WHITE PAPER

uplight

Tapping Customer Energy Resources

How VPPs Support Growing Capacity Needs

Executive Summary

Since their inception, utilities have had one overarching mandate: to deliver affordable, reliable electricity to customers. But in recent years, utility obligations have expanded to include objectives related to decarbonization, customer choice and satisfaction, environmental justice and equity, and grid modernization. These changes are happening against a backdrop of increasing extreme weather events, rapid load growth, and profound changes in the way customers think about and use energy.

Faced with this complexity, balancing these competing needs can seem like an impossible task. It's clear that the historical model of investing solely in utility-owned generation, transmission, and distribution infrastructure can only deliver on two of the three outcomes of energy reliability, affordability, and decarbonization.

Fortunately, there's a massive but largely untapped resource at utilities' disposal that can help achieve all three goals at once: customers and their growing number of distributed energy resources (DERs), including solar, battery storage, electric vehicles (EVs) and EV chargers, home and commercial building appliances, and industrial and manufacturing systems. Unlocking flexibility from customer-sited DERs can turn new loads into firm, clean capacity for the grid, reduce customer and utility energy spend, and support the industry as it continues its journey towards net-zero emissions.

Utilities are already tapping into DERs today, but there's significant room for growth and maturation across the industry thanks to emerging technologies and business models that transform DER programs into **virtual (or distributed) power plants (VPPs)**. VPPs are a natural evolution of utility demand-side management initiatives, combining multiple technologies and customer segments into a cohesive portfolio that is operated much like a conventional supply resource.

This white paper will define Uplight's perspectives on VPPs and their role within utilities' overall resource mix, explore how VPPs support grid operator objectives and customer preferences, and outline a few initial steps utilities can take to get started on their VPP journey.

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What Is a Virtual Power Plant (VPP)?

Every day, there are dozens of new articles published on VPPs. But what exactly **is** a VPP? Various definitions have been floated by organizations such as the Department of Energy, IEEE, and Rocky Mountain Institute, among others, over the past decade. But there is still no industry-standard definition of what these programs are, how they operate, or how they're procured.

At Uplight, our definition of a fully-materialized VPP is as follows:

> **A virtual (or distributed) power plant is an aggregation of multiple energy asset types and customer segments, managed cohesively as a portfolio of resources, and operated like a conventional power plant to support a wide range of grid services year-round.**

How Does a VPP Differ from Traditional Demand Response (DR)?

In the United States, demand response (DR) and VPPs frequently get lumped together because the term VPP is used so broadly across the industry. While we appreciate the intent to be inclusive, given some fundamental differences in capabilities, operating principles, and commercial models, we think it's important to be more precise with terminology.

Given the ideal-state definition above, we distinguish utility DR and VPPs in the following ways:

- VPPs involve **multiple resource types**, while DR programs generally focus on a single asset (e.g. smart thermostats, C&I loads, etc.). In practice, a VPP can comprise DR programs as well as other load-shifting resources like time-varying rates, distributed solar, EV managed charging, and more. Consolidating multiple resources provides more flexibility in terms of portfolio composition, expands the scope of grid services, and simplifies the customer recruitment and enrollment experience.
- VPPs bring together **multiple customer segments or programs** (residential, SMB, and commercial / industrial), whereas utility DR programs are designed around a single customer segment.
- VPPs provide **multiple grid services** (peak shaving, network constraint management, wholesale price hedging, etc.), while DR programs typically support peak load reduction only.
- VPPs are **operated year-round**, whereas DR programs typically run only seasonally (summer and winter). VPPs are dispatched to reach a megawatt (MW) capacity target instead of using a one-size-fits-all event model. By extension, VPPs also must be able to forecast and schedule available capacity days to months ahead.

Just like a traditional power plant, ideal-state VPPs are a reliable capacity resource that can be dispatched throughout the entire course of a year. Like all types of generation with varying output due to factors like maintenance, ramping requirements, or weather, VPPs may not have 100% nameplate capacity available 100% of the time—but if designed properly, they can consistently deliver some capacity. It's critical that VPPs accurately forecast availability on both operating and planning time horizons so utility staff can account for it.

Because VPPs require a new way of unifying and operating different portfolios of assets, they also need to be evaluated and valued distinctly from a more narrow DSM framework. **Figure 1** explores a few of the unique considerations that impact how utilities procure and measure VPPs versus traditional DR programs.

	Demand Response	VPPs
Program Design	Programs segmented by customer or technology type	Single resource comprising multiple customer segments and technologies
Dispatch Strategy	Event-based peak reduction	Multiple grid services (e.g. peak shaving, network constraints, wholesale hedge, etc.)
Funding Mechanism	Short-term DSM filing cycles (average 3 years)	Long-term resource planning (e.g. 5+ year IRP)
Buyer	DSM team	Multiple stakeholders across Supply, Network Ops, Network Planning & DSM
Contract Structure	Fixed fee, $/device	Pay for performance, $/MW
Evaluation Metrics	Enrollments & DSM filing targets (cost-effectiveness of MW/MWh savings)	Stacked value across supply, network and resource adequacy

Figure 1. *Comparing DR and VPP program attributes.*

Unlike a DR program, which is typically procured by a Demand-Side Management (DSM) program team, VPPs involve buy-in from other stakeholders as well, including the supply, network operations, and planning teams. Similarly, VPPs are starting to be funded as a supply resource through general rate cases instead of through shorter-term DSM filings, and often involve pay-for-performance or contractual guarantees for capacity delivery.

Sonoma Clean Power

VPPs in Action: Sonoma Clean Power

Sonoma Clean Power (SCP) is a community-choice aggregator (CCA) serving 230,000 customers in Northern California. SCP needed a way to cost-effectively mitigate peak load while enabling customers across all segments to participate in programs that unlock flexible capacity from DERs.

Using Uplight's DERMS, the CCA was able to aggregate residential, SMB, and commercial & industrial (C&I) behavioral demand response (BDR) programs into a VPP. With this consolidated management and dispatch capabilities, SCP can use predictive controls to forecast total load shift and intelligent analytics to perform measurement and verification (M&V) after every event.

As a result, SCP was able to drive .35kW of load shed per participant throughout their summer 2023 season, and 2.4MW of total load shed across 7,000 program enrollees during a single event.

Constructing a VPP Through the Demand Stack

Energy sector professionals are familiar with the concept of the supply stack—a combination of energy resources that follows a hierarchical arrangement based on cost and availability. A typical utility supply stack is comprised of three categories: always-on baseload resources that have the lowest short-term operational costs (historically coal and nuclear, but now increasingly wind and solar); mid-merit resources like gas and hydro that can be called upon to address daily ebbs and flows in power demand; and seldom-used, expensive peaker resources that are only fired up a handful of hours per year when demand is highest.

These same principles apply to the demand-side resources that comprise VPPs. Some resources, like energy efficiency programs and time-of-use rates, are analogous to baseload generation in that they persistently lower and shape demand with little to no marginal cost. Other resources, like EVs and stationary storage, have more complex economic profiles and controls and benefit from daily optimization. And others like demand response are often best dispatched more selectively in response to specific grid needs, as they incur operating costs in the form of customer fatigue and incentive payments. Each of these resource types has relative strengths and constraints. When managed holistically, their value and impact become much greater than the sum of their individual parts.

Realizing the full potential of VPPs requires not only understanding these nuances, but also being able to translate these factors into an ongoing operating model. By using AI-powered DER management software (DERMS) to build a **demand stack** that matches different grid needs using the best-fit resources within a VPP portfolio, utilities can embed VPPs into their core operational and planning processes **(Figure 2)**.

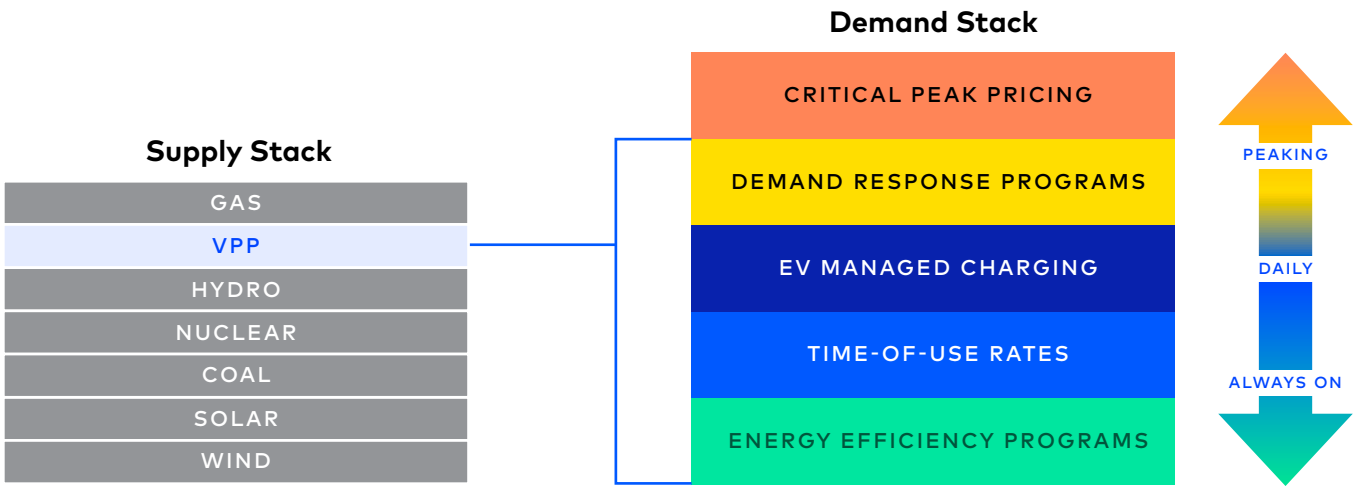

Figure 2. The demand stack brings together efficiency, rates, and flexible capacity from DERs to provide a reliable supply resource.

How Different Demand-Side Resources Contribute to Reliable, Dispatchable Load

Grid operators are used to having mid-term predictability and continuous visibility into supply resources. On the surface, demand-side resources seem less predictable and visible from a dispatch perspective. However, by optimizing program design, recruitment, and operations using a combination of technology and services, VPPs can compete on the same playing field as supply-side resources.

With a VPP platform serving as a single pane of glass, utilities can:

- Gain visibility into the real-time state of a variety of DERs, including things like battery, solar, and EV state of charge.
- Understand the operational bounds of DER portfolio designs and how they contribute to predictability.
- Predicting customer enrollment and participation rates and their impact on available flexibility.
- Use telemetry and event data to continually improve DER forecasting, planning, and dispatch.
- Dispatch resources in real time while balancing cost and reliability needs.

VPPs in Action: Puget Sound Energy

Driven by clean energy objectives and Washington state policy, utility Puget Sound Energy (PSE) and Uplight began developing a virtual power plant (VPP) in 2021 to provide a centralized platform for enrolling, dispatching, and assessing the performance of individual and combined DR programs across PSE's portfolio.

With turnkey services to support program expansion in 2023, PSE was able to scale its Flex VPP program from zero to 30 MWs in a matter of months. The expanded VPP provides aggregation, monitoring, reporting, and customer management for all participating programs, including energy efficiency, residential and commercial demand response, energy storage, and electric vehicles.

The Flex VPP brought together stakeholders from over 25 different departments within the utility, driving collaboration across digital transformation, network engineers, the program team, IT, and the supply / trading desk to determine when and where to call event dispatches. Ultimately, system ops owns dispatches and is able to treat the VPP just like any supply resource.

The Flex VPP is on track to reach 100 MW of capacity by 2025—enough energy to power approximately 100,000 homes—and is expected to scale over time as part of the 3,660 MW of demand-side and distributed resources that PSE plans to add to its system by 2045.

How the Demand Stack Supports Grid Operator Goals

Today, utilities must navigate growing complexity in the form of evolving customer preferences, legislative and regulatory mandates, and climate change. While each year brings new challenges for grid operators (hello, data center load growth), their primary goals related to affordability, reliability, and decarbonization remain the same.

Historically, the only real tool utilities have had to deliver on these outcomes has been investing in their own generation and transmission/distribution (T&D) infrastructure. These investments will continue to be critical for success, but utilities that only consider developing their own infrastructure while ignoring the opportunity of customer-owned resources run the risk of stranded assets, unacceptable rate increases, or both.

In contrast to conventional generation and grid infrastructure, VPPs are inherently dynamic, capable of evolving in scale and scope in parallel with utility needs. In the near term, VPPs can be deployed and begin delivering capacity within months with a much lower capital footprint than other supply resources. In the medium to long term, VPPs are uniquely capable of functioning like generation, transmission, *and* distribution resources, delivering benefits across all three foundational utility goals:

RELIABILITY

VPPs can be deployed to support resource adequacy, peak shaving, locational constraints, and other grid services that bolster grid reliability and ensure resilience during extreme weather events. These diverse portfolios of resources increase reliability—and provide flexible capacity across all hours, not just during peak demand periods.

AFFORDABILITY

By reducing peak demand, relieving network congestion, and balancing the grid VPPs are non-wires alternatives (NWAs) that help delay or defer infrastructure investments that in turn put upward pressure on customer rates. Additionally, VPP incentives funnel dollars back into local communities, helping offset the cost of energy for residential and C&I customers.

DECARBONIZATION

Instead of relying on polluting peaker plants that are typically the highest cost and least efficient to run, VPPs can cover the gap with clean capacity. Incorporating VPPs as a year-round flexible resource can also help utilities integrate new renewable generation and stay on track with fossil fuel plant retirements while accommodating load growth.

4 Steps to Kickstart Your VPP Journey

Every utility is in a different place on its journey to tap into demand-side resources. Some utilities are running multiple DSM programs including DR; others haven't even started. Some utilities have invested in an end-to-end DERMS set up that connects the control room to the customer; others don't have a DERMS at all.

Deploying a VPP for the first time can seem daunting, especially if your utility has joined the demand management journey more recently. The good news? There are some small steps you can take now that will pave the way for a fully-realized, sophisticated VPP program in the future—without requiring you to dive into the deep-end headfirst.

VPPs in Action: Clean Power Alliance

Clean Power Alliance (CPA) is the largest community choice aggregator (CCA) in California, serving 3 million customers across 30 cities in the Los Angeles area. Over the past few years, CPA has been putting programs in place to reduce peak capacity needs and secure resource adequacy using behind-the-meter assets.

Over the course of two years, Uplight delivered 6 MW in grid services contracts via 10,000 customers through a multi-asset VPP that brings together thermostat, EVSE, battery storage, and behavioral DR programs. These programs include low-to-medium income (LMI) households as well as other residential customers

Here are a few ways to get started on the path to VPP success.

1. **Expand current DR programs.** DR programs are an important stepping stone on the path to launching a fully-fledged VPP. If your utility is already investing in DR, expanding existing programs to include new device types, customer segments, or grid services can be a great way to build momentum toward a future VPP. For example, if you have an existing residential thermostat program in place, you could expand the program to include commercial HVAC systems in the future.

2. **Define VPP value across departments.** Because the scope of a VPP is much broader than a traditional DSM program, more stakeholders need to be involved in defining the value upfront. Even if your organization isn't ready to launch a VPP program yet, now's a great time to start pulling together contributors across your program, supply desk, network ops, and IT teams to start discussions about how and where VPPs can support your utility's operational goals.

   Additionally, putting a dollar value on megawatts generated (or conserved) through VPPs can give your organization a head start in incorporating demand-side resources into your integrated resource planning (IRP) process as a new source of supply.

3. **Advocate for regulatory support of VPPs.** VPPs can provide a wide range of benefits for both utilities and energy customers—but they require updated policies and ongoing regulatory support to gain traction. Utilities, energy retailers and aggregators, technology providers, and other industry leaders have an opportunity to advocate for the value VPPs can provide with regulators. Real-world use cases that show the impact of active DR, rates, and other demand management programs in generating reliable flexibility can help make the case that VPPs deserve to be compensated as a new supply resource and integrated into long-term resource planning.

4. **Explore turnkey VPP services.** Managing an end-to-end VPP program is complex. From program design to recruitment and marketing to event dispatch and M&V to customer incentives and support, VPPs require significant operational investment, coordination, and expertise.

   The good news is that turnkey VPP services can help utilities efficiently stand up new programs. By leveraging outside experts to oversee design recommendations, operational logistics, and customer engagement—and optimize these program elements based on learnings from other VPP programs—utilities can deploy and optimize VPPs without overtaxing their current team's bandwidth.

A New Perspective on Demand-Side Flexibility

For years, the industry has viewed DERs as variable in the demand equation. At best, they've been used as blunt instruments to reduce peak load when energy demand outpaces supply. At worst, they've been lumped into a broader electrification category that's causing concerns around rapidly increasing load growth year over year.

Today, VPPs are changing the narrative around DERs. By aggregating a wide range of assets into a single, dispatchable demand stack, VPPs can leverage customer-sited energy assets to provide value to the grid on par with traditional supply resources.

These aggregations can be assembled quickly and cost effectively compared to traditional generation sources. They leverage clean sources of energy that can make a real impact on utility-specific and regional decarbonization targets. And they put dollars back into the pockets of energy customers, uplifting communities and incentivizing the adoption of new DERs.

Launching new VPP programs won't happen overnight. But with a shared vision for what VPPs can do and the value they can provide, the industry can start to align on a path forward. Demand is the new supply—and that's something grid operators, energy customers, and regulators can get excited about.

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Get an Edge in Driving a Cleaner Energy Future

Uplight creates and manages capacity for the grid through networks of connected devices that generate, shift, or save energy. We combine best-in-class customer experiences with an open flexible capacity management platform that improves grid resilience, reduces costs, and accelerates decarbonization.

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Curious to learn more? Request more information or schedule a demonstration with an Uplight virtual power plant expert.

Contact us at www.uplight.com