

How can Blockchain Technology be Used for Electrical Utilities in the Future

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Robert graduated from Assumption University of Thailand with a Bachelor Degree in Electrical and Electronics Engineering. Robert's current projects at Power Quality Thailand include assembling and testing PQSim 200, as well as demonstrating, promoting and training in Power Quality products.

"We keep moving forward, opening new doors, and doing new things, because we're curious and curiosity keeps leading us down new paths." – Walt Disney

How can Blockchain be used for Electrical Utilities in the future?

What is Blockchain?

“The blockchain is an *incorruptible digital ledger* of economic transactions that can be programmed to record not just financial transaction but virtually everything of value.”

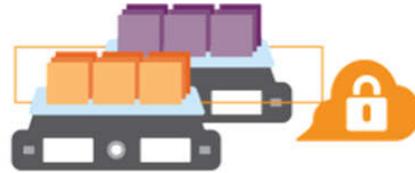
- Don & Alex Tapscott, authors Blockchain Revolution (2016)

- Blockchain cannot be controlled by any single entity
- Has no single point of failure
- Allows digital information to be distributed but not copied
- The blockchain is transparent so one can track the data if they want to

DEVELOPMENT OF BLOCKCHAIN



In 2008, a person or group known as Satoshi Nakamoto develop the first blockchain.



Hash cash, sha-256 (cryptographic technology) like method to add blocks to the chain without requiring them to be signed by a trusted third party

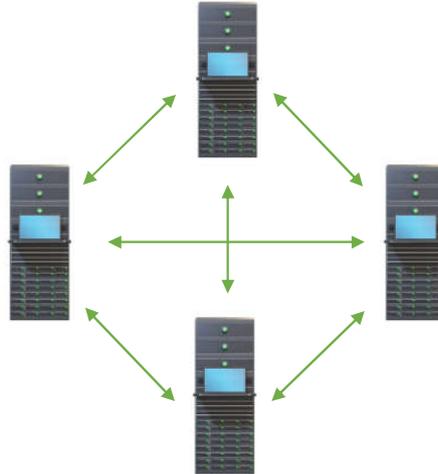


This hash is a value generated from a string of text using a mathematical function. A hash can be compared to a fingerprint, as each hash is unique.

In a process called "Proof-of-Work", its an algorithm used to confirm transactions and produce new blocks to the chain.



This design and network had developed into Peer to Peer Electronic cash system known as Bitcoin.



Hashing and the proof-of-work mechanism ensure the security to the whole blockchain network.



SHA-256



ethereum

KECCAK-256



SHA-512

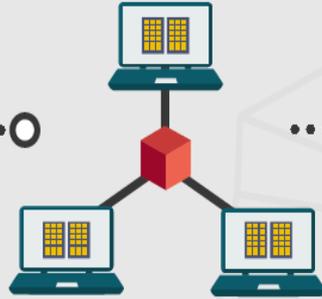


Script

HOW DOES IT WORK?



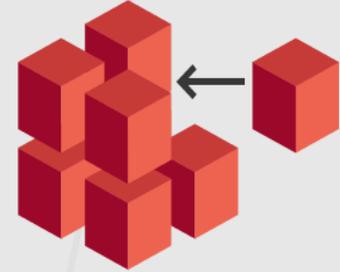
SOMEONE REQUESTS
A TRANSACTION.



THE REQUESTED TRANSACTION
IS BROADCAST TO A PEER-TO-
PEER NETWORK CONSISTING OF
COMPUTERS, KNOWN AS NODES.



THE NETWORK OF NODES
VALIDATES THE TRANSACTION
AND THE USER'S STATUS USING
KNOWN ALGORITHMS.



ONCE VERIFIED, THE TRANSACTION
IS COMBINED WITH OTHER
TRANSACTIONS TO CREATE A NEW
BLOCK OF DATA FOR THE LEDGER.

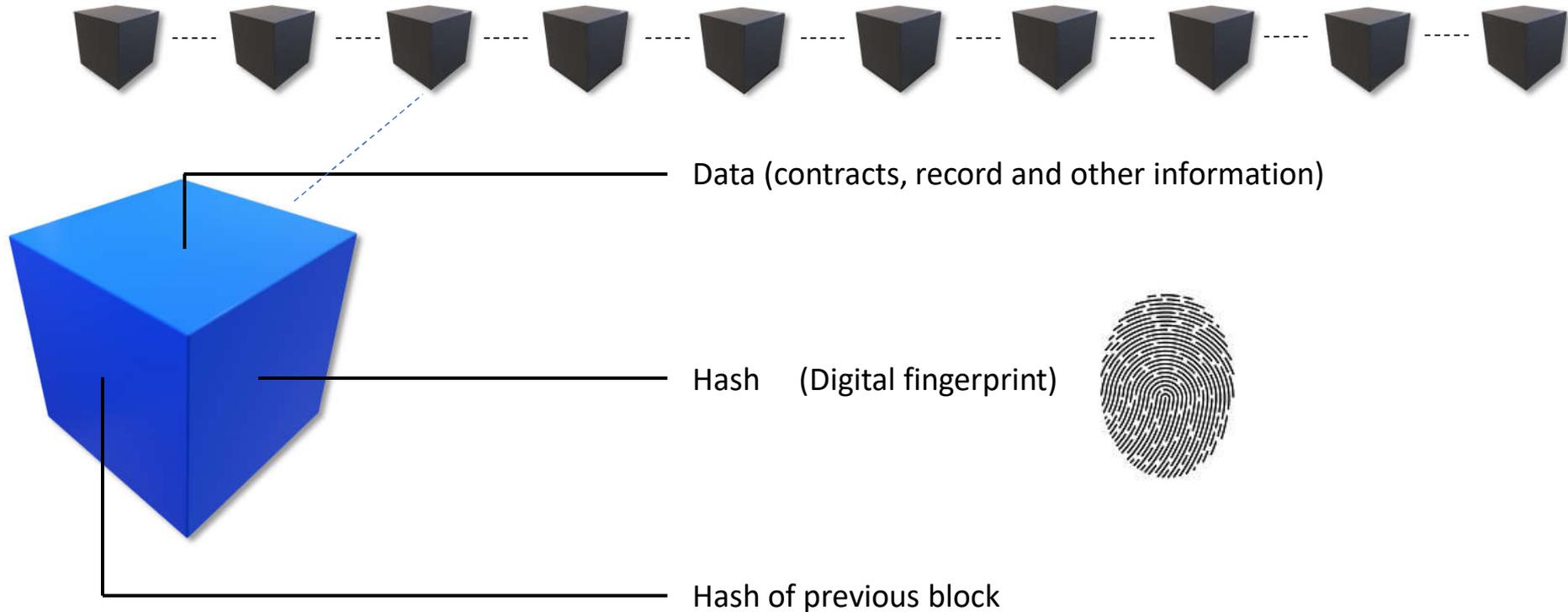
THE
TRANSACTION
IS COMPLETE.



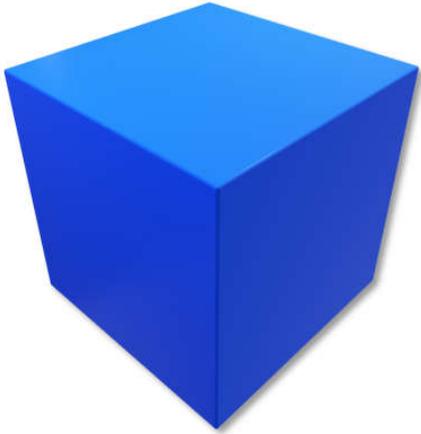
THE NEW BLOCK IS THEN ADDED TO THE
EXISTING BLOCKCHAIN, IN A WAY THAT IS
PERMANENT AND UNALTERABLE.

Block in Blockchain

Blockchain is basically a chain of blocks ordered in a network system.
Each blocks contains data of transaction bundled together.



Each block references the previous block and contains data, its own hash and the hash of the previous block.

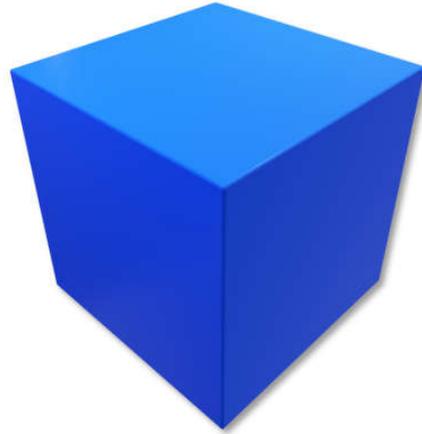


Hash

1A4Z

Previous Hash:

0000

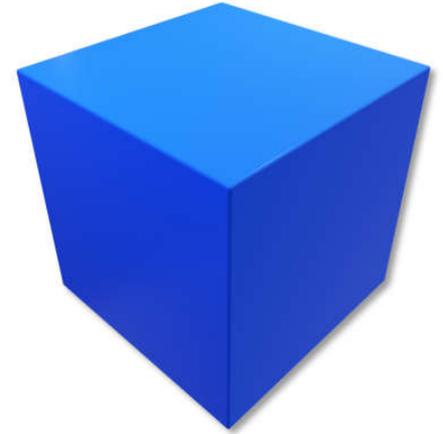


Hash

2K0G

Previous Hash:

1A4Z



Hash

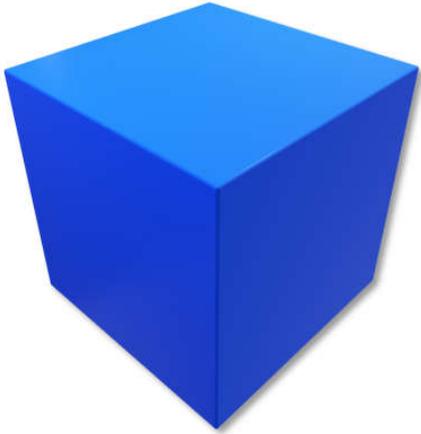
2Y3L

Previous Hash:

2K0G

Each block references the previous block of the previous block.

ins data, its own hash and the hash

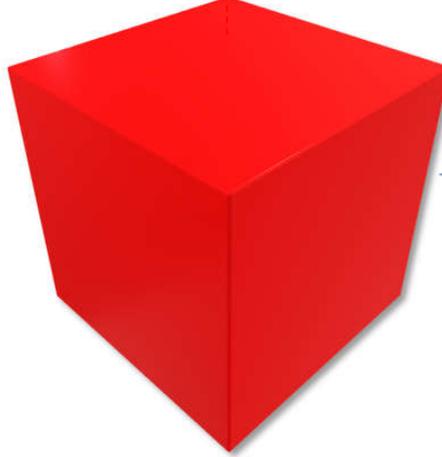


Hash

1A4Z

Previous Hash:

0000

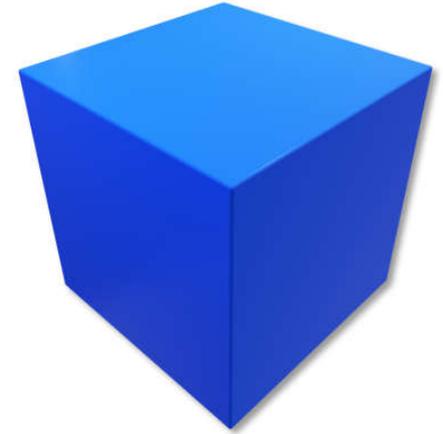


Hash

N30U

Previous Hash:

1A4Z



Hash

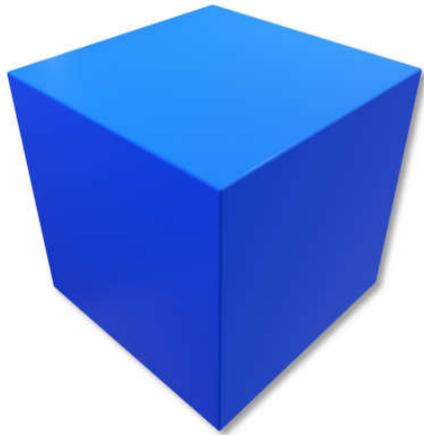
2Y3L

Previous Hash:

2K0G



To change any data in a block , every copy across the blockchain or network will have to be changed thus ensuring the security of the recorded data.

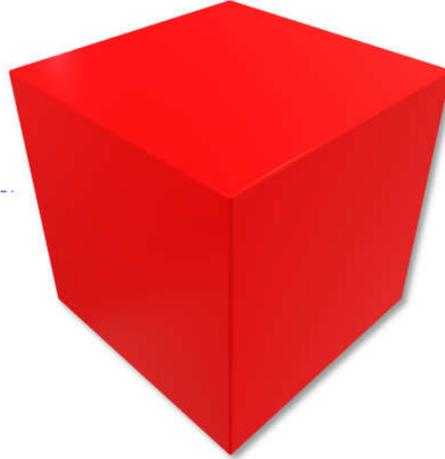


Hash

1A4Z

Previous Hash:

0000

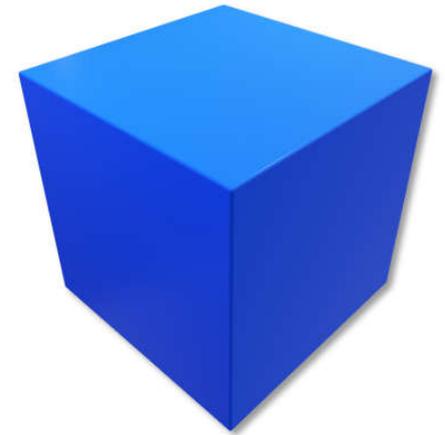


Hash

N30U

Previous Hash:

1A4Z



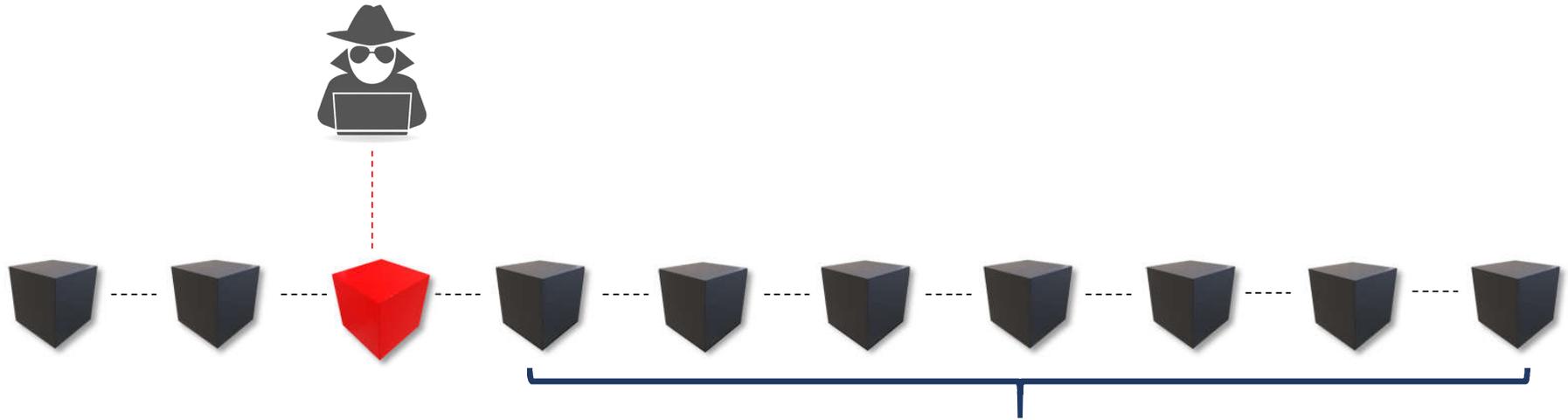
Hash

2Y3L

Previous Hash:

2K0G





**Difficult and expensive - it depends also on type and size of the network.
It requires to take control over the majority of nodes and uses a very high computing processing power to change the complex mathematical problem for each block.**

How Blockchain is implemented in the Power Industry?

Blockchain technology can offer many innovations for the power industry and solutions in improving the power system . Blockchain takes advantage of Peer to Peer network (P2P) energy trading.

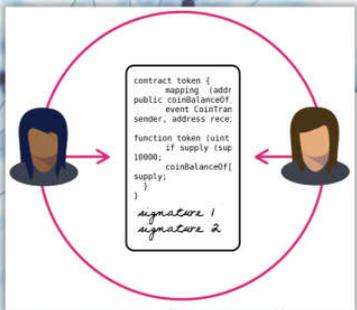
- **Smart contracts**
- **Microgrid - Projects**
- **Machine to Machine Payments**

What is a Smart Contract?

- A smart contract is a computer program designed to facilitate, verify and enforce an agreement.

- Works on the principles of blockchain.

- Enforces a relationship with cryptographic code.



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Smart Contracts



Option contract written as code into a blockchain.



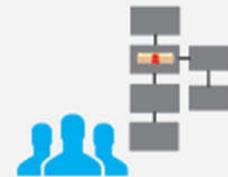
Contract is part of the public blockchain.



Parties involved in the contract are anonymous.



Contract executes itself when the conditions are met.



Regulators use blockchain to keep an eye on contracts.



Blockchain Companies for the Energy Sector

Electron (UK): a team of blockchain, energy and e-trading professionals using decentralized technology to advance the shared infrastructure of the energy markets.

LO3 Energy (USA): is developing blockchain based innovations to revolutionize how energy can be generated, stored, bought, sold and used, all at the local level.

Projects:

- The Brooklyn Microgrid (Brooklyn , New York, USA)
- Allgau Microgrid (Allgau, Germany)

Energy Web Foundation (Switzerland): is a global non-profit organization focused on accelerating blockchain technology across the energy sector.

Power Ledger (Australia): Founded with over 100 years of energy industry experience and a world-class development team, Power Ledger gives companies and communities the tools they need to enable a new world for energy.

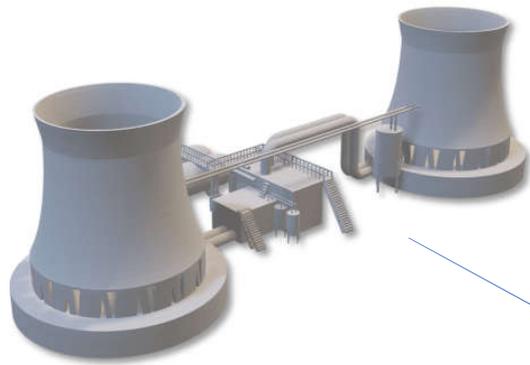
ELECTRON


LO3 ENERGY

 **energy web**
FOUNDATION

POWER  **LEDGER**

TRADITIONAL POWER GRID



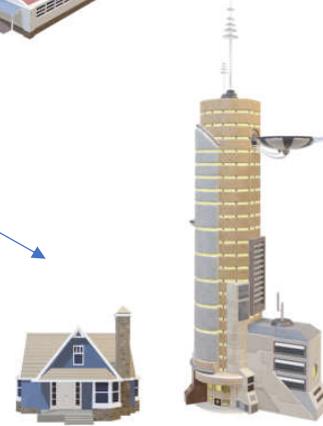
Power Plant



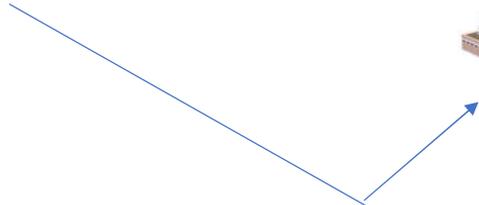
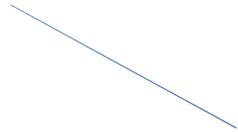
Utility Grid



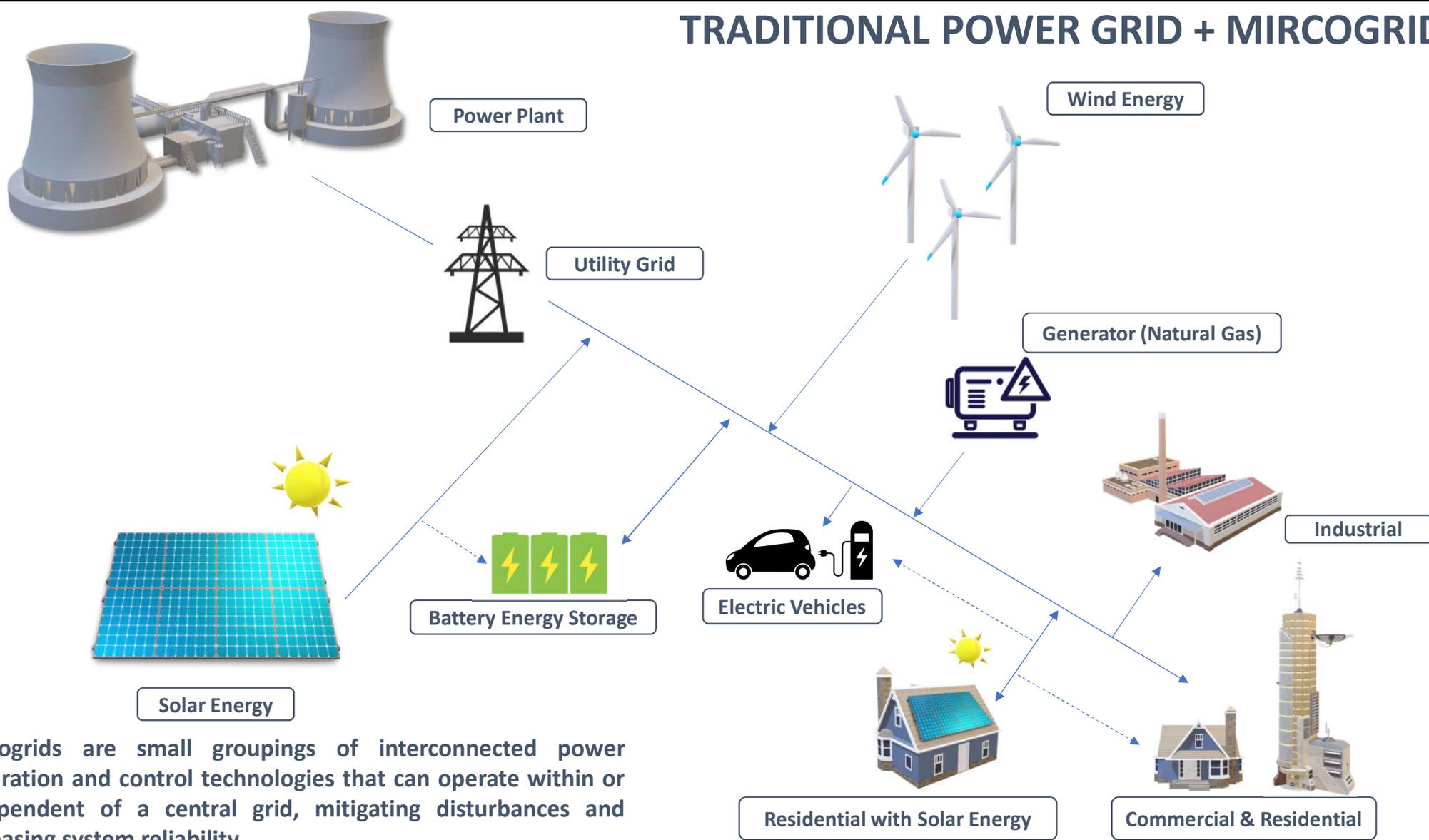
Industrial



Commercial & Residential



TRADITIONAL POWER GRID + MICROGRID



Microgrids are small groupings of interconnected power generation and control technologies that can operate within or independent of a central grid, mitigating disturbances and increasing system reliability.

Brooklyn Microgrid is powered by EXERGY, a blockchain enabled platform which allows for local energy transactions through an online marketplace.



- **Residents with rooftop solar PV sell their excess energy to their neighbors, instead of relying on net metering to sell it back to their utility.**
- **Every solar microgrid prosumer connects to the microgrid through a dual-purpose meter called a Trans Active Grid Element (TAG-e). The TAG-e both measures the participant's energy production and consumption and communicates with other TAG-e devices to record transactions in the blockchain.**

President Street Microgrid Sandbox

Potential
Neighbor
Consumers

Solar
Renewable
Producers





Martha

Neighbor

Martha's surplus production is converted to energy credits



Surplus physically flows from Martha to neighbor



Smart meter
Surplus production

Traditional meter
Surplus consumption

Consumers can choose where to buy renewables from

Energy credits are traded Microgrid based on smart contracts

Local Transactive
Microgrid

Renewable provider

P2P market
Ethereum blockchain

Production

Source: Transactive Grid

Power Ledger Projects BCPG Apartment Microgrid, Thailand.

(Announced on December 17th, 2017)



Power Ledger, together with Thai renewable energy business BCPG, have launched a world-first peer-to-peer (P2P) renewable energy trading trial at the T77 urban precinct in Bangkok, Thailand.

- BCPG will design and install the connections, meters and solar PV.
- Power Ledger will provide its world-leading blockchain technology as the transactive layer across 18 meter points to monitor energy transactions between participants, enable P2P trading, generate invoicing, and evaluate the trading position of individual participants.
- Thai utility Metropolitan Electricity Authority (MEA) will allow access to its network for the physical transaction of energy between participants.



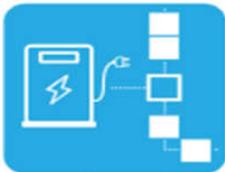
▪ P2P platform will be used to trade up to 635KW of BCPG solar PV energy capacity between four participating entities at T77, demonstrating the efficient trading of renewable energy in order to lower energy costs for consumers.

▪ Participants in the energy trading trial include the Habito shopping mall, Bangkok International Preparatory & Secondary School, Park Court Serviced Apartments and Dental Hospital Bangkok.

▪ *June 2nd , 2018

BCPG will also install a 12MW rooftop solar power system for Chiang Mai University's Smart City Clean Energy project, using Power Ledger's Peer-to-Peer Platform to help with energy conservation and promote the use of clean, renewable energy by selling electricity to the university.

Machine 2 Machine payments: Blockchain offers a means for devices to interact and transfer value in an efficient way.



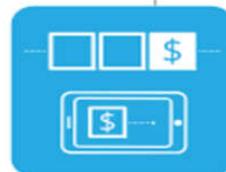
EV charging station owners, both public and private, register their stations to a blockchain system



Station owners offer their chargers for use in the network, setting station availability and pricing preferences



Potential users can see maps of the station network and ratings of each charging station



Users pay owners for electricity used securely and instantly via a blockchain ledger

Blockchain in the next 10 years.

What businesses might be impacted?

Banking and online payment systems:

- **Blockchain does not require integration with a bank account or credit card**
- **Reduce transaction cost**
- **Increase transaction speed and security**

Auditor:

- **Coordination and overhead cost will be reduced.**
- **Checks and controls will become minimized or eliminated.**
- **Blockchain will remove the need to reconcile between different entities within a company, as each will share the same set of data. Therefore, accountants are also likely to see a change in their role. (Check that the blockchain network operates fairly and according to agreed principles.)**

Data Collection/Privacy

- **The probability of breaches is decreased due to encryption of all data present on the blockchain.**
- **You control your identity or information.**

Companies that had adopted blockchain technology

FedEx: is one of the world's biggest logistics management companies and handles billions of dollars worth of cargo every year. They are using Blockchains to track high-value cargo and are soon planning to extend the functionality to almost all their shipments.

IBM: multinational information technology company. Using the Hyperledger Blockchain creator tool, they can help the organizations to create their own distributed ledger and smart contract systems. They have already partnered with some businesses that deal with logistics to increase efficiency and lower costs for them.

Walmart: is an American multinational retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores. Partnered with IBM to create a Blockchain for tracking food globally through its supply chain.

Microsoft: a tech giant that has embraced Blockchain Technology since its inception. Microsoft had started accepting Bitcoin payments on its website in 2014 when almost no one had even heard of cryptocurrencies. Microsoft has also secured some 40 patents related to the use of Blockchains as payment gateways and for secure storage.

Mastercard: an American multinational financial services corporation. Filed over 30 Blockchain related patents, some under the title of "Method and System For Instantaneous Payment using Recorded Guarantees," which seems to imply that they are building their own Blockchain based payment gateways.



Key Points

- **Environment**
- **Piracy/Security & Control**
- **Smart Asset Management – Payment & Exchange “Wallet”**
- **Complexity – New Technology & Ongoing Development**
- **Network size**
- **Regulation**
- **Power Consumption**

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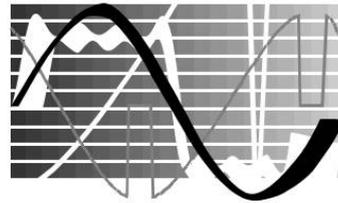
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