Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

Application of Blockchain in Energy Sector

Vivek Patel
Symbiosis Centre for Management and Human Resource Development
M.B.A. (Infrastructure Development and Management)

Dr. Rahul Hiremath
Symbiosis Centre for Management and Human Resource Development
Adjunct Faculty
M.B.A. (Infrastructure Development and Management)

Deep Patel
Symbiosis Centre for Management and Human Resource Development
M.B.A. (Infrastructure Development and Management)

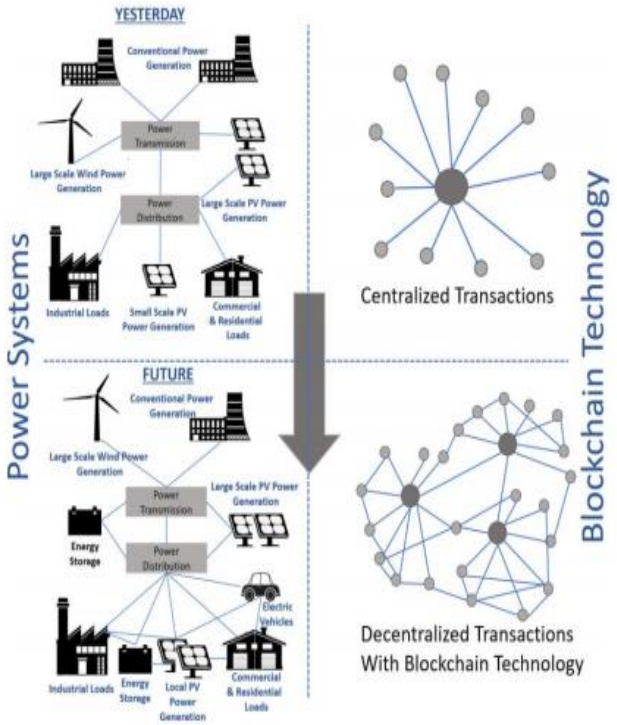
***Abstract*—The Indian economy and moreover the Indian energy sector is at the doorstep of revolution in the way energy is being transmitted. The process has begun to change the conventional system of transmission to more agile and smart system depended on advanced technology. Due to increase in the variety of sources of power, grid system in India has started experiencing stress. Above all this India will need a robust charging infrastructure for charging of EVs. Blockchain has the potential to solve the problem of India of creating a charging infrastructure in the short period of time and also can tackle the issue of lack of range of electricity for such EV. Blockchain even promises to present a practical solution of maintaining the transaction privacy of the users. With its distributed ledger technology, all the transaction done can be collected together and can be assigned a specific unique code thus maintaining the privacy. As renewable sector is growing at a significant 17.33% CAGR. The transmission & distribution losses and lower power purchase agreement (PPA) price for prosumer lead to further momentum in blockchain technology. Indian should grab the opportunity with both the hands and make the most of the best practices amalgamating with the innovation by Indian companies. India has the potential to become the driver of digitally driven future of distribution and transmission of renewable energy.**

Keywords—Energy Blockchain, Peer-to-Peer Trading, Renewable energy trading, Energy Infrastructure

I. INTRODUCTION

A disruptive technology has evolved in this digital era which is based on cryptography, known as Blockchain. This technology support real time transaction management. Interpreting from the name, Blockchain, create a block of data interlinked with the previous block in the chain. This can be seen as a Distributed Ledger that consists of number of digitally recorded data stored linearly. Transaction done through Blockchain cannot be manipulated because each block has a unique number and a hash function, which is linked to the previous block. This eliminate the need of a central administrator because this transaction is recorded on a distributed ledger and it is confirmed by the peers who are in the network. In India generally there is traditional energy market, in which the customers can buy power from the designated companies. There is a new energy trading system known as Peer-To-Peer (P2P), in this the individuals who generate their own energy trough renewable sources can sell the excess power to the one who need that

The energy is then stored in what is a called a digital electricity plant (VPP) which enables the manage and tracking of the assets. Before every day of buying and selling starts, the device makes use of an average of forecasting to expect approximately how much energy may be created inside the day. In a smart grid, the energy users play a position as each energy consumer and supplier. The excessive renewable energy generations may be traded with the utility and different users in the deficit of electricity resources for mutual advantages.



II. LITERATURE REVIEW

There is growth in renewable energy sources now due to which energy trading is shifting to distributed manner from centralised manner. The additional generated renewable energy can be traded through application to the other users having power deficit for the mutual benefits. People has widely adopted a digital distributed public ledger technology, Blockchain. Government has also shown their vision for smart grids, new models, technologies which has the potential to develop solution to manage energy efficiently, and allow an optimal flow of power. Generally, in a traditional grid, individuals can only buy power, whereas in smart grid technology individual plays a role of both Power supplier and consumer.

Challenges of Blockchain enabled Energy Trading:

(I) Compare to the transaction cost, efficiency is low and due to other technical shortcoming of the technology it is impossible to meet the system requirements.

(iii) Blockchain Technology is difficult to understand so people, at least in the beginning, may refrain from adopting it.

(iv) The methodology of pricing a deal is not fixed.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

(v) There is no incentive mechanism to boost the use of blockchain based energy transfer. The issue that is still unresolved is how to maintain the privacy of the data

(vi) There are many variables which affect the system as a whole, in such multiple variables ensuring the minimum cost is difficult

(vii) Unclear and rigid guidelines or framework

(viii) Currently, there is also the issue of high-power consumption in blockchain technology

(ix) Lack of interoperability

(x) Additional cost of infrastructure of blockchain network [1].

III. METHODOLOGY

A blockchain model was developed based on the energy exchange model which is currently established at Brooklyn, USA. After thorough review of literature in the fields of blockchain and energy transmission, nuances like infrastructure, process, phone applications model was constructed to enhance the efficiency and convenience. After that, feasibility study of decentralized blockchain system is carried out. There are many companies such as Power ledger, Ener chain, Me SOL share etc. which are currently involved in this development of energy blockchain. This report is based on meticulous study of various applications based blockchain models, implemented by different companies across globe. Currently there are some gaps which limits the utilities of blockchain technology which are analyzed under certain parameters with the help of different research reports and expert's articles, base on which some remedial solutions are being provided to mitigate them.

IV. ANALYSIS

A. *Applications of Blockchain*

1) Wholesale electricity distribution:

Companies seeking to implement blockchain technology into wholesale power distribution awareness on connecting end-users with the grid. Blockchain is a technology which combines IOT devices allowing consumers to buy and sell energy without delay from the grid in preference to from retailers.

Grid+ is a blockchain energy company focusing on wholesale power distribution. The firm has diagnosed retailers because the driving source of inefficiency within the client energy market. Retailers very own little or no of the grid infrastructure. Supplementing stores with a blockchain-based totally platform has the capacity to reduce customer bills with the aid of round 40%.

2) Peer-to-peer energy trading:

A report published by wood says that more than 50% of power project based on blockchain is into P2P trading. In this system individual having excess power can trade to another individual who need power. This does not involve any other agency

Many firms are using Ethereum of enterprise versions. For example, the energy web foundation basis utilizes Ethereum, Truffle developer tools, and gnosis multi-signature wallets to construct out their platform.

Peoples that produce their own power may have the ability to alternate it with their neighbors and friends. The Australian-based totally company, power ledger, has connected groups to one another to create "micro grids." Micro grids are a group of interconnected hundreds and disbursed energy resources. And in areas of the growing world wherein energy grids can be unreliable or nonexistent, possibilities exist for genuine peer-to-peer grids to emerge from the electricity vacuum – the start-up MeSOL proportion is connecting homes in Bangladesh so they can alternate excess power from rooftop solar panels.

Nevertheless, even if blockchain does no longer replace the grid, it can permit more participants to trade energy. For example, Vattenfall, the largest Nordic utility, is walking trials in which, it makes use of a private blockchain network to document energy transactions in which department shops or maybe person houses can sell power generated by means of disbursed batteries or sun panels; formerly, such transactions might had been prohibitively high priced and time-consuming to process.

3) Electricity data management:

Blockchain can provide customers greater performance and control over their energy assets. Moreover, an immutable ledger gives secured and actual-time updates of energy utilization facts. Numerous types of energy records include market place prices, marginal prices, electricity regulation compliance, and fuel prices. Records is frequently intentionally controlled or all at once distorted and excluded.

The financial prices of purposeful defilement and incidental administrative mistakes can be impeding to businesses and governments. The straightforwardness of open blockchains similarly lessens the percentages for money related or records misuse.

4) Commodity trading:

The gas and energy are exchanging industry is another domain of potential disturbance using blockchain innovation. Organizations have put millions in building exclusive exchanging stages customized to the one of a kind in energy industry. Noteworthy expenses are required to look after, update, and secure these frameworks. Applying blockchain innovation to product exchanging would be less expensive and more proficient than existing restrictive frameworks. Permanence, security, and instantaneousness would all be able to be modified in the blockchain evacuating the moderate versatility of huge scale restrictive frameworks.

International companies dealing into energy Blockchain are:

GRID+, ONDIFLO, Radiant Earth [2].

B. *Analyzing the Components of a Blockchain-powered P2P Lending Platform*

1) Peer-to-Peer Lending:

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

This is a financial system in which the borrowers directly contact the lenders and borrow money in an unsecured manner. The limitation of this system is that it is dependent on third party which cause to increase the transaction time and cost.

2) Decentralized P2P Lending:

In decentralized P2P crediting, either outsider isn't required, or that the operational costs of outcast organizations are low. Additionally, the decentralization point of view encourages crediting frameworks and executes them inside minutes. It enables a P2P advancing structure to fill in as a united stage for individuals and associations to get and advance credits successfully without including any center individual at competitive rates.

It not only does faster check credits and KYC/AML (Know Your Customer and Anti Money Laundering) protocols but also it provides anywhere, anytime accessibility. And, this new decentralized system can be accessed anywhere on any device having an active internet connection.

3) Creating a public blockchain-based P2P lending platform:

Generally P2P lending platform is not a type of any financial construction and in most case all the banking regulation does not affect this system. In this system loans are not secured and there is a risk on lender side in case the borrower default in repayment of the money.

4) Market Risks:

The major drawback of this system is that lender get profit if borrower repay the loans whereas borrower get money promptly

An Overview of a Public P2P Lending Platform

A prototype model was made for this platform. This prototype model does not use centralized blockchain technology instead it uses Ethereum, third-party integrations, and technology like smart contract to boost the entire process. On these platforms provisions were made to repay loans through ERC20 currencies.

5) A typical loan application process:

It takes about 3-4 minutes to procedure a loan application on the decentralized P2P platform (internet site). At some stage in the procedure, it creates a blockchain based totally loan smart statement, containing a completely unique identifier for the one who has requested amount. It requires borrower to add their PII (personally identifiable records) to make sure adherence to neighborhood guidelines and KYC protocols. The resulting rating takes into consideration social media profiles, expert groups, and verifiable statistics on web sites to improve the KYC manner. After a successful verification and scoring of the information, the platform lists or publishes the loan request for lenders. In a reverse auction device, involved lenders offer the loan to ability debtors at low competitive interest charges. Similarly, the supply for lenders to offer syndicated loans reduces the risk of decentralized P2P lending.

6) Smart contracts-powered automated lending processes:

After agreeing to one of the offers when borrower download the funds it initiates smart contract which is based on blockchain technology. This technology automatically notified payment reminder, collect funds and remit it to assigned account. In case of default platform automatically applies penalties on borrower. It keeps on notifying the borrower when the payment due date arrives. Late payments cause to higher interest rate and gets applied to the successive payments.

7) Reducing the last market risk of lending:

The platform makes use of Smart Compensation Fund Contract plan to lessen the remaining predominant risk of P2P lending, which include default borrower. After every loan application process, it assigns a small price to the Smart Compensation Fund. The amount gets accumulated fractionally because the volume of loan programs increases. It makes the Smart Compensation Fund serve as a guarantor for lenders, reducing or maybe putting off the final major threat inside the system. This price arrangement is implemented to cover operational and increase costs and remodel tokens into a high-value digital currency.

There are many companies which work in the domain of blockchain technology. One of those is oodles, a company which provides services such as P2P trading, syndicate loans, mutual funds etc. Their application allows users to analyze business situations and take decisions accordingly [3].

8) Applying blockchain technology to electric power systems:

Nowadays our electric power systems are getting more and more complex. Blockchain can be effectively used to cope up with this complexity. In 2017, many startups together raised some 300 million USD to use that money in development of blockchain technology in energy sector. Blockchain can also be used to track the production of clean energy. There are development going around the use of blockchain technology for the payment of charging EVs etc.

Energy utilities cannot adapt the change quickly due to coverage problems and need of stable returns, so prosumers must set up their smart system to assist grid fit demand with risky renewable electricity supply. And utilities, customers, and third-party companies ought to collaborate to harness the substantial streams of real-time operational information to make sure the power system functions seamlessly.

Blockchain is second most attractive venture for investors. Companies like Tokyo Electric Power Company in Japan, E.ON from Germany are initiating their own ventures or partnering with emerging startup. There are companies who own power plant and trade their electricity in wholesale market. In their opinion blockchain is a way to improve the efficiency of markets. The big corporate house around the world are partnering with star-up or launching their own initiative, they believe blockchain as a way to improve the functioning of not only market but also in transmission and distribution sector.

In another category companies tie up with the nonprofit organizations. For e.g., worlds major oil companies like Shell and Statoil tie up with nonprofit institute Rocky Mountain to support Energy Web Foundation. Major goal is to develop blockchain platform and built energy application on it.

As India's power sector is regulated with many rules and guidelines, it will important to watch the involvement of regulatory agencies in the commercial usage of blockchain based P2P power transfer.

9) Grid transactions:

More than a few different energy trading applications which can be much less radical than a truly decentralized peer-to-peer network are much more likely to gain business traction – and help from incumbent utilities and regulatory government. These "grid transactions" relate to energy buying and selling inside the context of an electric powered energy gadget wherein the energy grid remains quintessential, even supposing its shape and feature modifications extensively.

Enel is spearheading the Enerchain undertaking to use blockchain to enhance existing wholesale electricity markets.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

In such markets, proprietors of large energy plants sell bulk quantities of power to utilities and retailers that then promote the energy to quit users. Presently, those markets require a centralised entity going for walks proprietary software program to mediate each energy transaction, that is each time-eating and luxurious. If these markets indexed and cleared transactions on a blockchain network, but transactions can be tested speedy and cheaply. Similarly, the transaction statistics could be transparent for all market individuals to get entry to, permitting extra efficient buying and selling. Eventually, those wholesale markets may want to develop their pool of participants because a blockchain community can cope with a multitude of smaller transactions that could overwhelm a centralised system.

As a result, corporations and even families could participate, selling their excess disbursed technology into the marketplace and responding to charges that replicate the grid's needs at every moment. However, on the extra nearby scales served by means of the distribution grid, no such market exists that takes into account immediate differences in consumer demand amongst neighborhoods or constraints on neighborhood distribution capability. Thus far, utilities have invested in highly-priced infrastructure enhancements, consisting of new electric substations, when the prevailing distribution grid cannot meet changing neighborhood desires. However, because the prices of allotted energy resources – from solar panels to batteries to gasoline cells – fall, it'd be extra practical to harness such assets, whether or not located on a consumer's premises or at the distribution grid managed with the aid of an application. New so-called distribution markets may want to make this possible. Numerous jurisdictions, from south Australia to the big apple, are experimenting with these markets. In such markets, customers could buy or promote power at time-varying prices primarily based on their place. Customers might rent smart software program retailers to act on their behalf and optimize their power manufacturing and intake primarily based on marketplace signals. And in the event that they signed up with 3rd party aggregators, clients ought to pool their sources – providing to the grid the services of a so-known as virtual energy plant – that would assist the general device hold supply and call for in stability in spite of an inflow of intermittent renewable energy at the grid.

Furthermore, smart contracts encoded into the blockchain ledger ought to mechanically trigger transactions while sure situations are met – for instance, clients might offer to price their batteries with excess energy from the grid whilst the immediately repayment offered for presenting charging services exceeds their pre-programmed threshold – facilitating green trading. Nonetheless, many other advances can be wished on pinnacle of a blockchain infrastructure to recognize distribution markets. Putting granular charges in such a market and frequently updating them will require a utility (or a few other entities tasked with coping with any such market) to install an array of sensors on the distribution grid, deduce the constraints faced at each area within the community, and perform in depth computations to determine actual-time charges for the marketplace.

Certainly, Australia's experimental decentralized power alternate undertaking is centered on fixing those pressing technical demanding situations first. The undertaking's sponsors continue to be noncommittal on whether or not the platform will ultimately document transactions on a blockchain.

10) Energy financing:

Due to blockchain the base of number of investors increases and that make easy to raise funding for renewable energy projects. If a small part of total cost can be source through this system than it can be attractive even for the traditional investors. With further advancement in the technology the cost of wind and solar projects has reduced drastically and thus this is becoming more attractive for every kind of investors.

11) Sustainability attribution:

One of the most on the spot applications of blockchain to electric electricity is its use to file and alternate attributes of sustainability. Examples of such attributes consist of whether or not a unit of energy is renewable and how much emissions resulted from its manufacturing. Currently, structures to track such attributes are centrally controlled, complex, and at risk of fraud or mistakes. Moreover, the compartmentalization of systems prevents seamless buying and selling of attributes throughout regions.

A decentralized blockchain community ought to allow accurate, transparent and frictionless monitoring and trading of those attributes, which could boost up clean power deployment and carbon emissions reduction. As an instance, the energy web basis's starting place software makes use of a blockchain to track power generation all the way down to the kilowatt-hour and to report attributes such as the carbon emissions associated with energy manufacturing. This would enable calculation of carbon offset credit to be more accurate, which give a mechanism to alternate credits for carbon emissions reduced to balance out emissions created someplace else, for proprietors and clients of low-carbon energy. Recognizing this capacity, numerous utilities and companies, together with Microsoft, Singapore energy and Engie, are taking part in pilot tasks that use starting place. Through this, governments may emerge as better equipped to adjust carbon emissions as contemporary jurisdictions and policies have struggled to track and file emissions.

Government may use allotted ledgers in future for filing and trading of carbon emitted while producing, transporting, and the usage of power. A business vertical of IBM called as Russian carbon fund which are into building blockchain network to record carbon footprints.

12) Electric vehicles:

The line among the electrical power and transportation sectors is blurring because of the growing reputation of EVs. Such vehicles, but nevertheless face obstacles to client adoption – specially, a lack of public charging infrastructure can demotivate potential buyers. Blockchain networks that allow private proprietors of charging infrastructure to seamlessly sell charging offerings to EV owners should enhance the appeal and uptake of EVs.

For example, German utility startup Motionwerk tie up with the Californian start-up on a pilot project in California to create a platform for charging of EV's and this would encourage charger owners to rent it to EV users.

In the current scenario, companies are finding it difficult to reduce the cost of building and maintain charging stations. Blockchain based technology has the potential to reduce the transaction cost by charging electric vehicles through the power which is un-utilized in residential or commercial centers. If this become a reality that the biggest road block in the adaption of the EV can be thrown away. Also, blockchain network can allow more exotic charging transactions. For examples inductive chargers can be installed below the road, that can charge the vehicle wireless, on traffic signal. Smart contract can

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

also be used allow EV to get charge or get discharge based on the demand, which will convert vehicles into moving batteries.

13) Other applications:

A startup named Finnish is working on helping electricity customers manage a range of appliances which are connected by internet. This startup aims to record the power usage of appliances and notified customers accordingly, this save the money of customers. For example, with the goal of changing energy providers rapidly (currently it takes three weeks) in the United Kingdom, the electricity regulator Office of Gas and Electricity Markets (Ofgem) wants to register members' power meters as digital entities on a blockchain network

A few steps have been taken in the domain of blockchain technology to improve cybersecurity of electric power systems. As an instance, siemens and U.S. government entities tie up which include the Departments of Energy and Defense is carrying out a pilot project of using the cryptographic algorithms that cause blockchain to secure essential energy sector infrastructure and prevent unauthorized breaches. The European Union general data privacy regulation, 2018 calls for in a few instances to erase the private facts looking for that privacy is individual proper and shouldn't be share on such platform. A set of standards ensuring that unique blockchain structures are interoperable may want to increase the pace of commercialization of blockchain technology.

At present some countries are creating a whole new pilot system known as sandbox, where innovators can implement their idea without affecting the existing electric system, thereby making possible to raise funds and implement on larger scale and promoting startups [4].

C. Need for energy blockchain in India

1) Overview of Energy Sector in India:

According to world energy consumption index India ranks 6th. The main reason behind this is growing the demand of power due to more urbanization. It is believed that in the last 30 years the demand has increase 3.6% every year. According to the data published on the website of power ministry, as of Dec 2012, the installed capacity of power generation is 210951.72 MW. By 2030 it is expected that the total demand in India will be more than 950,000 MW. Though on the other side of the picture, 2/3rd of the rural area is still lacking electricity. Major source of power generation in India is thermal (coal, gas, oil) – 67%, hydro – 13.5%, nuclear – 2.1% and Renewable Energy Sources (RES)- 17.4%.

2) Thrust on Solar Power Generation:

The carbon emission in India is going above the level of ceiling standard set. At global level India is 3rd largest emitter of greenhouse gases. According to a report, if India keep on continuing its modern-day technique for production of power than it can be devastating for the atmosphere in India.

Considering the situation of India, PM Modi has decided that by 2022 the install capacity of renewable energy in India should be 175 GW, out of which more than 100 GW will be solar energy. Government of India with the help of state governments are giving subsidy up to 70% for installing solar panels. Government is also giving push to solar power parks in the country. The solar generation capacity has been increased by four times from 2014 to 2017. As of 2017 it stands at 12.50GW. Also, the average current price has been reduced by more than 15% making it cheaper than thermal power.

3) Current Solar Power Distribution Landscape in India and Challenges:

Nowadays, solar power needs to be directed to central grids for distribution. There may be no off-grid mechanism to store on transmission cost and wastage occurs. This additionally effects in more infrastructure set-ups and admin expenses. Solar farms rely upon the capability to resell energy to the public grid to preserve profitability – a gain that's not possible in off-grid settings. This also limits energy distribution to rural regions that are not connected to power grid.

4) Blockchain can enable an off grid decentralized sustainable solar power distribution Framework:

In a country like India, where humans in rural abodes are nonetheless disadvantaged of energy, sun power holds a variety of promise. Sun energy is abundantly available and offers every family a possibility to generate power of its own. This paves course for development of a self-sustained energy technology capacity that has much less reliance on a centralized framework [5].

A blockchain-enabled decentralized P2P micro energy grid structure can deliver together small companies of a community together, to buy/sell solar energy for a price without directing power to a significant grid. Photovoltaics systems set up on rooftops of diverse households in location can be interconnected through the conventional energy micro grid. The transactions may be managed and saved using a primary blockchain linked to the grid.

Captive solar plant owners in a village can form a consortium and get a benefit by setting up blockchain-based solar micro-grid.

I) Solar plant owners after forming a consortium can develop crypto currency for energy trading.

ii) Get funding in the form of equity and distributing stake, use that fund to setup infrastructure across the rural India

iii) Price can be set just like gold price mechanism, based on real time demand supply, price can be adjusted

iv) Digital token can be given on behalf of dividends to investors only if they meet certain criteria [5].

v) Business issues in energy supply:

Currently there is a highly competitive environment in the energy business where private and public entities facing issues to generate the estimated revenue and therefore there very likely that companies try to increase the tariff rate and ultimately payable to the consumers to reduce their losses or increase or the profits. Currently TATA power has filed petition to increase the tariff rates. By using blockchain there would be no chances of these such business issues

6) Rising customer expectation on efficient energy provision:

India is developing nation and currently customer are expecting more on the needs and even willing to pay for it but in return they need the efficient energy provision as its must in any sector such as manufacturing, construction, automobile etc. The business of many sectors is dependent on the electricity/energy supply.

7) Reaching to the remote areas where not possible to supply through conventional method:

Though government has launched schemes like Saubhagya or Pradhan mantri sahaj bijlee yojana, still it is not possible to reach the many villages, remote areas to provide electricity through grid. By using blockchain the vicinity can develop their personal grid and share the energy.

8) No gain for the consumer consuming less units:

Currently if the consumer is getting the gain to do the captive solar plant on roof if he is able to consume the power

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

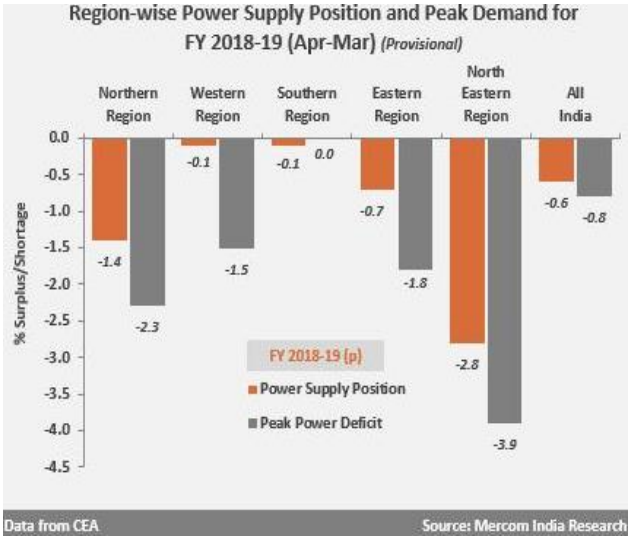
generated otherwise to sell the power to grid at the 3rs/unit doesn't makes sense. If blockchain is enabled, one can consider the selling of power generated and further reduce the payback period of the solar plant.

9) Current Transmission & Distribution losses:

Government launched the scheme UDAY to reduce the DISCOMs losses through transmission and distribution but that also didn't work as per the expectations. Current T & D losses are 20% which is double then the average of world.

10) Technological Issues:

Current technology of grid is not capable to handle power generated from renewable source.



D. Objectives of Blockchain based Solar Energy Sources

1) Promote Renewable sources of Energy: Currently, there are many villages in India where transmission of energy is not possible. Establishing captive blockchain based micro grid in these areas would reduce dependency on conventional sources of energy with simultaneously meeting their energy needs.

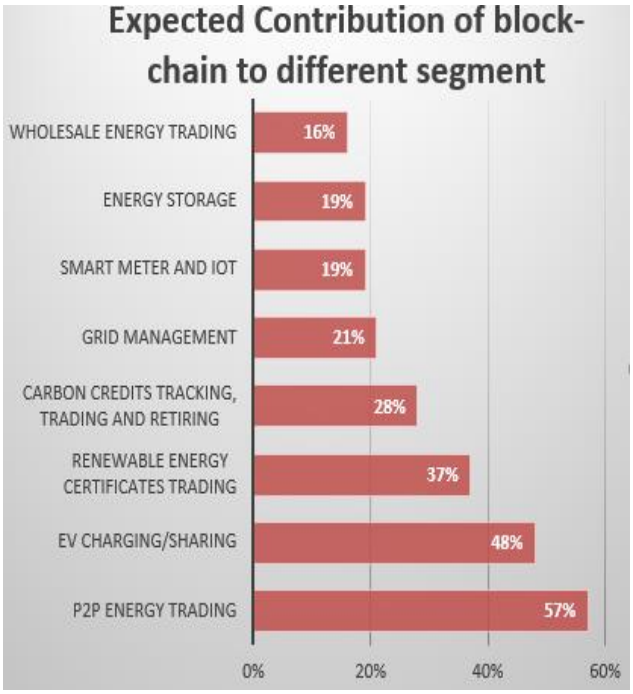
2. Disintermediation: This would eliminate all third parties, govt. departments, DISCOMs etc. There is no need of agency for track record of meter readings, bill calculations, dispatching bills to customers. For example, the prosumer and consumer can develop a customized contract binding both of them without any intermediary. The consumer would be able to check the real time consumption of energy and the charges applied on it.

3. Low Cost: Elimination of intermediaries and fairer pricing of energy due to higher market transparency resulted into lower cost of transactions.

4. Expanding the boundaries of Energy market: Prosumers should be free up from the central authority and be able to sell energy the way they want. One should be able to switch the supplier and flexible tariff which would create a competitive market and benefit to the users.

5. Permanent record of exercises: There are no additional endeavors expected to catch the exchanges between different elements. Every movement of hubs on blockchain is recorded sequentially on a permanent basis for the future reference.

6. Free from Error: All transactions and its receipts being digitalized would reach towards zero error segment. As, blockchain reduces the chance of mistakes, this would save the time and cost of the organisation.



V. FINDINGS AND RECOMMENDATIONS

1) Distributed Ledger Technology:

Distributed Ledger Technology (DLT) is answer to some of the question which P2P platform has in context of traceability and volume economics. Digital Ledger Technology (DLT) is a technology which can store same data, same time at multiple places and can also change it as and when one of the stakeholders puts new entry. This technology does not need any kind of centralized data storage. Electricity is neither created nor destroyed outside the system. Therefore, it is utmost necessary to keep the record of the transaction done. DLT make it easy to audit the volume of electricity traded on the platform over the lifecycle.

2. Technology Architecture

Atlantic Power Exchange (APX) has taken quit a unique approach for P2P technology design. In this approach they divide technology stack into domains will form a hierarchy of layer. By this approach they can easily identify the group which are relevant to each domain.

2.1 Energy Domain

In this domain, production of power is done and it is distributed to prosumers or consumers. This is where smart

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

meters are used to track the usage of electricity and make system more efficient.

2.2 Control and communication domain

Inside the control and communication domain the digitized energy data transmission occurs. This platform design serves as an export signal on this domain. With this functionality a mass coordinated response to demand spikes can solve many of the blackout events in particular the activities related to the frequency drops. The communication hardware and the telecommunications providers function in this area.

2.3 Token domain

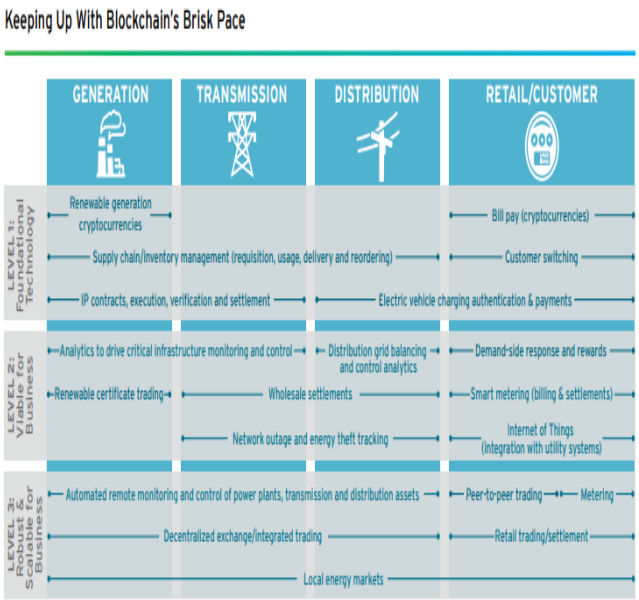
The token area is the place the transformation between energy information and token happens (Tokenization) just as the token exchange. The exchange among presumes and purchaser (Nodes) is overseen and settled right now. This foundation deals with the installment from purchaser to prosumer and interfaces with control and correspondence space to conclusion of the installments [6].

3. Don't overcommit, and be particular. Utilities should concentrate on assessing and choosing a negligible arrangement of blockchain-based arrangements that address their current business challenges and are monetarily reasonable.

4. Start slow, fail fast. By testing out blockchain with pilot ventures, utilities will get an unparalleled view to new and rising advancements in the space.

5. Stay cautious on the administrative front. In the exceptionally controlled utility condition, we expect that utilities will bear a short-to medium-term time of transient administrative changes over the globe until a reasonable arrangement of guidelines rises that is material and pleasing to overall utility associations.

6. Build alliances/partnerships. Utilities need to proactively join forces with specialty innovation, counseling firms and driving colleges/companies to consistently investigate blockchain alternatives and guarantee they remain on top of things.



7. Models involving service providers as a solution

Apparently a completely decentralized, Blockchain-based distributed exchanging stage would be hard to accommodate inside the current lawful system. An assistance model can be utilized to abuse the upsides of Blockchain innovation and to package the related legitimate and administrative dangers.

World's first company to implement this idea is Wuppertal Public utilities, Germany in 2017, they open service based on blockchain where clients can legitimately buy power from neighborhood green power providers.

Blockchain frameworks need exorbitant new foundation, custom ICT gear, programming and many other things which add up investor's cost and may overtake the benefit from the system. Also, smart meters are still not technically compatible, so integrating existing smart meter with distributed ledgers to infrastructure grid may also add up the cost.

At present, facts in blockchain systems can be transferred for low expenses, however validation and verification of data comes with high hardware and energy expenses. Verification of stake or confirmation of power calculations may additionally altogether improve this in a while. Inside the field of network correspondences anyhow, blockchain frameworks would want to cope with previously settled preparations, for instance, telemetry, which isn't simply regularly developed, but additionally essentially much less luxurious innovation arrangement. Promising preparations proposed to cope with this take a look at is setting away real facts in 'sidechains' and working the blockchain as controlled layer as opposed to as a capacity layer [7].

Blockchain advancements can aid or quicken such destinations, subsequently facilitate properly with modern administrative desires, anyway administrative systems could ought to be revised to permit larger reception of DLT. As an instance, in general lines float administrative structures don't allow customer to consumer energy changing, for example, in a few P2P power buying and selling ventures. New agreement sorts might be required to depict understandings among prosumers and buyers, especially while counterparties utilize the open matrix. Specifically, some other structure would require new and possibly more and more adaptable power taxes, which might be proper now vigorously directed. As a rule, nearby or microgrid energy markets would should be incorporated with current administrative practice.

Best perspective for Regulators of Blockchain use in Energy Blockchain application in Energy sector:

• It is essential for the regulators to understand the criticality and application of blockchain and identify ways to cop up with the related risks.

• To hire right people and right skills is the main priority which can be expensive

• Regulators must tie up with the experienced players and startups to drive the market which will induce expertise and innovations lied within

• Proper regulations regarding framework and licensing of energy producer

• Create an environment of multiple suppliers per consumer. Also create opportunities for the suppliers to enter into market of peer-to-peer or peer-to-local energy trading market.

• Policies should be designed to support real time pricing which in fact encourage more market players to involve.

• Ensure proper cybersecurity: data privacy and grid related security issues

• Help market players through sand-boxes: test, fail, repeat, succeed [8]

• Permissioned and privacy mechanisms: There are two categories of blockchain, public and private. In public categories any miner can contribute whereas in private category only people who has been given access can use the platform. Therefore, use of permissioned chain should be done in

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 11, November-2020

application with defined authorities or entities with management responsibilities.

- Energy policy and regulatory layer: In any country, a basic framework is constructed by policymakers. Likewise, the policy related to the energy sector covers all the aspect of the sector like technical, monetary, safety. Keeping in view the requirement of the country or state, policymakers are given responsibility of forming all the legal documents. After forming or updating the legislative documents, it is implemented through pre-determined path.
- Business layer Investors: The stakeholders of a typical power market are trading companies, T&D system operators, investors, banks etc. But in the recent scenario some new players have enter in this category, this include, prosumers and progressive service provider agencies. Other than this there are secondary stakeholders which include service provider, product provider who help in sustaining the power network and giving product and services to various stakeholders.
- Control and optimization layer: From last two decades or more Supervisory Control and Data Acquisition (SCADA) systems are been used in power sector. SCADA and other peer advanced technology are being used to control and monitor the performance of intelligent energy systems so that algorithm that can be used in decision making can be utilized.

VI. CONCLUSIONS

Currently, there is need of flexibility and better efficiency in energy trading market which can be fulfilled by Blockchain. Blockchain based energy trading is gradually developing and has shown a significant success rate. The main application of blockchain technology in energy trading is storage of transaction data, privacy, fast and reliable source of transferring energy from prosumer to consumer. A better incentive mechanism is induced in the system to encourage the users. Also, elimination of distributor on a smaller domestic scale would reduce burden on DISCOMs and price would be determined internally between prosumer and consumer. Here, Regulatory mechanisms remains the main problem for all projects. Though current projects are either small or pilot projects but have shown considerable good results. Furthermore, it is necessary to assess the willingness of the investors and consumers to pay for it. Also, use of edge computing will help to reduce the time for the transactions and the malicious practices, will foster the sense of trust to the consumers and the related stakeholders. It would increase the efficiency of the RWE server which process large number of transactions at a time. P2P energy trading is must to promote sustainability in energy sector and maximize the use of renewable energy sources. Need to do more partnerships/tie up with the foreign companies which deals in blockchain can help to develop, maintain infrastructure of blockchain. By this Indian market would grow slow and steadily and investors would find an opportunity in this business. Need private companies to indulge in this to maintain the infrastructure once developed. The private companies can get revenue in form of percentage of the transaction done or on the number of transactions.

VII. REFERENCES

[1] N. Wang, X. Zhou, X. Lu and Z. Guan, "When Energy Trading meets Blockchain in Electrical Power System: The State of the Art," Applied Sciences, vol. 9, no. 8, 2019.
[2] Consensys, "Blockchain in Energy and Sustainability," [Online]. Available: https://consensys.net/blockchain-use-cases/energy-and-sustainability/.
[3] M. Kumar, "Analyzing the Components of a Blockchain-powered P2P Lending Platform," 14 July 2019. [Online]. Available: https://blockchain.oodles.io/blog/blockchain-decentralized-p2p-lending-analysis/.
[4] Smart Energy International, "Applying blockchain technology to electric power systems," 31 October 2018. [Online]. Available: https://www.smart-energy.com/industry-sectors/policy-regulation/applying-blockchain-technology-electric-power-systems/.
[5] P. Mahawar, "BLOCKCHAIN DEFINING FUTURE OF ENERGY IN INDIA," 7 July 2017. [Online]. Available: https://www.mphasis.com/home/thought-leadership/blog/blockchain-defining-future-of-energy-in-india.html.
[6] M. Khachiki, "P2P energy trading - Challenges and Opportunities," 26 August 2019. [Online]. Available: https://energycentral.com/c/gr/p2p-energy-trading-challenges-and-opportunities.
[7] M. Andoni, V. Robu and D. Flynn, "Blockchain technology in the energy sector: A systematic review of challenges and opportunities," Elsevier, vol. 100, pp. 143-174, February 2019.
[8] PWC, "Regulators: unblocking the Blockchain in the energy sector," 5 June 2018. [Online]. Available: https://www.ceer.eu/documents/104400/-/-/c1441b50-3998-2188-19f3-14dab93649d3.
[9] Cognizant, "Blockchain for Power Utilities: A View on Capabilities and Adoption," March 2018. [Online]. Available: https://www.cognizant.com/whitepapers/blockchain-for-power-utilities-a-view-on-capabilities-and-adoption-codex3372.pdf.
[10] "Blockchain Techologies For the Energy Access Sector," [Online]. Available: https://energypedia.info/wiki/Blockchain_Techologies_For_the_Energy_Access_Sector#Companies_and_Organisations_Using_Blockchain_Technology_for_Energy_Access.
[11] P. Bhakta, "P2Ps are in a race to build 1st blockchain platform here," 29 March 2018. [Online]. Available: https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/p2ps-are-in-a-race-to-build-1st-blockchain-platform-here/articleshow/63526371.cms?from=mdr.
[12] D. C. Schneider, "Legal Update Energy law: Blockchain in the energy sector," 22 March 2018. [Online]. Available: https://www.greenmatch.ch/en/blog/legal-update-blockchain.
[13] F. Omezzine and J. Schleich, "The future of blockchain according to experts in the energy secto," 5 March 2019. [Online]. Available: https://theconversation.com/the-future-of-blockchain-according-to-experts-in-the-energy-sector-111780.