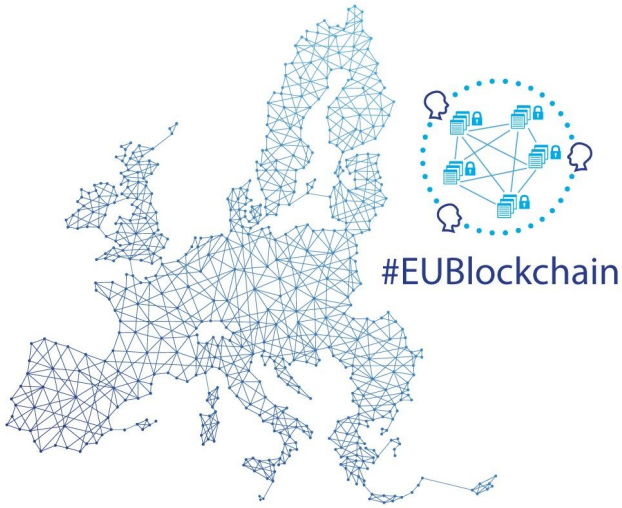
EU BLOCKCHAIN OBSERVATORY & FORUM

Workshop Report - Energy and Sustainability – Online Video Conference, 5 March, 2020



By the European Commission, Directorate-General of Communications Networks, Content & Technology.

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Presentation: Overview of use cases in the energy sector; Presentation of the academic paper

Alexander Denzler (Lucerne University of Applied Sciences and Arts)

- The day opened with a presentation of the academic paper on blockchain-based P2P energy markets written for the Observatory by the Lucerne University of Applied Sciences (which is an academic partner of the University).
- The status quo in energy markets is very top-down focused. There are a few energy producers who put energy on the grid, the grid distributes energy to consumers, and some consumers feed energy back into the grid (prosumers).
- The market is very much a standardised one with the two main players being
    - Distribution System Operator (DSO)
    - Local Power Distributor (LPD)
- If you are a prosumer and have extra capacity, you can sell it, but you have to go through the LPD as the trusted third party. That means:
    - The LPD sets the price (to its favour)
    - Limited incentives for prosumers to generate a surplus as they have no pricing power

    - And therefore limited support for distributed energy production (photovoltaic and wind power, for instance)
- Yet more and more people are becoming prosumers and energy production from this source is becoming significant. That means energy production is getting more decentralised. Yet there is a disconnect with the centralised status quo of energy distribution.
- Blockchain could help us deal with this problem. It can help cut out the middleman via a decentralised auction house (DAH). In this case, the blockchain takes the place of the trusted third party. So here the question “do you need a blockchain” in this particular case can be answered with a clear “yes”.
- A blockchain-based P2P energy market would likely feature the following multi-layered architecture (here in reverse order, from bottom to top):
    - **Device layer:** all the gadgets in a home, but can also be a solar panel, battery or boiler. Basically anything that consumes energy and/or provides data.
    - **Smart meter layer:** Situated between the devices and the outside world, smart meters gather data, package it and send it out. Today such meters are not designed for blockchain or P2P use cases, so they need to be blockchain-enabled so they can in effect act as nodes in the network.
    - **Transmission layer:** Once you have the data, you can send it out it on the transmission layer. Today there are different technologies for this, including Long Range (LoRA), General Packet Radio Service and Power Line Communication (PLC), but they are not always reliable enough for a P2P market.
    - **Communication layer:** This is the blockchain and related technologies layer, including smart contracts and some sort of identity framework. Here is where consumption and production are recorded and where payments can be processed. Issues here include who issues identities, what kind of blockchain to use, how to ensure the economics make sense and, assuming this is run by a consortium, what is the governance model of both the network and the consortium.
    - **Management layer:** This layer is responsible for processing data coming from lower layers, taking decisions, propagating them downwards and regulating the behaviour of the system, among other things to make sure the network does not become overwhelmed.
    - **Decentralised Auction House (DAH):** All of this information is fed to the Decentralised Auction House, which acts as the clearing house of the network, and allows for the actual P2P energy trading.
- Such an architecture enables a new setup in which we can change how data is managed and how people interact in the network. Because all players in the market are now equal and the LPD is no longer governing everything, we can set new kinds of incentives. Prosumers can safely generate more energy than they need for themselves without the need to install big batteries as they know they can sell excess energy at market prices any time they want. This creates a bottom up approach, which allows for

local communities to generate and consume energy themselves. This in turn enables a higher degree of energy autarchy in local communities.

- In a P2P energy market, the seller and buyer set the prices themselves through the DAH, which acts as the matching engine. Prosumers would have their infrastructure (for example, a solar panel) certified in some way, and this certification would be available on the blockchain. All actors (buyers and sellers) would also deposit collateral in a mutual account. If one of the actors does not honour the terms of the agreement, for example does not buy or sell as much as agreed, the LPD would step in to assure the balance of the energy grid. In this case, the LPD would be awarded funds from the escrow account.
- Smart meters are key to P2P energy markets. Unfortunately, today's smart meters tend to be slow and the communications uplinks are not always reliable. There are also many different kinds adhering to different standards. This is a barrier to P2P networks. Smart meters are also protected by law. Their software and hardware cannot be altered. Setting up a P2P energy would therefore likely require new meters, which is a barrier as well.
- Open challenges and issues in P2P energy markets include:
    - Understanding the legal hurdles and political resistance, especially among incumbents. This includes thorny issues around data protection, as the energy consumption data of an individual is very likely to be considered personal data under the GDPR.
    - Choosing the right protocol that best fits the needs of the network. There is a lot of choice in the blockchain world today, but many protocols are only one or two years old, so not only is the technology immature, but it is still not certain which protocols will stand the test of time.
    - How to best structure a decentralised auction house and design the smart contracts behind it. Who will design the DAH? How can we best design the incentives and business models? How can we write secure algorithms to do automated trading?
    - Governance of a P2P system. What are the roles? What is the business logic? How do we best design a win-win situation?
    - Design and building blockchain-ready smart meters

Panel discussion: Reinventing energy grids with peer-to-peer and decentralized technologies. Promises and first implementations

Alexandra Schneiders (UCL); Jun Takashiro (Japanese Ministry of Economy, Trade and Industry); Ken Timsit (ConsenSys); Etienne Gehain (Engie)

- When talking about decentralised energy production and identifiers, we are talking about decentralised systems. Blockchain is one database technology that is particularly suited to decentralised systems, but these systems require much more than the database part For example there are the various hardware components like smart meters in the P2P energy market example.
- While blockchain is not required for everything in this stack, when companies try to set up decentralised ecosystems, often the main stumbling block that they encounter is payments.
- Payments solutions, because they deal with money, are complex and require a large development and maintenance effort. That makes it important for everyone to adopt a standard solution instead of having a different solution for each hardware provider. A standard solution can also help drive adoption. If you have to convince people to install solar panels, then produce extra power, that is already more work. If on top of all of that you have to convince them to maintain multiple accounts for different networks and auctions, that is a huge problem. So it is advisable to use a payments option that is already widely used. Some blockchain networks have proven they can do this.
- The French power company Engie has been experimenting with blockchain in local energy markets and has worked on several use cases, including (non-binding) renewable energy certificates for actors on the local network, which was a good proof of concept for other uses cases where you have to certify that something happened with an asset.
- This experience showed that the real hurdles in local trading use cases are mostly regulation and then managing the roles and responsibilities of the various actors. What happens if there is a blackout? Who is liable?
- In P2P energy trading, smart contracts are the main selling point for using blockchain technology. But there is confusion about smart contracts, even among experts. Smart contracts can enable P2P financial transactions and automate agreements, but they cannot automate the physical movement of energy. You cannot guarantee that the energy being sold is the same energy that the seller produced. There are many known issues around smart contracts. Because they are immutable, they can be risky especially for individuals who may not be familiar with them: once deployed, there is generally no going back. There are also questions around the legal recognition of smart contracts. But all in all they should be seen as an essential element of P2P energy trading.
- Fairness and equity will be important considerations in P2P energy markets. Everyone should be able to take part, not just those who can afford a solar panel on the roof. Designers of these markets will have to be careful not to inadvertently discriminate.
- Consumers generally will not care whether blockchain is under the hood or not. One draw of blockchain however is helping everyone feel like they are part of a community effort. Gamification can also be an excellent motivator for people, and so a tool for adoption.
- An important question in these types of blockchain projects is return on investment. While it is fairly easy to imagine the benefits to society of P2P energy markets, for

example more renewable energy or greater energy efficiency, it can be harder to demonstrate a short term return for a specific investment. This can unfortunately be a hurdle. This is why, while we have seen a lot of experimentation in these markets, we have not seen many examples in production.

- Grid+ in Texas provides an interesting example. Grid+ Energy, which is developing a full energy distribution platform for residential users, discovered an unexpected use case in payments processing through the ability to process payments daily. There are countries outside of Europe where collecting and managing payments is very expensive for providers. The ability to reduce this cost has provided practical ROI for the company at this early stage.
- In terms of legal and regulatory issues, it will be important to have the legal ability to use data stored on a blockchain to generate an invoice. Right now in France, for example, by law only the consumption data coming from the IT system of the Distribution System Operator can be used. This is quite understandable considering the status quo architecture. But if you cannot officially settle transactions and send money because the data cannot be legally used, then the whole thing remains a theoretical exercise. So we need the approval of some kind of standard to allow this to happen.
- Nor is it just a question of standards. Now it is not legally possible to take data from a blockchain and use it to trigger a smart contract. That legal barrier needs to be removed. And once you have consumption data in a smart contract and use it to trigger payments using for instance some kind of stable coin, you often have the issue that most commercial banks will not open an account for you. Government support to educate financial institutions and get them comfortable with these types of transactions is needed.
- Governments need to enable experiments, which makes regulatory sandboxes an essential tool to allow policy makers to see what blockchain is all about. In Japan, where the Ministry of the Economy has made P2P energy trading a priority, there is such a sandbox. The Japanese government also makes it possible to use energy data in other sectors. This was a change in the law that came about because of experience in the regulatory sandbox.

Presentation: Blockchain solutions for the energy sector: lessons learnt from the EWF

Meerim Ruslanova (EWF)

- The next presenter gave an overview of the Energy Web Foundation (EWF) and showcased two of its projects.
- EWF is a non-profit foundation founded by the Rocky Mountain Institute and Grid Singularity with the aim of developing open-source blockchain-based digital infrastructure for the energy sector to help catalyse a large-scale energy & blockchain ecosystem.

- EWF's open-source technology stack has three layers (here from bottom to top):
    - **Blockchain:** The Energy Web blockchain, an Ethereum-based public blockchain that is governed by qualified energy industry players.
    - **SDKs:** Two software development kits, EW Origin and EW Flex, to build applications on that blockchain.
    - **Application layer:** 7 energy blockchain dApps in 3 domains: certificates/guarantees; demand response; and electronic vehicles (EV) charging

- **EW Origin**
    - EWF's EW Origin is a tool for building applications for automated, streamlined, cost effective & accurate renewable energy tracking and trading of energy attribute certificates (EACs).
    - It covers the four basic steps of the value chain: i) registering assets and users; ii) issuing compliance certificates; iii) matching demand and supply; and iv) enabling users to cancel and redeem certificates.
    - EWF is focusing on developing streamlined EAC marketplaces in the ~30 countries that issue I-RECs, starting with PTT in Thailand but soon also including Turkey and El Salvador. (An I-REC is a type of voluntary renewable energy certificate popular in the developing world.)
    - Thailand has an ambitious renewable energy target. Today the country's power mix is largely fossil-based, putting a lot of focus on residential solar power generation. To reach its goal the country is relying on both corporates and individuals. But there are limited options for the private sector to get involved, so it needs support to promote renewable energy projects.
    - PTT, a local provider has partnered with EWF to build a digital marketplace for I-RECS. The marketplace is scheduled to go live in mid 2020 and would be the first marketplace in the country open to buyers and sellers of different sizes and that would be capable of providing various products in line with the I-REC standard,
    - The project's first step is to tackle the issue of procurement of I-RECs. It will then move towards supporting new and small-scale assets, as well automating parts of the PPA process. (PPAs, or Purchase Power Agreements, are long-term agreements between a renewable developer and a consumer for the purchase of energy.) Ultimately the project aims to create a support mechanism for the existing renewable energy projects, as well as facilitate new project development. Once a voluntary market for renewables is mature enough, the project hopes to propose that regulators establish a mandatory tracking system.
    - Origin is also working to implement other projects, focusing on four domains where reliable, scalable tracking of renewables unlocks additional value.
        - **REC & PPA markets:** Expand existing markets by lowering barriers to entry for all buyers and generators.

        - **Electronic Vehicle (EV) optimization:** Provide verified “green” charging products and reward EV owners for flexibility.
        - **Sourcing low-carbon fuel:** Certify low-carbon fuel sources for EV drivers and others; support markets for emerging low-carbon fuels like biogas.
        - **Scalable carbon markets:** Support emissions tracking, trading, and reporting at the state and national level.

- **EWF Flux:**
    - The EWF’s EW Flex is a tool for onboarding distributed energy resources (DER) onto the grid. enabling them to participate in markets and share data and provide services. (A DER is a local device, like a rooftop solar panel, that generates electricity and is connected to the grid.)
    - Onboarding DERs onto the grid and electricity markets is a complex process. Asset and user information is siloed across individually managed registries and databases. Achieving interoperability and coordination is expensive, and DSOs are often not aware of where DERs are located.
    - EW Flex enables trustless data sharing, DER onboarding, and settlement using any number of market models or incentives.
    - In Germany, EWF executed a pilot together with E.DIS, a German transmission system operator (TSO) and Sonnen, a battery company. The pilot aimed at testing how Sonnen’s 17 customer-sited battery systems (54 kW of capacity) can take excess power from E.DIS wind and solar that would consequently balance the grid, avoid curtailment of renewable energy assets and provide the power for households’ use.
    - When the system is running, renewable energy assets produce electricity, part of which is required by the grid and part of which is excess. E.DIS recognizes it and requests flexibility services for the excess power from the batteries. Sonnen captures this demand and offers a fee and capacity. If E.DIS agrees, then the flexibility service is confirmed and batteries are activated. A transaction then occurs and Sonnen is paid on Energy Web’s test blockchain, Volta.

Panel discussion: How to accelerate use cases leveraging blockchain for sustainability?

Pietro Grassano (Algorand); Miroslav Polzer (Climate Chain Coalition & GLOCHA); Maiko Meguro (European Commision); Ana Karen (ClimateTrade)

- The transition to the zero carbon society, which has been agreed in the Paris Agreement and the European Green Deal, can be expected to become the largest market on earth.

Blockchain can be used for tokenisation, creating digital assets not just for payments or to identify stakeholders in a network or contributions to an energy marketplace, but also to create tradable digital assets out of climate change outcomes. That is important as today public goods outcomes are not rewarded. Tokenisation might be one of the key ingredients, along with AI and IoT, to make this possible. Along with work on unique object identification, we also need work on unique outcome identification. This could be part of what hopefully could become a global blockchain infrastructure for climate change, and hopefully catalyse a new ecosystem for climate stability and environment. This is something that can only be done with public sector support.

- Blockchain could also be a big part of new solutions for carbon markets. The main things that blockchain brings to the table here is traceability and transparency. These are basic to provide trust for the person or company who wants to make the transaction. Here too, this can only be done with public sector support.
- There are in fact many promising use cases for blockchain in green energy. On a high level, blockchain could help defragment the systems landscape, contributing to interoperability between different projects, though many of the issues in these cases are off-chain ones, like governance. Climate change use cases are exciting, but we also have to work on the surrounding problems too.
- The idea for carbon markets has been around for over 25 years. Blockchain could accelerate things by providing a shared framework. It can help bring about an equilibrium between public and private interests. It could also be a powerful tool for re-internalisation of potential externalities. If the impact of your activities is made transparent, as could be done on a blockchain-based platform, then you might be more inclined to change your energy behavior. PlanetWatch is building the first immutable air quality data ledger in the world, on the Algorand blockchain, and it uses tokens to incentivise people to generate real-time air quality data and earn utility tokens they can use for goods and services on the platform.
- Tokenisation and gamification can be powerful mechanisms to incentivise the production of reliable data at the citizen level. This can in turn be used by local authorities or companies who are creating their own carbon footprint balance sheet, for instance. We have seen similar ideas work in non-blockchain contexts, for instance white certificates.
- Digital assets will have a big impact in the energy space, because they allow you to tokenise information. The world is also demanding new models of transparency, which blockchain can help deliver. Along with AI and IoT it will be an important part of the infrastructure.

Working session: Priorities for the EU related to sustainability of blockchain technologies

All participants

- Sustainable energy is a big issue facing companies and also the public. There has also been a lot of bad press for blockchain due to the energy question.
- Discussion therefore took place around how we can assess the energy usage of blockchains, measure their improvement, and get that message out.
- This included suggestions for an EU ratings system for blockchain sustainability, an idea with its pros and cons.
- Another option is to fund more targeted research, so we have better facts and figures and therefore make better comparisons.
- By looking at real energy use per transaction, for example, we may be able to compare blockchains to other sectors, for example cloud providers. That could also put the energy consumption of blockchains into perspective.

Appendix

Workshop slides

- EU Blockchain Observatory and Forum Energy Workshop Main Deck
- P2P Energy Markets Presentation
- EWF Presentation

Workshop videos

- Videos from this and all other workshops can be found on the EU Observatory website under reports.
- Videos specific to this workshop:
    - Energy Workshop video

Official agenda

Time	Activity
10:00	**Introduction and objectives of the day**

10:10	**Presentation: Overview of use cases in the energy sector; Presentation of the academic paper** Alexander Denzler (Lucerne University of Applied Sciences and Arts)
10:40	**Panel discussion: Reinventing energy grids with peer-to-peer and decentralized technologies. Promises and first implementations** Alexandra Schneiders (UCL); Jun Takashiro (Japanese Ministry of Economy, Trade and Industry); Ken Timsit (ConsenSys); Etienne Gehain (Engie)
11:25	**Presentation: Blockchain solutions for the energy sector: lessons learnt from the EWF** Meerim Ruslanova (EWF)
11:55	**Panel discussion: How to accelerate use cases leveraging blockchain for sustainability?** Pietro Grassano (Algorand); Miroslav Polzer (Climate Chain Coalition & GLOCHA); Maiko Meguro (European Commision); Ana Karen (ClimateTrade)
12:40	**Working session: Priorities for the EU related to sustainability of blockchain technologies**
13:30	**End of the day**