You, Too, Can Be a Virtual Power Plant!

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ABSTRACT

Our electrical grid faces massive load growth from data centers, electrification, and other sources, which cannot be fully addressed with the existing resource mix – especially at peak times. As demand grows and seasonal peaks shift, the status quo of demand flexibility solutions that focus largely on summer peaks and are heavily dependent on customer adoption of controllable devices will no longer be sufficient.

To come to terms with this new reality, the energy industry must use an "all resources on deck" approach to meeting peak demand. Most demand flexibility programs require large numbers of customers to adopt new technologies that may not be available or attractive to all customers, leaving behind those who cannot or do not want to buy a new device or enroll in an automated program. We cannot afford to leave these savings untapped, and should instead enable these customers to be energy partners in creating demand flexibility. This approach must include leveraging end-use residential customers as another kind of Distributed Energy Resource (DER) to drive peak reduction.

This paper will examine the current landscape of demand flexibility resources, demonstrate the importance of taking an "all resources" approach, and detail the specific, underutilized benefits of behavior-based resources like Behavioral Demand Response and Peak Time Rebates. This will include case studies from utilities successfully deploying both summer and winter programs, and recommendations for integrating behavior-based resources into the evolving demand flexibility landscape.

Introduction: Challenges Facing the Electrical Grid

The growing focus on demand flexibility is the result of surging energy demand in the U.S. The Energy Information Administration (EIA) is projecting the strongest four-year growth in electricity demand in over 25 years, largely due to new data centers (EIA 2026). The North American Electric Reliability Corporation (NERC) recently assessed that 13 out of 23 geographic areas they studied will face resource adequacy challenges in the next ten years, and nine will face those challenges in just the next two years (NERC 2026). Many are looking to Virtual Power Plants (VPPs) to meet these challenges. Rocky Mountain Institute (RMI) estimates that "…by 2030, VPPs could reduce peak demand in the United States by 60 gigawatts (GW). That number could grow to more than 200 GW by 2050. By avoiding generation buildout, decreasing wholesale energy costs, and avoiding or deferring transmission and distribution investments, VPPs can help reduce annual power sector expenditure by $17 billion in 2030" (Brehm, K., McEvoy, A., Usry, C., and Dyson, M.). Residential demand flexibility is estimated to represent almost 30% of that total peak demand (19.8 GW on average).

Current VPP Landscape

While the concept of a VPP is not new, it has recently come to dominate the conversation about energy needs in the U.S. (Bates Ramirez 2025). While there is no universally agreed upon definition, VPPs generally refer to the aggregation of flexible loads, often sited with a utility customer "behind the meter," to help balance electricity supply and demand. The U.S. Department of Energy (DOE) defines a VPP as “aggregations of DERs such as rooftop solar with behind-the-meter (BTM) batteries, electric vehicles (EVs) and electric water heaters, smart buildings and their controls, and flexible commercial and industrial (C&I) loads that can balance electricity demand and supply, as well as provide utility-scale and utility-grade grid services” (DOE 2025). Lawrence Berkeley National Lab (LBNL) identified over 30 other definitions of VPPs, and notes that terms like DERs, flexible loads, load flexibility, and demand response (DR) are used interchangeably with the term VPP (LBNL 2025b).

The Smart Electric Power Alliance (SEPA) recently found that the “North American VPP market has reached 37.5 gigawatts (GW) of flexible, behind-the-meter (BTM) capacity, a 14% increase over total VPP capacity in 2024, while the number of active VPP deployments, monetized programs, and unique offtakers each rose by more than 33% during the same time period” (SEPA 2025). SEPA’s most recent report on VPP activity across the country shows that 35 states and the District of Columbia have VPP activity (SEPA 2026).

Role of the Customer

The various pathways for VPP operation and management, and how VPP platforms, distribution system operators, and bulk power system operators interact, are the subject of much of the current VPP discourse. However, a systems- and technology-focused approach to VPP deployment often neglects customers and how they engage with the grid. VPPs may be operated by a utility for its own system needs, run by the utility but operated by third parties, and/or bid into a wholesale market. The diagram in Figure 1 illustrates the different forms of VPP participation models while also highlighting that, regardless of participation model, the one constant is the participation of electricity consumers.

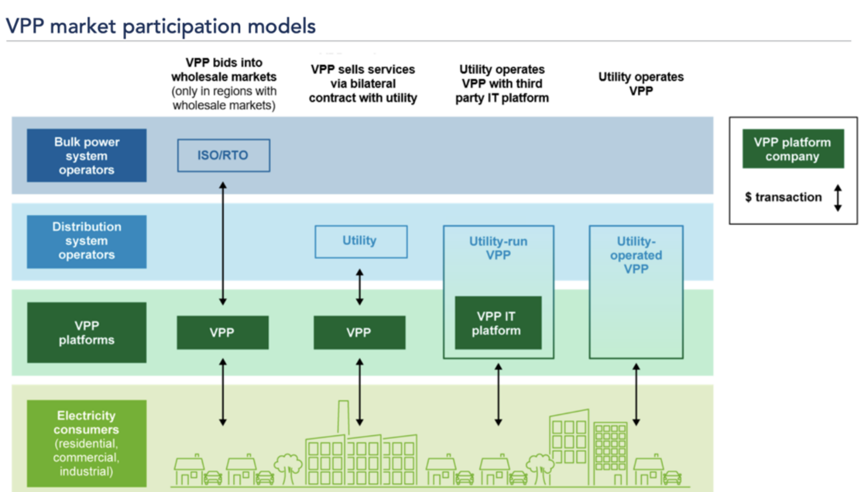

Figure 1: VPP Market Participation Models. *Source*: DOE 2025

The most common way for electricity consumers to participate in VPPs is by adopting some kind of Distributed Energy Resource (DER). DERs also do not have a single agreed upon definition but generally refer to a broad category of devices and technologies that generate or store electricity and interact with the local electric distribution system. They can be connected directly to the distribution grid, or located at a customer premise, behind the utility meter.[1]

Barriers to Customer Participation in Existing Frameworks

As noted above, DR and VPPs rely heavily on customer adoption of DERs and willingness to participate in device control programs, but there are still barriers to engaging residential customers at the scale required to meet projected load growth. These barriers, discussed below, have led to customer participation rates that will not be sufficient to meet the demand reduction needs of the grid.

Reliance on Customer Adoption of DERs

Cost. Recent customer engagement studies have identified upfront costs as a consistent barrier to DER adoption (PSE 2023). Smart thermostats, the most commonly adopted DER, range from about $80 to almost $300, plus installation costs, and are not compatible with some heating, ventilation, and air-conditioning systems. A battery storage system installation averages $15,000 to $21,000 before incentives (JM Batteries 2026). Similarly, the average cost of an EV in the US in 2025 was $58,034 (Cox Automotive 2025). Median household income in the U.S. is $83,730 (USCB 2025) and households are already spending greater percentages of their income on energy (NEADA 2026). Cost barriers and rising bills mean not all customers are able to participate in DR and VPP programs – even if they have the desire to do so. This not only leaves potential demand reductions on the table, it also excludes many customers from earning incentives for their actions.

Awareness and accessibility. Even where costs have come down, customers' awareness of, and ability to access these devices and programs remains a common barrier. Despite many years of successful DR programs, lack of awareness has contributed to relatively low participation, with less than 7% of residential households enrolled in a demand response (Aristizabal, Baker, Ash 2026). While adoption of DERs like smart thermostats has significantly increased in recent years, a 2025 report found that only about 16% of households with internet access have smart thermostats; of that group, only about 20% of those households participate in DR programs (Kent 2025). This shows that adoption of devices does not necessarily translate to DR program participation. The report also noted that awareness varied across the country. Overall, 54 percent of non-participating customers have not heard of or do not think their utility offers DR, with awareness being lowest in Kentucky, Tennessee, Alabama and Mississippi, where a combined 59% of customers polled said they were unaware of or lacked access to demand response programs. Awareness is highest on the West Coast, where 44% of customers said they lacked access or awareness (Kent 2025).

[1] For example, the California Public Utilities Code PUC §769(a) defines DERS as "distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.". PJM defines DERs as "any generators or electric energy storage resources connected to lower-voltage local distribution lines and/or on the customer's side of the utility meter" (PJM 2025).

Programs that rely on access to DERs are particularly inaccessible to those who are income constrained, or renters who often do not have the ability to install devices in the home. Using smart thermostats, EVs, and batteries as DERs also requires that a customer has the ability to install in-home equipment, which is mostly restricted to single-family homeowners, and for EVs, those with off-street parking. Access to solar may also require that a customer lives in a geographically favorable location.

Awareness of and ability to participate in DR and VPP programs can also be impacted by who runs the program. Utility programs have the advantage of an established, familiar relationship with their customers to solicit enrollment, as well as direct access to customer consumption data needed to run and measure programs. Aggregator-run programs, on the other hand, may be more flexible in the programs and services that they can offer, but may have to work harder to acquire new participants.

Customer sentiment towards direct control. Even for customers who do have a connected device, there is still significant hesitance to cede control to a utility or aggregator. A Smart Energy Consumer Collaborative Survey (SECC) found that only about half of customers are willing to enroll in a DR program, even though 63% of consumers would be willing to *voluntarily* shift their usage (SECC 2025a). The gap is even larger for winter programs, where 79% of customers surveyed by SECC were willing to voluntarily change their behavior, compared to only 59% who would participate in a direct load control program in the winter. (SECC 2025b). Another study found that the most common objections to enrolling in a smart thermostat program were "don't want someone controlling my stuff" (29% of customers) and concerns about comfort or convenience (34% of customers) (Kent 2025).

Focus on Summer Peaks

Today's DR and VPP programs are substantially focused on summer peaks. With fewer winter programs, customers have limited demand flexibility opportunities. Summer peak is significant and growing, as evidenced by record-setting peaks in July 2025, leading states and utilities to focus on summer VPP programs and goals (EIA 2025). However, several regions of the US are experiencing an increase in winter peaks due to heating electrification. The New York Independent System Operator (NYISO) expects the state to shift to a winter-peaking grid around 2036 (Walton 2024b). New England typically sees peak demand occur during the summer, but by 2033, the region's grid operator expects the summer and winter peaks to be roughly equal — with the potential for higher winter peaks depending on weather (Walton 2024a). LBNL notes that demand flexibility programs will need to evolve to meet the needs of growing winter demand (Murphy, S. et al 2024). Programs will need to be responsive to the fact that winter days have a morning peak in addition to an afternoon one, as well as customers' concerns about comfort. Customers may be less amenable to curtailing their heating in the winter because of comfort, or concerns about freezing pipes or strain on their heating system (SECC 2025b). The relevant technology is also different; baseboard heating, for example, is less likely to be paired with a smart thermostat.

All Resources on Deck: Empowering All Customers as Energy Partners

The need for VPPs to meet current and projected demand growth means that no resource should be left off the table. A true "all of the above" approach should be resource neutral, addressing not only the Megawatt (MW) capacity needed but also acknowledging the human element. Resources that enable robust customer engagement while also delivering savings will be particularly useful. Residential end-users themselves have demonstrated capacity to use their behavior as another kind of DER, significantly expanding the population of customers who are eligible to participate in DR programs. Despite this, behavior-based demand flexibility resources are often excluded from DR and VPP programs, leaving both demand savings and opportunities to engage and educate customers on the table. A more customer-centric approach can help increase adoption of DERs, increase and maintain enrollment in device control programs, and help customers feel more empowered in their contributions to the grid.

Overview of Behavior-Based Resources

Behavior-based demand flexibility works by merging the power of behavioral science with detailed customer energy usage data, surfaced in a way that makes it easy for customers to understand and act upon. Importantly, behavioral resources motivate customers to change when and how they use energy without requiring customers to install a new device or enroll in an automated program. Instead, they combine personalized communications, timely prompts, and social comparisons to achieve results.

Utilities currently deploy several types of behavior-based demand flexibility programs. This paper focuses on event-based DR, often known as Behavioral Demand Response (BDR), which can be deployed with an incentive as a Peak Time Rebate (PTR), asking customers to respond to behavioral nudges to shift usage during peak events. Other approaches include passive EV managed charging – giving customers personalized insights into their charging behavior and encouraging off-peak charging which acts as an alternative to active managed charging for customers who do not wish to give over control of their charging, as well as time-of-use rate coaching – which gives customers personalized insights into the timing of their energy usage and reminding customers of the opportunity to save by shifting usage to off peak times. Behavioral resources may be deployed with or without monetary incentives.

Utilities are asking customers to not only change their consumption behavior, but to build new energy habits. Installation of connected devices, allowing devices to be enrolled into automated programs, or participating in DR events in response to a signal, are all dependent on a customer's willingness to alter their normal behavior. They all require a customer to commit to a decision or to change a habit. Behavior-based solutions do more than deliver on individual saving events, they help customers get used to engaging with the grid in new ways through DR and VPP programs.

Power of Behavioral Science

Behavioral solutions work without a device or monetary incentive because they leverage the power of behavioral science and social norming that have been proven to reliably shape customer energy behavior (Galport 2022). The most notable example of this is Home Energy Reports (HERs), which pioneered the use of normative comparisons to motivate customers to reduce energy consumption. Over 30 states have approved HERs as an energy efficiency (EE) resource, and it remains a key component of many utilities' EE portfolios (Galport 2022). The same behavioral science concepts that underly the Home Energy Report are employed in behavior-based demand flexibility to induce *shifts* in customer usage, as opposed to reductions.

Communications, such as those shown in Figure 2, are designed to grab customers' attention, influence their decisions, facilitate action, and sustain long-term behavior. Behavioral science principles including descriptive and injunctive norms, loss aversion, feedback and process signals, simplification, and reduced friction are all employed to engage and motivate customers.

Meeting Customers Where They Are with Customer Communication Preferences

Behavioral resources also have the advantage of being able to reach customers in the ways that work for them; there is a range of messaging media by which "dispatch" signals can be delivered, including email, short message service (SMS) text, and Interactive Voice Response (IVR). Customers can choose which channel works for them, further ensuring that customers remain engaged and satisfied with the program. While simply offering multiple channels facilitates consumer choice, a focus on actual consumer communication preferences has proven to be a powerful engagement tool. Allowing customers to choose their preferred channel helps keep customers engaged and reduces customer frustration. Customers may respond more readily to a certain channel (e.g. SMS may elicit a greater response than email for a given customer) if they are allowed to express a preference. Providing additional options, especially "real time" channels like IVR and SMS, can improve savings; for example, according to internal data, Opower BDR programs with a large portion of households enrolled in IVR by default save on average double those with little or no IVR enrollment. Using preferred channels enables utilities to deepen savings and provides ancillary benefits such as reduced call center volume and improved perception of the utility.

In 2025, the Federal Communications Commission (FCC) affirmed the importance of being able to reach customers through opt-out text messages. There had been legal uncertainty that prevented utilities from reaching their customers through text, despite it being one of the most effective demand response channels. The FCC clarified a prior ruling, allowing utilities to send peak demand texts to customers who have previously provided their phone number to the utility, even if they have not expressly opted-in to the DR program (FCC 2025).

Scale and Location

Perhaps the most unique benefit that behavioral resources provide is the ability to easily reach a particularly large audience of utility ratepayers by utilizing an "opt-out" or auto-enrollment design. While this approach is inappropriate for programs that control a customer's device, it is a perfect fit for those that ask for voluntary behavior change. Even though a customer has been auto enrolled to receive behavioral DR communications, the choice to take action is always theirs. While customers may opt out at any time, observed program opt-out rates for behavioral programs are generally quite low, typically below 1% (Galport 2022). In contrast to a device-based program, which requires a ramp up period to get enough devices installed and enrolled, behavior-based programs can reach all target customers right from the start to begin habituating energy saving behaviors.

Additionally, as the particular location of DR efforts becomes more important to avoid distribution system overload/failure, the locational value of DERs becomes critical (Kent 2025). Even where there are not enough connected or automated devices on a given feeder to generate meaningful reductions, there may be enough customers on that feeder whose behavior can be harnessed.

Customer Sentiment and Engagement

The SECC study noted above highlights that many customers who do not have connected devices or are unwilling to let a utility or aggregator control them are still willing to voluntarily shift load. The discrepancy, while not very large, showcases the need to provide customers with another option – one that allows them to maintain control while still contributing to demand response. By focusing on customer experience, behavior-based resources embody the VPP objective to "…Encourage participation and ensure long-term retention, ultimately sustaining program momentum and enabling large-scale customer engagement" (LBNL 2025a). This participation is an important tool to drive direct value both to *and* from energy consumers as demand growth from data centers, electrification, and other sources puts pressure on electricity rates.

Marketing and Awareness

Scale, particularly in the residential segment, is highly valuable for both direct peak reduction and because it creates the opportunity to reach a large group of customers with targeted messaging. Behavioral resources simultaneously function as both a savings tool and as a marketing tool to increase awareness of grid events among customers. While demand reduction and load shift are, themselves, worthwhile outcomes of any VPP resource, personalized customer education adds value by addressing two key barriers to VPPs: customer awareness and reliance on device adoption and program enrollment. Behavioral resources present a valuable marketing opportunity to enable customers to participate in other programs including traditional standalone EE (e.g. weatherization, retrofits, etc.) and DR programs (e.g. rebated thermostats), as well as programs integrated into VPPs. Messaging can be personalized to ensure that customers are getting recommendations that are right for them; if they do not already have a smart thermostat, they can get rebate and marketplace information, but if they do, the messaging can focus on enrolling their thermostat in an automated program or on other devices they may want to adopt. Through this large-scale, targeted messaging, behavioral approaches can deliver both immediate demand savings as well as greater awareness of additional opportunities to adopt new devices or participate in automated programs, for example receiving a rebate to adopt a smart thermostat.

Equity

Behavior-based tools also drive valuable equity outcomes by enabling participation in a VPP or DR program without the often-costly requirement of investing in devices. While devices undoubtedly drive deeper per-household demand savings, they require up-front investment that may not be feasible for all households – even when discounted through upstream or downstream incentives. In addition to access to VPP and DR participation, behavioral resources deployed with a financial incentive enable renters, low-income households, and other disadvantaged communities to be compensated for demand reduction. While other DR programs and VPP resources offer compensation to participants, it is limited to customers who already have a device; incentivized behavioral resources enable customer participation –and compensation– even without a device. Additional strategies that behavioral resources deploy for reaching underserved segments include offering communications in multiple languages, messaging tailored to low- and moderate-income households, providing no- and low-cost peak demand savings tips, and channeling eligible customers to utility programs providing significant device rebates or participation incentives.

Behavioral Demand Response: Underutilized Solution

BDR is the most prevalent example of behavior-based DR programs, but is not currently being utilized to its full potential. It drives residential peak demand reduction and shifting of demand through opt-out communications. BDR can be "dispatched" across channels, e.g. SMS text messages, emails, IVR, and printed materials, to inform residential utility ratepayers of the need to reduce consumption during specific time periods. Impact is measured using a Randomized Controlled Trial (RCT), a type of experimental design in which members of an eligible population are randomly assigned to either a treatment group or a control group. The treatment and control group are tested for statistical equivalency. A program intervention is then provided only to the treatment group. The outcomes for these two groups are compared, resulting in unbiased and highly rigorous program energy savings estimates (NREL 2020).

At the beginning of a DR "season" (either summer or winter), a residential customer receives a pre-season welcome letter introducing them to BDR and providing key utility-specific information such as when a peak period takes place (e.g. 4-9 pm on weekday non-holidays). When a BDR event is triggered, typically the day before or the day of a peak event, preemptive messaging is sent to "prime" utility customers for the event by providing key information on timing and duration of the event, along with tailored, customer-specific tips for reducing consumption.

On the day following the event, customers receive a post-event communication detailing the customer's achieved demand reduction and –critically– a normative comparison demonstrating how that customer's demand reduction compares to that achieved by similar homes. This specific set, cadence, and content of tailored communications enables BDR to provide a number of key benefits to customers, the utility, the grid, and the local community in the form of scale, seasonality, equity, and accessibility.

See Figure 2 for examples of BDR communications that use behavioral science to convey a call to action and highlight a customer's impact on the peak day.

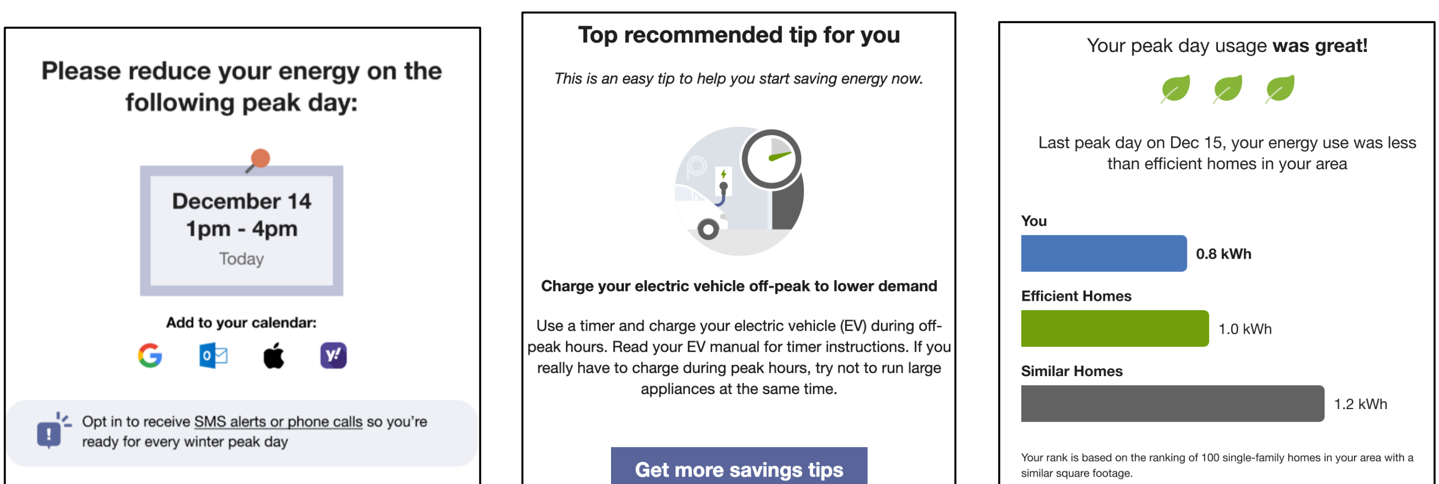

Figure 2. Examples of BDR communications: call to action, personalized energy saving tip, and post-event normative comparison. *Source:* Sample Opower communications, June 2026.

Key Benefits of Behavioral Demand Response

Scale. While BDR programs are underutilized, they are not a new phenomenon. For over 10 years, utilities have successfully deployed BDR programs at scale to drive crucial benefits to utility ratepayers, the grid, and the environment. Puget Sound Energy (PSE) engages more than 450,000 customers in its BDR program, which is dispatched through the utility's VPP (PSE 2024). Similarly, at Pacific Gas & Electric, BDR has scaled from 50,000 participants in 2015 up to 545,000 in 2024 (PG&E 2024). Baltimore Gas & Electric (BGE) has deployed PTR since 2012, engaging up to 850,000 customers in peak events (BGE 2024). Notably, customers participating in BDR events demonstrate a clear desire to remain engaged throughout a season; opt-out rates for IVR phone calls average lower than 0.7% per BDR event.

Meaningful Demand Reduction. BDR programs have repeatedly shown meaningful demand reduction. Across 11 events in 2023 called by CPS Energy, 350,000 households achieved 16.7 MW of coincident peak demand savings (CPS 2024). Other implementations, such as at Sacramento Municipal Utility District (SMUD), have consistently saved over 3% of each household's energy consumption per event. In summer 2025, BGE's Manager of Demand Response and Load Management Programs reported that their behavior-based program "had a highly successful event, shedding approximately 150 MW from the BGE system during peak demand…To put that into perspective, it would take more than $500 million in battery storage to match that level of load reduction. This is a powerful example of how DR can deliver real value quickly, affordably, and at scale" (Sprayregen 2025). Internal data indicates that in summer 2025 Opower drove over 186 MW of capacity savings across all in-market BDR/PTR programs. In addition to these observed results, a New York study identified the future potential of behavior-based DR as a demand flexibility resource; it found that BDR could contribute over 500 MW in summer, and over 200 MW in winter (Brattle 2025).

Compatibility with Device-Based DR. Although BDR does not require participation via a device, it can nonetheless enhance and strengthen engagement with, and savings from, smart thermostats, batteries, and other DERs. By providing tailored savings tips, normative comparison to other similarly-equipped homes, and pre- and post-event messaging, BDR enables VPPs to fully realize the value of the participants *and* their devices as grid assets to both reduce peak demand and shift energy consumption. For example, Figure 3 shows a communication tailored to a home with a remotely controllable air conditioning system the utility intends to cycle in response to peak demand.

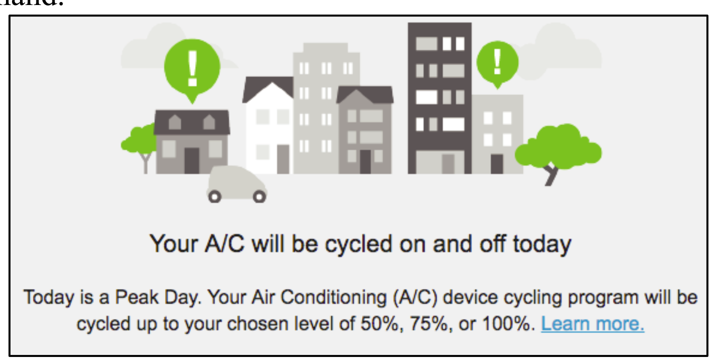

Figure 3: Example of behavioral communication for device-focused peak demand program. *Source:* Opower Communication.

Deploying behavioral peak reduction programs alongside device-based programs can provide greater overall benefit than either one individually. Behavioral programs are able to elicit savings from a wider range of customers while also proactively funneling those customers into device-based programs – driving even deeper savings per household. Customers may move between programs, starting with voluntary behavioral savings, which may make them more receptive to device control programs. On the other hand, some may want to opt-out of ceding control of their device, but may still be willing to shift usage via a behavioral program. Regardless of where a customer is on their load shifting journey, the combination of behavior-based and device-based programs ensures that almost everyone has an opportunity to participate in the way that works best for them.

Suitability for Winter Peaks. As noted above, while many existing VPPs are focused on driving peak demand reduction in summer due to high temperatures, winter peaks are proliferating – particularly in the face of increased climate volatility. This affects utilities in the Northeastern United States, but has become more broadly impactful, with 55% of all utility customers reported experiencing an outage in 2025 (JD Power 2026). Many utilities, therefore, are facing a new reality of dual peaks in both summer and winter; BDR has demonstrated meaningful demand reductions across both demand peaks, allowing utilities to amortize the value of their VPP across a wider period. By driving demand reduction across a large set of customers and end-uses, BDR represents a valuable facet of a VPP that can be deployed alongside other resources to alleviate peak demand and shift usage, reducing costs and improving grid reliability in the process.

Behavioral Demand Response Positioning Within VPP Frameworks

BDR acts as one component of a broader set of VPP tools due to its unique program design and characteristics. While VPP frameworks may attempt to leverage more resources by taking a "technology-neutral" approach, this is not sufficient to capture the full breadth of resources available since human behavior is not classified as a "technology." As such, it is important to assess its complementary value alongside a panoply of VPP resources. BDR avoids unneeded supply and distribution grid investment alongside other VPP resources, doing so on a daily or seasonal time scale. Complimenting BDR with both rapidly dispatchable resources that respond in minutes (e.g. backup generators, emergency load control), as well as longer-term resources (e.g. seasonal energy storage, EE) that affect seasonal or annual demand shifts (LBNL 2025c), leverages the full spectrum of VPP resources, from individual customers to large aggregations of devices, across multiple geographies and time horizons. For example, a VPP that "…Includes load flexibility, interruptible load, and behavioral load shaping for residential, commercial, and industrial loads…" (Brehm and Tobin 2024), therefore achieves valuable diversity across segments, timescales, and customer classes to meaningfully address "10-20% of peak load by 2030, saving approximately $10 billion per year in the process" in utility expenditures (Brehm and Tobin 2024).

Case Study: How Puget Sound Energy Incorporates Behavioral Demand Response into its Virtual Power Plant

PSE, a Washington investor-owned utility serving 6,000 square miles primarily in the Puget Sound region of Western Washington, has incorporated BDR into its VPP. Initially filed in the General Rate Case in 2023, PSE's "Flex Rewards" BDR program has grown to represent a significant customer-facing facet of the utility's set of load flexibility solutions as part of a broader VPP strategy in the form of $68.1M of projected benefits over the life of the program (PSE 2024). PSE envisions BDR as key to progress towards a future state in which utilities and customers work together to meet reliability, resiliency, and cost goals. Historically, utilities have approached automated DR as being an "invisible experience" that takes place largely through automated, device-based programs. While still effective in reducing demand, this approach often does not facilitate a customer-focused environment that tells the story of utility actions to establish grid resiliency and reliability. This can contribute to the observed lack of customer awareness and acceptance of DR programs – unintentionally driving a wedge between customers and utilities.

While load flexibility measures are often unobtrusive, not taking steps to inform, educate, and empower customers to take action in ways that make sense to them further separates utilities from the end state goal of being "energy partners" with their customers. The status quo often takes the form of customers' devices receiving signals to reduce demand, while the utility hopes the customer understands why this is taking place – if they notice at all. This limits the utility's ability to provide an informative "story" that can help customers understand the purpose of peak demand event or load flexibility program and how it will impact them.

In response to this status quo, PSE employs behavioral messaging through BDR which alleviates the types of engagement challenges referenced above. This simultaneously addresses important equity concerns, by not just providing options to customers who may not have the ability to enroll devices (or who have devices and do not like ceding control), but also provides customers with deeply valuable insights to how their actions play a role in their day to day lives within their home, community, and region.

PSE's BDR Programmatic Approach and Results

Developed from the outset as a dual-season demand flexibility program, PSE's Flex Rewards program sets event guidelines as follows: "Flex events will only occur during the hours of 7 a.m. to 10 p.m., typically lasting between 2-4 hours each, and will never take place on holidays…Winter events can occur from Nov. 1 to March 31 and summer events can occur from May 1 to Sept. 30" (PSE 2026). Utilizing customer communication channels including text messaging, IVR, email, and paper mailers, Flex Rewards has driven statistically significant peak load reduction of up to 16.6 MW per event during the course of three successive seasons of deployment. Aggregating per-household savings rates of 0.6%-1.5% (as shown in Figure 6) across up to 450,000 households therefore results in meaningful demand reduction.

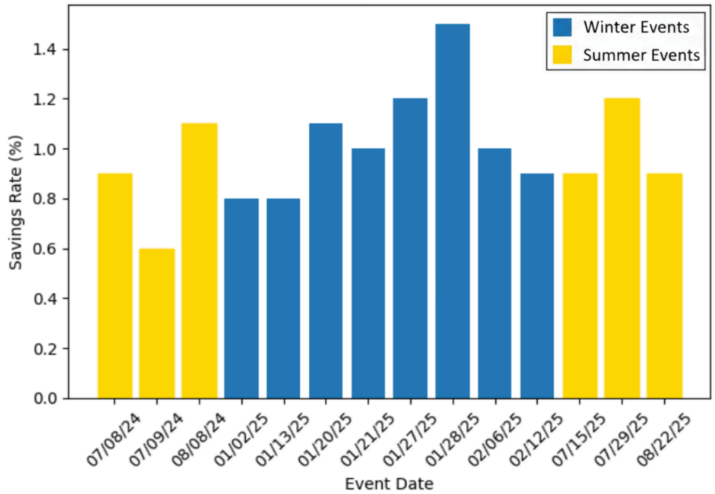

Figure 6: Behavioral Demand Response Per Household Event Results at PSE, 2024-2025. *Source*: Opower internal data.

Beginning in summer 2026, PSE will shift Flex Rewards' program design from solely utilizing a behavioral signal to include a monetary rebate available to all participating customers in the form of a $25 enrollment gift card, $15 re-enrollment gift card for successive seasons, and $1/kW of reduced demand during peak events (PSE 2026). This programmatic alteration, aimed at spreading the monetary benefits of demand response to all communities in PSE's service territory, will be an interesting case study in the impact of an incentivized BDR program as part of a broader VPP strategy.

Future Program State

Looking forward, PSE continues to envision BDR as a component of its broader VPP strategy. As PSE continues to examine the effectiveness of Automated Demand Response (ADR), including staggering ADR programs across temporal and locational configurations, the utility will explore how BDR can facilitate pre-conditioning – thereby limiting "snapback" (i.e. the increase in energy and demand in the hours immediately following a demand response event.). By co-deploying BDR with ADR, PSE could deepen the value of behavioral programs by timing them to reduce negative ADR impacts.

Additionally, PSE plans to leverage BDR to increase participation in a range of other utility programs, including EE. PSE's behavioral programs –including BDR, Home Energy Reports, and other data-driven customer-focused messaging – drive incremental benefits by cross-selling EE alongside DR. Harmonizing EE and DR across Opower's messaging exposes customers to both conservation approaches: driving permanent usage reduction and grid-responsive reduction. These savings can be further maximized when paired with time-of-use rates.

BDR remains an important layer of PSE's VPP strategy, enabling customer-focused engagement in a highly technical, complex, and evolving landscape. PSE looks forward to sharing learnings as it continues to deploy dual-season BDR –soon transitioning to PTR– as part of its broader VPP strategy.

Conclusion and Recommendations

As energy demand grows and the grid becomes more complex, VPPs will be critical to maintaining reliability and affordability. To enable these VPPs, utilities will need to ask customers to be more engaged in their energy choices than ever before, and success will depend on customers' willingness and ability to participate. Customer engagement efforts will come in many forms, whether driving awareness of programs, providing the right motivation to participate, or asking customers to change their behavior, and utilities must use all resources available to achieve these goals. BDR will be a critical tool for utilities to meet customers where they are and move them to the next step in their VPP participation journey – all while delivering meaningful demand reduction.

To unlock the power of behavior-based resources in VPPs, utilities, policymakers, and stakeholders should consider the following:

- Look beyond devices and consider the human element of VPP programs;
- Prioritize customer engagement tools that reach a broad audience, while still giving personalized insights;
- Enable and encourage utility-run programs to participate in VPPs in order to reach scale and maximize impact;
- Take a "customer journey" approach that meets people where they are and guides them towards increasing involvement in VPPs;
- Ensure that VPP rules do not unintentionally exclude behavior-based resources. Language that only refers to "devices" ignores the valuable role that BDR can play.

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