

UKPN's Constellation project shows how renewable energy is driving edge compute adoption in the utilities sector

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In 2019, the UK Government revised its Climate Change Act, which legally requires the UK economy to reach net-zero emissions by 2050 (the previous target required an 80% reduction in emissions from 1990 levels by 2050). With net zero expected to require a high degree of societal shift away from fossil fuel and combustion sources, as well as the deep electrification of the transport and heavy industries, the UK must dramatically increase its capacity to produce clean, renewable electricity. However, the UK could fall short of its net zero target if changes are not completed that will enable the existing power distribution network to handle greater capacity, as well deal with fluxes in demand in a more-efficient and flexible manner.

More consumers now have the ability to produce their own electricity such as via rooftop solar panels and on-site microgrids and hence the electricity distribution network, which was designed to efficiently manage the flow of electricity to the customer, is now on the receiving end of significant energy flows. Consequently, electricity utility companies are having to entirely rethink the management of their infrastructure to support the growing reliance on low-carbon energy and the move away from a one-way to a two-way grid.

Adapting to this new environment will be almost impossible for utility companies to accomplish with their pre-existing industrial control systems, which are built on proprietary systems and hardware. It will require the kind of elastic scaling and flexible distribution of workloads that can only be facilitated by the adoption of edge-native computing. For operators, this development will open up the potential for new revenue streams because deterministic connectivity will be critical for these transformative projects. However, this may also lead to new competition for the traditional utility companies.

Electricity companies are adopting edge compute technology to adapt to renewable energy; this creates revenue opportunities for operators

The Constellation initiative, created by the UK Power Network (UKPN), which maintains electricity networks in the South East region of England, and an ecosystem of partners, is a pioneering project that will adapt the utility for a renewable future by transforming its electricity substations into digital, interoperable and future-proof edge compute platforms. The project is at the trial stage, but UKPN has already virtualised some of its substations, consolidating three applications on a rack/device that it is calling the Constellation Cubical.

UKPN wants to modernise the way that it monitors and manages its infrastructure. Like other electricity companies, it uses intelligent electronic devices (IEDs), which monitor infrastructure and feed data/signals to radio telemetry units (RTUs). To help adapt to a bi-directional and dynamic grid, it decided to deploy three applications at the substation level. These applications work on separate aspects of the grid to optimise operations, minimise outages and increase capacity by allowing dynamic changes in the power network, and each application is produced by a separate vendor (GE, ABB and Siemens).

Instead of taking a traditional approach and using three RTU units for each application, UKPN was able (with assistance of its vendors) to disaggregate the hardware and software elements and run the applications virtually

on a server in the Constellation Cubical using a VMWare hypervisor. The management and monitoring of the applications remain in the public cloud (Microsoft Azure), but the Cubical can run autonomously. As with every edge project, connectivity is critical and Constellation is using a network slice provided by Vodafone's 5G Standalone (SA) network to support economically scalable and reliable substation-to-substation communication, at latencies below 10ms.

By virtualising its substations, UKPN can reduce the amount of hardware that it needs for the substations, as well as minimise the hardware required to deploy a platform that will enable it to move to a more-flexible, software-based model of application deployment and management. Edge compute of this kind opens up opportunities for operators, particularly in terms of their network services, which can guarantee service reliability and low latency. However, operators should also be aware of a competitive threat: digitally transformed utility companies would be well-positioned to sell a range of services to both consumers and enterprises using their network of substation industrial edge compute nodes. Services such as surveillance and monitoring, IoT smart-home services or even edge compute itself could compete with operators' activities in those markets.

Initiatives such as UKPN's Constellation project improve the UK grid's reliability and flexibility, helping to meet net zero targets

Distributed network operators (DNOs) such as UKPN are now evolving into distributed system operators (DSOs)¹ and are having to manage a power network that is capable of importing and exporting power. To address this, UKPN's Constellation solution can reliably connect more small-scale renewable distributed energy resources (DERs) to the network.

The Constellation solution can access real-time data about the operation of various distributed grid devices from its virtual substations, which it can analyse to match changing energy demands with generated energy. This will reduce the likelihood of future widespread renewable energy disconnection or curtailment. In turn, UKPN can help the UK to expand its portfolio of renewable energy resources, power grid resilience, as well as reduce costs for consumers.

UKPN aims to release enough renewable energy capacity to power more than 700 000 homes in the East of England, saving around 65 000 tonnes of CO₂ emissions (equivalent to 38 607 return flights from London to New York),² as well as saving consumers more than GBP750 million on their energy bills by 2050. Although this is a relatively small proportion of the UK's renewable energy requirements by 2050, the Constellation solution illustrates how other 'ecosystems' (involving operators and DSOs) can leverage a smart substation architecture and public 5G network slices to drive improved flexibility, reliability and capacity of low-carbon energy generation across the UK.

¹ DNOs are companies that own and operate the cables and towers that bring electricity from the national transmission network to homes and businesses. DSOs share many of the same responsibilities as distribution network operators, but there is a new emphasis on the active, data-driven balancing of supply and demand.

² Vodafone (22 July 2021), [Vodafone to provide 5G for UK Power Networks' world first smart substation trial.](#)