How Blockchain and Cryptocurrency boost Internet of Electricity

The vision of an internet of electricity (read my previous article) is becoming a lot more real with the growing understanding and adoption of blockchain and cryptocurrency.

Just to set the scene: "*In my mind we will move towards an internet of electricity shaped by the imperative of decarbonisation (supported by the electrification of sectors which today use fossil fuels), featuring distributed generation with a high share of RE, empowered by storage in all forms (grid, behind the meter and EVs), demand response supported by smart grid assets down to white goods – and a fully transparent cost and value structure that takes into account LCoE, cost of externalities, time and location of generation, value of ancillary services and storage, opportunity cost, etc.*

Going even a bit further out I believe we are on a trajectory towards a "neuronal electricity network" in which generation and demand are optimised on result – empowered by machine learning algorithms, while any transaction could be recorded in a blockchain and monetary transactions could be based on cryptocurrency. This would mean a total restructuring of the current ecosystem where we would not need any intermediary anymore and could hence optimise operation on entire system level towards cost and result without barriers."

There are many websites out there where one can learn about blockchain and crypto currencies such as Bitcoin and Ether. To get us going without too much theory let's just get some important basics straight which should suffice.

A blockchain is a public ledger (think of it as a file with information, stored and updated simultaneously across multiple computers) in which transactions are recorded chronologically and 'publicly' – and it needs three main components: users, nodes and miners.

Note: whenever I put something in ' ' that means that it kind of is like this – but one can think of exceptions.

Users can be humans or machines performing transactions (e.g. sending and receiving money or anything else 'non-physical' of value). A **node** is every computer on which a full copy of the blockchain is stored and constantly updated, so that in near real time the latest version of the blockchain is always available on every single node. Why is that? This helps making the blockchain practically resistant to hackers. If someone would try to change the content of the blockchain he would need to do this simultaneously on all nodes – otherwise the deviation would be immediately detected in the consensus process and the hacked version sitting on the hacker's node would be disapproved. Finally, **miners** are nodes with the permission to create the blocks of the blockchain in which the information is stored. In addition to that, when a block of transactions is created, miners take the information in that block, and apply a mathematical formula to it, turning it into a hash – a seemingly random sequence of letters and numbers. This hash is stored together with the block, at the end of the blockchain at that point in time and written into the header of the next mined block. That is another level of safety. The hash is created based on the content of the block. Let's assume a hacker could change the content of a block simultaneously on all nodes, then the chain would break at that point since the hash would differ from the header of the next block. A great online mock up helping to get familiar with this concept is https://anders.com/blockchain/blockchain.html.

The last thing I need you to understand before we move on to Energy is that there are 3 different types of blockchains: **Public Blockchains** – such as Bitcoin and Ethereum (Anyone in the world can explore it, perform transactions, consult them and participate in the consensus process.). **Corporate Blockchains** – such as R3 (Approved users can explore it, perform transactions, consult them but only a pre-defined set of nodes – e.g. hosted by several Classification and Certification societies – can perform the consensus process.). **Private Blockchains** – such as Multichain (Anyone in the world might or might not be able to explore it, but only a private group can perform transactions, consult them and participate in the consensus process.).

So now let's assume we have the classic setup one could consider reasonable for a smart city ecosystem: A centralized electricity system with large scale renewables, storage and flexible back up power interconnected to a decentralized electricity system with distributed generation, combined heat and power, electric vehicles, smart white goods etc. We will need all kind of sensors and smart meters, smart thermostats and assume all grid connected assets (anything that is connect to the grid – from the nuclear power plant to your coffee machine) are setup as an IoT environment and there are capable algorithms and communication protocols in place that allow any grid connected asset to interact with each other allowing for generation and demand capacity management optimised on result – honouring some hard settings (e.g. the hospitals operations theatre needs power no matter what). We of course need a good set of energy market rules as well – though maybe a machine learning process could help here to dynamically develop such rules to drive certain behaviours while constantly adapting to user preferences and best performance.

All these assets I mention above (and many more) provide services to / receive services from the grid – e.g. the generation/consumption of megawatt hours, non-generation/consumption of megawatt hours, delayed consumption (e.g. washing clothes another time of the day) and reduced performance (e.g. aircon in the mall temporarily allows 24 degrees Celsius instead of 21 degrees Celsius), ancillary services like static inertia, storage – and many more.

All these are basically transactions – transactions that we can record in a Public Blockchain. And if we couple this with a crypto currency – all these transactions could be valuated and paid for instantly – based on the real cost / market value of the service provided to / received from the grid – taking into account among others the individual LCoE or value, time, location, externalities, opportunity cost, etc. We would not need any intermediary anymore and could hence optimise operation on entire system level towards cost and result without barriers.

Let's as an example apply this concept to kilowatt hours. For a start, we would now be able to differentiate kilowatt hours from different sources (if we would want that we could differentiate down to individual generator level – e.g. a single wind turbine or a single solar panel) and guarantee that at no point in time e.g. more green electrons are consumed than available. If an individual or a company decides it only wants renewable energy they could restrict themselves to this mantra and optimise their setup accordingly. So, whenever they consume a kWh that is a transaction in the blockchain and one green kWh (maybe the most competitive) will be recorded consumed in the blockchain and paid at its current rate in crypto currency. Let's assume there is another company that also only wants to use renewable energy but are fine to defer consumption or reduce performance. In case there are not enough green kWh for company 1 then company 2 may be fine to defer consumption and leave the not consumed kWh to company 1 and will receive a reward for this… in crypto currency. That could be a premium on top of the price/kWh company 1 has to pay. That is a very simple example – but I hope it gives an idea of the endless possibilities of this concept – which will always reward the most viable solution, which might in cases be storage, flexible back up power, etc. – you name it.

In parallel a Corporate Blockchain would allow to watchdog that all grid connected assets are having valid certificates (blocks can have an inherent expiry date!), receive the required inspections and maintenance etc. – otherwise there is a breach in that asset's blockchain which immediately highlights deviation and a certain punishment could be applied or the asset is automatically taken offline.

In addition, there is another advantage enabled by this approach. Since there is no intermediary there are practically no cost for transaction and hence any transaction can be infinitely small. This would enable very new use cases – i.e. wireless charging of electric vehicles at a red traffic light. Even if just for seconds – it would not matter anymore. Having said that, the blockchain itself consumes a lot of energy. Mark Gimein in his Bloomberg article states that "Virtual Bitcoin Mining Is a Real-World Environmental Disaster" – and that is because the mining and hashing process needs so much computational power. The Economist article estimated that even if all miners used modern facilities, the combined electricity consumption would be 1.46 terawatt-hours per year!

The aim of this article is to introduce the principal of blockchain and cryptocurrency in a simple way and to get you started thinking how this could change the world – here based on an energy example.

About the author

Mathias Steck *(老马) is Regional Manager Asia Pacific, Energy & Renewables Advisory, at DNV GL.* *Before the merger of DNV and Germanischer Lloyd in September 2013 Mathias was the Regional Manager of GL Garrad Hassan Asia Pacific. He and his team of today 120 experts across the region deliver advisory services to the energy value chain including renewables and energy efficiency. Their expertise spans onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use, as well as energy markets and regulations. Mathias has 10 years of experience in the wind turbine industry. During this time he has performed a wide range of tasks as an expert in charge of structural components of wind turbines including reviews, inspections, expert opinions, failure analysis, technical due diligence, guideline development and technical seminars. Mathias has a German Diploma (equivalent to Masters Degree) in 'Civil Engineering and Environmental Technology' (2001) from the 'Technical University Hamburg-Harburg'. There he worked as a student assistant in the 'Department of Steel and Timber Constructions' and elsewhere at engineering company 'IWB'. Whilst studying, Mathias earned the 'Vordiplom prize of Hamburg Construction' for the top five intermediate diplomas and a stipendiary from 'Konrad Adenauer Foundation Germany'. Over the course of his diploma, Mathias also took the opportunity to study at the 'University of Manchester Institute of Science and Technology' specialising in concrete and steel structures as well as an additional Degree in Geotechnics. After graduation, Mathias worked as a junior engineer for one year at 'STRABAG', where his tasks included quotation processing, design, optimization, planning and project coordination for large-scale construction sites in Germany, Turkey, Hungary and Kosovo. Mathias joined Germanischer Lloyd in 2003 in the Wind Energy group. There he was involved in the inspection, review and computation of wind turbine foundations and towers and furthermore worked to develop the tools and Finite Element models of several wind turbine components and offshore substructures. Mathias took on the role of Project Manager for certification services and advisor for customers in India, China, USA, Japan, Korea and Europe. In 2008 he took on the role of Head of the Civil Engineering Group and then the Department Head of Renewable Energy Asia where he began building the GL engineering teams in India and China, being based in Mumbai and Bangalore, India from 2008 to 2011. Outside of these duties, Mathias has been active in various GL committees. He was the spokesman for the Germanischer Lloyd Industrial Services 'Economic Advisory Committee' and a member of the works council of the 'Business Segment Wind Energy'. Today Mathias is Director of several GL entities in Asia Pacific. Mathias has also co-authored a number of technical papers which covered research on reclassification of steel failures and the development and construction of wind turbines on land and at sea. To join Mr. Steck's professional network on LinkedIn, click here.*