

# The concept of the blockchain technology model use to settle the charging process of an electric vehicle

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**Abstract**—Blockchain is a technology that uses a chain of blocks, which allows sending and storing information in a distributed way, creating a decentralized data register. The article presents the concept of using a model, that uses blockchain technology, in the area of electromobility, which is the process of charging electric vehicles. The work shows the concept of a model in which through the use of block chains it would be possible to settle the purchase and sale transactions of electricity in the charger. This technology could allow partial or complete decentralization of the process, full automation without involving intermediate units. The article also shows how such transactions could be carried out automatically and without supervision - giving certainty of previously established principles, rules and assumptions implemented on the basis of smart contracts. The article presents a new idea for using the model for settlements in the area of the electricity market.

**Keywords**—blockchain, charger, electromobility, electric car, electric vehicle, charging point, Initial Coin Offering, EV, Vehicle to Grid.

## I. INTRODUCTION

It is certain that one of the upcoming global technological changes in the modern automotive market will be the detonation of the combustion engine as the main drive unit [1] and replacing it with an electric motor. The consequences of this change will be felt by all participants of this market [2]. Electromobility has become an inherent concept of considering the future of transport. In addition, the concept Vehicle to Grid (V2G) makes you perceive a car not only as a means of transport, but also as an energy store. The development of electromobility may help the power industry (talk about Polish energy), but it will also be a big challenge for it. Investment needs resulting from the introduction of electric vehicles into the market and construction of electrical vehicle charging infrastructure will force modernization and expansion of transmission and distribution networks, construction of electrical charging infrastructure will contribute to technological development, and the handling of the charging process will give the opportunity to develop new concepts such as the use of blockchain technology.

However, in order for electromobility to become a viable alternative to conventional means of transport, its implementation must be preceded by modeling of ongoing technological processes and a comprehensive economic analysis and, most importantly, development of the infrastructure of chargers.

Today, a relatively long chain of intermediaries is involved in the electricity market and the energy trading process, starting with the producer and ending with the recipient. Will it be possible to establish direct contacts between these two market entities if blockchain is used to settle payments for the purchase and sale of energy? Can the recently adopted EU RED II directive enforce such legislative changes so that recipients can freely exchange energy? The answer is unambiguous. The use of block technology to settle the charging process for electric vehicle is possible, but it requires a lot of support not only on the ideological side, but also on the part of infrastructure development, charging points and popularization of electric vehicles.

## II. THE CONCEPT AND OPERATION OF BLOCKCHAIN TECHNOLOGY

Blockchain technology originally appeared to support new forms of the digital currency, but over time it has become a promising basis for transactions supporting sharing economy, understood as economic models based on selfless sharing, exchange and paid product lending [3].

Currently, Blockchain is using intensive and effective cryptographic concepts, such as creating unique and unambiguous "data imprints" using one-way hash functions (so-called hash functions), which are in practice used for quick identification of digital data and verification of data integrity [4]. An important component of blockchain technology, which will find its application in the further part of the work, is asymmetrical cryptography that allows to secure the exchange of information or even to encrypt information exchanged between two parties, without the need for the parties to agree on one common security key. Asymmetric cryptography is the basis for blockchain. Each participant in the blockchain network interacting with other network participants each time uses their private key to sign the transactions they send and

the public keys of the recipients of these transactions. Another important technology to mention is time marking - all objects and events in the blockchain are very precisely placed on the synchronized timeline and together they create a reliable, chronologically arranged history. The element that is a pillar, providing unique blockchain functional features are the mechanisms of consensus and smart contracts - which will be the basis for accounting for the charging process of electric vehicles [4,5].

When describing the blockchain much easier, we can say that it is called a block chain that is capable of storing and transmitting various time stamped information in a distributed manner. This information is compiled in data blocks that are parts of the whole chain. Such a system can create a completely decentralized register or database [2]. This distributed database, based on a peer-to-peer network (P2P), has no highlighted central node, or any "super administrator", so that the blockchain does not have a single point of failure. In addition, the mechanism of consensus and continuous verification of records, secures the transaction system against abuse and other types of manipulation [3].

Blockchain can be modified depending on the application in a given field of the economy. Typically, the cryptocurrency blockchain properties are:

- decentralized and distributed database, that all data and the entire blockchain history is available for download by every network user,
- data (transactions) recorded in the block are immutable and irreversible, i.e. the transaction register that the blockchain offers, cannot be edited,
- transactions are encrypted by cryptographic tools,
- the transaction register is public - everyone has access to the entire transaction history [6].

### III. BLOCKCHAIN IN THE ELECTROMOBILITY SECTOR

From a technical point of view, blockchain is a tool that allows both the registration of transactions between parties, as well as the space constituting a computational platform for executing programs called smart contracts.

The idea of settling an electric vehicle charging transaction using blockchain technology could operate on the basis of a platform, system or application dedicated to these activities. Every recipient (charging vehicle) and electricity producer (electricity grid, renewable energy source) and the seller (car handing over energy in the V2G concept), through the platform would be able to register and thus become its user. Users and charging stations would have to have the appropriate software installed, working with the platform, so that information about the downloaded, generated and entered into the network energy, would be saved and entered into individual blocks of the chain. Such logging would allow to record the entire history related to the consumption and energy profile for each individual user (car) and each kilowatt hour. Additionally, the kept register would have information on all power flows in the charging station and transactions made, thanks to which the created database of operations together with their entire history would be updated on an ongoing basis

(Fig.1.). According to the principle of blockchain technology, transactions would be disseminated and verified between individual network nodes, and the database would not anticipate any changes to the information collected.

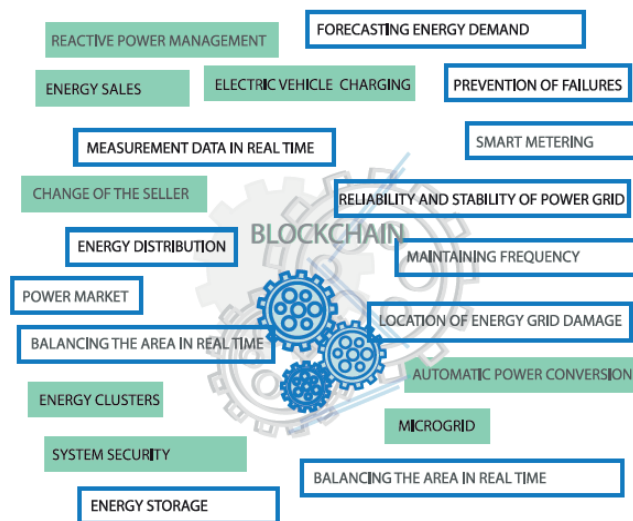


Fig. 1. Application of blockchain technology [3]

The whole operation of the application would consist in registering all transactions with the participation of the loader (Fig.2.). The process of charging an electric vehicle, the process of reselling energy with EV thanks to V2G, ie the process of the amount of electricity collected and delivered registered in the electronic currency. The whole idea of transaction execution in the proposed model should be defined through smart contracts, ie computer protocols that check and enforce the performance of the contract [5]. Smart contract is performed automatically, based on previously identified rules and rules, via a computer running software (code). There are alternative and wider definitions, but for legal purposes and the use of blockchains to account for the charging process of an electric vehicle, an important element is the elimination of human control [5].

These smart contract rules for charging electric vehicles and for putting energy into the grid are, for example, fulfilling: the payment condition, the amount of energy given, and even enforcing obligations, minimizing exceptions and minimizing the need for intermediary trust. The related economic objectives of the process are to reduce the risk of fraud, enforcement costs and other transaction costs [7,8].

Conducting the settlement process on the basis of an smart contract limits the costs associated with trust to a minimum (this results from testing the algorithm). In addition, because an smart contract is an automated computer protocol, human error is irrelevant. Transparency in the reading of contract terms is very high, because each result based on the input data is tested [9].

In addition, the control of the network functions necessary to perform the contract may be implemented in a neutral blockchain environment that does not distinguish any of the process participants. According to the concept, the

infrastructure combines real market participants with contracts (contracts), and the power grid is used to realize energy flows. The trade and technical layer are separated from each other, and the rules of their virtual coexistence are determined by the code of a smart contract in the blockchain network [10].

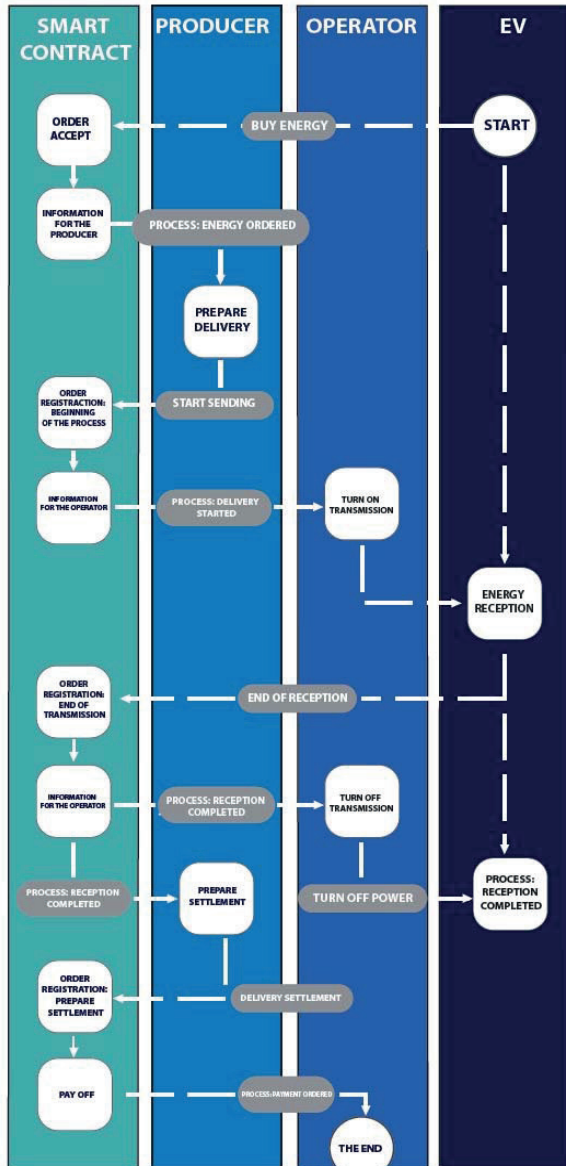


Fig. 2. The concept of the billing process [10]

Blockchain thus enables a certain, direct and secure exchange of financial assets between two peer-to-peer users, which is a huge advantage over traditional solutions that cannot be done without a trusted third party to settle transactions.

Thanks to using the peer-to-peer network (P2P) and combining the activities of using smart contracts, purchase and sale transactions could be carried out directly between all users registered on the platform. The algorithm treated as the initiator of individual transactions, would perform them on the

basis of strictly defined assumptions and rules for their conduct. Thanks to this, the energy trading would be so automated that the settlements would be carried out automatically considering all assumptions given by individual users. [5].

#### IV. INITIAL COIN OFFERING A TOOL FOR RAISING CAPITAL

Undoubtedly, linking the development of electromobility with the development of industry and the integration of electric vehicles into the electricity grid requires adequate financial outlays. The purpose of financing and managing the infrastructure for charging electric vehicles may be a tool for acquiring equity capital, i.e. Initial Coin Offering (ICO). The capital requirements for creating a network of chargers supported by the described model using blockchain technology are undoubtedly enormous. Therefore, developing the network thanks to the Initial Coin Offering system seems to be one of the better ways to finance this type of enterprise.

Initial Coin Offering is a method of acquiring capital in the form of cryptocurrencies or tokens to finance a venture (i.e. an electric vehicles charging station). The organizing party presents its plans and assumptions in a document called White Paper, which is also a contract template. He is responsible for organizing the marketing campaign and providing the infrastructure supporting the initiative through a smart contract based on blockchain - a computer program assigning investors a certain number of tokens in exchange for cryptocurrencies. After fulfilling the specified condition, the token gives the investor certain rights. Depending on these rights, is distinguished:

- utility tokens - they give rights in the form of eg priority to goods or services provided by the issuer,
- security tokens - allow users to participate in the profits of the undertaking, give the right to vote honored to the token
- personal tokens - represent the share in profits generated by a natural person

From ICO crowdfunding it differs in that it gives additional benefits, which will be awarded to the token after a strict condition, which ensures smart contract in an automated way [11,12].

The assumption of the model is precisely the use of ICO to raise funds for launching a network of chargers based on the settlement of transactions for the purchase and sale of electricity in blockchain technology. An investment in a network for charging electric vehicles is unpredictable, risky, and the horizon of return from it is unknown. We are not able to accurately predict up to 10 years when there will appear a million electric vehicles on our roads (talk about Poland) [13]. Therefore, the strategy of obtaining capital under ICO for such a risky investment can help finance the electronic currency market and its issuance. Initial Coin Offering could be an ideal solution as a capital donor because the electromobility market is currently focused on speculation, idealization, forecasts and the time horizon is of lesser importance and is very difficult to define.



## V. SUMMARY

The approach to the development of electromobility presented in the work and the blockchain concept of operation assumes the use of technology in the process of charging electric cars. This concept is also dictated by the growing demand for mobile electric devices equipped with high-capacity energy storage facilities (the price of which is a significant part of the cost of the entire car) [14]. By using block chains, sales and purchase of electricity could be carried out directly and autonomously between generators and energy consumers. Such a settlement model results in partial or complete decentralization of the process, because some of its solutions would not require the operation of any central supervisory body. Such transactions based on smart contracts could be automatically based on predefined rules and rules.

Blockchain is a kind of computing platform identified with a distributed way of recording information about transactions. This type of technology may be the right choice when designing systems (they fit perfectly into buy and sell transactions), but other technologies will be more appropriate for many purposes. It is important to decide whether the use of blockchain is right when undertaking a design challenge. In particular, if the system is used only within one organization or organizational unit, in this case it is not recommended to build it on blockchain technology at this time [15].

Using blockchain technology to model the electricity accounting system in the charging process, as well as the opportunity to participate in the market of the infrastructure being built, it goes beyond the financial application of technology. Aspects for which blockchain can become a factor in changing business models are primarily more efficient and secure applications, the exclusion of unnecessary intermediaries, or numerous innovations [5]. By modeling and describing the entire charging process accounting system, including the energy, economic and financial analysis of the process, possible scenarios for the development of electromobility itself, rather the infrastructure to support it, should also be taken into account. As of today, the network of electric chargers is very dispersed and irregular. It is not possible to ensure the continuity of moving to distant distances. This is undoubtedly a barrier to the development of this concept. Opposite the financial restrictions comes the

possibility of using ICO as a method of raising capital. The financial contribution from ICO through the purchase of infrastructure will give the option of modeling the settlement of the charging process using blockchains. Going against energy, however, is another industry that has noticed the potential of blockchain technology.

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