Enabling a Smart Port Energy System through Blockchain

White paper report

Presenter:
Ilhan Ünlü (Blocklab)

Moderator:
Dr. Milos Cvetkovic (TU Delft)

Report Authors:
Amy van Groot Battavé (RSM)
Bart van Lunteren (RSM)

Abstract

This white paper is set to communicate the contents and valuable insights from the discussions held during the practical case study workshop on blockchain as enabler for smart energy port systems at the Living Energy Conference 2019 in Rotterdam, The Netherlands. Presented *[link to presentation]* by Ilhan Ünlü from Blocklab to the participants. And moderated by Dr. Milos Cvetkovic from TU Delft.

The rise of renewable energy sources and the rising impact of data change the behaviour of energy systems. The fundamentals of data-enabled energy balancing has great implications for port energy systems. Based on discussions during the Living Energy Conference 2019, held on 12 April 2019 in Rotterdam these four challenges are identified comprise (1) regulations for local energy exchange platforms, (2) identifying the needs for digital services and data analytics, (3) potential of blockchain technology in this setting, and (4) potential privacy related concerns. Conclusions for the business and research community based on these discussions are presented.

Outline

This whitepaper aims at conveying some of the key issues that need to be taken into account when digitalizing energy practices in the Port of Rotterdam and assessing the potential role of blockchain in these system .These issues are based on discussions during the Living Energy Conference 2019, held on 12 April 2019 in Rotterdam. The remainder of this whitepaper is organised as follows. Section 1 discusses the context of this whitepaper and sets the scene. Section 2 discusses the audience for which this whitepaper is created. Section 3 summarises four identified challenges of technological appliances in smart port energy systems. Section 4 delves into each of these challenges and Section 5 provides conclusions of this whitepaper.

This white-paper report will be used as a basis to set up follow-up innovation projects with the stakeholders and to reach a wider international community.

Section 1: Introduction

At the present day, the Port of Rotterdam is facing two crucial transitions. The two challenges comprise (1) the transition from traditional to renewable energy sources, and (2) the growing digitalization of port operations. The aim of this workshop is to discuss the digital energy future of the port and address challenges that may impede the transformation into a "smart port" energy system.

Digital services and data analytics can aid in the integration of renewable energy sources (RES) in the port's energy system. Local balancing of energy demand and supply has become increasingly difficult due to the intermittent nature of RES, requiring more flexibility of other energy assets. For a large industrial cluster such as the port of Rotterdam, wherein multiple dependencies rely upon a robust energy system, coordination of different flexible assets can be facilitated by formation of a centralized platform for exchanging energy and flexibility. Blockchain is put forward as one of the key technologies to enable energy sharing with parties acting within the port ecosystem.

Section 2: Audience

This whitepaper benefits the research and business community. A variety of challenges are identified that could foster and contribute to the energy transition in a smart energy port system. These could serve as relevant inputs for researchers in designing, conducting, or facilitating research around this topic. Furthermore, for the business community this offers insights in what challenges are currently perceived in both industry and academics. These could serve as starting point in combatting those with contributions of other involved parties.

Section 3: Challenges

The workshop identified four challenges:

- Defining platform rules and governance for local energy exchange;

- Identifying needs for digital services and data analytics required to facilitate local energy exchange in the port;
- Understanding and assessing the potential of blockchain technology in future smart port energy systems and local markets;
- Privacy-related issues for a centralized data sharing platform.

Section 4: Contents

Discussion outcomes of the workshop are presented with respect to the challenges defined above. Thereafter, key takeaways of are consolidated and presented in Section 5: Conclusion.

Defining governance of a local energy exchange platform for the Port of Rotterdam

Enabling a centralized platform for local energy exchange in the port of Rotterdam poses to be more of a regulatory challenge rather than a technological challenge. Defining the local market as a balancing market firstly raises the question of what is meant by local balancing and where responsibilities lie. From a national balancing perspective, a crucial requirement for the local energy exchange platform within the port is that local optimization must always fulfil the purpose of national balancing. In its present form, the Dutch balancing market requires parties to take responsibility for ensuring grid balancing by financially penalizing parties that cause an imbalance to the grid. Therefore, a local energy exchange must, by design, take the national electricity market into account. Furthermore, the need for clearly defined balancing responsibilities *within the port* is also addressed. If the local energy exchange affects the national market, which of the parties within the port will be responsible is yet to be determined.

A digitized local energy exchange also poses the question of who is responsible for operation of a central trading platform. In essence, there are three choices for market design. Deals can be made bilaterally, as an exchange between two parties, they can

be supervised by a broker, and they can be auction driven. One of the methods put forward is the formation of a joint venture, whereby shares are held by the different parties active in the port. Furthermore, in defining the platform for local energy exchange, deciding upon the parties able to engage in the energy exchange is equally as important. Allowing for third-parties to interact with the platform, trust and a common understanding must be provided by the platform. Blockchain is a low-cost, accessible-for-all technology that allows for multiple participants to trade energy and flexibility. By design, use of blockchain technology tackles ownership and trust related issues.

Defining the underlying market structure of the local energy exchange is of relevance to industry participants. Initiating a local market within the port, with a gateway towards the national market is one of the options put forward. However, enabling a local electricity market must be handled with care. For smaller electricity markets, it is much more difficult to optimize and handle the inefficiencies presented as opposed to larger electricity markets[1].

Lastly, formation of a local energy exchange could also be viewed as the creation of an ecosystem wherein different energy sources exist next to each other. Ecosystems may also provide new business models for external parties, for example independent storage solution providers, to serve the ecosystem and simultaneously drive business.

Digital services and data

With regard to digital services and data analytics, machine learning algorithms and automated decision-making tools are mentioned as important tools in local energy exchange solutions for two use cases. Firstly, energy production forecasting has become increasingly difficult with the introduction of intermittent RES, for which human analysis proves to be limited. Machine learning algorithms however have shown to deliver more accurate forecasts in shorter time spans. Secondly, local

[1] *An energy market for trading electricity in smart grid neighbourhoods.* IEEE, pages 1-6.

trading of energy or flexibility can be fully automated by artificial agents which are able to trade in a matter of seconds without requiring human intervention. Yet, realizing such a system starts with having high fidelity measurements on distribution levels, which is currently insufficient. An action point put forward is the need to have a session on the design of this centralized digital market. Already existing public trading platforms may be useful for local use as well, as an alternative for blockchain technology.

Besides the opportunities for blockchain, artificial intelligence (AI) has also been assessed as a potential driver in designing digital energy services. In decentralized systems, these could play an important role, as is already seen in high frequency financial trading. A task that could be delegated to AI driven systems regards building algorithms for virtual power plants. Yet, there are also some critical issues. Generally, AI these days are good at pattern recognition tasks. Therefore, it was agreed that AI could serve a purpose in energy systems, potentially in an advisory role.

Blockchain

Two main applications are identified for use of blockchain technology. First of all, blockchain can be used to verify the source and actual amounts of demand and production in the market, and is able to keep track of all transactions being done. Secondly, blockchain technology can contribute to the regulation of peer-to-peer electricity markets. Micro-transactions, which would be the case for a local electricity exchange in the port, would be too costly for central intermediaries, as is done now in the electricity market. Blockchain is a low-cost alternative which can facilitate micro-trading in the port accessible to all parties that connect to the blockchain. This also implies that the entity that performs the best job can get the deal of exchanging energy, instead of the person who is granting the deal.

These micro-transactions could be coupled to a digital currency. There are several examples, such as the Juliet in De Ceuvel in Amsterdam, in which a digital currency for energy exchanges between households is currently being tested. Since the aim of such a currency is to trade within the community, this might offer interesting

potential for a port cluster, yet due to potential interactions with entities outside of the port system, a currency might not be feasible.

Privacy-related issues

Privacy related issues may arise if the port of Rotterdam decides to use a centralized and shared platform for local energy balancing. This highly depends on which data is required to be shared and the level of detail. However, if a local market system is enforced, privacy issues will be less worrisome, since price signals will be used as the tool to indicate the level of flexibility locally available. If prices are used for local market coordination, profits are induced, resulting in reduced transparency and perhaps reducing local optimisation potential. Blockchain can be used as a means of avoiding privacy related issues since it is possible to control the layers of visibility to participants.

Section 5: Conclusions

From the discussion points above, the following main conclusions can be drawn. Enabling a local energy exchange platform for the port of Rotterdam requires up-front regulations to identify where responsibilities lie and which market structures will control the local exchange. Digital services and data can help build the business case for a local energy exchange, whereas blockchain technology provides a cost efficient platform that holds the potential to both facilitate local energy trading as well as to verify the source and amount of energy demand and production. Furthermore, Blockchain technology may also aid in potential privacy issues as shared data visibility can be hidden in the blockchain.

Section 6: Additional resources

D. Ilic, P. Goncalves Da Silva, S. Karnouskos, M. Griesemer (2012). *An energy market for trading electricity in smart grid neighbourhoods.* IEEE, pages 1-6.