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WHEN TRUST MATTERS

A Policy and Regulatory Guide

DEMAND IS THE NEW SUPPLY: AFFORDABLE GRID STABILITY THROUGH DEMAND-SIDE SOLUTIONS

Authored by

Shawn Bodmann & Teague Douglas

Prepared by DNV for Alliance to Save Energy

REPORT

ABOUT ALLIANCE TO SAVE ENERGY

Founded in 1977 by Sens. Charles H. Percy (R-Ill.) and Hubert Humphrey (D-Minn.), the Alliance to Save Energy was launched following the oil embargo of the 1970s – a pivotal time in our nation's history that exposed fundamental weaknesses in our nation's economic security and challenged us to develop innovative energy solutions. Decades later, it continues its mission to create a more energy-productive world.

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Executive summary

In a time of environmental concerns, technological advancements, and surging energy demands, a critical question looms large: How can we manage grid load?

The energy industry faces an increasingly variable energy supply, a massive influx of new demand from electrifying transportation and heating, several years of transmission and distribution (T&D) backlog, and increasingly common and intense climate events. Electricity management programs that aim to balance the supply and demand of electricity on the grid, otherwise known as demand-side solutions, can be used for this purpose in more cost-effective and environmentally friendly ways than additional generation and T&D infrastructure. In the United States, demand-side solutions can create up to 200GW of capacity quicker and for billions of dollars less than generation and infrastructure. There are several trends creating tailwinds for demand-side grid benefits such as the deployment of advanced metering infrastructure (AMI), high-speed internet, and the increasing affordability and prevalence of residential technology. Despite the tailwinds, the utilization of customer-sited assets for load management is not growing fast enough to meet the changes on the grid and avoid costly investments to solve the issues through new infrastructure. With so much potential, why is the use of demand-side solutions still relatively low, and what can we do to increase it?

This paper presents the results of an intense publication review and in-depth interviews with energy delivery experts to understand the state of the industry, consider environmental justice, identify barriers preventing the use of demand-side solutions in the residential sector, and how to increase demand-side solutions that provide grid and customer benefits. We offer a set of recommendations to guide policymakers, regulators, utilities, grid operators, and equipment manufacturers toward improved grid stability while saving consumers billions of dollars. The paper does not focus on specific technologies but acknowledges that many technologies are required to solve grid needs. Next generation technologies, such as virtual power plants (VPP), grid-interactive efficient buildings (GEBs), and active energy efficiency (AEE), that leverage the ability to communicate grid needs to consumer devices offer the promise of taking demand flexibility to the next level to optimize grid operations. The authors include more traditional demand-side solutions, such as traditional energy efficiency (EE) and demand response (DR) within the broader concept of demand-side solutions, as they can also play a greater role than they already do.

Grid stability is achieved by balancing supply and demand, and grid operators tend to favor increasing supply. Over the past 10 years, the U.S. spent $120B to create 100 GW of new electric capacity with gas-fired plants and batteries. However, demand-side solutions are cheaper, cleaner, and quicker than the supply-side solutions. For example, demand-side solutions can deliver capacity for approximately half the cost of supply-side resources, and introduce new levels of flexibility in orchestrating the grid. Once widely deployed, demand flexibility technologies will offer much more value than traditional demand response. Demand flexibility offers the ability to reduce peak load; shift load from high to low-price times; react to emergency grid needs; and reshape load profiles to match intermittent renewables generation.

Demand-side solutions are under-utilized today, compared to their technical potential. Despite years of incentive programs offered by most utilities, participation in traditional residential energy efficiency programs remains low – approximately 6% of households participated in an energy efficiency program involving appliances and non-lighting equipment. Participation in traditional residential demand response programs is also low – approximately 10% of households participate – and total capacity offered by these programs has been flat for the last 10 years. Thus, even if restricted to older technologies, demand flexibility programs could achieve at least 10 times more capacity than current levels. The technical potential of currently installed air conditioners and water heaters alone is over 100 GW.

Only 6% of households participated in an energy efficiency program involving appliances and non-lighting equipment.

Technologies such as high-speed internet, advanced metering infrastructure, and home WiFi that make demand flexibility possible are already widely deployed (although less so in low-income and rural areas). However, demand flexibility has not yet achieved substantial market penetration. Most utilities are approaching it cautiously, at most offering pilot programs. This paper explores barriers and solutions to increasing the adoption of demand flexibility in the residential sector.

In this paper, we also consider how implementing more demand-side solutions could benefit low-income households and households in historically marginalized communities. These households generally pay a higher percentage of their income for utilities despite having less reliable service and experiencing the most difficult and long-term effects of climate disasters. Additional infrastructure spending can increase the electricity rates of all consumers. Demand-side resources could achieve the same goals as common supply-side resources but at a lower cost, helping to ease the energy burden of marginalized households. Ensuring marginalized households are early participants in demand-side solutions will be essential to achieving energy equity.

Below are the barriers and corresponding solutions to increasing demand-side solutions in the residential sector:

Solution 1

Utility business models and operations, and regulatory frameworks interact in ways that disincentivize the implementation of residential load management investments.

- **Solution 1a:** Identify and develop strategies that place demand-side utility investments at par with supply-side investments, across the utility footprint, including investor-owned utilities; rural cooperatives; and public power.
- **Solution 1b:** Increase transparency and regulatory oversight of distribution system planning.
- **Solution 1c:** Identify and develop a common set of standards and data for modelling, measuring, managing, forecasting, and reporting on a utility's demand-side investments.
- **Solution 1d:** Make it easier for third parties such as aggregators to operate in the residential market.

Solution 2

High levels of participation across a diverse geography are needed on the residential side to create meaningful programs that can be used by distribution operators.

- **Solution 2a:** Increase the use of automatic enrollment, access, and opt-out recruitment methods.
- **Solution 2b:** Increase compensation and subsidies to encourage participation.
- **Solution 2c:** Strategically educate consumers about the benefits of demand-side solutions, including impacts on energy affordability.

Solution 3

It takes more money, time, and effort to install load management technologies in marginalized households.

- **Solution 3a:** Identify and develop strategies that prioritize energy efficiency investments in marginalized communities.
- **Solution 3b:** Develop coalitions of public and private organizations to invest in projects in marginalized communities.
- **Solution 3c:** Lower administrative barriers to accessing public funding and integrate program offerings for serving marginalized households.

As the energy landscape grapples with the challenges of environmental sustainability, technological evolution, and increasing energy demands, the need to effectively manage grid load is increasingly apparent. Demand-side solutions not only address these challenges but do so in a way that is both cost-effective and environmentally responsible. However, despite its potential, the implementation of demand-side solutions in the residential sector is not as widespread as it should be. By implementing these recommendations, we envision not only enhanced grid stability but also a path toward energy equity, where demand-side solutions play a key role in shaping a sustainable and inclusive energy future.

Introduction

Electricity is getting more expensive in many parts of the country as the aging, outdated grid is losing reliability.

Massive additional loads from the electrification of transportation and space heating will add daily stress on the system, and extreme climate events represent acute stressors that are happening with greater frequency and strength. Wider deployment of renewable generation is essential for slowing climate change, and because these assets produce electricity asynchronously with demand, they create a need for additional mechanisms to balance supply and demand. Increased renewable generation also requires additional transmission and distribution (T&D) infrastructure build-up, and current queues represent several years' worth of backlog.

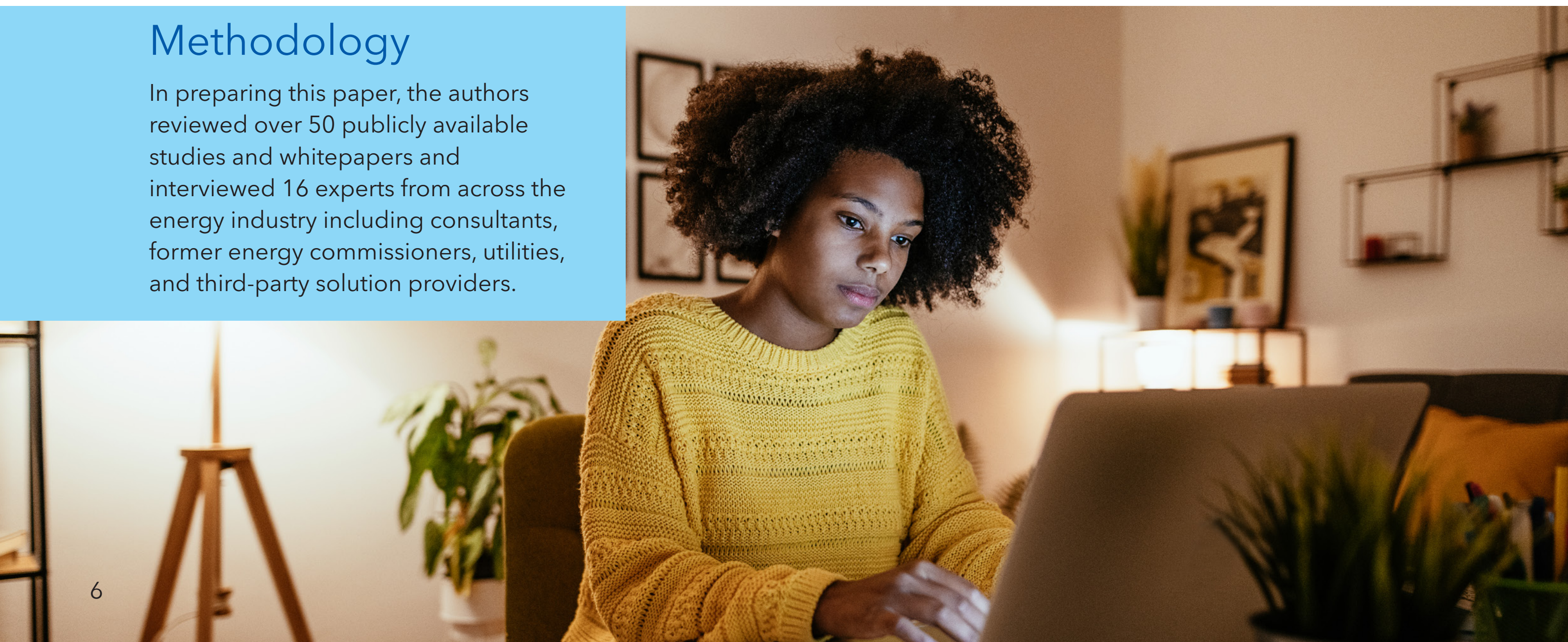
Balancing supply and demand requires increasing supply or decreasing demand, often quickly. The traditional solutions focus on the supply side by adding fossil fuel generation, primarily in the form of natural gas-fired "peaker" plants to handle the highest potential demand peak and maintain resource adequacy. The unintentional solution on the demand side is rolling blackouts and brownouts, which are undesirable from safety, environmental, and economic perspectives. Intentional demand-side solutions offer safer, cleaner, quicker, and cheaper options for balancing loads that give money directly back to consumers.

The demand-side solutions this paper focuses on include concepts such as traditional energy efficiency (EE) and demand response (DR), as well as more recent concepts such as demand flexibility, virtual power plants (VPP), grid-interactive efficient buildings (GEBs), and active energy efficiency (AEE). "Demand-side" refers to any customer-sited resource that can mitigate supply and demand imbalances on the electrical grid by lowering or raising demand, but generally does not include behavioral strategies such as conservation. It includes and is not limited to approaches such as traditional EE programs that reduce loads across the board, traditional DR programs historically used to shave system peaks, distributed generation with or without batteries, battery systems that can be charged during times of low demand and discharged during high demand, and grid-interactive efficient buildings that automatically reduce demand during peak hours.

The authors include energy efficiency measures such as weatherization and more efficient appliances because these measures reduce demand in ways that can eliminate or defer the need for additional generation, and they are often the most cost-effective means of meeting energy system needs. Furthermore, they are a foundational technology that enhances the effectiveness of more active demand-side measures, and their adoption faces many of the same barriers. Realizing the full potential of demand-side solutions, including greater energy reliability, affordability, and emission reductions, depends on successful policies that incentivize insulating and sealing the building envelope, which are essential components of traditional energy efficiency, as are standards and codes impacting equipment and appliances in the home.

Methodology

In preparing this paper, the authors reviewed over 50 publicly available studies and whitepapers and interviewed 16 experts from across the energy industry including consultants, former energy commissioners, utilities, and third-party solution providers.



State of the industry

The electricity industry spends substantial amounts of money on generation capacity for resource adequacy, and these needs could be met less expensively through demand-side options.

Over the past decade, the U.S. has spent over $120 billion to add 100 GW of new capacity primarily in gas-fired generators and lithium-ion batteries, largely to maintain resource adequacy.[1] The United States will need to add an additional 200 to 400 GW of peak capacity by 2035 to solve resource adequacy challenges. Obtaining this capacity through demand-side resources will cost approximately half as much as paying for generation resources. Aggressively pursued demand-side solutions just in California and New York could save as much as $60 billion by 2035.[2] Meeting just 60 GW of the needed capacity increase through demand-side resources could save Americans $20 billion over the next 10 years.[3] When non-energy impacts such as pollution are considered, demand-side solutions could have zero or even negative net costs.[4]

Demand-side solutions are not new. Retail energy efficiency and demand response programs have been in use since the 1970s, and FERC has updated rules to increase wholesale market DR since 2008. Residential EE, retail DR, and wholesale DR each have different purposes in the current energy ecosystem. Energy efficiency permanently removes load and in turn, reduces the need to build more generation capacity. Utilities use retail demand response programs today to shave system peaks and reduce peak energy costs. As utilities shift from demand response to demand flexibility, retail capacity can be used to reduce peak-related transmission and distribution costs, and provide load following, but our interviews indicated that utilities have had only modest returns on investment in this category. ISOs and RTOs use wholesale demand flexibility to achieve grid reliability; retail demand flexibility serves this purpose only in emergencies.

Despite the maturity of demand-side solutions, market penetration remains low. A mere 23% of households participated in any residential energy efficiency programs, including free or subsidized lighting, appliance recycling, energy audits, and rebates for new appliances or equipment. When only the appliances or equipment type of program is considered, participation drops to 6%.[5] As an example of the magnitude of unrealized EE potential, a recent study estimated that there are 2.9GW of summer (3.4% of ERCOT's peak) and 10.5GW of winter load (13% of ERCOT's peak) reduction available through traditional EE programs in Texas alone.[6]

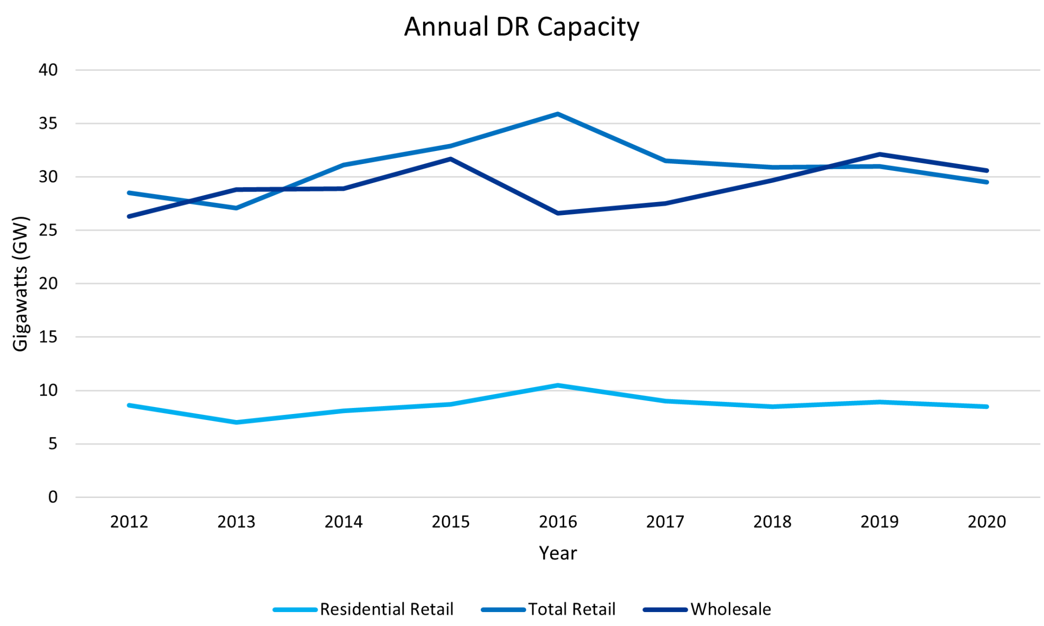


Figure 1 DR Capacity Growth (FERC 2014-2022)

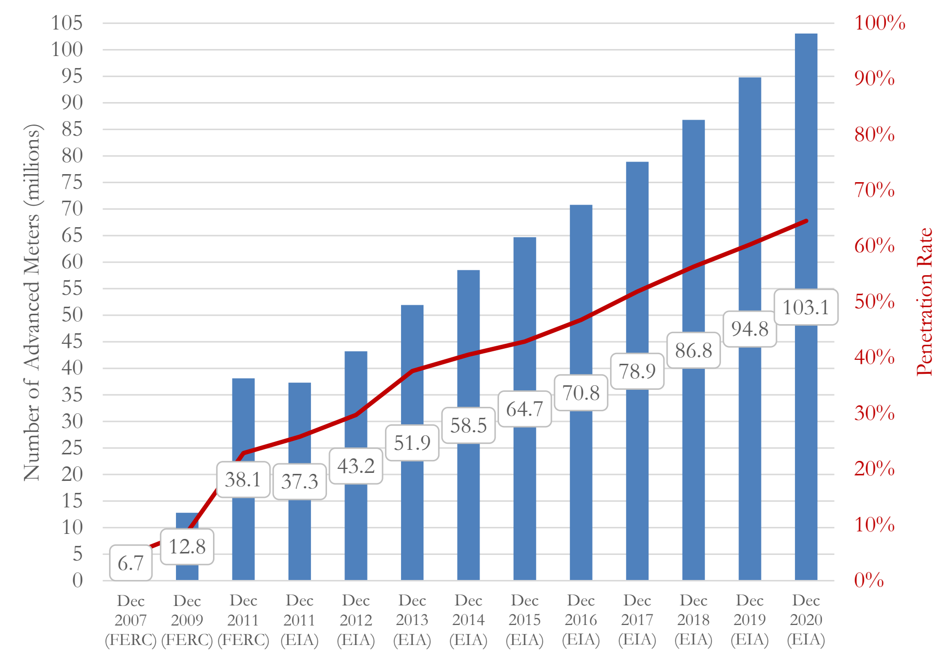


Figure 2. AMI Growth (FERC 2022)

Market penetration of demand response capacity has been flat for the last decade. Figure 1 shows the total capacity in retail markets (broken out by the residential portion and the total including residential) and wholesale markets. There are approximately 9GW of capacity from residential customers in currently operating retail demand response programs, an additional 21GW of capacity from commercial and industrial retail customers, and approximately 30GW in wholesale demand response programs. The wholesale capacity amounts to approximately 6% of the nationwide peak load.[7] While total demand response program capacity has increased in some regions, that growth has mostly been offset by losses in other regions, resulting in little total, nationwide demand response program capacity growth.[8]

In terms of overall potential, residential participation could be over 10 times the current levels. The number of customers enrolled in retail demand response programs was approximately 11.6 million in 2020,[9] which is approximately 1 in 10 U.S. households. We estimate that control technology installed on all residential air conditioning has a demand response potential of approximately 83GW and residential water heating could offer an additional 20 GW. This is a total of over 100GW of potential from currently installed appliances, compared to the 9 GW currently enrolled. Increased electrification of heating and transportation are both additional opportunities not included in these estimates.

Meanwhile, technology and communications advances and cost decreases have led to widespread deployment of enabling technologies that can be used to improve grid reliability and address more nuanced goals such as load shifting and reducing local distribution-level constraints. Advanced metering infrastructure (AMI) penetration increased steadily from almost none in 2007 to approximately 65% of consumers in 2022.[10] Approximately 73% of adults lived in a household with broadband internet in 2020.[11] In 2023, 92% of homes have internet, 92% of homes have Wi-Fi, and 41% of homes have at least one smart device.[12] However, this distribution is not homogenous - rural and low-income homes have as much as 25% less access to these technologies.

While the enabling infrastructure (internet, AMI, Wi-Fi) is widely available, the use of new technology that takes advantage of that infrastructure to manage demand has been more sluggish. As of 2020, approximately 10% of US households were on time-varying rates (TVRs). In addition to the ability to use price signals to encourage customers to voluntarily reduce use during times when electricity is expensive, TVRs unlock the potential of automation technology such as smart thermostats to maximize consumer value while minimizing consumer effort. However, by 2020, less than 20% of U.S. households had a smart thermostat, and penetration is expected to be less than 33% by 2026. Electric vehicles (EVs) account for under 10% of new car sales in 2023, and the state-by-state adoption rate is uneven. This uneven adoption is expected to continue at least through 2035.[13] Even among EV owners, only a small number have the technology to maximize the DR potential of their vehicle batteries. Among EV owners, approximately two-thirds have permanent level 2 chargers, but there was little evidence that they took advantage of charging during times of lower rates.[14] As of 2020, there was less than 1GW of behind-the-meter battery storage in both residential and non-residential applications, although this is expected to increase to over 7GW by 2025.[15]

These enabling technologies provide the foundation for demand flexibility technologies to expand the value streams for load management. Widespread adoption of residential demand flexibility would expand utilities' ability to use customer assets to defer distribution system capacity and infrastructure in a more targeted and localized manner. The advanced control possibilities of these technologies open the opportunity for load shifting to better match intermittent renewable generation and consumers who can take advantage of using electricity when prices are cheapest. This also expands the market for ancillary services.

Energy equity and environmental justice

The state of the energy industry is not homogenous. Low-income households and households in historically marginalized (primarily along racial lines) communities (referred to collectively as marginalized households for the remainder of this paper) experience a different energy infrastructure than those in wealthier and whiter areas. Marginalized households often pay a higher percentage of their income for utilities, experience greater pollution, have less reliable service, and often experience the worst and longest negative effects of climate disasters.[16]

Despite receiving lesser benefits, marginalized households do not pay less for the energy system. While many utilities offer low-income rates and other bill assistance subsidies, marginalized households actually pay more per square foot for energy than more affluent households.[17] Furthermore, any additional costs to maintain energy infrastructure will almost certainly be paid for through utility rates, whether the solution is supply-side or demand-side, capitalized or part of a performance-based incentive.

This situation has several energy equity implications. First, any additional infrastructure spending has a risk of increasing the electricity rates of all consumers, including marginalized households. Because marginalized households are already facing higher energy burdens, when demand-side resources can achieve the same goals as supply-side resources at a lower cost, they would do less harm to already marginalized households. Additionally, energy efficiency improvements in their homes would lower their utility bills. Similarly, to the extent that demand-side resources result in less pollution, they disproportionately benefit marginalized households. Finally, demand-side solutions could increase reliability in marginalized areas as well.

Less obviously, delaying the implementation of demand-side solutions in marginalized households would likely increase inequities. Marginalized households participate less in existing programs and have less access to enabling technologies such as high-speed internet and Wi-Fi. Left to conventional market effects, marginalized households will be unable to afford to install demand-side solutions and energy equity gaps will increase. Worse, current approaches to pay for EE and DR programs effectively raise the bills of all consumers. They take a little from everyone to incentivize a relative few to install equipment they would not otherwise install. Without deliberate intervention, more affluent households will likely continue to participate at higher rates, and the benefits will disproportionately flow to more affluent households.

Barriers & solutions

The following section presents the barriers and solutions to implementing demand-side solutions in the residential sector.

We intend for these solutions to guide policymakers, regulators, utilities, grid operators, and equipment manufacturers toward improved grid stability that is both environmentally sound and cost-effective for the consumer. For each set of barriers and solutions, we chose several real-world examples where stakeholders are attempting to put similar concepts into practice.

Barrier 1

Utility business models and operations and regulatory frameworks interact in ways that disincentivize implementation of residential investments.

The traditional utility business model is a cost-of-service model where utilities make a return on investment in infrastructure and the volume of energy delivered to customers. This model has natural tension with demand-side solutions that decrease consumption or the need to build infrastructure. Decoupling combined with other policies that require or incentivize energy efficiency has created room for demand-side solutions, but barriers favoring capital investments persist.

Valuing the avoided costs of building out the local distribution system by leveraging demand-side solutions is new ground for many utilities and therefore carries risk, unknowns, and a harder path to gain traction. Siloing within utilities makes it difficult for managers of demand-side solutions to design and build programs that meaningfully address grid needs. Distribution engineers often distrust the reliability of customer-sited solutions because participation is not mandatory, and they rely on many small loads at various customer sites. At the planning level, utilities may be making invalid or insufficient assumptions about future customer adoption of DERs, using outdated modelling approaches, and making piecemeal rather than system-level decisions. Planning on the distribution system may not be happening frequently enough to account for the speed of technology changes.

For wholesale markets, there are several barriers to restricting customer asset participation. For third-party market actors who serve as aggregators and enablers of load management technology deployment, it is very difficult to build a business model around selling megawatts during unpredictable periods when prices are extremely high. Most business models rely on steady, predictable revenue streams. Markets that reflect the contributions of customer-sighted DERs to grid operations are not available in all wholesale markets.

Solution 1a: Identify and develop strategies that place demand-side utility investments at par with supply-side investments, across the utility footprint, including investor-owned utilities; rural cooperatives; and public power.
Investor-owned utilities need to be able to earn a profit from investments in this space. Not-for-profit energy providers need to show that the investments are cost effective. The use of performance-based regulations is one way to implement this solution. Performance-based Regulations (PBRs) shift the dynamics around how utilities traditionally make money (selling energy and cap ex) by rewarding (or penalizing) the utility for achieving goals, targets, or performance measures. PBRs create the opportunity to include more priorities than cost of service and reliability and align investor, customer, and policy objectives such as state environmental goals, operational efficiency, enhanced reliability, and equity issues. In our interviews, experts

agreed that PBRs won't completely remove the bias toward cost-of-service business models, and there is no one, universal PBR structure. Allowing utilities to pay for these investments through rate increases similar to how they pay for capital improvements is another method to implement this solution. Additional policies such as decoupling will increase the effectiveness of either approach.

Solution 1b: Increase transparency and regulatory oversight of distribution system planning. Smart planning efforts would help ensure that utilities are making valid assumptions about customer-sighted DERs and other technologies, are using up-to-date modelling approaches, and are taking system-level rather than piecemeal approaches. Iteration of distribution system planning will keep these plans up-to-date with rapid technological changes. Transparency allows for better alignment of public needs with distribution investments.

Solution 1c: Identify and develop a common set of standards and data for modelling, measuring, managing, forecasting, and reporting on a utility's energy efficiency investments, including demand flexibility. Digital platforms that make distribution and consumption data available to a broader set of stakeholders can fuel innovative solutions.

Solution 1d: Make it easier for third parties such as aggregators to operate in the residential market. Third parties need pricing structures that provide steady, predictable revenue streams rather than huge, unpredictable payouts every few years. Acceleration of FERC 2222 and new market creation will increase DER adoption.

Real World Examples

BG&E's behavioral demand response program leverages a combination of several policy initiatives to help it fit within the utility's business model: decoupling, using rates to pay for operational expenses at a profit, a minimum savings requirement, permission to sell DR capacity into wholesale markets, and ability to make profit on in-front-of-meter infrastructure investments that facilitate the DR. It also uses an opt-out model to increase participation rates. BG&E case study.

Massachusetts is undergoing a statewide planning effort led by the Grid Modernization Advisory Council (GMAC). GMAC reviews and provides recommendations on Massachusetts' forthcoming electric-sector modernization plans that identify areas on the grid that are under constraint and include non-wires or demand-side solutions. Mass Case study.

New York State's first Integrated Energy Data Resource (IEDR) Program houses energy-related data from an array of public and private sources, including utilities, DER, government agencies, and consumers. The data is searchable and actionable to inform investment decisions, identify operational inefficiencies, monitor the effectiveness of policy objectives, promote innovation, and encourage new business models.
NY case study.

Barrier 2

High levels of participation are needed on the residential side to create meaningful programs that can be used by distribution operators.

To unlock the demand side assets for more than just peak reduction, distribution operators need a load they can trust, load at scale, and load they can attribute to grid locations. Low adoption of certain DERs like residential storage and/or low enrollment in programs are barriers to handing over the keys (aka button) to distribution operators and allowing them to do more with those assets. Unlike energy efficiency programs, where any amount of participation is valuable, solutions intended to defer infrastructure investments or replace retiring generations have an all-or-nothing quality to them. If minimum participation levels are not reached, the infrastructure solution will need to be built anyway.

Opt-in has been the predominant model for EE and DR retail programs to date and has produced low participation levels. Current programs have low participation relative to customers with eligible technology and enrolled customers are not always the ones with the highest load potential or are not located optimally on the grid. Many consumers are unaware of existing programs.

Load management programs elicit participation through monetary compensation of consumers for modifying when they use energy or giving temporary control to utilities, grid operators, or third-party aggregators. The more compensation programs can offer consumers, the more participants they can enroll. Thus, unlocking additional value streams for customer solutions such as ancillary benefits or resiliency would allow program administrators to increase enrollment.

Several of our interviews identified the inability to value early adoption technologies like EV chargers or the inability to value customer DERs for multiple grid benefits. For example, batteries have the opportunity to solve more grid needs (avoided generation capacity, frequency regulation, energy price arbitrage, etc.) than a thermostat, but not all states have mechanisms or markets to pass along those values to the customer. For electric vehicles, utilities struggle with how to value their grid benefits and therefore, cannot share the value with customers through programs.

Consumers do not understand the energy system and why different solutions are necessary. Many solutions face customer pushback and therefore, make it harder to solve grid issues. Customers do not like rate increases or structural changes such as TVRs. Nobody wants new generation or transmission lines near where they live. Customers live busy lives and do not have the time or energy to exert extra effort to proactively control their energy use. On the other hand, customers also do not want someone else controlling their household devices.

Solution 2a: Increase the use of automatic enrollment, access, and opt-out recruitment methods. The carrot approach has delivered the participation rates to date. More assertive and creative approaches to enrollment (e.g., point-of-sale enrollment, TVR rates as default, codes, and standards) will be required to substantially increase participation.

Solution 2b: Increase compensation and subsidies to encourage participation. Policies like the Inflation Reduction Act (IRA) are increasing the adoption of DERs in households. They are not long-term solutions but help drive down costs for customers and reduce risk for manufacturers. Customer compensation can also increase from policies and practices that allow residential load management investments to be compensated for more than peak load shaving but receive compensation for values like T&D infrastructure avoided costs or emergency response. For example, guaranteed income streams for multiple years might be more effective than one-time subsidies or rebates.

Solution 2c: Strategically educate consumers about the benefits of demand-side solutions, including impacts on energy affordability. Consumer education is not sufficient to motivate behavioral changes or massive increases in opt-in participation. However, it is a necessary first step to showing consumers that they are part of the solution and increase their likeness to enroll in load management programs. In many ways, demand-side solutions ask consumers to change their relationship with the energy ecosystem from flipping switches to seeing themselves as consumers, producers, and participants. The messaging should speak to various audiences about the benefits of residential investments, above and beyond grid reliability, such as cost savings and carbon and pollution reduction.

Real World Examples

Green Mountain Power offers a residential storage battery with the option to bring-your-own-battery or lease a battery from GMP. Participation by lease customers is 100x more than the BYOT customers demonstrating there are real barriers for customers to procure batteries on their own and without supportive program designs. GMP case study.

Meta-analysis of TVR programs shows that opt-out strategies generate approximately 90% enrollment compared to 25% enrollment for opt-in strategies. Retention rates for both strategies are similar, around 80%. TVR case study.

Alliant Energy has produced the Powerhouse television show since 1996. This show uses a home improvement format to educate viewers about energy-saving upgrades to their homes. In a 2012 study, WE estimated that the show is responsible for 1.25 million annual kWh and 4.3 MW of peak reduction, above and beyond Alliant's energy efficiency and demand response programs. Alliant case study.

Barrier 3

It takes more money, time, and effort to install load management technologies in marginalized households.

Without deliberate intervention, marginalized households will likely be left to late or no adoption. Historically, marginalized households are less likely to participate in energy efficiency programs, own smart thermostats, and own electric vehicles. However, interventions designed to bring in marginalized households as early as possible could help to relieve energy inequities by giving them the benefits of early adoption. These benefits would be in addition to the peripheral benefits of lower (or less-increased) rates and pollution increased reliability and reduced utility bills from more efficient homes.

Marginalized households are often less ready to receive weatherization or load management technologies than more affluent households. Marginalized households are less likely to have enabling technologies such as high-speed internet or home Wi-Fi. In many cases (one interviewee told us 40% of the homes they serve), low-income homes require so much remedial maintenance for underlying issues such as leaky roofs, asbestos, and sub-code wiring that they cannot participate in even low/no-cost energy efficiency programs. Investing in the remedial retrofits needed to bring these homes to ready status takes additional funding. Finding this funding is a common challenge for low-income energy efficiency programs, in part because utilities are either not allowed to pay for them, or their costs count against cost-effectiveness calculations. This restriction is not altogether unfair – many of these underlying issues are not ones for which utilities are responsible.

Finding the funding is often a matter of bringing together funding from multiple sources. The administrative burdens of this exercise are usually too great for an individual household or small contractor. Community-based organizations (CBOs) and non-profits are often well-situated to combine multiple funding sources, but it takes effort, communication, and coordination across the various funding sources and their individual requirements. This effort takes staff time, which increases the costs even more.

Even after their homes are made ready, low-income households are less able to afford the equipment upgrades that would facilitate participation in load management programs. The typical energy efficiency rebate that pays for a portion of the incremental cost of the higher-efficiency (or DR-ready) equipment still does not make these measures affordable to low-income households. Other funding mechanisms such as income-tax credits are also less effective for low-income households because they do not pay much in taxes to begin with. Even grants favor organizations that have time and resources to hire staff to fill out complicated applications.

Marginalized areas also need more education and awareness than more affluent areas. Because of current inequities in participation, marginalized households are less likely to know another household that has similar devices. They are also more likely to know other households that have had their utilities shut off. This creates both a knowledge and trust gap that utilities or other organizations need to work to close to recruit these households into programs.

Solution 3a: Identify and develop strategies that prioritize energy efficiency investments in marginalized communities. This will help increase the amount of available funding. The federal government (Justice40) and several state legislatures (e.g.: California, Illinois, New York, Washington) have led the way in this type of policy. The authors recommend a whole-of-market approach along the lines of Justice40 where 40% of investments flow to marginalized households. Policies such as the Department of Energy's requirements that grant applications include a community benefits plan also fit into this solution. Eliminate or modify cost-effectiveness tests to make it possible for utilities to invest more in remedial retrofits. Utilities could still be held accountable to other tests. Performance-based incentives can be used to set equity goals for utilities. Approaches such as those to Barrier 2 that make demand-side investments more amenable to utility business models would also help.

Solution 3b: Develop coalitions of public and private organizations to invest in projects in marginalized communities. This would also increase available funding. Include utilities, federal, state, and local government agencies, and private sector actors in the coalitions. Expand coalitions into organizations with missions related to but not directly involving energy such as public health and affordable housing. Integrate community-based and faith-based organizations; in many cases, these organizations are the best liaisons between the coalition and the community. Learn from the successes of community solar projects.

Solution 3c: Lower administrative barriers to accessing public funding and integrate program offerings for serving marginalized households. This will help maximize the availability and use of funding that is already available. Find ways to allow singular applications to funding sources that address multiple solutions in the home (not just energy) instead of unique applications for each. Allow qualification and data collection for one subsidy program (such as SNAP) to qualify households for other subsidy programs. Reduce the complexity and amount of information required in applications. When it comes to federal grants, state energy offices could provide staff or partner with CBOs to help communities identify and apply for grants.

Real World Examples

The Clean Energy Transformation Act of 2019 (CETA) sets a commitment for Washington state's electricity supply to be free of greenhouse gas emissions by 2045. It requires utilities to provide energy assistance programs and funding available to marginalized households and define metrics to show they are achieving this goal. CETA case study.

Groundswell's new community solar array will provide no-cost solar energy to more than 6,000 low to moderate-income households. This project is a partnership between for-profit corporations, non-profits, faith-based organizations, and government. It leverages SolarForAll funding and the WorkingPower Impact Fund that combines market-rate capital with philanthropic funding to help finance projects in front-line communities. Groundswell case study.

Mass Saves program administrators (PAs) work with LEAN to administer their income-eligible program. LEAN combines funding streams from the PAs, and federal and state grants to provide a "one-stop shop" for weatherization and energy efficiency upgrades to low-income households. The PAs also partner with municipalities and CBOs to deliver programs. A study conducted by WE in 2019 found that low-income areas in Massachusetts were participating in energy efficiency programs at a comparable rate as higher-income areas due to the success of Mass Save's low-income multifamily program. Mass Saves's case study.

Glossary

Active energy efficiency (AEE): Optimizing the use of energy by integrating the benefits of traditional energy efficiency measures with the opportunities presented by digital technologies.

Decoupling: A policy that separates utility profit from generation and volume of energy delivered.

Demand peak: A period in which consumer demand for electricity is the highest.

Demand response (DR): Balancing demand on power grids by encouraging end-users to reduce electric consumption during high-demand periods.

Distributed energy resources (DERs): Electricity supply or demand resources that are interconnected to the electric grid. For this paper, DERs are customer-sighted.

Demand flexibility: Demand flexibility, also sometimes referred to as load flexibility, is the capability to reduce, shed, shift, or modulate electricity consumption in real time in a way that is beneficial to both consumers and the power system.

Distributed generation (DG): Generation of electricity at or near where it will be used.

Energy efficiency (EE): Using less energy/electricity to perform the same function.

Generation capacity: The maximum electric output that an electricity generator can physically produce.

Grid-interactive efficient buildings (GEBs): An energy-efficient building that optimizes a combination of energy efficiency, energy storage, renewable energy, and load flexibility through the use of smart controls.

Independent System Operator (ISO): An independent non-profit organization that manages electric grid operations and system planning, typically within a single state.

Load following: Demand-side load management strategy that adjusts demand as power output for electricity fluctuates throughout the day; typically used at a lower load for longer hours to balance out the variability of renewables

Local distribution network: Grid resources are owned and maintained by a local distribution operator, usually a utility, co-op, or municipality, to deliver electricity to end users.

Peaker plants: A power plant that generally only operates during times of particularly high electricity demand.

Resource adequacy (RA): Sufficient capacity and reserves to reliably serve electricity demand at any time.

Retail demand response: Demand response capability that operates in the retail market – usually within a local distribution network – as opposed to selling to a wholesale market operated by ISOs and RTOs.

Regional Transmission Organization (RTO): An independent, membership-based, non-profit organization that operates bulk electric power systems ensuring reliability and optimizing supply and demand bids for wholesale electric power.

Technical potential: The theoretical maximum amount of a resource that could be achieved if there were no non-technical barriers.

Time-varying rates (TVRs): Electrical rates that vary by typical demand. Categories include Time-of-Use (TOU), Critical Peak Pricing (CPP), Peak Time Rebate (PTR) and Real Time Pricing (RTP).

Virtual power plants (VPPs): An aggregate of distributed energy resources that is connected to the grid in a way that allows it to serve resource adequacy needs.

Wholesale market demand response: Demand response capability that sells directly to a wholesale energy market operated by an ISO or RTO.

References

[1]Brattle 2023, Real Reliability: The Value of Virtual Power. https://www.brattle.com/wp-content/uploads/2023/04/Real-Reliability-The-Value-of-Virtual-Power_5.3.2023.pdf, retrieved Nov 1, 2023.

[2]Dept of Energy 2023a, Pathways to Commercial Liftoff: Virtual Power Plants. https://liftoff.energy.gov/vpp/ . Retrieve Nov 1, 2023.

[3]Brattle 2023.

[4]Brattle 2023.

[5]LBNL 2021, Who is participating in residential energy efficiency programs? https://eta-publications.lbl.gov/sites/default/files/ee_program_participation.pdf, retrieved Nov 1, 2023.

[6]ACEEE 2021. Energy Efficiency and Demand Response: Tools To Address Texas's Reliability Challenges, https://www.aceee.org/sites/default/files/pdfs/energy_efficiency_and_demand_response_for_texas_10-13-21_final_0.pdf, retrieved Nov 6, 2023.

[7]FERC 2014 - 2022, Assessment of Demand Response and Advanced Metering. https://www.ferc.gov/power-sales-and-markets/demand-response/reports-demand-response-and-advanced-metering, retrieved Nov 1, 2023.

[8]FERC 2014 - 2022, Assessment of Demand Response and Advanced Metering. https://www.ferc.gov/power-sales-and-markets/demand-response/reports-demand-response-and-advanced-metering, retrieved Nov 1, 2023.

[9]FERC 2014 - 2022, Assessment of Demand Response and Advanced Metering. https://www.ferc.gov/power-sales-and-markets/demand-response/reports-demand-response-and-advanced-metering, retrieved Nov 1, 2023.

[10]FERC 2022, Assessment of Demand Response and Advanced Metering. https://www.ferc.gov/news-events/news/ferc-staff-issues-report-2022-assessment-demand-response-and-advanced-metering, retrieved Nov 6, 2023.

[11]Pew 2021, Internet/Broadband Factsheet. https://www.pewresearch.org/internet/fact-sheet/internet-broadband, retrieved Nov 6, 2023.

[12]Parks Associates, 2023, Next-Generation Smart Home: Building for the Future. https://www.parksassociates.com/products/whitepapers/next-gen-smart-home-2023, retrieved Nov 6, 2023.

[13]JD Power 2023a, America Grows Increasingly Divided on EV Adoption. https://www.jdpower.com/business/resources/america-grows-increasingly-divided-ev-adoption, retrieved Nov 7, 2023.

[14]JD Power 2023b, Rising Rates Short Circuit Electric Vehicle Home Charging Satisfaction, J.D. Power Finds. https://www.jdpower.com/business/press-releases/2023-us-electric-vehicle-experience-evx-home-charging-study, retrieved Nov 16, 2023.

[15]NREL 2022, Check the Storage Stack: Comparing Behind-the-Meter Energy Storage State Policy Stacks in the United States. https://www.nrel.gov/docs/fy22osti/83045.pdf, retrieved Nov 7, 2023.

[16]USGCRP 2023, Ch. 20. Social systems and justice. In: Fifth National Climate Assessment. https://doi.org/10.7930/NCA5.2023.CH20, retrieved Nov 14, 2023.

[17]EIA 2023. Energy insecure households were billed more for energy than other households. https://www.eia.gov/todayinenergy/detail.php?id=56640, retrieved Nov 14, 2023.

[18]ACEEE 2023. Toward more Equitable Energy Efficiency Programs for Underserved Households. https://www.aceee.org/sites/default/files/pdfs/B2301.pdf, retrieved Nov 13, 2023.

[19]ACS 2022. American Community Survey S2801, Types of Computers and Internet Subscriptions. https://data.census.gov/table/ACSST1Y2022.S2801?q=internet, retrieved Nov 13, 2023.

Authors

Dr. Shawn Bodmann

Director - North American Energy and Climate Equity

As director of DNV North America's Energy and Climate Equity group, Dr. Bodmann applies 20 years of research and consulting experience to creating a fair and just clean energy transition where at risk and traditionally under-represented communities lower their energy burden and share in the economic benefits of decarbonization.

Teague Douglas

Senior Consultant - Strategy, Markets & Risk

Teague Douglas is a driven consultant at DNV with demonstrated results in helping companies introduce and scale emergent technologies through energy utility programs and end-use customers. Her experience as a strategist and implementer in the clean energy space has positioned her to excel at synthesizing market trends and client needs and translating technical information to provide useful insights and actions for developing new products, road mapping go-to-market strategies, and launching new programs.

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