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As the use of electricity soars in the move to decrease our reliance on fossil fuels, smart grids have become an essential element in enabling a stable energy market. An AI and analytics-based smart grid will require the ability to process data locally and quickly - this is where edge computing fits. This article explores the benefits of the combination of smart grids and edge computing.

Smart grid is an electricity grid system that uses data and analytics to optimise that way decisions are made to deliver electricity. Part of this includes the use of smart meters to track customers" electricity usage, IoT sensors to monitor pipelines, but, more importantly, AI mechanisms to balance supply and demand proactively, particularly as more energy supplied on the electricity grid comes from variable renewable energy sources, such as wind and solar.

Global emissions from fossil fuels are on the rise, with 34 global tonnes of CO2 emitted worldwide in 2020. Even though 2020 was one of the first periods in recent years during which global CO2 emissions were predicted to decline, there is still no signs that this trend will continue once lockdowns are eased. One way to do so is by using more renewable energy, which has been continuously increasing in capacity. In Europe, renewable energy represented 19.7% of energy consumed in 2019, which was only 0.3% short of the target.

Moving from fossil fuels to wind and solar energy presents new challenges for balancing the electricity supply system. Our report, How 5G can cut 1.7 billion tonnes of CO2 emissions by 2030, illustrates the impact switching to electric vehicles will have, given that it consumes over double the amount of (fossil fuel) energy as the UK does in electricity.

However, due to the variable nature of these renewables (it"s not always sunny or windy) and our limited ability to store energy (with current battery technologies), the growing dependence on renewables means that supply cannot be controlled to meet demand. New business models enabled by millions of connected devices (washing machines, electric vehicle chargers) will allow us to reverse the market model so that demand actually meets supply.

A smart grid is an electricity supply network that uses digital communications technology to react to usage changes. With the rising numbers of households and energy usage, there is also a rising interest in monitoring data related to energy production, usage or storage to maximise the customer experience, often using cloud computing-based applications.

However, the cloud has certain limitations. For example, an electricity company and/or the government may not want systems controlling the supply of electricity to be processed in a data centre outside their country. Secondly, in order to track supply and demand in real-time, plus use the data to predict both of these in advance, a huge number of sensors need to ingest information. Processing this in the cloud would be

inefficient as it imposes significant costs from data transport and increases the potential for latency in processing time.

Edge computing poses an alternative, by bringing computing closer to users and the source of the data.

How do smart grids and edge computing work? Within a smart grid, there are grid users, who could be energy generators or storage owners, as well as end-users. Market operators are in charge of power markets and communicate with providers of energy services, whereas system operators control the physical power system. The edge acts as an intermediary that facilitates storage and communication between computing resources and the smart grid that controls the centre of things.

Power distribution and transmission networks are important when carrying power the last few miles to end-users. The role of smart grids within this context is to facilitate smooth frequency control to ensure stable conditions within the network, checking for any imbalance between generation and loads. It also checks for VAR (voltage-ampere reaction) regulation to avoid power factor penalties. Edge computing can guarantee low latency, which helps to monitor the frequency of the grid in real-time and proactively make any decisions to mitigate power factor penalties.

With the rise of smart homes and smart metering, smart grids are dealing with an increasing volume of private and sensitive information on their end-users. The possibility of leaking such information is unthinkable for both energy providers and end-users. The public cloud is often not in the same town / city / country and reduces the amount of control residents and governments feel they have on their data. Edge computing"s ability to process data locally can help in the selection of which data needs to go through the cloud and which data can stay local. Consequently, the data risk is reduced.

Even though the use of edge computing in smart grids is at an early stage, it is a promising one for tackling challenges, especially for energy management and improving sustainability.

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