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A Survey on Blockchain Application for Smart Grid

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ABSTRACT: The idea of smart grid has been introduced as a replacement vision of the traditional installation to work out an economical method of desegregation green and renewable energy technologies. During this method, Internet-connected smart grid, also called energy internet, is additionally rising as an innovative approach to ensure the energy from anyplace at any time. The ultimate goal of those developments is to create a sustainable society. However, desegregation and coordinating an outsized range of growing connections are often difficult issues for the normal centralized grid system. On the other hand, blockchain has some glorious options which enable it to be a promising application for the smart grid paradigm. In this paper, we have a tendency to aim to produce a comprehensive survey on the application of blockchain in the smart grid. As such, we tend to determine the significant security challenges of sensible grid situations that can be addressed by blockchain. Then, we have a tendency to showcase a variety of blockchain-based recent analysis works given in several literatures addressing security problems within the space of the smart grid.

I.INTRODUCTION

Today, energy demand is ever growing, and therefore the want for electricity as anenergy supply is growing even quicker [23]. Due to societal and technical developments, it'll be inevitable that power generation from renewable energy sources can play a very important role to meet the energy demand. The main challenge is that the look of the new form of grid user called the prosumer, World Health Organization produces and consumes electrical energy in a very native space [25]. Smart grids propose a solution to the combination of those distributed energy sources to maintain the protection of the electricity grid. The focus of Smart grids is to facilitate native production and consumption by prosumers and shoppers [25]. By stimulating local energy production and consumption, the transmission losses are reduced. Prosumers and shoppers ought to be in a position to trade electricity with one another in a very peer to look fashion. To manage these transactions between shoppers and prosumers taking part among the Smart grid in a very centralized manner would doubtless be terribly pricey and would need advanced communication infrastructure [27]. As a result, it would be clear that a suburbanized methodology would be most well-liked [28].

Applications supported blockchain may provide solutions to problems of various levels of quality among the Smart grid. Blockchain is showing to be one of the foremost riotous innovations in recent years. Industrialists and researchers are looking forward to a positive future for blockchain technology and backing it with vital investments and analysis efforts. With its biggest success, the Bitcoin system, blockchain technology has drawn attention to its distinct options, including decentralization, transparency, and openness, provenance, peer-to-peer (P2P) transactions, smart contracts, incentive mechanisms, distributed ledger technology, timeliness, support of cryptocurrencies, and forbidding users from double-spending. These features mean that blockchain technology has vast potential to transform the operative methodologies of several industries and government organizations.
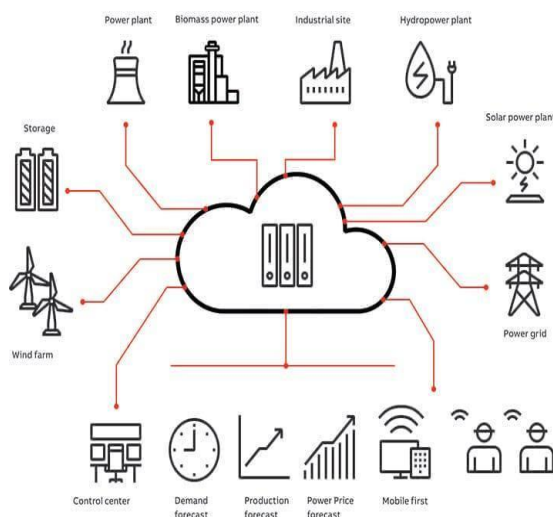
II.SMART GRID

A customary power grid framework conveys power from a couple of focal generators to a gathering of clients. Nonetheless, smart grid frameworks utilize two-route streams of power and data. In this way, a smart grid system builds an energy delivery network with advantages like security, reliability, resilience, efficiency, and sustainability.[2]

Smart grids are electric utility networks that depend on the bi-directional progression of data among purchasers, makers and specialist organizations to effectively convey power. The idea of smart grid has as of late acquired broad prominence because of progression of data correspondence innovation including shrewd metering, brilliant machines, and the multiplication of inexhaustible energy and energy effective assets in this manner taking into consideration more effective and solid transmission of power, better combination of client possessed force age frameworks and improved security.[2]-[4]

III.BENEFITS OF SMART GRIDS

The smart grids are very useful in the modern days, where it opens a lot of facility to day-to-day life.[7] Facilities are,

Metering: Smart grid metering involves employing advanced metering infrastructure and automated meter reading technology to bi-directionally transmit information between customers and the utility.[16] With these smart strategies, electric power utility administrators can precisely foresee the day-by-day request profile as a result of the exact power utilization information being assembled from their customers.

Energy trading: The deregulation of the electrical power grid has given rise to the decentralization of electricity markets around the world. As a result of this, consumers are able to buy electricity at favorable prices on spot and from future markets.

Virtual power plants: With the concept of VPPs in smart grids, power can be generated closer to the loads without the need to transmit power through transmission lines over long distances to minimize power losses. There are lots of benefits gained by smart grids.

IV.CHALLENGES OF TRADITIONAL SMART GRID

- Affordability issues caused by 1) Lack of metering 2) Inefficiency and irregularity in billing [18] 3) High connection costs 4) Availability of alternatives

- Dissatisfaction among customers due to 1) Uncertain power supply 2) Long duration of power cuts leading to inadequacy

- Low demand due to lack of appliances run by electricity

- Lack of proper documentation, such as proof of residency

V.BLOCKCHAIN TECHNOLOGY

Blockchain speaks to a cryptographically secure appropriated computerized record over a P2P organization of processing gadgets and frameworks.[8] Blockchain is likewise characterized as a dispersed information structure whereby all information things are forever recorded after they are checked by larger part of the hubs in P2P network. The key components of a blockchain system include:

- Linked linear data structures to incrementally append data items in existing valid blockchains,

- Cryptographic algorithms to generate hash keys to anonymously access the data items on the blockchain,

- Consensus algorithms to ensure the validity of changes in already stored data, and [21]

- Message passing protocols to enable P2P communication over the underlying network. Blockchain technologies use a variety of consensus algorithms.

VI.BLOCKCHAIN IN SMART GRID

Many researchers and industry leaders believe that the rise of the blockchain technology will theoretically adopt advanced development and smooth the shift towards the smart grid.[5]-[7] Decentralized advancements have consistently been a reason for some keen framework innovations in smart grid technologies. The integration of metering, energy trading and etc.., [14] into the electrical grid has begun a broad research area on new control schemes to address these issues [12]. The different and desirable advantages of blockchain technology created considerable interest in exploring and adopting this technology in smart grids.[8]-[9]

Blockchains applications in the brilliant framework could be separated through the various pieces of the keen lattice as follows:

- Power generation: Blockchain technology gives the dispatching agencies a full knowledge about the overall operation status of a power grid in a real-time perspective.[1] This enables them to develop dispatching plans that would maximize profits.

- Power Transmission and Distribution: Blockchain systems enable the automation and control centers to have decentralized systems that overcome the main challenges seen in the traditional centralized systems.

- Power Consumptions: Similar to the generation and transmission sides, blockchain could be beneficial in this side by managing the energy trading between the prosumers and the different energy storage systems as well as the electric vehicles.[10]

VII.ETHEREUM BLOCKCHAIN FOR SMART GRID

Ethereum is a one type of smart contract system which is software based and publicly available for everyone.[13]

The main goal of theEthereum is to develop the programming code for each and any decentralized system.

The application of smart contracts in smart grid technology is the most favorable one.

The main idea is to eliminate third parties in order to reduce cost. Also, via this application the opportunities of individuals to produce and sell energy to each other can be significantly increased.[15] The smart contract technology allows the peer-to-peer energy exchange directly between each other without including the transmission and distribution systems that are transacting on different scales.[19] The fundamental capacity of the smart contracts is to distinguish malevolent utilization of electrical power and electrical data and to report such activities into an information base.

VIII.CURRENT SMART GRIDTECHNOLOGIES OF BLOCKCHAIN

Control of microgrids is turning into a vital topic particularly with the mixing of the numerous distributed energy resources (DERs). The requirement for a demand-based management and optimized operation of the microgrid is that the focus for the researchers today [29]. Similarly, blockchain technology has been incorporated inside this space for its doable blessings and profits. In [30], a DERs programming mechanism is designed to support blockchain technology. The use of blockchain here provides a trustworthy platform so all DERs are trusty and secured. Though blockchains have gotten substantial interest as a platform for distributed computation and information supervising, Münsing et al. [32] examine their utilization to change the distributed optimization and management of DERs in microgrids wherever decentralized optimum power flow (OPF) model for programming a combination of DERs is projected. Demand facet management supported blockchain technology is investigated in [31]. The projected theme here will cut back the Peak-to-Average quantitative relation to profit the electrical grid furthermore as smoothing the dips within the load profile caused by constraints of the provision. A brand-new perspective is given in [33] wherever decentralization of medium-voltage direct-current (MVDC) link management is enforced via Blockchain. This management strategy provides the grid operators shared responsibilities inside the energy system.

● Electric vehicles affiliation to the smart grids has been a very hot topic within the previous couple of years as illustrated in [35]. The charging of the EVs is that the primary concern once it comes to the reference to the smart grid as uncoordinated charging of those vehicles will place severe stress on the power grid [36]. Thus, many approaches are projected to address this drawback as well as the blockchain technology

● With the rise of microgrid and distributed generation, energy trading becomes a really hot topic for numerous researchers and business leaders. Blockchain compete in a very important role during this space. A signal of origin certificate is issued to produce a guarantee of the commercialism method in the energy market. This adoption of blockchain within the trading process within the energy market helps in reducing the time and effort needed by removing the intermediaries from the market

IX.RESEARCH CHALLENGES

In this section, we tend to present the implications of research challenges to be self-addressed :

• Throughput in financial applications is outlined as dealing processing time that is typically measured as the number transactions will be processed per second. Throughput within the blockchain is said to dam interval time which remains a crucial difficult issue in its implementation in cryptocurrency and additionally, different applications. This low throughput in blockchain opens a range of challenges such as real-time transactions and micro-payment. Moreover, most prosperous and well-liked cryptocurrencies like bitcoin can't be used directly in good grid situations because of their low throughput. Notably, current public blockchains do not have enough high throughputs to engage with financial systems. Since in smart grid scenarios, the amount of data will most likely be high, and both financial & non-financial transactions will happen, addressing this throughput drawback would be a big step forward in order to build the decentralized network for the smart grid.

• The resource-constrained smart devices aren't ready to meet the substantial process consumption to participate in consensus. Hence, the design of edge computing-assisted mechanisms is one among the research challenges. One common limitation of all presently widespread consensus mechanisms is their single-purpose application like the usage

in cryptocurrency solely. Thus, investigating the ways that blockchain consensus can still participate in future research beyond cryptocurrency applications, significantly for different smart grid scenarios and, also, the way to adopt currently widespread mechanisms with the smart grid.

X.BLOCKCHAIN FOR FUTURE SMART GRID

Integrating and coordinating an outsized variety of growing connections may be a difficult issue for the normal centralized grid system. Consequently, the smart grid is undergoing a transformation to the decentralized topology from its centralized form. On the other hand, blockchain has some wonderful options which create it a promising application for smart grid paradigm.

The utilization of the blockchain in smart grids could offer various advantages to our current and future electrical power system. Most of the advantages to the electrical power system which are specifically linked to the characteristics and the working principles of the blockchain arise from the established decentralized trading infrastructure.[34] The major advantages linked to characteristics and the working principles of the blockchain with respect to the electrical power system are the decentralization of trust, increased security, increased resilience, increased transparency, increased scalability, less bureaucracy, and increased computational capacity. From these advantages, several new frameworks of blockchain in smart grids could be adopted as illustrated next:

- Blockchain may be simply integrated into the various components of the smart grid by making a cyber layer that's designed for the blockchain applications. It shows that each application within the sensible grid may have its own given blockchains like energy commerce and cyber physical security blockchains. Energy commerce blockchain shall be connected to the various energy traders within the grid such as ability plants, shoppers and prosumers.

- Through the adoption of an increased level of the blockchain, a decentralized computing platform is formed additionally to the mercantilism infrastructure. Once all the peers who participate inside the network devote a share of their procedure capability, the entire offered procedure capability is enhanced inside the wattage system.[6] This is a critical side once it involves the operation and management of the microgrids. totally different parts within the microgrids may have their own blockchains, like good metering individual, wind energy individual, and energy storage individual. These different chains shall offer the microgrids with a lot of flexible, reliable, and secure operation and management structure. Further, it will increase the trust between the homeowners of those microgrids and also the utilities additionally. Moreover, the Blockchain increases the measurability of the electrical power system; thus, if an additional client would be connected to the microgrid there would be a negligible increase in quality.

- Blockchain offers enlarged security for the electric power system. The applied cryptographic securitization combined with the agreement mechanism provides fixity of the data that has been incorporated within the Blockchain. Once an energy transaction/data has been enclosed within the blockchain, it would be powerful to change this dealing for illegitimate purposes or to delete the dealing leading to a really secure and sturdy system. The Blockchain conjointly provides enlarged resiliency for the electric power system. Since each peer in the network contains a duplicate of the ledger, there's associate degree absence of one purpose of failure compared to centralized information architectures that decrease the vulnerability for malicious attacks and so the electric power system is a lot more resilient. Besides, it will increase the resilience of the electrical power system as a result of the procedure capability being fragmented instead of focused in one big computer. These blockchains shall have the protection means of the smart grid by providing a reliable and secure information storing platform. what is more, because there's no direct link between the identity among the Blockchain setting and also the identity of the precise consumer/producer. Therefore, it'll decrease the vulnerability against malicious attacks that will increase the resilience of the electrical power system.

XI.CONCLUSION

In this paper, we provide a comprehensive survey on application of blockchain in smart grid, which will be useful for the government and also to a many number of industries, this platform is a sovereign blockchain-based framework which has the properties of guaranteeing straightforwardness, provenance and changelessness is actualized on a smart grid framework [20]. We enable this platform to be a solution to the ever-increasing electricity shortage problems and also to be a helping hand for the large-scale industries producing electricity.[22] With the fuse of smart meters, consumers can really know the measure of wattage being devoured and furthermore which apparatuses burn-through them the most. The usage of smart contracts in this model improves the straightforwardness, as due amounts are applied to defaulters in any exchange. This stage in the huge scope guarantees security.

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