Turning electric cars and household batteries
into distributed energy sources

Controlling weather-dependent renewable electricity production with blockchain

2

How can IT make our world more sustainable, save millions of Euros and improve customer loyalty and engagement? Europe is undergoing a widescale energy transition, replacing fossil fuels and nuclear power with renewable energy sources. TenneT is driving this transition for more than 41 million customers in the Netherlands and Germany by implementing a first-of-a-kind blockchain for energy. It enables a better integration of renewable energy sources into the grid, by using flexibility from widely-distributed devices such as electric cars and household batteries. The potential is huge.

By Kitty Döppenbecker

TenneT manages more than 22,500 kilometers of electrical grid and plays two pivotal roles as an electricity transmission system operator (TSO). First, it's responsible for long-distance transport of electricity within countries and across borders. Second, it has to guarantee a continuous supply of electricity by balancing supply and demand 24 hours a day.

More volatile grid

As renewable electricity generation accounts for a growing share in the overall power supply, the electricity grid is becoming more volatile. "Wind and solar power are largely weather dependent. There is a big impact if the sun does or doesn't shine, or if the wind does or doesn't blow. In the past we could easily rely on large power plants to give us a bit of extra power, or ask them to produce less in order to secure system balance," says René Kerkmeester, Digital Transformation Lead at TenneT. "It was a very predictable system," says Kerkmeester. "We also see much more volatility on the demand side than in the past. For example, we now have electric cars whose batteries need charging, but we don't know exactly where and when that power supply will be needed."

Re-dispatching energy

There's no surefire way to predict this fluctuating supply and demand, but TenneT must still balance the grid at all times. Often, there is a sudden increase in renewable energy production in northern Germany, as well as a rise in demand from industry and households in the south. Resulting grid congestions constrain the electricity to flow to where it is needed, requiring TenneT to curtail wind turbines in the north and to increase production from large coal or gas-fired power plants in the south. The cost of this process is now approaching 1 billion euros annually; these re-dispatch costs are passed on to consumers as part of the grid fee households pay in their electricity bills.

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Sustainable approach: 'crowd balancing'

'Crowd balancing' aims to source electricity from, and to store electricity in, decentralized, flexible units such as household electricity storage batteries and electric vehicles. However, before integrating these smaller electricity sources into the grid, TenneT realized that it would need to implement new technologies to support this change and solve two critical issues. Kerkmeester explains, "We needed a way to manage the electricity flow to and from these small, individual electricity sources. Furthermore, we needed a solution to accurately record and monitor those energy transactions to ensure they actually occur as reported, and to use that information as a basis for payment."

First-of-a-kind blockchain implementation

TenneT found the technology to accomplish its goals in blockchain. Blockchain offers new possibilities to securely and intelligently manage flows of electricity in networks with decentralized, distributed energy sources. TenneT has embarked on a first-of-a-kind implementation of blockchain technology in the Energy & Utilities (E&U) industry in Europe together with IBM. The blockchain platform built by IBM is a distributed, permissioned ledger system that provides an immutable record of transactions communicated between TenneT and its energy partners with cloud technology.

Turning car batteries into distributed energy sources

In the Netherlands, TenneT is working on a blockchain project with Vandebron Energie B.V., a marketplace provider of renewable energy. Vandebron links small-scale energy producers such as farmers with energy-conscious consumers. Vandebron's (approximately 100,000) customers get their power from this marketplace with more than 120 local sources. Many of the company's customers also drive electric vehicles, charging them at their homes.

TenneT will draw power from the Vandebron electrical network to supplement the grid in times of highest demand. Participating Vandebron customers will make the capacity of their car batteries available as distributed energy sources to help TenneT balance the grid. The process will be transparent to the car owner, who will simply plug the car in to charge it, as usual. When TenneT needs to increase power in the grid, charging will briefly stop, and the car owner will be compensated for the interruption. The blockchain records each car's energy availability and every transaction in response to signals from TenneT.

Storing energy generated by solar panels

In Germany, TenneT is cooperating with sonnen GmbH, which manufactures and distributes home battery and energy-storage systems. →

"We needed to manage electricity flow from small individual electricity sources and accurately monitor energy transactions."

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René Kerkmeester,
Digital Transformation
Lead, TenneT

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René Kerkmeester, Digital Transformation Lead, TenneT

The sonnen batteries store energy generated by home solar panels or collected directly from the electrical grid when rates are lowest. Typically, homeowners use the stored energy from these batteries to power their home or sell it back to the electricity distributor when rates are highest.

For this project, sonnen has created the sonnenCommunity, a network of home energy storage systems that form a virtual energy pool for TenneT to tap into. The blockchain solution designed and developed by TenneT and IBM records the transfer of energy between the grid and the flexible devices, so that TenneT always has visibility into the pool of available energy and storage capacity. TenneT can then use the devices to absorb or discharge excess power in a matter of seconds when and where required, helping reduce transmission bottlenecks in the grid.

Lower electricity costs, higher earnings

This alternative to re-dispatch measures, particularly in areas of higher power demand, helps reduce the occurrence and associated costs of increasing the energy output of fossil-fuel or nuclear power plants. It also helps increase the use of renewable energy by reducing the need to curtail wind energy generation at times of insufficient transport capacity. Homeowners benefit from lower

electricity costs and can earn money each time they provide power to the grid. The process is transparent to the homeowner, and the blockchain ledger helps ensure transaction accuracy and transparency between sonnen and TenneT.

Increasing customer loyalty

The blockchain technology enables TenneT to facilitate and trust the thousands of recorded transactions in the secure ledger. In both projects, the partner companies manage their networks of distributed devices and their relationships with their customers. TenneT interacts with Vandebron and sonnen to set prices and manage payment transactions to the companies. In this way the energy partners, rather than TenneT, manage the relationship with the end consumer.

The expectation is that sonnen and Vandebron will acquire more customers and increase customer loyalty and engagement as more citizens decide to participate in this crowd-balancing initiative. TenneT also anticipates that positive results from its initial blockchain implementations with sonnen and Vandebron will encourage other energy companies and aggregators to enter the new crowd-sourced energy market.

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Standard for Europe

Through its crowd-balancing projects in Germany and the Netherlands, TenneT is paving the way for consumers across Europe to participate in the energy transition from fossil fuels to renewable energy. "We believe that blockchain could potentially form the basis for a new European energy system, and become a standard for other European countries," concludes Kerkmeester. ●

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