Executive Summary

INTRODUCTION

Major technological improvements in renewable energy technology and reduced construction costs over the past few years have led to a rapid development of solar and wind generators all across the globe. Unlike the big coal and gas generators, renewables were much faster and cheaper to build, sparking the rise of many privately owned generators joining the energy market and forming the foundation for a new distributed energy system – a system where energy buyers would not need to rely on one single source of electricity but could potentially pick and choose the producers that would fit their needs the best and transact with them directly.

The first sign of this new emerging disintermediated system has been the rise of corporate Power Purchase Agreements (PPAs). These arrangements were structured around a transaction whereby a large corporation would commit to buy electricity directly from a new generator over a long period of time (typically 10+ years) for a fixed price. This helped generators to gain financial certainty and businesses to lock in low electricity prices offered by new renewable technologies.

Blockchain as a distributed and immutable ledger seemed like the perfect fit for this new emerging distributed system which is why WePower designed a platform using blockchain to enable direct transactions between electricity users and producers.

Transactions in electricity markets are settled in hourly, 30 minutes or, in some markets soon, on a 5 min basis. This means that to process transactions between a single consumer and producer would create at least 8,760 data entries for a year and if you take a 10-year tenure of a standard PPA this would grow to 87,600 data entries at the point when the contracts are issued. In order for this system to reach meaningful scale, it needs to support thousands of buyers and hundreds of generators.

To build a scalable and cost-efficient technology stack we needed to test and optimize our technology on different blockchain platforms.

Our first test involved tokenizing an entire year's worth of energy consumption and production data and putting it on Ethereum blockchain. The tokenization process involved converting a real-world asset, in our case energy, into a digital token that could be stored, monitored and traded on a blockchain.

WHY BLOCKCHAIN?

Energy markets around the world differ significantly, which causes limitations when it comes to using particular business models. The universality of the blockchain and the energy tokenization approach provides a common cross-market technological base - allowing WePower to easily adapt to local market requirements without fundamentally changing our technological solution.

We set out to test our energy tokenization technology as close to the real world environment as possible including its interaction with PPAs. We aimed to test the feasibility of blockchain technology for energy data recording, storage and representing power purchasing logic. For that - a huge dataset was needed which is why we partnered with Estonian Transmission System Operator (TSO) Elering.

UTILIZING ESTFEED

Estonia provided the ideal infrastructure for this type of test as the county has 100% smart meter coverage and a data sharing platform called Estfeed. Estfeed enables consumers to download and share their data with any persons or companies whom they choose, as well as anonymous and aggregated data, such as that used for WePower's pilot. This made it easier for us to conduct our tests.

TOKENIZATION PILOT GOALS

Lack of scalability is one of the biggest roadblocks when it comes to blockchain solutions for the energy market. There is also a lack of reference architectures for combining centralized IT platforms with public blockchains. In order to succeed, we needed to:

- Design a testing environment that would be realistic, yet fully compliant with privacy regulations.
- Test the asynchronous integration layer between WePower's centralized platform and a public blockchain.
- Test the processing capacity needed to run the WePower trading platform at a national level.

THE FIRST STAGE OF THE ELERING PILOT

The Elering pilot conceptually started in September 2017, when the Memorandum of Understanding was signed formalizing the initiative to pilot the uploading of national scale energy data into a public blockchain.

By January 2018 it was clear that the scope should be the tokenization of one year's worth of electricity consumption and production data. To reach that goal, Smart Energy Contracts were written, detailed concepts and test plans were composed, data prepared and necessary integrations finalized. In October 2018 the test itself was finally concluded.

ANALYZING AND OPTIMIZING THE DATASET

In the first stage of the pilot, we generated Smart Energy Tokens to represent energy ownership and match consumption with production. Our analysis was based on real-world electricity production and consumption data. In Estonia, the main source of renewable energy is wind.

During the data preparations, the main focus was to examine the data sets we were going to use for the test. With the full set of granularly separated data points - it soon became clear that the storing of data would have taken roughly 14 years.

Without further optimization, the cost of tokenizing the most granular data set possible for 2017 (6.132 billion data points) would have resulted in a cost of EUR 210 million. That timeframe and cost level were unrealistic and alternative approaches and additional optimizations had to be considered.

For loading the consumption and production data into the blockchain we chose to optimize by aggregating the data onto the zip code level instead of granular consumption point level and summarizing hourly consumption into monthly consumption.

The result: 26,000 hours and 24TWh of energy consumption data was turned into 38,973,240,000 Smart Energy Tokens.

CONCLUSION

The first phase of the Elering tokenization pilot helped WePower to validate and verify the logic and processes that will be at the core of the WePower platform. We have been able to generate Smart Energy Contracts and Smart Energy Tokens based on real-life data on various granularity levels.

During this process of data preparation, we gained valuable experience in dealing with an Energy System Operator. It is possible to exchange data in various formats, but the existence of the Estfeed data hub that provides data in a unified format makes it possible to operate the WePower energy contracting and trading model more efficiently and will be the focal point of further innovation when more data hubs are implemented across markets in various countries.

We acknowledge that the scalability of Ethereum blockchain currently has limitations. However, the problem is being tackled by Ethereum developers with plans to implement sharding, i.e. partitioning data into subsets, and moving from energy-intensive Proof of Work to a more environmentally friendly Proof of Stake consensus model. Ethereum co-founder Vitalik Buterin has stressed that there is a need for solutions that mitigate expensive storage costs that could escalate exponentially as the system expands.

The balance between cost and transaction confirmation times has to be considered continuously while communicating with the blockchain. Practical lessons from coding perspective will be analyzed and implemented in the coming stages of WePower's pipeline. While Ethereum is currently one of the most mature blockchain solutions, supporting smart contracts, a fully decentralized application for large-scale autonomous usage is not yet feasible for large-scale energy trading on the blockchain. For now, a hybrid solution will be utilized while monitoring the rapid development of Ethereum as well as other blockchain/DLT technologies.

NEXT STEPS

As the overall challenge has several layers of complexity, our approach is that of continuous research and development. The solution must be able to be scaled to 5 min energy market settlement time-frames, millions of users and terawatt-hours of electricity. For this purpose, WePower has created and validated several concepts and assumptions introduced in greater detail here: PDF / GITHUB / R&D page.

Our R&D team is focused on the features that are required to further optimize WePower's platform for large-scale commodity trading purposes (for example, electricity and energy price settlement and netting). The roadmap is leading the way to concepts that support WePower in growing to a fully functioning virtual utility.

When we have the essentials covered, then will look deeper into energy market behavior. This is also known as the second phase of the Elering pilot, where we will explore different aspects of secondary Smart Energy Contract marketplace dynamics.

Ensuring cyber security is correctly addressed throughout the entire project lifecycle is a critical success factor. With additional functionality being added to Smart Energy Contracts and the Platform's functionality, we will continue to ensure these functions do not compromise the security of users.