines, which carry it to substations. Finally, distribution lines carry electricity from substations to houses, businesses, and schools.

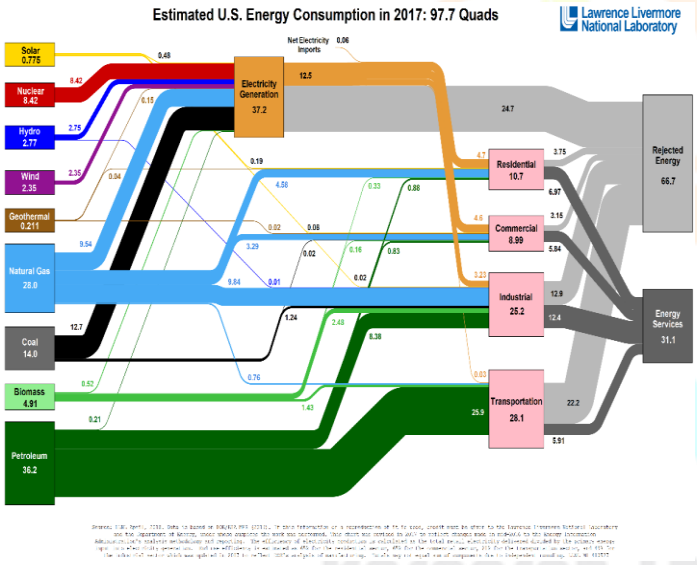
Since there is an extensive network used when electricity is being transmitted, this created power losses. The U.S. grid loses about 5 percent of all the electricity generated through transmission and

distribution—enough to power all seven Central American countries four times. Separately, grid congestion, like traffic congestion, leads to waste and costs consumers approximately $6 billion annually in higher energy bills.

Different power is lost at different stages:

- 1-2% of energy is lost during the step-up transformer from when the electricity is generated to when it is transmitted.
- 2-4% of energy is lost in the transmission lines
- 1-2% of energy is lost during the step-down of the transform from the transmission line to distribution.
- 4-6% of energy is lost during the distribution

So, the average loss of power between the power plant and consumers ranges between 8-15%.



- On the diagram, one thing that is immediately noticeable is that a whopping 68% of all energy is actually rejected energy, or energy that gets wasted through various inefficiencies.
- It's quite eye-opening to look at this data sorted by sector:

Sector	End-Use Efficiency	Rejected Energy (Quads)
Residential	65%	3.75
Commercial	65%	3.15
Industrial	49%	12.9
Transportation	21%	22.2

Table 1 Shows the consumed and rejected energy in different sectors

The transportation sector used 28.1 quads of energy in 2017, about 28.8% of the total consumption. However, it wasted 22.2 quads of that energy with its poor efficiency rate, which made for more rejected energy than the other three sectors combined.

Conclusion

The presented research work is an attempt to address the issue of P2P energy-market implementation with the help of blockchain technology. A thorough review of various published work has been done to analyze the current scenario prevailing in the energy market and how blockchain technology can be used in this direction. The energy being wasted or remain unused has been converted for further usage in different areas but as Blockchain technology is in its nascent stage of development and the expectation is very high, therefore this paper also outlines the limitations of blockchain technology in its present state.It is expected that the presented work will encourage readers to pursue research work in the application of blockchains in the energy sector.Blockchain technology has gained significant momentum in recent times because of the number of industries that are investing in it. In this direction,

some initiatives taken by different industries are reviewed.

References

1. Aparna Kumari et.al , "When Blockchain Meets Smart Grid: Secure Energy Trading in Demand Response Management, August 15,2020,IEEE Xplore
2. M. Andonia et.al , "Blockchain technology in the energy sector: A systematic review of challenges and opportunities,Renewable and Sustainable Energy Reviews", Renewable and Sustainable Energy Reviews, vol. 100, pp 143-174, Feb. 2019.
3. R. G. Pratt, P. Balducci, C. Gerkensmeyer, S. Katipamula, M. C. KintnerMeyer, T. F. Sanquist, K. P. Schneider, and T. Secrets, "The smart grid: an estimation of the energy and co2 benefits," 2010.
4. K. Parmenter and P. Hurtado, "The green grid energy savings and carbon emissions reductions enabled by a smart grid," 2008.
5. W. Tushar, W. Saad, H. V. Poor, and D. B. Smith, "Economics of electric vehicle charging: A game theoretic approach," IEEE Trans. on Smart Grid, vol. abs/1208.0631, 2012.
6. W. Tushar, J. A. Zhang, D. B. Smith, H. V. Poor, and S. Thi´ebaux, "Prioritizing consumers in smart grid: A game theoretic approach," IEEE Trans. Smart Grid, vol. 5, no. 3, pp. 1429–1438, 2014.
7. H. Liang, A. K. Tamang, W. Zhuang, and X. S. Shen, "Stochastic information management in smart grid," IEEE Communication Tutorials and Surveys, 2014.
8. K. Wang, F. Ciucu, C. Lin, and S. Low, "A stochastic power network calculus for integrating renewable energy sources into the power grid," IEEE Journal on Selected Areas in Communications, vol. 30, no. 6, pp. 1037–1048, July 2012.
9. P. Vytelingum, S. D. Ramchurn, T. D. Voice, A. Rogers, and N. R. Jennings, "Trading agents for the smart electricity grid," in Proceedings of the 9th International Conference on Autonomous Agents and Multiagent Systems: Volume 1, ser. AAMAS '10. Richland, SC: International Foundation for Autonomous Agents and Multiagent Systems, 2010, pp. 897–904.
10. D. Ilic, P. Da Silva, S. Karnouskos, and M. Griesemer, "An energy market for trading electricity in smart grid neighbourhoods," in IEEE International Conference on Digital Ecosystems Technologies, June 2012, pp. 1–6.
11. S. Chen, N. B. Shroff, and P. Sinha, "Energy trading in the smart grid: From end-user's perspective," in Asilomar Conference on Signals, Systems and Computers, Nov 2013, pp. 327–331.
12. D. T. Nguyen and L. B. Le, "Optimal energy management for cooperative microgrids with renewable energy resources," in IEEE International Conference on Smart Grid Communications, Oct 2013, pp. 678–683.
13. Y. Wang, W. Saad, Z. Han, H. Poor, and T. Basar, "A game-theoretic approach to energy trading in the smart grid," IEEE Transactions on Smart Grid, vol. 5, no. 3, pp. 1439–1450, May 2014.
14. Z. Wang and L. Wang, "Adaptive negotiation agent for facilitating bidirectional energy trading between smart building and utility grid," IEEE Trans. on Smart Grid, vol. 4, no. 2, pp. 702–710, June 2013.
15. J. Matamoros, D. Gregoratti, and M. Dohler, "Microgrids energy trading in islanding mode," in IEEE International Conference on Smart Grid Communications, Nov 2012, pp. 49–54.
16. [19] J. Castaneda, J. Enslin, D. Elizondo, N. Abed, and S. Teleke, "Application of statcom with energy storage for wind farm integration," in IEEE PES Transmission and Distribution Conference and Exposition, New Orleans, LA, USA, Apr. 2010, pp. 1–6.
17. B. Roberts and C. Sandberg, "The role of energy storage in development of smart grids," Proceedings of the IEEE, vol. 99, no. 6, pp. 1139–1144, June 2011.
18. A. Agung, "Blockchain for smart grid:, Journal of King Saud University - Computer and Information Sciences.vol. 34, Issue 3, March 2022, Pages 666-675