Blockchain for Smart Energy Systems

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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

Traditional central trusted 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 concept



- 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.

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



Power grid today

Microgrid

Future power grid: network of microgrids

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



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



Centralized ledger with centralized verification and computation



Distributed ledger with decentralized verification and computation 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

Energy Trading

Major economies in the world view blockchain as a promising technology for the energy sector

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

Published: January 19, 2021

A Tokyo Tech research team led by Specially Appointed Professor Takuya Oda of the Institute of Innovative Research and Professor Keisuke Tanaka of the School of Computing, in collaboration with Mitsubishi Electric



BLOCKCHAIN NEWS AUGUST 12, 2016 15:38

Perth Startup Set to Begin Trials of P2P Energy Trading on the Blockchain



ACCEPTS BITCOIN NOVEMBER 18, 2016 13:18

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 T MODEL S Discharging

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



Kang, et. Al, **"Enabling Localized Peer-to-Peer Electricity Trading among Electric Vehicles with Consortium Blockchains,"** IEEE Transactions on Industrial Informatics, Vol.13, Issue 6, pp. 3154-3164, Dec. 2017

Thank you!



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