Blockchain for Smart Energy Systems

25.01.2022
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Smartgrid-dagen 2022 Jan. 25, 2022, NTNU Trondheim, Norway

Fig- src: https://www.ippo-engineering.eu/en/smart-energy-definition-and-development/
https://cryptorobby.blog/2018/05/14/blockchain-in-energy/
Blockchain

Blockchain is a decentralized database that keeps a transparent and permanent record of transactions.

Blockchain is an emerging technology for distributed computing and decentralized data sharing among network nodes.

Key features
- Decentralized technology
- Lack of trust
- Immutability
- Enhanced security
Trusted Central authority

The center has access to and control of users’ data, e.g., Visa, Mastercard, PayPal, banks, and Amazon.

- Very high working load to the center
- The central tends to become the single failure point of failure in the case of cyber attacks.
Blockchain is a globally maintained and shared distributed database. All nodes have the same database. There is no central organization to manage the database.

Blockchain records the transactions permanently. The data can only be added and searched but cannot be deleted or modified.

- No central data. Each node has all data.
Blockchain applications in general

Sweden officially uses Blockchain to register land and properties

Second-hand car value certification
The paradigm shift from centralized to decentralized operations.
Energy sharing: The concept of *prosumers*

- **Consumer**: a house only uses electricity from power grid
- **Prosumer**: recently, we have renewable energy in our home, consumers are not just customer anymore. A prosumer refers to a house that can both produce and consume energy
- **Energy sharing** is closely related to the concept *prosumer*
Decentralized energy trading: everyone can contribute/share power

Common feature
- No need of a third-party utility participating for energy exchange among houses or electric vehicles
- Low cost, flexible, new business models

Challenge
Need a method to ensure secure energy trading among untrusted houses or EVs

Blockchain as a distributed ledger to store the data about local energy transactions is a promising approach
Blockchain can play a crucial role in transforming the energy market. In the current energy market, energy consumers and energy producers trade energy through intermediaries such as the distribution system operator, transmission system operator, and meter operator. This leads to inefficiencies and higher costs.

Blockchain enabled decentralized energy market model eliminates these intermediaries, allowing energy consumers and energy producers to trade energy directly with each other, reducing costs and increasing efficiency.

Energy consumers and energy producers trade energy directly with each other without a third party.
Blockchain can facilitate the transition of the smart energy systems to a distributed paradigm.

Three conditions to use Blockchain:

- Distributed environment
- Nodes do not trust each other
- Nodes perform transactions

Role of Blockchain:

To record transactions permanently and update securely among untrusted nodes.
Major economies in the world view blockchain as a promising technology for the energy sector.

- **Japan**: Mitsubishi Electric and Tokyo Tech Develop Blockchain Technology to Optimize P2P Energy Trading. For more flexible trading environments and expanded use of surplus electricity from renewable energy.

- **Australia**: Siemens Partners With LO3 Building Blockchain Microgrids. The largest engineering corporation in the world, Siemens AG has recently announced an energy collaboration with startup LO3 Energy to create blockchain microgrids. The blockchain protocol aims to enable energy trades facilitated by a distributed ledger platform.

- **Germany**: A Majority of the German Energy Industry is Interested in Blockchain Tech.
Energy Communities and Local Trading: The Brooklyn Microgrid

Prosumer

Decentralized (P2P) energy trade
Energy Communities and Local Trading: Norway’s first pilot microgrid in Hvaler

171 MWh/year from solar and wind
Energy P2P Sharing among Electric Vehicles (EVs)

Charging Station/Aggregator

Information exchange

Charging

Discharging

Energy flow

Information flow

CA: certificate agent
LAG: local aggregator
BV: battery vehicles
Consortium blockchain for secure energy P2P transaction

Architecture

- Two types of energy nodes: energy buyer and energy seller
- Community central nodes audit the transactions and record them into the shared ledger, i.e., blockchain

Consortium Blockchain

Blockchain with multiple authorized nodes to establish the distributed shared ledger

Thank you!

Questions?

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