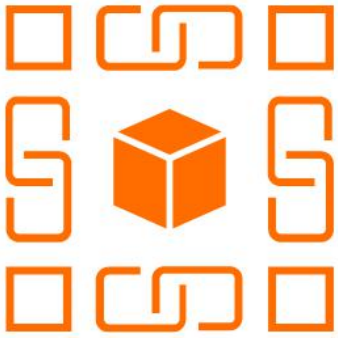

BChain Dynamics

Connect • Learn • Grow

Solar Energy Hub

Bringing the power of the sun to you.

An integrated blockchain-based energy management platform with bilateral trading for microgrid communities

Team: R3 Chain
Members:Rakesh Raushan, Rhythum Preet Kaur

Mentor: Jignesh Vasoya
Guide: Kapil Agrawal

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Abstract:

Blockchain-based smart contract for energy demand management is fast growing and sustainable sector in blockchain.The application is proposed for the energy demand side

management through peer-to-peer exchange of users. The application is proposed for the energy demand side management through peer-to-peer exchange of information and energy in the real-time market. Smart contracts guaranteed by blockchain technologies are implemented
to create a seamless and efficient trading system. The benefits of distributed energy management are presented such as economic savings, reduction of peak load and increased market efficiency facilitated by blockchain management are presented such as economic savings, reduction of peak load and increased market efficiency facilitated by blockchain. The paper ends with a discussion of challenges and market barriers the technology needs to overcome to get past the hype phase, prove its commercial viability and finally be adopted in the mainstream.

Introduction:

Current energy systems are facing a revolutionary transformation from both supply and demand sides .Distributed energy resources (DERs) such as solar photovoltaic (PV) arrays and small-scale energy storage systems are becoming a substantial source of power. Meanwhile, technology evolution on the demand side will lead to the adoption of a significant number of electrical vehicles (EVs) and fuel cell (FC) vehicles, electrification of the heating
sector, smart controllable loads, and the proliferation of using flexibility in load management schemes such as demand response . These substantial changes require more flexible and resilient energy distribution networks and trading response. These substantial changes require more flexible and resilient energy distribution networks and trading systems . However, the existing transportation and energy systems are incapable of handling these flexibilities readily without deploying proactive design and operation strategies in a holistic system manner .

Among all blockchain applications, the Peer-to-Peer (P2P) electric power trading stands out to be a suitable application, considering the following reasons:

1) The P2P trading and record of consensus can be achieved with blockchain.
Blockchain is a distributed system naturally designed for peer-to-peer interactions. In a P2P trading system, every participant is able to define their own behaviors and interact with others. Compared with the traditional grid, all the centralized actions, such as power transmission, pricing and settlement are now customized. Meanwhile, all end-users' activities can be recorded trustworthily, without the need for a third party.

2) Blockchain helps to reduce the threshold of participation in the electricity market for local

retailers. The grid infrastructure requires a huge amount of capital investment, as well as extensive operating and maintenance cost, keeping a high barrier for small-scale companies to participate. Blockchain technology enables fund-raising from investors and even end users. All participants will have partial ownership and benefit from grid infrastructures that are represented by the tokens in this system, which are their certification of right and can be traded as well. Moreover, blockchain will also reduce the cost of daily operation by using a decentralized system instead of a third-party intermediary. Therefore, end users can play an active role in energy sales, pricing and settlement in the electrical power trading, triggering more vitality in such markets.

3) Smart contract is a suitable platform for many new technologies to be implemented in P2P power trading system. New paradigms such as demand response, auction mechanisms and scheduled power consumption, require the underlying framework to support synchronous circulation of information and value with automated actions taken on behalf of the energy user. Smart contract bears abundant capabilities to meet these requirements by offering programmable user behaviors, transparent and credible transaction records etc.,

Problem Statement :

- **Using and distributing energy in your hand.**
- **Have you ever imagined creating your own electrical energy for your space?**
- **Ever thought of distributing that energy without letting people know your identity?**
- **Ever thought of creating energy and trading it for currency?**

Existing System

About 65% of the electricity consumed in India is generated by thermal power plants, 22% by hydroelectric power plants, 3% by nuclear power plants and rest by 10% from other alternate sources like solar, wind, biomass etc. 53.7% of India's commercial energy demand is met through the country's vast coal reserves.

Presently used centralized energy planning model ignores energy needs of rural areas and poor and has also led to environmental degradation, whereas decentralized energy planning model is in the interest of efficient utilization of resources.

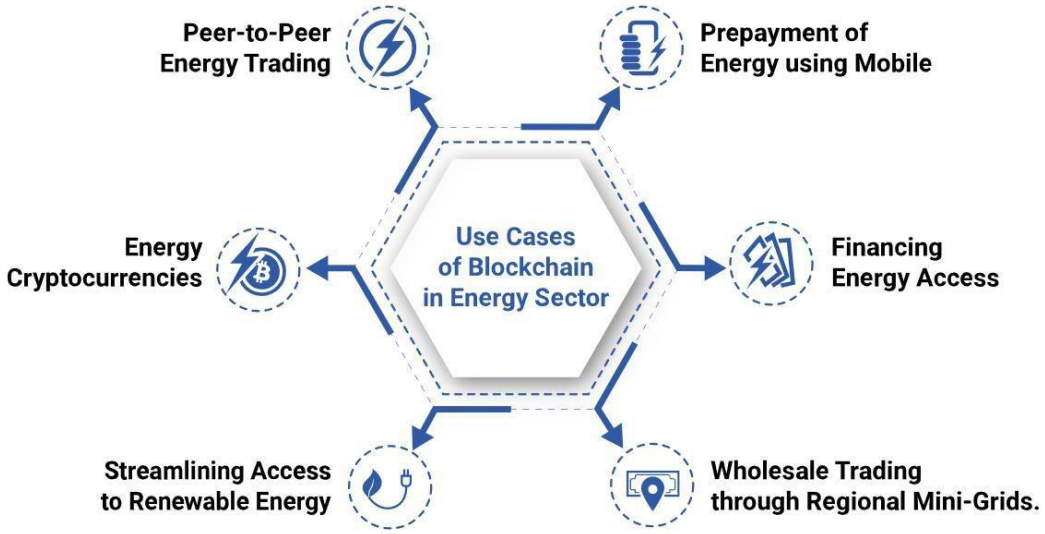
Right now especially in India, the energy paradigm is controlled and owned by a central authority I.e. the government, but what if we could decentralize this and break the monopoly of the third man charging us amounts whatever they like?
In fact we can as be as an environmentalist or an active global warming activist but our limbs of reasoning get amputated by the energy we have to use at our homes whose source isn't even under our control, Its like we are used to eat non vegetarian food even if we want to be vegetarian just because the government says so. Sounds bad right?
Apart from that we do really struggle to get clean energy I.e. energy from renewable resources eg-solar energy, wind energy etc.

Proposed System:

Blockchain: The Next Big Thing For Renewable Energy
The present work shows the feasibility of decentralized energy options for the residential and small scale applications in a village or a cluster of villages.It is found that the small scale power generation systems based on the renewable energy sources are more efficient and cost effective. Thus the focus should be on the small scale renewable energy technologies that can be implemented locally by communities and small scale producers, but can make a significant overall contribution towards the national energy supply.

How can Blockchain be implemented?

Retailers are the driving source of inefficiency in the consumer electricity market. Retailers own very little of the grid infrastructure. Instead, they only manage the kinds of services that blockchain technology can replace, such as billing and metering usage. Supplementing retailers with a blockchain-based platform has the potential to reduce consumer bills by around 40%. By connecting users directly to the grid, Blockchain allows users to buy energy from the grid at a cost they desire. The result is a more equitable and stable energy market with lower electricity costs.



India's power system is currently experiencing a major shift to higher shares of variable renewable energy, which is making system integration and flexibility priority issues. The Government of India has supported greater interconnections across the country and now requires the existing coal fleet to operate more flexibly. It is also promoting affordable battery storage.

Advantages:

- A reduced cost of utility bills and/or lower transaction costs in the market for gas or electricity, lowering the need for working capital.
- New opportunities for communication among energy devices such as water heaters, electric vehicles, batteries, solar PV installations, and so on with the grid

operator (smart grids).

• Cost reduction due to more information for utilities and grid operators for the integration of volatile renewable energy capacity into the grid.

• Access to affordable energy for the underserved communities through local and decentralized renewables grids.
Usually, customers have to wait for 60 days for electricity bills but because of implementing blockchain, it could be done in real-time.

• Support from the government.

In order to encourage people to adopt solar energy, the government offers tax credits to those who install rooftop solar panels whether it be for residential or commercial purposes. As per the Ministry of New and Renewable Energy, the government pays 30% of the installation cost as a subsidy to the installer.
Low maintenance cost.
The chief factor that accentuates the importance of rooftop solar panels is that they require very less maintenance. They come with a service life of over 20 years if maintained properly.

• Suitable for Indian climate

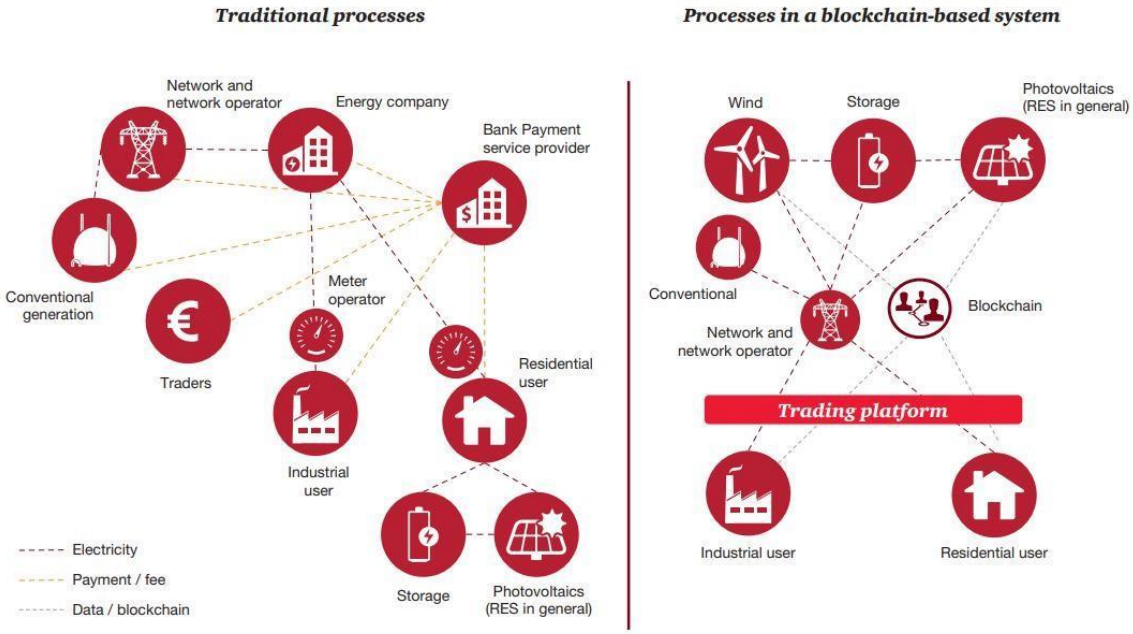
Rooftop solar panels utilize sunlight to convert it into electricity. India is situated at an ideal geographical location and receives ample tropical sunlight. There are almost 300 sunny days with clear skies each year in India. Thus, rooftop solar panels are ideal to be used here.

• Multiple applications of solar power.

Along with the generation of electricity, solar power can meet several other purposes. It can be used to heat water and supply hot water or air to a building. It can also be used to run electric generators.

• It doesn't require additional space for installation

One of the biggest advantages of rooftop solar panels is that they can be installed on any type of roof. So, people don't need to vacate a land or invest in buying additional land to set up rooftop solar panels. Furthermore, the panels offer protection to the roof of the building in which they are installed.



How will Blockchain and decentralization help achieve our goals?

The answer is Solar Decentralization using Blockchain and IOT
This application focuses on the **decentralized** distribution of solar energy between networks using IoT (Internet of Things) enabled devices and Blockchain technology.

IoT provides a medium for software part to interact with the physical part which is energy and transmission grid. **IoT connects the physical battery containing the energy to the cloud database which is then used to interact with the software.** IoT also enables the transfer of energy through the physical medium on the command given by the user through the user application

Decentralization helps in achieving a system which doesn't require any middleman and works on the cumulative trust of the nodes - often referred to as the ConsensusBased Algorithm such Proof of Work (PoW) and Proof of Stake (PoS) connecting all the users in a peer-to-peer (P2P) energy market running on a blockchain network who could enter directly into energy exchanges with any other member without restrictions or oversight from a centralized authority.

The blockchain expands on the typical capacities of a P2P market, allowing for the creation of “smart contracts,” in which energy transactions are immediate, automated, and flexible based on supply and demand in the system. Unlike a P2P energy market, in existing energy markets, all energy consumers are typically connected to a macrogrid and purchase their electricity at prices given by a single central utility, as well as are unable to make personal decisions on the type of energy that powers their home.

In a blockchain P2P energy market, however, if Network Member B wanted energy

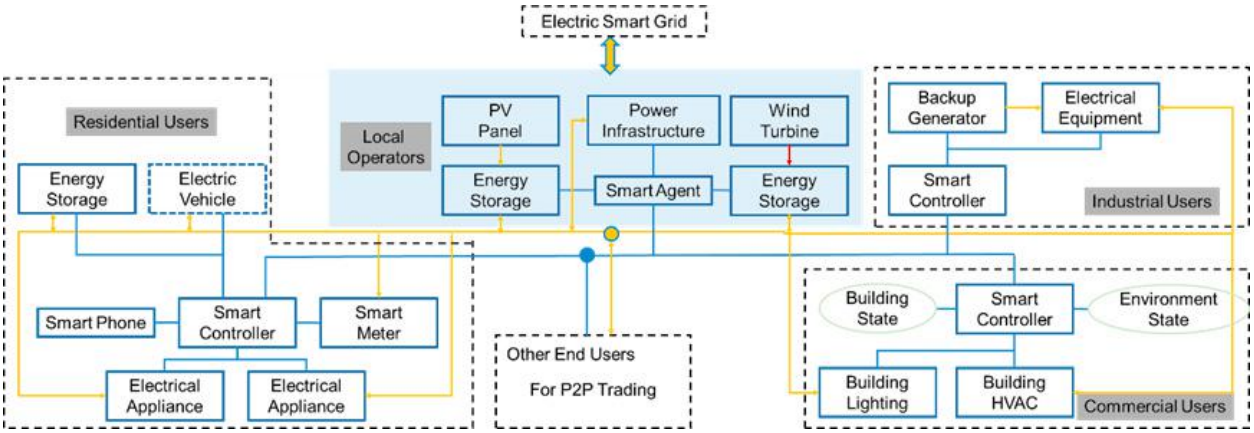
from a specific source– i.e., solar–then Network Member B could directly purchase energy from Network Member A, who is producing solar-power, rather than from the central utility. However, if Network Member B, C and D all demand a higher quantity of solar than there is a supply of, they could bid up the price of purchasing that power to a much higher price than the one that Network Member A would receive through standard net-metering with the central utility.

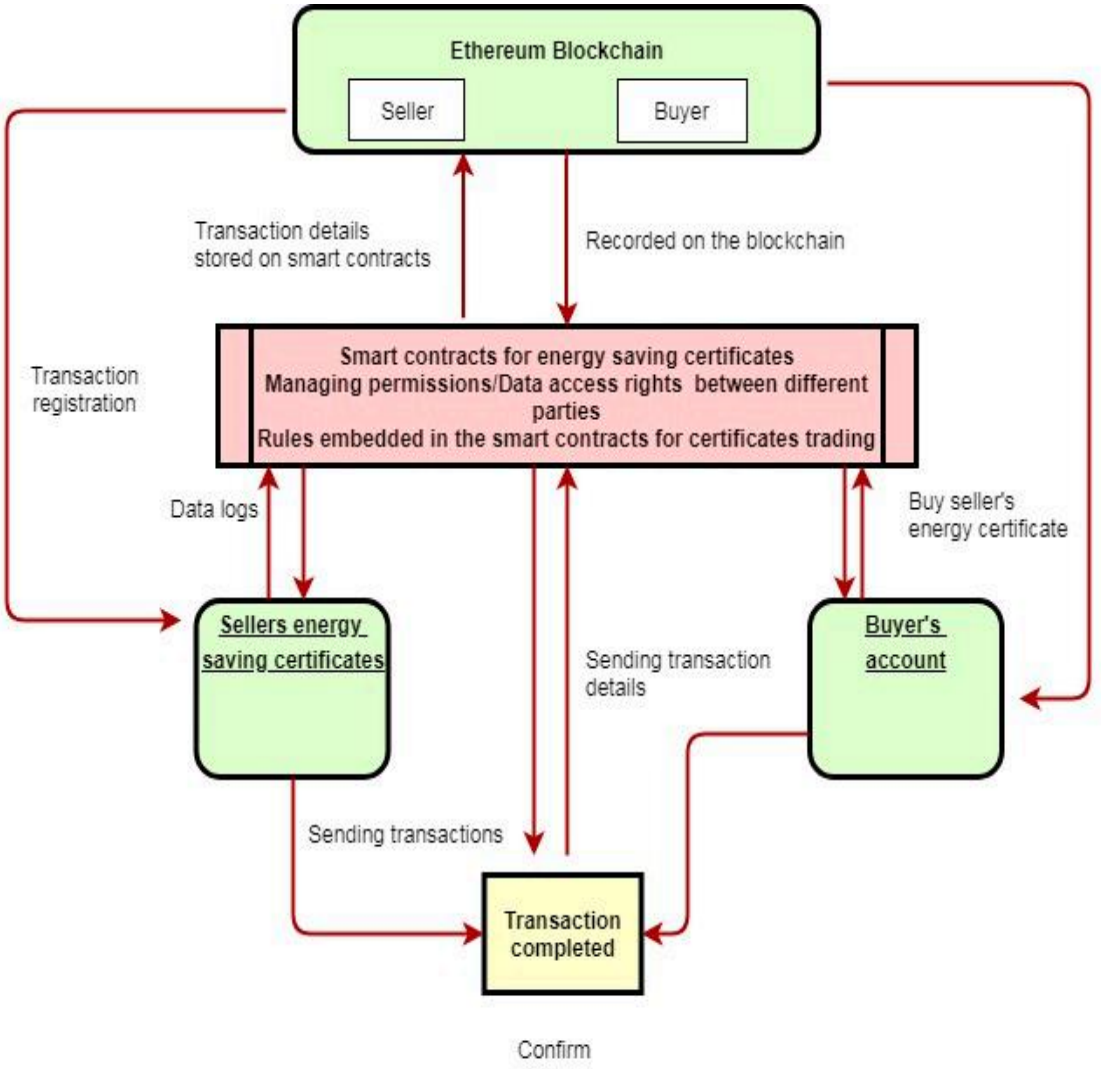
The benefit of this bidding process is that it provides community members who choose to purchase DERs monetary benefits that are much greater than those typically provided by a utility; clean-energy producers could be paid high prices for the electricity they produce, reducing the financial burden of purchasing and installing DERs, thereby making DERs a more attractive option.

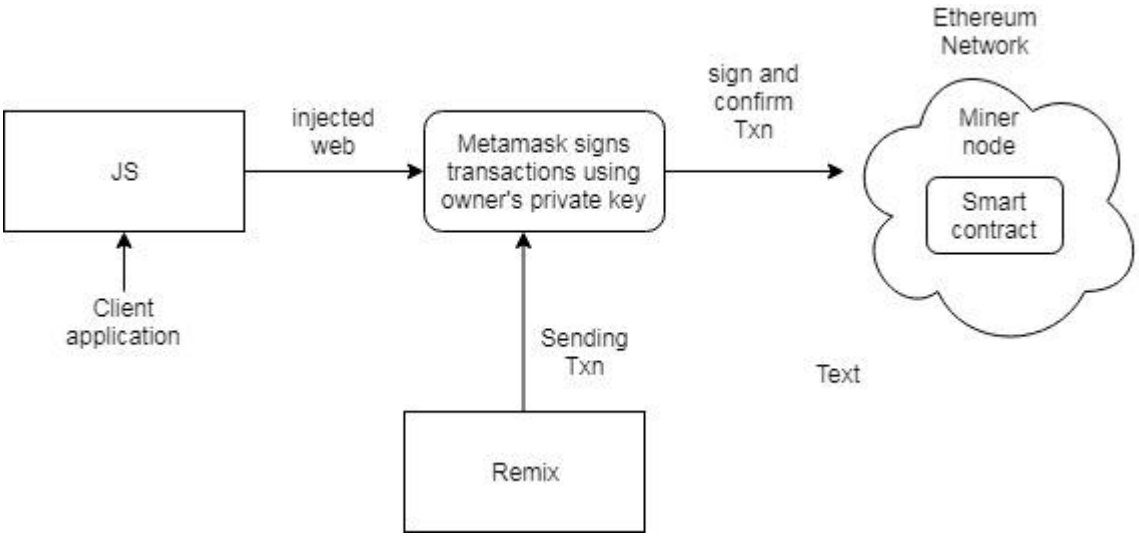
System Design

Systems diagram and energy management models

In this section we first briefly introduce the overall methodology for the optimization of distributed energy supply and demand matching as illustrated in Figure . A game theory based model for demand side management under different supply constraints is presented as the foundation for implementing blockchain enabled smart contracts.




Ethereum Blockchain
Seller
Buyer
Transaction details
stored on smart contracts
Recorded on the blockchain
Transaction
registration
Smart contracts for energy saving certificates
Managing permissions/Data access rights between different parties
Rules embedded in the smart contracts for certificates trading
Data logs
Buy seller's
energy certificate
Sellers energy
saving certificates
Sending transaction
details
Buyer's
account
Sending transactions
Transaction
completed
Confirm



Implementation

Module 1:

Decentralized Identities

Module 2:

IoT,Smart grid, smart devices, automation and asset management
For communication of smart devices, data transmission or storage

Module 3:

Metering/billing and security

Module 4:

Cryptocurrencies, tokens and investment

Module 5:

Decentralised energy trading

Module 6:

Green certificates and carbon trading

Module 7:

Electric e-mobility

Tools/Technologies To Be Used

MongoDB,Uni Swap,Ethereum,Solidity,Remix,React,web3.js,Smart Contract,Metamask wallet,BlockVigil ,Node Js,Arduino,Raspberry Pi,IBM Blumix ,Azure IOT Hub,BAAS

Conclusion

Surveys and detailed planning would need to be carried out in order to ensure that the demand for clean energy in an area was significant enough to reward solar installers to a meaningful level.

As of 2017, the use of blockchain in peer-to-peer energy markets in order to incentivize the purchase of distributed energy resources is a largely untested idea. Testing and implementation of this idea would require working under local regulations, as well as performing more location-specific demand assessments that could provide DER customers more accurate benefit projections of their purchasesthereby providing incentives to DER installers and accelerating the integration of distributed energy resources into global energy infrastructure.

Many companies are already using blockchain as a tool to make energy grids more accessible and sustainable by promoting data-sharing in real time. The idea behind creating energy grids linked to blockchain is fairly simple: by giving consumers total control over where they source their energy as well as the information behind the production itself it drives competition and promotes sustainable energy.

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