

**There is a wave of renewable energy coming, which has great consequences for the grid. We are moving from a centralized energy system with a few players to a decentralized situation with million solar panels and batteries. To coordinate this effectively, energy companies are beginning to apply blockchain technology.**

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Our grid is relatively simple. Producers produce and consumers consume. But how long will it stay this way? Consumers produce energy more often, with solar panels on their roofs, for example. And maybe, in the future, we will attach house batteries to the grid. Everyone produces, consumes, and stores energy. To maintain the overview in such a system, researchers and energy companies are testing blockchain, the technology behind bitcoin. Three large companies that maintain the grid, including the Dutch TenneT, already announced that they will create their own blockchain system, called Equigy. In Italy energy company Evolvere has already tested a blockchain solution and in Australia, tests are being done.

### **A decentralized general ledger**

'Blockchain is an ICT-tool that allows for digitalizing a growing number of decentralized energy sources', says Tarek Alsaif, who works on smart energy systems design at the Wageningen University of Research. 'The amount of electrical vehicles, solar panels, heat pumps, wind turbines and batteries is growing exponentially. If we want to use the flexibility of these sources and keep them in balance, than we do need a digital platform.' What does this mean? Blockchain is mostly known as the technology behind the digital coin bitcoin. Because of blockchain it was possible to build a virtual coin, without it being controlled by one person or party. No easy task, because digital objects normally can be copied as often as people want. This would be a disaster for a coin that is supposed to be scarce. Usually this is solved by registering all coins in a central database. In this way one party is responsible for all the coins and the registration of the transactions.

This prevents the making of endless copies of the coin, because their existence is registered at one central space. Blockchain decentralizes this system. Instead of making one group responsible for the registration of all the transactions, it spreads the list of all the transactions within a network in which everyone is equal. This means that this is a sort of decentralized general ledger in which transactions are being registered without one person or group having the monopoly. 'A blockchain system is useful for renewable energy. You can support a great number of different actors that share information and market transactions with each other in a decentralized way' says David Vangulick, who works for the Belgian energy company ORES and does a promotion research about blockchain and energy at the Université de Liège.

### **Maintaining balance**

In the future a family with solar panels will sell its surplus of energy to the grid. One of the neighbors with an electric car opens up the battery at peak moments for the grid to store surplus energy, which is sold later that day. Smart, digital energy meters keep track of all these transactions which are being registered on a blockchain. 'The end users do not have to be part of the entire system', says Alsaif. 'They may not even know that there is a blockchain behind this. Someone may simply choose that his electrical vehicle should be charged at a particular time, but in the meanwhile the energy company can use it's battery to maintain the balance in the grid. By the end of the month, he receives an amount of money in his bank account.'

Such a system is being built by energy companies like TenneT, right here, right now in the Netherlands. 'We are a transmission system operator', says Martin van 't Verlaat of TenneT. 'We maintain the balance in the grid. We build and maintain the electricity poles that you see in the field. But we also do system management. For example, we make sure that the frequency of the grid stays at fifty hertz. This is a continuous process in which production and consumption are being attuned to each other in real time. When there are deviations, the power plants work harder or slower.' This system is about to change,

because of the wave of renewable energy that is coming. 'In the last decade we saw a massive increase of renewable energy' says Van 't Verlaat. 'Solar and wind are less predictable sources of energy, which means that complexity and dynamics are increasing when it comes to the grid.' Before this, grid management relied on power plants, which made it relatively easy to balance the grid.

'To be able to balance the grid better, we have to become less dependent on power plants. This was the reason that we looked at blockchain technology, which we can use to build a network for all new elements which produce or store energy. Solar panels, house batteries, electrical vehicles or heat pumps. They are flexible, but currently they do not have easy access to the balancing market. This is why we try to create an easily accessible system, where a pool of these devices has access to the market.'

### **Transparent administration**

By bringing these flexible elements into the grid now, TenneT hopes to need to do less long term investments. Families receive a payment for participating. According to Van 't Verlaat this payment is several hundred of euros per year, though this does depend on which elements are connected to the grid, the market, and the system. So, why do we need blockchain for this? Can a normal database not do the same, when it comes to building digital systems like these? 'With how we are setting up the system now, with a limited number of groups, we could have used other technologies' says Van 't Verlaat. 'That would have been easier in some cases, too. However, we have a vision for a future in which the energy market changes, and it changes a lot. In the future, we expect there will be energy production on all levels, and many groups that consume energy. This is why we chose blockchain. This way, we can validate if our approach results in flexibility. If you have a large number of actors, from people with solar panels to large energy companies, and you want a complete administration, you do need blockchain.'

### **Scale and rules**

Because of the large number of groups on the grid, that do not always trust each other, a normal database controlled by one player is insufficient, is the expectation. Blockchain, on the other hand, provides a way to keep track of the transaction in a decentralized way. 'This is how you create transparency when you allow for a large number of players,' says Alskaf. 'There are stakeholders and competitors who do not necessarily trust each other, like grid management, energy companies, aggregators or end users. In such a situation, it will not do to rely on a third party. All those stakeholders need to come together on one platform, and blockchain offers that possibility. If you could do this in company where everyone trusts each other, you probably don't need blockchain.'

There are technical issues to be solved before blockchain can connect millions of devices to the grid. One of the challenges is scale. Crypto currencies like bitcoin have had challenges for years with the speed with which they deliver transactions. A simple transaction of a couple of bitcoins can take hours. 'Current day blockchain can be compared to databases in the nineties', says Alskaf. 'It is a technology that is still in progress. It works on a small scale, but when it comes to large volumes or high transaction speed, blockchain still falls short.' Energy companies solve this problem by using a specific type of blockchain. 'We use a so called private blockchain', says Van 't Verlaat. 'A number of validated groups can participate, as opposed to public blockchains like Bitcoin, in which everyone can participate. This helps to manage the capacity.' Legislation is an issue too. In a number of countries, you can't simply sell energy back to the grid. 'If we want to achieve more than a number of pilots, the rules will have to change.'

### **Switzerland**

At TenneT they continue working on their pilot with great enthusiasm. 'In the Netherlands we have made a lot of progress', says Van 't Verlaat. 'We are currently wrapping up our pilot. If the results are positive, we expand it next year. We would like to do the same in Germany and Switzerland.' It seems that innovations like this are beginning to permeate the energy market. 'It starts to grow', says Vangulick. 'I do not expect it to be booming immediately. It must come together step by step. But within a year of five, we will know if blockchain is useful in this context.'

