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Unlocking the Benefits of Virtual Power Plants with Digital Technology

Most people, when they imagine a power plant, picture equipment like smokestacks that stretch hundreds of feet into the sky, massive, spinning turbines and the hum of electric transmission lines that deliver power into the bulk electric grid.

As power demand increases beyond current power plant capacities and clean energy goals are accelerated, power generation sources of the future will start to look different. In fact, some of these new components—rooftop solar, battery energy storage, electric vehicles and distributed energy resources (DERs)—can already be found in millions of homes.

While the grid has historically been a one-way street, with power moving from power plants to end consumers, DERs are rapidly changing that model. The rise of grid-edge technologies such as smart thermostats, controllable heat and pool pumps, and electric vehicles, require more intelligent and automatic ways to manage the power demand on the grid. While this adds complexity to grid operations, it also provides an opportunity for utilities and end consumers alike.

The Value of VPPs

When DERs and other devices are logically grouped or aggregated, they can form a virtual power plant, or VPP, providing load flexibility for grids that are reaching capacity or economic value with energy market participation, like a traditional power plant. VPPs also have the potential to reduce, or in some cases even eliminate, the need to build new fossil fuel power plants. In addition to saving utilities millions in construction and operations costs, VPPs are a way to reduce greenhouse gas emissions and accelerate the clean energy transition.

For utilities, retail energy providers and independent power producers (IPPs), VPPs offer a way to group millions of small-impact DERs and renewables into an aggregate resource that has a large impact on the grid—potentially reaching into the megawatts. Once grouped together into a VPP, these DERs can help balance load across the grid, avoid grid congestion and address both capacity and demand challenges, ensuring safe, reliable electricity for all customers.

VPPs may also represent an economic opportunity. Spurred by new regulation such as FERC Order 2222 in the U.S. with expected RTO/ISO full compliance between 2024-2029, and "Winter Package" in Europe where markets are ready (Germany, Netherlands, Nordic countries), utilities, retail energy providers, and third-party aggregators who manage VPPs may be in a region where they can sell excess power capacity into the energy market. This economic gain can then be passed on to the end consumers enrolled in the VPP in the form of rebates or discounts on utility bills.

Despite these opportunities, there are still hurdles that must be overcome before VPPs see widespread adoption.

Challenges Still Exist

As VPPs become increasingly popular, one of the largest challenges ahead is in how to quickly deploy and integrate the technology to ensure it can effectively optimize both small-scale DERs, like rooftop solar and smart thermostats, alongside utility-scale resources, such as large batteries or solar producing megawatts of power. For instance, it can be complex and costly to integrate and manage various DER communication protocols.

The establishment and operation of VPPs within a utility can also face challenges related to organizational change manage-

ment. The power of VPPs can be valuable for many different functional areas—from control room operations to customer management teams—helping to drive collaboration across the utility. While load flexibility is the key objective of utility operations, conducting consumer engagement and educating customer management teams and business teams about the ability to offer different utility revenue models, will show internal and external audiences the additional value drivers of VPPs.

Utilities are beginning to tackle these kinds of challenges by adopting a "crawl, walk, run" approach.

Retail energy providers, IPPs and utilities can begin by evaluating what their VPP objectives are in the short-, medium- and long-term, and have a clear implementation plan with phases that deliver corresponding functionality. A pragmatic approach to deployment and stepwise realization of enterprise-wide benefits will result in focused deliverables and a successful project.

Digital Technology Unlocks VPP Benefits

Important early steps in the "crawl" and "walk" phases will be determining how to integrate VPPs into a utility's daily operations. Grid management software is a core component of establishing VPPs with full enterprise integration. Ensuring operators have end-to-end powerflow visibility from the traditional generation plant all the way to grid-edge devices, and can optimize their performance in real time as conditions change, is a crucial component to realizing the benefits of VPPs.

Digital technologies such as enterprise Distributed Energy Resource Management Systems (DERMS), Advanced Distribution Management System (ADMS), Energy Management Systems (EMS) and Generation Management Systems (GMS) will enable operators to visualize, optimize, and control VPPs alongside large-scale traditional generation and renewable generation assets for end-to-end grid orchestration and market operations. In addition, enterprise-level DERMS and standard industry communication standards, such as ICCP, Modbus, OpenADR 2.0b, and IEEE 2030.5, will help ensure fast and efficient deployments at scale and overcome common communication protocol obstacles.

Reaching the 'Run' Stage with an Integrated VPP

When VPPs are integrated with these technologies in the control room as part of a "System-of-Systems" design approach, which provides a fully integrated operational system incorporating many different third-party aggregator systems, utilities can leverage the as-operated network model to solve complex grid issues and further streamline grid operations.

Once utilities have reached the "run" stage with VPP digital technology, they can use machine learning capabilities based on historical data to identify load trends and other patterns such as generation trends based on weather. This can inform everything from when demand peaks are forecasted and how capacity charges can be avoided, to where grid violations or overloads might occur. With an integrated VPP solution, real-time operations, demand planning, customer program management, and market participation can all use the same enterprise system to meet multiple real-time and forward-looking objectives, bringing value to various functions within a utility.

Going forward, as grid operations become increasingly complex with distributed generation and renewable power resources become increasingly common, VPPs will be a vital tool in efforts to ensure reliability and resiliency by adding flexibility to the grid. To get there, an enterprise-wide, pragmatic approach to VPP implementation will accelerate the success of these new initiatives for both utilities and end users.

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