HOW BLOCKCHAIN TECHOLOGY MIGHT ALTER THE ELECTRICITY SECTOR – AN INSTITUTIONAL PERSPECTIVE

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Overview

Blockchain technology offers the potential to change how contractual relations evolve and how transactions are executed in the electricity system. While the current discussion about blockchain focuses on technological aspects, we want to shed some light on the potential institutional implications of blockchain technology in the energy sector. At the heart of the analysis stands the question how the institutional design and regulation of the hierarchical organized energy supply chain might change due to the application of blockchain technology in the (near) future.

In a nutshell, a blockchain is a distributed, digital peer-to-peer register, which stores every transaction between two connected agents in a ledger. This ledger is distributed on all connected nodes. This distributed data set consists of a collection of historic data about all transactions made. Each transaction is added to the dataset as part of new block (in a linear and chronological order), which results in a full record of all transactions made between two parties. As each connected node carries the same data set, algorithms can be used on each node to verify transactions. Thereby, blockchain technology provides the basis to execute transactions without the involvement of an intermediate that both parties trust, as the blockchain itself provides the trust to all involved market parties.

Currently, the application of blockchain technology is focusing on the financial sector (e.g. BitCoin). But the development does not stop here. Rather, current projects try to investigate how blockchain technology might be applicable to the energy sector as well. For example, the Dutch transmission system operator TenneT cooperates with Sonnen, a battery storage provider, to aggregate flexibility from 6,000 battery storages in Germany for network congestion management via a blockchain application. There is actually a long list of pilot projects that address different use-cases for blockchain technology in the energy sector, the Brooklyn MicroGrid and PowerLedger in Australia are probably the most prominent examples.

Methods

We take a closer look at the different global initiatives that apply blockchain technology to the energy sector and based on these insights we derive first estimates how the future institutional design of the energy sector might change due to these new technical solutions. Our analysis is based on the assumption that some of these initiatives that want to apply blockchain to the energy sector are actually going to be successful in the near future. New Institutional Economics provides the theoretical fundament for the analysis. With a focus on transaction costs we analyse how different applications of blockchain solutions might change the way how transactions are executed within the different segments of the energy supply chain: generation, networks and retail. As the energy sector is a highly regulated business we put special emphasis on the interdependencies of blockchain technology and energy regulation.

Results

Different blockchain applications strive to challenge the generators and retailors business case, but the institutional setup of these two segments is not likely to change significantly due to the application of blockchain technology. Rather, what we can expect is that blockchain technology will reduce market entry barriers to the generation and retail sector, and thereby increase competition in these markets. For example, blockchain technology offers the potential to solve one of the key problems of renewables that hinder them from taking over further market shares from conventional generators: it gives them access to markets that are not usually accessible to small-scale distributed resources. For example, in most flexibility markets, in the US as well as in Europe, you can only

participate with a capacity of 500 kW, 1 MW or even 5 MW and the qualification processes for these markets are very demanding for decentralized resources. Most photovoltaic power plants are far smaller; in Germany, a photovoltaic power plant has an average size of less than 50kW. Therefore, distributed renewables and especially photovoltaics cannot access the existing flexibility markets (notwithstanding the question whether they have a financial incentive to do so). This problem is addressed by the before mentioned blockchain project of TenneT and Sonnen in Germany. A similar effect can be expected in the retail sector where different Peer-2-Peer (P2P) blockchain solutions strive to enable network users to trade electricity on a very decentralized level without the need for intermediaries. P2P trading is at the heart of many projects, for example Power Ledger in Australia, Grid+ in the US or the NiceGrid project in France.

From an institutional perspective, the application of blockchain technology to the network sector might result in the most significant institutional changes in the future. We discuss two issues in greater detail in the paper.:

First, we show that network operation might change with the application of blockchain technology. More specifically, we discuss how smart contracts could be used to provide local network services (like voltage control, reactive power etc.) on the distribution grid level via autonomous processes. The automated operation of the distribution networks might result in a new institutional design with either very few network operators (as the final legally responsible entity) or a very fragmented system with many different operators even on a very decentralized level of the final costumers.

Second, we discuss the potential implications of blockchain technology on the regulatory process of the network operators. Under the assumption that the regulator can have real-time access to the network operators' transactions, information asymmetry between the regulator and the network operator can significantly be reduced, leading to a more efficient regulation scheme and network operation. While the first reaction of the network operator to such a detailed supervision might be very reluctant, transaction transparency might incorporate the potential for the network operator to performed tasks and market based relations with other parties that would otherwise not be possible, due to the regulators lack of information and overview.

Conclusions

The blockchain technology starts to change the way we organize financial transactions. Among others, the current discussion about this technology points at its potential in the energy sector. Within this paper we provide a first but not final scratch of the potential institutional implications the blockchain might have in the energy sector. All thoughts in this paper are based on the (yet to be confirmed) assumption, that we can apply the blockchain technology to a significant extent. Due to the novelty of the blockchain technology it is too early to provide concrete and final statements, rather we point at new areas of research in this context.

We conclude that driven by blockchain technology the most significant changes in the institutional environment of the energy sector can be expected in network operation. Furthermore, regulation might gain significantly from blockchain technology, especially due to a reduction of information asymmetry between regulators and regulated entities.

Yet, it needs to be specific to which extend this will be possible. Further research is required to specify how exactly we can apply the blockchain to the electricity sector and how this might challenge the existing institutional framework. Therefore, the paper concludes with a roadmap for further research related to the institutional implications of blockchain technology in the energy sector.