Blockchain Technology

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The blockchain is a new technology targeted at storing and managing sensitive data, where pieces ('blocks') of information are entered in a dedicated system by independent users and linked by cryptographic keys (forming the 'chain'). The particularities of a blockchain system are enhanced data security through encryption, anonymization, and immutability; decentralization through peer-to-peer operation, and transparency through open access. The main applications of blockchain are cryptocurrency mining, smart trading and contracts, secure information transfer.

1. Introduction

The blockchain technology was created as a solution to the problem of mistrust and data security. The first steps were taken in 1991, when Stuart Haber and W. Scott Stornetta first spoke about a cryptographically secure blockchain integrating optimal Merkel type trees in the concept[1]. Following the financial crisis of 2008, the concept of blockchain as a distributed database was developed for the bitcoin cryptocurrency[2], proposing a solution to change the way monetary transactions are carried out in traditional markets. A blockchain represents a decentralized ledger of transactions that take place in a network. This network consists of nodes owned by independent entities that use a cryptographic protocol to validate the transactions that are entered in the ledger and to ensure that the entered data cannot be altered or changed. It is immutable, secure, and completely transparent. The decentralized blockchain networks are harder to penetrate and manipulate by dangerous entities. Some of the most known uses for blockchain technology are:

- Cryptocurrency trading. The first blockchain was created for bitcoin mining[3].

- Data storage. The blockchain system can be used for the safe storage of sensitive information: medical records[4] or scientific data[5] that need to be prevented from unauthorized access.

- Secure, non-discriminatory, and transparent trading in all types of markets. The blockchain system can protect the offers from fraudulent modification or deletion by encryption and can ensure fair trading by anonymization and peer-to-peer, decentralized access. Also, new payment methods and financial services can be developed[6].

- IoT infrastructure operation security in smart homes. The blockchain technology can be used for encrypting the sensor and communication data between the connected devices[7].

2. Example: The Use of Blockchain in the Energy Trading Sector

The electricity industry, with its complex supply chain with a need for increased transparency and improved data management and its highly transactional trading market that requiring fast settlement, is an extremely suitable candidate for blockchain technology-based innovation. Coupled with other innovative technologies (smart electricity grids, data mining, IoT devices), it has the potential to provide solutions to various challenges in the energy sector such as the incentivization of local generation from renewable resources[8] or the creation of local electricity markets[9] and energy poverty mitigation[10]. An example of a blockchain-based market model for local communities with local renewable generation is described in Figure 1[11]. Its main characteristics are:
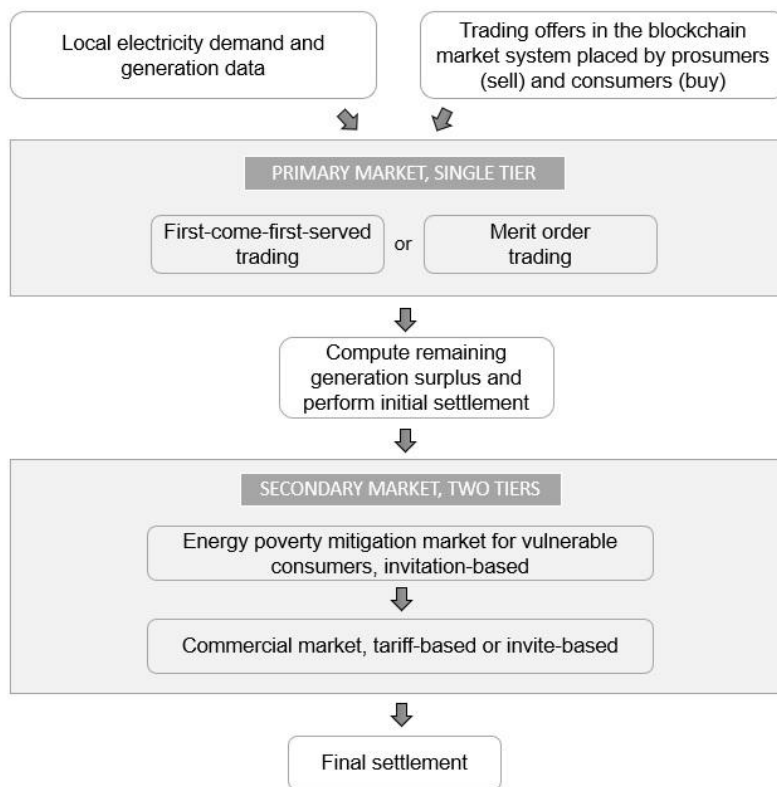
Figure 1. A local market model for electricity trading in microgrids[11]

- Trading is performed in a local market, operated at microgrid or community level;

- Trading can be initiated when entities with generation surplus (called 'prosumers') want to sell electricity to local consumers;

- The sell and buy offers are entered by the participants in an encrypted and anonymous blockchain ledger;

- Only full quantity trading offers are accepted for settlement, no fractions are allowed;

- Sell and buy quantity and price offers are traded on an hourly basis;

- The prosumer and consumer selling and buying offers are managed by a local non-profit entity using two possible market mechanisms integrated into a blockchain trading system:

  - A primary market for prosumer-consumer trading.

  - A secondary two-tiered market for energy poverty mitigation and commercial trading.

- The primary market can use two alternative trading methods: the 'first-come-first-served' method or the merit order method used in traditional day-ahead markets.

- The secondary market provides two optional trading tiers:

  - The energy poverty mitigation tier for low-income consumers, which would benefit from electricity prices lower than the commercial tariffs used by commercial suppliers.

  - The commercial tier, with two alternative trading mechanisms:

    - Fee-access consumers, which enter the market occasionally, in exchange for a fee,

    - Invite-access consumers who do not enter offers directly, but are represented (invited) in the market by other participants.

- Consumers can also enter the secondary market, if the traded quantity is higher than their actual consumption, generating a surplus.

- For the invite option of the commercial tier, a consumer can acquire electricity only from prosumers with which they have signed previously peer-to-peer options contracts.

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