

GRID TECHNOLOGIES

Virtual power plants take their place in reality

Industry has long lauded the transformative power of algorithms and the Internet of Things. Now, these technologies are having a material impact for decentralised energy generators, reports Andrew Williams.



In an era awash with tech buzzwords it can be hard to tell a genuine innovation from another web-connected gadget. At first glance, a ‘virtual power plant’ (VPP) might seem like an abstract concept, but its real-world applications are increasingly beyond dispute.

In basic terms, a VPP is a single distributed energy resource made up of a collection of electrically consuming or generating devices. These appliances are typically spread across multiple locations and connected over the internet to behave like – and perform the actions of – a traditional fossil fuel power plant.

Such systems commonly consist of a number of domestic batteries in residential homes linked to a single control centre capable of discharging them at the same time. According to Stavros Sachinis, Head of Residential Demand Response at Centrica, traditional generators, such as fossil fuel power plants, can perform numerous tasks by increasing and decreasing their output at different

Centrica and sonnen have installed a network of 100 domestic battery systems to create the UK’s ‘most advanced’ VPP

Photo: Centrica

speeds across the day. This allows them to access multiple ways of making money.

For example, they can trade their power on the open wholesale power markets and commit to future contracts designed to secure the UK’s electricity supply for the long term. In the UK, they can also provide numerous services to the electricity system operator, National Grid, which compensate for system imbalances.

‘If designed in the right way, with the right mix of devices, a VPP can perform the same actions, contribute to the electricity system in the same way, and access the same sources of revenue by increasing and decreasing the total net electrical production of the aggregated devices,’ says Sachinis.

Flexibility markets

An example of such a system is a UK Power Networks (UKPN) scheme to source flexibility from Social Energy’s AI-driven virtual power plant, made up of solar-powered domestic batteries. Daniel Mahoney, Marketing Director

at Social Energy, explains that the Social Energy VPP combines large numbers of residential solar and approved battery systems ranging from 3 kWh to 5.8 kWh capacity, including the company’s Duracell Energy Bank product. Each battery is connected to the ‘Social Energy Hub’ – and in turn to a VPP cloud – using a home broadband connection.

‘The VPP cloud uses big data and advanced AI to predict the energy needs of the home,’ Mahoney says. ‘The VPP then coordinates and optimises the operation of the batteries to store energy when it is cheap – either from the grid or from solar panels – and to provide flexibility services to energy companies like UKPN and others. These services help keep the grid stable and in return Social Energy’s customers receive additional payments whilst also allowing them to benefit by consuming more of their own solar energy.’

According to Sotiris Georgiopoulos, Head of Smart Grid Development at UK Power Networks, VPPs like this have a potential role to play in UKPN’s ongoing establishment of a flexibility market because of their ability to unite multiple assets to deliver network capacity as a service. This may enable the company to save customers money by deferring the need to build new electricity infrastructure, such as electric vehicle charging points.

However, some challenges remain – particularly in relation to the cost of batteries and the return on investment for domestic customers. Georgiopoulos believes the situation could change as the technology improves, the cost of batteries comes down and new business models emerge.

‘As a regulated monopoly, UKPN plays the role of a technology-agnostic neutral market facilitator. We have ambitious plans for

growing our flexibility market and working with VPP providers such as Social Energy clearly has a potentially important role to play,' he says. 'Where virtual power stations can provide a cost-effective means of deferring network investment then we want to do as much as we can to help enable that customer saving.'

Cloud-based system

Across the world, Australian energy supplier AGL has connected more than 1,000 batteries installed at solar-powered homes in Adelaide. The project – a world first when launched in 2016 – was partially funded by the Australian Renewable Energy Agency, and is now the largest VPP of its kind operating in Australia.

The scheme's key feature is that it allows the batteries to communicate with each other, as well as charge and discharge, via a cloud-based platform utilising smart controls and algorithms. This creates a connected system that is able to function as a 5 MW, sometimes more, solar peaking plant – but with more rapid response times that enable batteries to support the grid during periods of instability by discharging when demand rises.

'The VPP allows AGL to manage customers' batteries to provide support services when the grid most needs it, such as during a heatwave when there is high demand for electricity,' says Hughes. 'Orchestrating these batteries as a VPP enables us to create more value than if the batteries were only being used to consume more solar, and we can share that additional value with customers.'

A key motivation for the establishment of the VPP is the fact that the electricity market in the region is currently subject to a range of complex and interrelated challenges – including the retirement of large, synchronous power generators and the fact that rising gas prices are rendering gas-fired electricity more expensive. When coupled with the fact that 'intermittent' renewables now account for a larger proportion of the energy supply mix, the state's enthusiastic adoption of residential rooftop solar generation made it a perfect location for AGL to test the potential for a VPP to stabilise the grid.

Although AGL admits the fact that VPPs are not yet economically viable – largely as a result of limited commercial-scale deployment and long payback

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**Stavros Sachinis,
Centrica**

periods for residential storage systems – management believes falling costs will ultimately support commercial viability. The holy grail endpoint is to make purchasing a battery a commercially rational decision for consumers.

Since it was first established, the Adelaide scheme has also been expanded to incorporate recruitment via AGL's 'bring your own battery' programme, which currently runs in South Australia, Victoria, Queensland and New South Wales, in addition to the continued sales of battery systems in South Australia.

Benefits and challenges

Elsewhere, Centrica has teamed up with German energy storage outfit Sonnen on a project to create a virtual plant via the integration of 100 domestic batteries into an existing VPP made up of industrial batteries and machines. The scheme follows a pioneering partnership between the two on the Cornwall Local Energy Market, an EU-funded project, which is exploring how local homes and businesses might participate in local energy trading and VPPs.

As Sachinis explains, the new scheme combines Centrica's patented FlexPond software platform with Sonnen's capabilities in building virtual communities of home batteries. These networks utilise advanced algorithms and AI that can independently orchestrate the charging and discharging of batteries.

'Due to the diversity of device types in the VPP, the batteries can continue to perform their "day job" of storing solar power generated in the home for use in the evening, whilst also participating in a number of other value-generating services to National Grid,' Sachinis explains.

Sachinis believes the key benefit of VPPs compared to traditional bricks and mortar plants is the fact that they are more economically efficient because they use devices and appliances that already exist. They also lead to lower bills for customers since the devices and appliances that make up a VPP are typically located in businesses and increasingly in homes. This means that, as well as accessing the same revenue generating opportunities as traditional power plants, they can be controlled to reduce energy bills for customers.

Other advantages relate to the fact that VPPs move energy market value towards the customer and

that they are low carbon energy systems that provide more flexibility in the electricity system and ultimately enable more variable renewable generation to be connected as we transition towards a net zero energy network.

Despite the apparent benefits, Sachinis stresses that VPPs are still in their infancy and have traditionally been the realm of very large industrial businesses using very large high energy consuming devices. Therefore, they will need to scale to incorporate smaller devices and appliances in homes and businesses so that they can grow and become a significant source of flexible power for energy systems around the world.

To realise this potential, Sachinis believes several challenges must be overcome – including the fact that the vast majority of devices and appliances in homes and businesses that would be suitable to participate in a VPP, such as electric heating, HVAC, and even some more modern heat pumps, typically lack the connectivity required and have extremely long replacement cycles.

Other challenges relate to how to best ensure dispersed and diverse gadgets can behave autonomously in real time like a power station, without impacting the end user or the primary use of that gadget. Questions also remain about how to engage and reward customers.

Looking ahead, Sachinis believes the technology required to build and operate advanced VPPs exists today. In time, he expects industry will devise new and novel ways to engage and reward homes and businesses for allowing their IoT connected devices and appliances to become an active part of the energy system.

'I see the winners in this market winning through partnerships and think there will be a fascinating convergence of industry sectors,' Sachinis concludes. 'I can also see VPPs becoming more local and providing localised, community, city, even street level services to the distribution networks as they have to accommodate the massive influx in local solar, wind, electric heating and transport.' ●