

Blockchain, the New Energy Revolution

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Abstract Blockchain technology is nothing more than a new way of managing data, essentially a decentralized database. There are a lot of blockchains today, Bitcoin being the first. While Bitcoin's only blockchain application is cryptocurrency, recent developments allow the blockchain to be applied in many areas, including energy. In this paper, we asked about the key points of this revolutionary technology, what it means for the energy sector and how it can accelerate the transition to the energy market. We find that through the application of blockchain technology is the opportunity to streamline internal processes and processes shared with external market participants. Also, this fundamentally changes the landscape of energy and commodity trading.

Keywords: blockchain, cryptocurrency, bitcoin, energy commodities

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1. Introduction

Pilot projects for blockchain technology are beginning to appear everywhere, particularly in the energy sector. This decentralized system could soon be invited in all stages of the transaction between producer and consumer.

Literally "blockchain", the blockchain is a "technology of storage and transmission of information, transparent, secure and functioning without central control organ" [1,2].

In this decentralized transaction system, each step is validated by independent users. The exchange history is kept in a secure database, accessible at any time.

In Europe, experiments are now underway, particularly in France with Sunchain or Solarcoin. However, in 2015, start-ups in Brooklyn developed a platform to buy energy from their neighbors. Through a dedicated blockchain, these neighbors produce and buy photovoltaic electricity. Called Brooklyn microgrid (BMG), this operation has created a mini energy market that may eventually open up outside.

The blockchain applies mainly today to projects of collective self-consumption, but other applications are expected. In a study published in December 2016, PWC believes that other solutions could emerge soon, in connection with the customer relationship (relief, billing, archiving) or production (certificates of authenticity of green energy, certificates of quotas of CO2 ...). In the long term, smart contracts can be envisaged: once the purchasing and sales criteria have been defined, the transactions could be triggered automatically, directly and securely between the producer and the consumer. It remains to solve the question of scaling up, with the

management of balance networks.

The blockchain is inviting itself into the energy landscape, facilitating the development of innovative practices: collective self-consumption, peer-to-peer exchanges or wholesale markets, charging roaming electric vehicles, green certificates. To what extent do these new modalities question the organization of the sector, the role of incumbents and the regulatory framework? How to take advantage of blockchain technology to meet the emerging aspirations of consumers and territories in terms of energy consumption?

To answer all these questions, our study is planned as follows. Section 2 presents the definition of the blockchain. Section 3 discusses the potential benefits of blockchain. Section 4 presents the use of blockchain in commodity management and Section 4 provides the most important conclusions.

2. What is the Blockchain?

One (or one) blockchain, or chain of blocks, is a technology of storage and transmission of information without control organ. Technically, it is a distributed database whose information sent by the users and the internal links to the database are checked and grouped at regular time intervals in blocks, the whole being secured by cryptography, and thus forming chain. By extension, a blockchain is a distributed database that maintains a list of records protected against falsification or modification by storage nodes; it is therefore a distributed and secure register of all transactions made since the start of the distributed system (Figure 1).

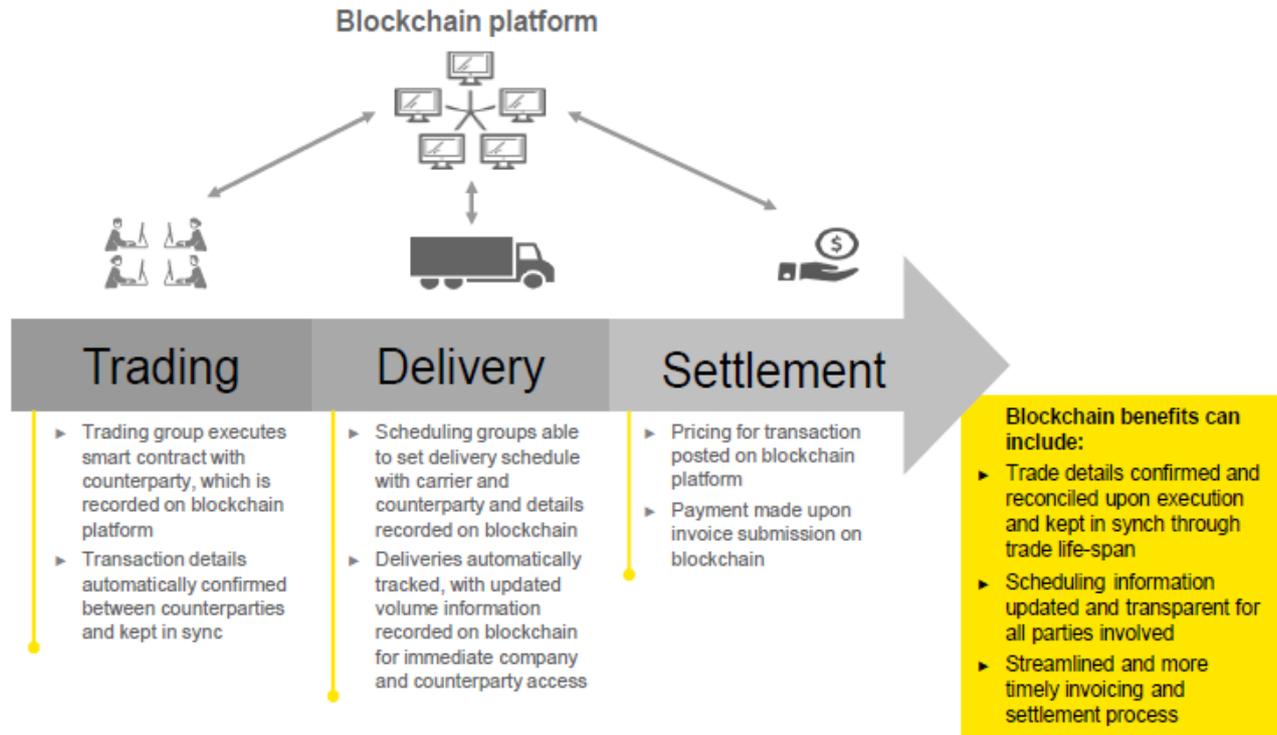


Figure 1. Blockchain illustrative example

The blockchain is an information storage and transmission technology, transparent, secure, and operating without a central control organ.

By extension, a blockchain is a database that contains the history of all the exchanges made between its users since its creation. This database is secure and distributed: it is shared by its different users, without intermediaries, which allows everyone to check the validity of the chain.

There are public blockchains, open to all, and private blockchains, whose access and use are limited to a certain number of actors.

A public blockchain can therefore be likened to a large public accounting book, anonymous and unfalsifiable.

The first blockchain appeared in 2008 with the bitcoin digital currency, developed by a stranger appearing under the pseudonym Satoshi Nakamoto. It is the underlying architecture [3,4].

If blockchain and bitcoin were built together, today many actors (companies, governments, etc.) are considering the use of blockchain technology for other cases than digital currency. Any public blockchain necessarily works with a currency or a token (token) programmable. Bitcoin is an example of a programmable currency.

Transactions between network users are grouped into blocks. Each block is validated by the nodes of the network called the "minors", according to techniques that depend on the type of blockchain [5]. In the bitcoin blockchain this technique is called "Proof-of-Work", proof of work, and consists in solving algorithmic problems.

Once the block is validated, it is time stamped and added to the block chain. The transaction is then visible to the receiver as well as the entire network. The decentralized character of the blockchain, coupled with its

security and transparency, promises much broader applications than the monetary domain.

We can classify the use of the blockchain in three categories [6]:

- Applications for the transfer of assets (monetary use, but not only: securities, votes, shares, bonds ...).
- Blockchain applications as a registry: it ensures better traceability of products and assets.
- Smart contracts: These are stand-alone programs that automatically execute the terms and conditions of a contract, without requiring human intervention once started.

The fields of exploitation are immense: banks, insurance, health and pharmaceutical industry, supply chain of many sectors (agribusiness, luxury, international trade, distribution, wines, aeronautics, automobile ...), music industry, energy, real estate, and vote.

Above all, the blockchain paves the way for a new web, the decentralized web, and a new digital economy, the economy token. To understand their issues, it is crucial to avoid caricatures about cryptoactives, which are at the heart of this revolution.

Of course, these promises are not without challenges, be they economic, legal, governance or ecological. That's why we make the choice at Blockchain France to approach blockchain technology from every angle, without bias, and without hiding its limits.

3. Potential Benefits of Blockchain

3.1. No Intermediary

The blockchain could revolutionize the monetary system because it no longer requires the intervention of a banking

structure. With digital currencies using blockchain technology, it is possible to make transactions directly from individual to individual without intermediary. No need for a banker, an administration that notes and stores all the information concerning your monetary exchanges. All this information will be included in the blocks of the chain. Encrypted currency is, in a sense, its own banking administration.

3.2. A Saving of Billions

According to a report by the Goldman Sachs, the removal of all these intermediaries could save billions of dollars each year to banking institutions, financial markets and many industries. The report talks about \$ 2 billion for the United States and \$ 6 billion worldwide. But many other sectors could also save very large amounts of money by using this technology.

3.3. "Uberize Uber"

The blockchain could also bring about a real transformation of what is today often called, wrongly, the participatory economy or the sharing economy. Companies like Uber, AirBnb and Deliveroo have built their empire on this system of pooling independent workers and customers. These companies reaped profits by withdrawing a commission each time a service was performed. As explained by Usine Digitale, a blockchain technology could eliminate these intermediaries by directly connecting customers with service sellers. And all administrative matters would be kept ... in the blocks.

3.4. Traceability and Transparency

The information contained in the blockchain cannot be deleted or modified. Once an operation has been completed, it will remain etched forever in the chain of blocks: this allows knowing exactly the path traveled by the information. This traceability and transparency is a great asset for banking institutions - and those who monitor them. With this system that could "revolutionize finance", banks could regain the confidence of a part of the population.

3.5. Fight against Fraud

Since fraud is often a matter of manipulating numbers and letters on paper, what better than a technology with which one could store all kinds of information without modifying it? The blockchain plays this role. Sale of social housing, scam per kilometer on used vehicles, offshore companies. All this information could be found chronologically in a secure and easily searchable file.

3.6. Scientific and Medical Research

The creation of the Sophia robot series is a good example of the usefulness of the blockchain. The start-up Singularity NET has been able to develop these articulated artificial intelligences with a human face thanks to a

blockchain system. No information could be lost along the way and researchers were able to work on the project from several corners of the globe. This lack of fragmentation of the work of the blockchain also interested the European Union, which sees applications in the field of health, the management of personal data or in the processing of logistical issues.

4. The Use of Blockchain in Commodity Management

If the first application of the blockchain was the financial disintermediation, the removal of intermediary between two actors can be applied to many other domains.

Thus, some imagine and already put in place blockchains dedicated to energy issues, and in particular electrical. The best-known example is the Brooklyn microgrid, which allows individuals to interact without going through a third party.

Some produce electricity through their own solar panels; others buy this electricity to consume. There is no longer an intermediary company: transactions are managed via a blockchain.

It is possible that this process of disintermediation extends to other parts of the value chain of the electrical system. In particular, blockchain technology can help:

- Make transfers of assets, especially energy, capacity or guarantees of origin

- Keep transparent and immutable records, and therefore certify

- Automatically conclude contracts between actors

Already, Engie is experimenting in the Yonne blockchain technology on a network of connected water meters. The app is built to automatically trigger the convenience store call in case of a leak.

In France always, the company Lumo uses the blockchain within the framework of crowdfunding. Investors are paid in Solarcoins, which is a cryptocurrency rewarding photovoltaic producers. Investors can use it to pay their electricity bill. On the other side of the Rhine, RWE is also interested in the use of blockchain in electric mobility.

Energy companies are already experimenting with blockchain applications. However, these applications remain for the moment of the field of experimentation. The blockchain has yet to demonstrate its ability to transform the operation of the energy system while maintaining a high quality of service.

Blockchain's energy consumption is directly related to "data mining" - solving mathematical problems to validate transactions and earn rewards. In the Bitcoin data mining system, every machine in the network competes for mathematical problems. The first one that solves all the problems "wins", receiving Bitcoins for its efforts, and at the same time blocks of transactions are validated

This large number of machines operating simultaneously results in enormous energy consumption. In March 2018, the Bitcoin network achieved 57 TWh of annual electricity needs, or about 86.5% of the Czech Republic's electricity consumption. A single bitcoin transaction requires more than 500,000 times more energy than a Visa transaction, resulting in huge carbon emissions. Fortunately, there are

alternatives to this system that could allow Bitcoin and other blockchains to become more sustainable.

For example, the current transaction validation system, "proof of work", could be replaced by another system called "proof of stake". This system consumes less energy because only certain (minor) nodes are programmed to do all the data extraction. Instead, it is shared according to users' interests in the network, with a 10% stake, which means that you make 10% of "mining". Therefore, it is more energy efficient.

To summarize, blockchain technologies such as Bitcoin currently use huge amounts of electricity. However, there are many alternative "working principles" that could help prevent energy wastage. Blockchain's ability to authorize peer-to-peer energy transactions could significantly disrupt the energy sector, including by encouraging decentralization.

The increasing use of small renewable energy facilities, such as rooftop solar panels, can create challenges for power grids designed for large centralized power plants. By allowing peer-to-peer energy trading and encouraging local consumption at the time of production, the blockchain could stabilize the network, helping this decentralization.

However, if the users were outsourcing themselves by paying money directly, many traditional market roles could be put into question, including distribution system operators, distributors, suppliers, metering operators, and more. Electricity, load sharing groups, etc.

Brooklyn Microgrid of New York, PowerLedger in Australia, Conjoule in Germany and many others have already successfully piloted community energy and peer-to-peer projects. However, in Europe, these experiences are limited to pilot projects subject to regulatory exemptions, or private micro-networks - peer-to-peer remains far from universally deployed.

The blockchain can also be used for monitoring electricity with at least two goals: rewards for renewable energy production (e.g. SolarCoin) and renewable energy certificates or carbon credits. For those who want to invest in renewable energies but lack funds, blockchain technology could allow collective investment, ensuring a fair and transparent sharing of revenues.

Renewable energy has completely changed the way energy is distributed within a community. In fact, by becoming more democratic, renewable energies have become accessible to individuals and any individual (almost) can produce, distribute, sell or buy his own energy without being dependent on a single distributor. Thanks to blockchains, energy trading between individuals is now possible. In the blockchain, all transactions related to this democratization of energy can be secured, stored, and transmitted between several parties.

The blockchain does not require a central authority because the participants validate the transactions themselves.

5. Conclusion

The blockchain technology can be a powerful tool for reconciling energy flows and trade flows, but it is not meant to replace all existing systems: it will first have to demonstrate its ability to do better and at a lower cost. It still lacks a "killer app" that would finally install the blockchain in the field of energy.

The blockchain is a technology that will allow individuals to access the information of a system directly without going through arbitrary intermediaries. With a blockchain system, transactions are easier, more accessible and controlled by everyone in the same system. Historic institutions, especially energy distributors or banks, see their systems turned upside down. Thus, the blockchain has a social impact above all that changes the way we view the administrations. We could see in the future for example the disappearance of physical banks (the rise of online banking only accelerates that). As for the blockchain of Solarcoin, it is for the moment only the carrot that drives individuals to produce more renewable energy because it is more symbolic than enriching. If blockchain manages to spread in other areas, it is all administrative systems that could be revolutionized. It is the democratization and facilitation of administrative tasks: the consumer, historically passive, becomes an actor.

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