Meeting Summer Peaks: The Need for Virtual Power Plants

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HIGHLIGHTS

- The possibility of extreme and wide-spread heat waves puts large swaths of the country at elevated risk for insufficient electricity generation to meet demand this summer.[1] This risk is likely to grow if utility projections of 38 GW of new peak load through 2028 materialize.[2]
- Virtual power plants (VPPs), aggregations of distributed energy resources that provide utility-scale and utility-grade grid services, can support utilities to affordably and reliably meet summer grid needs.[3]
- VPPs are rapidly deployable, affordably leverage existing assets, are configurable and adaptable, and enhance community resilience.
- Already-deployed VPPs will be dispatched to meet the peak this summer. New VPPs can be deployed in as little as 6-12 months — much faster than traditional transmission and generation — to manage peak as soon as 2025.
- Regulators and policymakers can leverage three key VPP policy principles to enable utilities and other load-serving entities to efficiently deploy VPPs by next summer:[4]

    1. **Advance policies to expand adoption of distributed energy resources (DERs) by diverse end-users** and ensure there is a sufficient asset base available for VPP enrollment.
    2. **Fairly compensate VPPs for services delivered** to enable customer participation and allow VPPS to fairly compete.
    3. **Enable value stacking to maximize benefits** to the grid while maintaining customer buy-in and support.

- More than 500 VPPs are currently operating nationwide. Utilities and regulators do not need to engage in lengthy design, regulatory, or pilot processes to deploy VPPs to meet summer reliability needs. Instead, decision makers should reference leading approaches from other jurisdictions.[5]

Introduction

After decades of relatively flat demand, US utilities are projecting significant growth in electricity use. In the near term, high-demand data centers, new manufacturing, and crypto-mining operations are driving the trend.[6] In the medium term, electrification of industry and consumer adoption of electric vehicles and heat pumps will continue to drive demand.

This demand growth could result in higher summer peaks: summertime peak demand is projected to grow by 38,000 MW in the next five years, equivalent to adding another California to the electric grid.[7] The timing, location, and scale of additions remains uncertain, and energy efficiency can mitigate impacts. Nevertheless, significant peak load growth could exacerbate risks that utilities and regulators are already facing.[8]

The National Oceanic and Atmospheric Administration predicts above average temperatures across the continental United States during the summer of 2024.[9] And grids around the nation are already facing summer stress due to the impacts of more extreme temperatures and more frequent and violent storms.

NERC's 2024 Summer Reliability Assessment *finds that "*a large part of North America remains at risk of supply shortfalls," with wide-area heat events that impact generation, wind output, and transmission systems, coupled with growth in demand on hot days that could create resource adequacy risks.

Meeting the Challenge of Growing Summer Peaks with VPPs

To meet summer peaks in the face of extreme summer heat and uncertain load growth, regulators and the utility industry need solutions that:

1. **Are rapidly deployable** to meet near-term summer peaks;
2. **Can leverage existing network and customer assets** to manage investment (and associated rate pressure);
3. **Are adaptable and configurable** to address changing grid needs in the face of uncertainty; and
4. **Enhance community energy resilience**, given increasing risk of extreme weather.

Virtual power plants (VPPs) can meet these needs — presenting a useful solution for regulators and utilities.[10] VPPs are aggregations of distributed energy resources that can provide utility-scale and utility-grade grid services. DOE has identified a range of benefits from VPPs that include and go beyond the four needs outlined above: resource adequacy, reliability and resilience, transmission and distribution infrastructure relief, versatility and flexibility, affordability, community empowerment, and decarbonization and air pollution relief. To further support VPPs' potential to meet summer peaks reliably and affordably, research from the *Brattle Group* found that VPPs can increase resource adequacy at a net utility system cost that is roughly 40% of a gas peaker and 60% of a battery, avoiding between $15 and $35 billion of potential capital investment nationwide.[11]

VPPs are not new: more than 500 VPPs have been deployed across North America, realizing these benefits.[12] However, given the increasingly urgent need for adaptable and low-cost near-term solutions, regulator and utility interest in VPPs is increasing as are the number of VPP policies and utility programs.[13]

ENABLING UTILITIES TO LEVERAGE VPPS: THE ROLE OF POLICY AND REGULATION

VPPs are not the only solution for summer reliability challenges. Instead, they exist as part of a portfolio of solutions, which includes investment in generation, distribution, transmission, and central battery storage infrastructure as well as grid-enhancing technologies, reconductoring, and clean repowering of existing or retiring fossil generation infrastructure. VPPs complement other approaches to support summer reliability and efficient operation of the grid.

VPPs cannot meet summer peak and other grid needs without effective regulation and policy. Virtual Power Partnership (VP3) and its members have identified 17 policy principles that regulators, policymakers, state energy offices, and other stakeholders should consider when developing or implementing VPP policies to help manage summer peak and beyond.

Three policy principles stand out related to the use of VPPs for summer reliability:

1. **Advance policies to expand adoption of distributed energy resources (DERs) by diverse end-users** and ensure there is a sufficient asset base available for VPP enrollment.
2. **Fairly compensate VPPs for services delivered** to enable customer participation and allow VPPS to fairly compete.
3. **Enable value stacking to maximize benefits** to the grid while maintaining customer buy-in and support.

These and other VPP policy principles are increasingly apparent in new and emerging state policies, including policies advanced in 13 states over the past year. **(For more details on VPP policy principles see box at the end of this document.)**

Supported by smart policy, utilities are developing effective and scalable VPP programs, showing how VPPs can positively impact grid planning and operations. VP3's *Utility Flipbook* highlights 14 of these programs and distills a set of leading practices that can be broadly applied across the sector. Utilities need not reinvent the wheel to implement VPPs: enabled by effective policy, utilities and grid operators can join their peers to use VPPs to meet summer peak and other grid challenges. **(For more details see VPP design and implementation at the end of this document.)**

VPPs in Action: Examples of VPPs Supporting Summer Reliability

This summer, VPPs will be deployed and dispatched across the country to address summer reliability needs. The following case studies illustrate how VPPs are helping regulators and utilities meet the need for reliable, resilient, and affordable electric power.

PEAK COINCIDENT CAPACITY IN 12 MONTHS OR LESS

Continued investment in traditional generation, distribution, and transmission infrastructure will be needed to meet long-term expectations for sustained load growth if utility projections materialize.[14] However, due to challenges with siting, interconnection, and development timelines, these solutions may take years or even decades to be deployed. Interconnection reform, repowering, and transmission planning reform can help accelerate deployment. Nevertheless, few traditional infrastructure solutions will be ready to meet near-term load growth. With regulatory vision and support, virtual power plants can be deployed in less than a year and have been deployed in as little as six months, demonstrating a unique ability to be ready by as soon as 2025:

- **A VPP run by the Ontario Independent Electricity System Operator enrolled 100,000 homes just six months after launching** in mid-2023. The Save on Energy Peak Perks program, run in partnership with grid-edge flexibility provider EnergyHub, can reduce summer peak demand by up to 90 MW.[15]
- In August 2022, California PUC launched Demand Side Grid Support (DSGS), allowing non-investor-owned-utility customers to participate in emergency reliability programs. **Within a year, DSGS had 142 MW of committed capacity**. It has since expanded and is helping to support the California grid in the face of drought and extreme heat.[16]
- In November 2022, **the Texas Public Utility Commission developed rules and approved an aggregate distributed energy resources (ADER) pilot in ERCOT just four months after the program was initially proposed**.[17] The program, intended to enhance grid reliability and lower energy costs, was initially capped at 80 MW of capacity. In light of the project's success thus far, regulators announced in December 2023 their plans to expand the pilot and enable ADERs to participate in ERCOT's contingency reserve service.[18] Phase 2 of the ADER pilot launched in February 2023.

LEVERAGING EXISTING ASSETS TO MAINTAIN AFFORDABILITY

VPPs can leverage customer-sited resources to support the grid, making efficient use of existing infrastructure and assets to help regulators and utilities manage customer affordability:

- In California, PG&E and Sunrun identified an opportunity to put customer batteries to work to support the grid. **Within six months, PG&E and Sunrun developed a program to dispatch 8,500 existing customer batteries to alleviate evening peaks driven by heat and AC load during August–October**. The program allowed PG&E to meet capacity needs without building costly new infrastructure, helping to guard against increasing rates.[19]
- In Arizona, APS is working with customers to ensure that their thermostats are smart and grid-interactive, providing peak load reduction when energy use is at its highest in the summer. **The Cool Rewards program, which has enrolled 83,000+ thermostats, provides affordability benefits for all APS customers.** Participating customers benefit from energy savings and non-participating customers benefit through reduced system costs for serving energy needs.[20]

CONFIGURABLE AND ADAPTABLE TO CHANGING GRID NEEDS

While regulators and the utility industry need near-term solutions to meet peaks over the next 12–15 months, they also need durable solutions that are adaptable to the rapidly changing conditions driven by uncertain load growth, extreme weather, and a transition in the generation fleet over the next decade.

VPPs can be configured and adapted to meet changing grid needs because they can provide multiple grid services (also known as "value stacking"). If a grid's needs change after a program's initial run (typically four or five years), regulators, utilities, or VPP operators may shift customer incentives and VPP operations to provide new services.

Leading utility programs, enabled by regulatory guidance and support, provide multiple services to the grids they serve:

- **Rocky Mountain Power's WattSmart Battery program dispatches batteries daily to support grid needs**. During the hottest months, batteries are deployed to help meet summer peaks. The rest of the year, WattSmart batteries are integrated into utility operations and dispatched daily and dynamically to provide multiple grid services including frequency support and capacity, and to support solar integration. By providing multiple value streams WattSmart Battery program was able to satisfactorily pass the cost benefit analysis required by the Utah Public Service Commission.[21]
- From the outset**, National Grid's ConnectedSolutions program has enabled value stacking with other programs**, such as the New England Capacity market. Based on the success of ConnectedSolutions, National Grid, with the guidance and support of its regulators, is looking beyond peak reduction and considering how VPPs can provide non-wires alternatives and "bridge to wires" solutions to address local capacity constraints, as well as calling on customer-owned DERs to reduce loads on the grid when the GHG marginal emission rates are high.[22]
- **Puget Sound Energy's VPP programs orchestrate multiple technologies to provide multiple grid services**. PSE, in collaboration with program operator Uplight, leverages behavioral load shaping, smart thermostats, water heaters, EVs, and interruptible load in its VPPs. While PSE has initially focused on summer peak management, in the future it plans to use VPPs to support local grid system capacity relief, ancillary services, energy arbitrage, and other services.[23]
- **Portland General Electric (PGE) is integrating VPPs into strategy, planning, and operations.** In the near term, PGE is using VPPs to meet summer peaks in the face of rapid load growth and increasingly

extreme and uncertain weather.[i] Through the Smart Grid Test Bed PGE is testing a variety of advanced approaches, including a pilot with Utilidata that leverages AI to collect data and more fully integrate VPPs into utility operations.[24] PGE planners estimates that by 2030, DERs and demand flexibility will meet 25% of peak demand.[25]

RESILIENT POWER FOR HOUSEHOLD AND COMMUNITY SAFETY

Beyond providing safe, reliable, and affordable power, many regulators and utilities see community energy resilience as a part of their mandate. Modern approaches to resilience emphasize distributed solutions to ensure the provision of critical energy services in the face of major disruptions.

During major disruptions to the normal provision of grid power, DERs within VPPs can provide critical energy services to households, businesses, and communities.

- **Green Mountain Power (GMP) is leveraging residential battery storage to provide resiliency during severe weather events.** GMP's two battery VPP programs help customers stay powered up during disruptions while also providing capacity during peaking events.[26] GMP believes that providing customers with batteries will be critical to maintaining grid resiliency in the face of future climate change-fueled storms.[27] Vermont regulators have lifted battery program capacity caps to support further expansion of the program.[28]
- **Holy Cross Energy (HCE) is using DERs to enhance community energy resilience**. Like much of the mountain west, HCE's service territory is at risk for major fires. VPP programs in HCE service territory ensure DERs can provide peak support and other services during normal operations and backup power when grid service is disrupted. HCE's Power+ program leverages customer-sited backup battery storage to support the grid while ensuring battery reserves are in place for backup power. The Basalt Vista project pilot coordinates multiple DERs, including solar and storage assets which can be used for backup power.
- **Utilities and automakers are working together to ensure EVs can provide resilient backup power (V2H) and support grid services (V2G)**. Notable pilots include a collaboration between Duke Energy and Ford and one between General Motors and PG&E. While the evolution of two-way charging is promising, many utilities are currently using one-way charging infrastructure to manage EV load during summer peaks.

[i] From 2022 to 2023 demand from industrial loads and data centers grew 10.6% in PGE service territory. PGE projects continued annual energy growth of 1.6% through 2042 driven by industrial load growth of 3.9% per year.

VPP Policy Principles and Resources for Policymakers

VPP POLICY PRINCIPLES

In 2024, VP3 and its members released a set of VPP policy principles to help regulators and policymakers understand how to leverage virtual power plants to achieve reliability and affordability outcomes for customers and the grid. These 17 principles are divided into five main categories. Three principles of particular relevance to summer reliability are outlined below:
DER Asset Base: For VPPs to provide reliable grid services, there needs to be a sufficient asset base of DERs to enroll and control.

- ***Advance policies to expand beneficial DER adoption by diverse end-users:*** Policymakers and regulators can advance policies to expand beneficial multi-technology DER adoption by diverse end-users — including low-to-moderate income, energy burdened, historically disadvantaged multifamily, single-family residential, commercial, and industrial customers — through mechanisms such as tax credits and rebates, utility up-front financing, utility on-bill financing, net energy metering, and/or DER carve-outs in energy portfolio standards.

Equitable Compensation: The US energy system is typically optimized on a least-cost basis. It is therefore imperative to enable equitable compensation structures for services provided by VPPs so VPPs can fairly compete with traditional generation, distribution, and transmission solutions, and so customers are incentivized to participate.

- ***Fairly compensate VPPs for services delivered:*** Compensation structures such as ongoing performance payments for the provision of grid services and/or time-varying or dynamic tariffs can unlock sustainable participation from these assets to maintain the customer buy-in and support the grid needs in time of summer stress. Regulators can add review and advance DER compensation, rate design, and performance payment policies that fairly compensate for the services DERs provide — including emergency summer response services — in a technology-neutral way.
- ***Enable value stacking to maximize benefits:*** VPPs have unique benefits and capabilities beyond that of traditional generation technologies. Policymakers and regulators can support value stacking — the participation of VPPs to stack multiple wholesale market and retail utility grid services — to maximize the services VPPs can provide to the grid and its customers, especially when it's needed most during times of high summer grid stress. VPPs can provide a diversity of grid services across multiple time horizons, with clear eligibility criteria and rules to prevent double counting.

For more on the VPP policy principles, read the policy brief.

VPP Design and Implementation: Leading Practice for Utilities

Successful VPP implementation requires not only effective program design, but also reimagined utility practices.

EFFECTIVE PROGRAM DESIGN

1. **Open access** in a VPP to integrate multiple technologies, vendors, and programs.
2. **Develop partnerships** that leverage third-party capacity and complementary capabilities.
3. **Streamline customer experience** during enrollment and participation.
4. **Execute long-term programs** (5+ years) with enrollment and operating terms to improve cost-effectiveness.
5. **Incentivize DERs** to enable additional customer participation.

REIMAGINED UTILITY PRACTICES

1. **Incorporate VPPs into planning** of generation and distribution.
    - Iteratively integrate DERs into planning processes.
    - Evaluate VPPs transparently with defined metrics.
2. **Proactively engage policymakers**, including regulators, around effective VPP policy.
    - Work with regulators to ensure policies allow for innovative and iterative approaches to DERs.
    - Consider whether components of performance-based regulation can support VPP deployment.
3. **Transform business practices**.
    - Implement cross-functional teams including customer programs, operations, distribution, and planning teams.
    - Automate VPP administrative and operational processes.

For more details see the *Virtual Power Plant Flipbook*.

Endnotes

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VIRTUAL POWER PLANT PARTNERSHIP

About VP3

The Virtual Power Plant Partnership, or VP3, is a coalition industry voices that seeks to shift the necessary policies, regulations, and market rules to unlock the market for virtual power plants (VPPs). Our members span hardware and software technology solution providers, distributed energy resource (DER) aggregators, and others.

A robust VPP market expands the possibilities for all DERs — empowering households, businesses, and communities to play a role in the energy transition alongside technology solution providers. Learn more at **vp3.io**.

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