DSM for Efficiency and Resiliency – Methods, Metrics, and Lessons Learned

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ABSTRACT

Amid a growing need to strengthen electric and gas resiliency at both the grid and customer levels while maintaining affordability, utilities are exploring opportunities both in front of and behind the meter. By better quantifying and integrating resiliency impacts into demand-side management (DSM) planning, energy efficiency program administrators can strengthen the grid's ability to consistently and reliably serve customers, enhance consumers' ability to be safe and comfortable during extreme temperatures and natural disasters, help reduce insurance costs, and offer bill reductions through enhanced load flexibility.

This paper examines how behind-the-meter DSM strategies can deliver high-performance homes that protect families while supporting the grid. The authors will first define resiliency and explain why it differs from reliability and is growing in importance. Next, the authors will outline a range of established and emerging metrics that can support deeper integration of resilience into DSM programs based on a meta-analysis of reports from utilities, regulatory commissions, and other organizations. The paper will then document two case studies from Consortium for Energy Efficiency (CEE) program administrators that are actively working to incorporate resiliency metrics into their portfolios as well as lessons learned to date from these efforts. Finally, the paper will highlight future opportunities for DSM program administrators to bolster resiliency through collaborative market transformation initiatives.

Introduction: The Growing Need for Improved Resiliency

Energy reliability can be defined as the ability of utilities to consistently meet customer electricity or gas needs without interruption and has long been a core focus of utilities and regulatory commissions. However, with growing impacts from extreme weather and evolving grid challenges, utilities are increasingly exposed to unexpected shocks and interruptions outside of the standard operating conditions they typically plan for. These types of atypical yet high-impact events fall outside of the purview of traditional reliability frameworks and may encompass multi-day events rather than shorter-duration events typically captured in reliability planning. Planning for these kinds of situations falls instead under the purview of resiliency, and utilities are increasingly focusing on both grid resiliency (making sure that energy systems can continue to serve customers despite unexpected shocks) and customer resiliency (helping to improve customer safety during extreme weather and other events).

To date, many utilities have prioritized improving grid resiliency at the transmission and distribution levels, particularly through strategies such as hardening infrastructure, investing in monitoring and early detection strategies, operational response improvements, vegetation management, or public safety power shutoff (PSPS) initiatives. Behind-the-meter (customer-focused) opportunities remain less common yet offer a range of additional opportunities to support both grid and customer resiliency. For this reason, a number of program administrators are looking at ways to better integrate resiliency impact considerations into energy efficiency, DSM, and other programmatic offerings.

Major Stressors and the Role of Natural Disasters

A handful of key stressors are driving a growing need for utilities to focus on resilience. Some are technology-driven challenges that have emerged in recent years, such as the rapid growth of AI data centers and a rise in physical attacks on grid infrastructure (Black and Veatch 2025) and cyberattacks (Dareen and Srivastava 2024), all of which can affect energy availability. Others—especially natural disasters such as extreme weather and fires—are increasingly affecting both energy grids and customer safety and may represent a unique opportunity to address in part through demand-side strategies.

The most recent report from the Intergovernmental Panel on Climate Change (IPCC) highlights the growing severity of climate change, the urgent need for rapid systemic changes in the energy sector, and the need for adaptation strategies to help manage emerging climate-driven impacts (IPCC 2023). Effects of climate change are already felt across North America, and the number of billion-dollar weather and climate-related disasters (adjusted for inflation to 2026 dollars) in the US has increased significantly in recent decades, from an average of around 3 events per year in the 1980s to 23 per year in the 2020s (Climate Central 2026).

For utilities, these kinds of events are driving up energy costs (Wiser et al. 2025), increasing insurance exposure (Barlow 2025), putting energy service at risk, and directly endangering customers. While electric outages often make headlines, the natural gas system can also be stressed by natural disasters such as extreme winter storms, floods, heat waves and droughts, with potential impacts to natural gas production, transportation, and storage (Arbaje and Specht 2024), making resiliency a critical issue for a wide range of energy utilities.

Bolstering Grid Resiliency

DSM strategies can offer multiple unique opportunities to help address emerging grid challenges. Particularly in areas facing rapid load growth, energy efficiency and load flexibility are currently among the lowest-cost resources for reducing electricity consumption and peak demand and offer significant potential to help manage the rapid addition of new loads (Specian and Aquino 2026). Similarly, when grid disruptions happen—whether from extreme weather events, cyberattacks, or other causes—scaled load flexibility provides the ability to rapidly adjust demand and can help mitigate both electric and gas customer impacts. This is particularly true if load flexibility strategies are geo-targeted to the most-affected areas, whether those be strained distribution transformers or low-pressure zones of the natural gas distribution system (Snell 2024).

Supporting Customer Resiliency

Utilities have long had customer safety as a core focus and priority, and DSM measures like building envelope upgrades, deep energy retrofits, and high-efficiency new construction can keep customers safer when sheltering in place or reduce the likelihood of property loss during fires and extreme weather (Passive House Network 2025). These non-energy impacts (NEIs) generally have not been effectively integrated into DSM programs to date but offer significant potential to increase program participation, keep customers and communities safer, and manage insurance exposure for both utilities and customers. If regulators better capture and incorporate these NEIs in utility benefit-cost analyses, utilities could integrate more holistic, high-impact measures in DSM programs and support more widespread deployments. Quantifying these NEIs also has potential to open the door to new partnerships—particularly with property or health insurance companies—to unlock new funding sources that could support scaled implementation of high-performance home solutions.

The Confluence of Energy Efficiency, Load Flexibility, Health, and Property Insurance

Measures that promote disaster resistance in buildings are often well-aligned to those that promote energy efficiency, and many technologies that promote energy efficiency in the built environment also provide greater disaster resistance. For instance, properly insulated and air sealed homes limit the heat loss during power outages so inhabitants can safely shelter in place for days to weeks without power while maintaining a safe interior temperature. Temperature and humidity control through building envelope optimization and a properly sized balanced ventilation system with heat or energy recovery reduces the risk of mold growth by eliminating the conditions for mold to proliferate. Back-up whole-house battery systems or natural gas-powered generators add an additional layer of redundancy to ensure low-load homes can function in case of power outages. And load flexibility further enhances grid-level resiliency by providing the ability to shift loads from non-essential appliances, home batteries, and electric vehicles in peak demand or outage events, thereby reducing the stress on an overburdened grid.

Depending on the climate zone and weather in a given region, energy efficient design can reduce risks associated with power outages, wind and flying debris, flooding and water damage, fire, and other weather-related destruction. Unsurprisingly, there are potential cost-saving opportunities associated with insuring energy efficient homes. By reducing the risk to lenders, energy efficient homes can reduce homeowners' insurance premiums. For example, Farmers Insurance and Travelers Insurance offer discounts of up to 5% to homeowners whose homes have ENERGY STAR, LEED, Passive House, or DOE certifications (Uhlig, 2024).

The emerging insurance benefits of DSM come at a critical point in time for the insurance industry. According to the Brookings Institute, average homeowners' insurance premiums increased by more than 30% between 2020 and 2023, or 13% adjusted for inflation. Insurance companies have stopped writing policies in some areas, and an increasing number of households that cannot find insurance in the private market are resorting to more limited "last resort" insurance plans that are intended to fill temporary gaps in the private property insurance market. Resiliency investments offer the potential to cost-effectively reduce losses during extreme weather conditions or natural disaster events. Achieving a broad uptake of risk mitigation measures could limit insurance premium increases by decreasing a home's risk and vulnerability. For example, building code mandates like California's wildfire building codes and Florida's hurricane wind codes have been effective in protecting recently-built homes from local environmental threats (Fowlie et al, 2025). Collectively, this may point to a set of emerging opportunities for better alignment between DSM program administrators and property insurance companies going forward to help both industries meet respective goals and shared objectives in a time of significant change, particularly in areas where voluntary programs can help customers go beyond existing building codes to save energy and improve resiliency.

Emerging Resilience Metrics

While utilities have leveraged reliability metrics—such as the System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), Customer Average Interruption Duration Index (CAIDI), and Average Service Availability Index

(ASAI)—to monitor system performance under normal operating conditions, these measures provide limited visibility into grid- and customer-level consequences during extreme events. By design, reliability metrics often exclude major event days and catastrophic outages, constraining their usefulness for evaluating resilience investments that are specifically intended to address low-probability, high-impact disruptions (Frick et al. 2021; Twitchell et al. 2020).

Utilities are required to meet NERC reliability standards and to address identified reliability threats in a cost-effective manner. Resilience, by contrast, lacks comparable binding standards. As a result, utilities must justify resilience investments under traditional economic screening frameworks. The challenge is that extreme or catastrophic events tend to occur infrequently and thus represent a small share of total outage hours a jurisdiction may experience. Investments designed solely to mitigate rare catastrophic events therefore struggle to pass cost-effectiveness tests given such limited ability to recover costs. Resilience investments are often justified through avoided damages, reduced human harm, or improved adaptability. These outcomes, despite and because of the difficulty in monetizing non-energy impacts, require distinct measurement approaches (Leddy et al. 2023).

Customer-facing resilience benefits are inherently hazard and location-specific. Extreme heat, extreme cold, wildfires, flooding, and extended outages from other causes each produce different risks depending on climate zone, building stock, and population vulnerability. The result is that, in some cases, energy efficiency upgrades might support resilience in response to one event and cause harm following another. Take increased insulation for example: in the event of a cold- or heat-related resilience event, it provides improved passive survivability, but during flood recovery, might hinder a space's ability to effectively dry. It is therefore essential that resilience valuation frameworks account for hazard-sensitive and locational realities, including effective identification of critical loads and community risk exposure (Macmillan et al. 2023).

Additional challenges to capturing the impacts of energy efficiency on customer-facing resilience include the time-horizon of impact, regulatory scrutiny, and barriers to access of important customer-level data. Reliability metrics, such as the value of lost load (VoLL), monetize interruption costs for shorter duration interruptions, typically to 24 hours, using customer damage functions which are updated based on customer interruption cost surveys. Tools like LBNL's ICE calculator (LBNL 2026) equip localities with the ability to understand what the damage might be of certain interruptions. However, the customer surveys that support interruption cost analyses typically capture the impacts of longer-term and widespread outages, including both direct customer costs and the broader direct and indirect costs associated with high-impact, low-probability events. While organizations are investing resources to develop new approaches to address these valuation challenges, DSM program administrators must continue to address the need to value customer-facing resilience.

A meta-analysis of relevant literature suggests that resilience impacts at the customer level can be approached and organized by three outcome categories, or metric stack (Leddy et al. 2023; Frick et al. 2021; Franconi et al. 2023; Srivastava et al. 2025; EPRI 2021):

- **Thermal safety** is a direct, standardizable, and mechanistically attributable benefit
- **Customer health** impact valuations can be built on top of exposure models and simulations, but require additional assumptions and data to translate exposure to monetized damage
- **Broader economic valuations** at the community level

Table 1 summarizes some of the most promising metrics within each these categories.

Table 1. Customer-Centric Resilience Metrics for DSM

Type	Metric/Approach	What it Captures	DSM-Resilience Integration	Limitations
Building and Occupant Thermal Safety	Passive survivability measured by Standard Effective Temperature (SET). Uninhabitable conditions: >216 hours outside a 54 - 84°F SET threshold over 7 days.	Building's ability to maintain habitable indoor conditions during extended outages, derived from whole-building simulation	Direct, mechanistic link between envelope/efficiency measures and occupant safety; scalable across climate zones, aligns with analysis of benefits of building code improvements	Sensitive to weather-file selection, outage scenario, and threshold definitions; typical meteorological year data can smooth extremes
Health Impact	Mortality risk reduction monetized via the Value of a Statistical Life (VSL)	Probabilistic estimate of avoided deaths from improved indoor conditions during extreme events	Reframes efficiency as a public-safety intervention	Sensitive in utility regulatory contexts
	Morbidity/cost-of-illness estimates	Avoided illness cost from reduced exposure to unsafe indoor conditions	Pairs efficiency with health-system savings, especially important in programs serving medically vulnerable customers	Requires explicit vulnerability (age, condition, mobility) and behavioral assumptions to effectively target customers
	Vulnerability-weighted exposure to target investment	Identifies customers and building types most exposed to harm based on hazard, building stock, and demographic risk	Offers a targeting and equity tool when monetization is infeasible; supports prioritization of resilience investments	Hazard and location specific

Economic Valuation	Hybrid regional economic models (e.g., ComEd POET)	Regional economic modeling paired with customer outage-tactic and cost surveys, applied to multi-day scenarios (e.g., 1-, 3-, 14-day outages)	Captures systemic, distributional (by income), and long-duration impacts that short-outage damage functions cannot	Higher analytical burden; less standardized; may exceed scope of routine DSM evaluation unless used selectively
	Property Damage/Asset Loss	Monetary value of avoided physical losses during outages and hazard events	Tangible and hazard-specific; readily monetizable when scoped to specific building types and hazards	Risk of double-counting across utility, customer, and societal perspectives if framing not defined explicitly
	Avoided emergency energy & capacity needs (reduced backup kWh and peak kW for critical services)	Direct resilience capability benefit: how much backup generation or storage is avoided by improved building performance	Quantifies a monetizable resilience benefit without requiring claims that efficiency reduces outage probability; bridges building performance and economic valuation	Requires explicit definition of critical services and outage scenarios

The following sections discuss these metrics and assess their applicability within DSM planning and evaluation contexts in further detail.

Building and Occupant Thermal Safety: Passive Survivability Metrics

Building and occupant-level thermal safety metrics represent one of the most direct and mechanistically attributable categories of resilience outcomes relevant to behind-the-meter DSM programs. These metrics quantify a building's ability to maintain habitable indoor conditions during extended outages, commonly referred to as passive survivability (Franconi et al. 2023; Srivastava et al. 2025). Unlike annual energy savings metrics, passive survivability metrics evaluate building performance during power outages. They assess how quickly indoor conditions deteriorate when heating or cooling systems are unavailable and how envelope-related efficiency measures influence that rate of deterioration. This is most often operationalized via a common metric: Standard Effective Temperature (SET) exceedance or "degree-hours" outside safe bounds, hours exceeding heat stress thresholds (e.g., heat index), the rate at which indoor temperature changes after an outage begins, and the total duration that indoor conditions remain within safe boundaries. SET is often considered the core of passive survivability. It considers dry-bulb temperature, humidity, air velocity and occupant activity/clothing assumptions (Franconi et al. 2023). Within the framework, livable conditions are typically defined as between 54° F and 86° F, and uninhabitable conditions are when SET degree-hours outside bounds exceed 216 over a 7-day outage. These metrics are typically derived from whole-building energy simulation using event-representative weather files and outage scenarios.[1] By holding hazard severity and outage duration constant, counterfactual simulations allow analysts to estimate incremental improvements in thermal endurance attributable to specific energy efficiency measures.[2]

DSM portfolio and program planners are interested in these indicators because they are scalable across building archetypes and climate zones, and they are directly aligned with code and retrofit evaluation workflows that utilities and regulators already recognize. They are also increasingly central to discussions of how code- and beyond-code-compliant buildings can protect occupants during extreme events (Franconi et al. 2023; Baniassadi and Sailor 2018). In practice, DSM teams can reduce ambiguity and improve comparability by adopting a standard scenario library (for example, 24-hour, 72-hour, and seven-day outages paired with locally relevant heat and cold events) and reporting results explicitly as scenario-based rather than universal predictions. Additionally, simulated impacts of efficiency investments can be paired with field-validation if one can observe and track participants' evacuation decisions such as what hot or cold spots exist at the room level, and what backup options are available to the building.

These metrics are not without interpretive risk. Typical meteorological year datasets can smooth extremes and understate resilience-relevant exposure, while single-event analyses may over or under represent future risk conditions. As a result, event selection, hazard probability weighting, and sensitivity analysis often determine whether results are persuasive in regulatory settings (Leddy et al. 2023; Srivastava et al. 2025). The extreme heat survivability literature also emphasizes that "thermal resiliency" conclusions can change depending on metric definition and threshold choice, particularly in hot-climate outages where unsafe conditions can arise rapidly in older homes (Baniassadi and Sailor 2018).

In program practice, thermal safety metrics can serve as foundational evidence for code advocacy, deep retrofit prioritization, and targeted support for vulnerable customers, while also providing a starting point for broader health impact analyses. Given the substantial progress in standardizing modeling and simulation methods and in establishing a clear causal pathway from energy and envelope efficiency to indoor thermal conditions, metrics such as passive survivability and other habitability indicators offer a practical and defensible entry point for customer resilience evaluation within DSM programs.

Health Impacts: Occupant Damage Metrics

Occupant damage metrics translate exposure conditions during extreme events into probabilistic health outcomes. Whereas passive survivability metrics describe the thermal conditions a household may experience during an outage, health impact metrics estimate what those conditions mean for mortality and morbidity risk, especially during extreme weather

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[1] Commonly leveraging EnergyPlus

[2] Notably envelope upgrades such as insulation, air sealing, high-performance windows, and passive design strategies.

events. In most applications, researchers apply straightforward causal logic: an efficiency measure improves indoor habitability during a long-term power interruption, that stability reduces the duration and severity of unsafe exposure, and reduced exposure lowers health risks. In practice, translating exposure into health outcomes requires explicit assumptions about vulnerability (age, medical conditions, mobility), behavioral adaptation (such as whether and when households relocate), and hazard frequency. (Leddy et al. 2023). For DSM purposes, these assumptions should be documented transparently when used to support investment prioritization.

For DSM planning, it is often useful to treat health metrics as a tiered tool rather than a necessity for every investment decision. In many jurisdictions, health indicators can be used first as a targeting and equity framework to identify customers and building types most exposed to harm and therefore prioritized for envelope and resilience investments. Monetization approaches, such as valuing avoided deaths through a "Value of a Statistical Life" or applying cost-of-illness estimates, are feasible and widely used in environmental and public health regulatory contexts, but they remain sensitive within utility regulation and have not yet been widely adopted as standard DSM screening inputs (Franconi et al. 2023). Commission precedent and stakeholder comfort with assumptions often determine whether monetized health impacts function as a value stream or remain primarily a prioritization mechanism. Ultimately, these metrics strengthen the case for efficiency as a public safety intervention rather than only an energy resource.

Health impact estimation typically layers building simulation outputs (exposure duration and severity) with hazard frequency assumptions and population vulnerability inputs to estimate incremental health risk reductions attributable to efficiency measures. In DSM practice, the most tractable use case is to apply these metrics selectively in programs serving medically vulnerable customers or high-risk housing types, where the resilience rationale is strong and the added analytical focus is helpful.

Economic Valuation: Interruption Costs and Property Damage

Economic metrics estimate the monetary impacts of service interruptions on households, businesses, and communities. Unlike physical performance or health metrics, these measures translate resilience outcomes directly into economic terms. However, the literature is clear that method choice should match outage context: value of lost load (VoLL) and customer damage function approaches are typically most defensible for short-duration and localized interruptions, whereas widespread, long-duration disruptions often require hybrid and regional modeling approaches to capture indirect and systemic impacts (Macmillan et al. 2023).

Within the interruption-cost research, frameworks that leverage VoLL, paired with customer impact surveys that inform customer damage functions, help assign dollar values to outage costs per customer-hour. A key limitation for DSM resilience valuation is that much of this work focuses on relatively short interruptions. For example, while highly valuable, the updated DOE ICE Calculator 2 initiative draws on extensive customer survey work but elicits willingness-to-pay and related valuation inputs for interruption durations only up to 24 hours; widespread and long-duration disruptions are not included (Larsen et al. 2026; Macmillan et al. 2023). This reinforces the broader planning challenge: DSM administrators may be asked to justify resilience benefits for rare, catastrophic events while existing valuation tools were designed to assess experiences of more routine outages.

Where long-duration, widespread disruptions are central to resilience objectives, hybrid and regional economic approaches can be more defensible than extrapolating short-outage customer damage functions. ComEd's Power Outage Economics Tool (POET), for example, pairs customer survey information on outage tactics and costs with regional economic modeling to estimate impacts on household consumption and distributional effects by income group under one-, three-, and 14-day outage scenarios (Larsen et al. 2024). This provides a pathway to capture systemic and distributional consequences that traditional interruption-cost studies may not fully reflect in widespread, long-duration contexts.[3]

Property damage and asset loss may be relevant for some hazards and building types, including avoided spoilage, avoided equipment damage, reduced insurance claims, and freeze-related structural damage. Furthermore, as with monetizing other non-energy impacts, defining perspectives (utility system, the customer, or society) is important to help avoid double counting the same impact in multiple contexts.

While economic consequence metrics are fully monetizable and familiar within resource adequacy and wholesale market contexts, several limitations are particularly relevant for DSM programs. VoLL and interruption cost estimates vary substantially by customer type and event context; many interruption cost studies are better calibrated for short-duration outages than catastrophic event dynamics; and economy-wide modeling approaches may exceed the scope of most DSM evaluation frameworks unless used selectively for resilience proceedings. As the long-duration outage literature stresses, model selection should be justified in relation to outage duration, location, and demographic context rather than assuming one method generalizes across scenarios.

For DSM planning, economic consequence metrics are most defensible when applied to hazard-specific scenarios, targeted geographic deployments, and damage-reduction modeling tied directly to building performance. When used carefully, these metrics allow resilience benefits to be incorporated into cost-effectiveness analyses or resilience adders while acknowledging uncertainty bounds. A practical intermediate metric that connects building performance to economic valuation is avoided emergency energy and capacity needs, reduced backup kWh and peak kW required to maintain critical services (Srivastava et al. 2025). This approach can be useful even when the program is not claiming that efficiency reduces outage probability, because it quantifies a direct resilience capability benefit that can later be monetized (e.g., avoided generator/storage sizing or fuel costs) where appropriate.

CEE Member Case Studies: Integrating Resiliency, DSM, and Customer Engagement

Amid the evolving mix of resiliency metrics and scopes of focus, several innovative energy efficiency program administrators are taking steps to more directly integrate resiliency considerations into customer-side programs. Key initiatives from Efficiency Vermont and Pacific Gas and Electric (PG&E) highlight some of the approaches different organizations are currently taking.

Efficiency Vermont's Energy Resilience Technical Support Program

Efficiency Vermont launched an Energy Resilience Technical Support Program for commercial and residential customers in January 2026. The program is a culmination of six years of research and development to establish an energy resilience planning approach and decision

[3] For instance, for a one-day interruption, 54% of respondents would stay home and 33% would temporarily relocate, while for a 14-day interruption only 8% of respondents would stay home.

framework that is approachable and achievable while ensuring meaningful and actionable outcomes. As a stand-alone program, it integrates with other energy efficiency offerings to optimize support and incentives for each customer's needs and pathway to energy resilience goals.

The program's scope encompasses buildings or campuses behind the meter. Efficiency Vermont's engineering consultants work with customers to determine risks to life and property, types of events that may inflict damage, and the nature and size of energy-using assets that protect life and property (Figure 1). Customers receive a few pathways they can choose to achieve their energy resilience goals. Efficiency Vermont evaluates relative costs and payback for energy resilience investments to inform customer decisions using a methodology developed during the R&D efforts. Critically, the planning process considers all energy sources in the analysis, including fossil fuels.

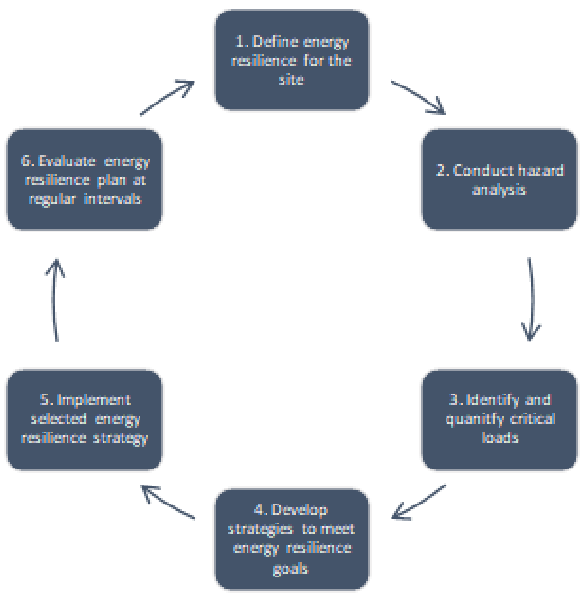

Figure 1. Efficiency Vermont's Energy Resilience Planning Framework

Commercial and municipal customers receive technical support to implement each step of the planning process. Efficiency Vermont's engineering consultants provide the expertise to conduct the analysis and identify pathways to achieving energy resilience goals. Residential customers receive condensed energy resilience planning support that is approachable and achievable for homeowners and tenants.

Commonly, only the largest commercial customers have been familiar with energy resilience. Small business and residential customers frequently approach Efficiency Vermont about technologies, such as generators or batteries, but do not have the energy resilience language to discuss their energy access concerns and why they are considering such measures. Short-term program goals include outreach and education in the market about energy resilience and how to evaluate resilience goals to optimize investment decisions and technology choices.

Customers who are members of vulnerable communities or experiencing economic challenges frequently ask Efficiency Vermont for ways to reduce their energy bills. Customers concerned about paying bills from month to month do not have the bandwidth to think about energy resilience because financial stress limits their capacity beyond immediate needs. It will be crucial for Efficiency Vermont to integrate critical load size reduction and efficiency into energy resilience planning so that these customers can relieve immediate economic pressure on energy bills while supporting energy resilience that protects against potential losses that could inflict further economic harm.

PG&E's Customer Resiliency Programs

As part of PG&E's Community Wildfire Safety Program, the utility may need to de-energize customers when specific weather conditions are present, resulting in a Public Safety Power Shut off (PSPS). In addition, when Enhanced Powerline Safety Settings (EPSS) are enabled, customers may experience an unplanned outage if an object strikes a line. In an effort to provide support to customers impacted by these outages, PG&E developed a portfolio of customer resiliency programs providing backup power solutions. The programs include both direct install and rebate offerings to meet various customer needs.

In 2020, PG&E launched the Portable Battery Program (PBP), which offers portable backup batteries to customers enrolled in the Medical Baseline or Self-Identified Vulnerable programs and who have experienced frequent wildfire safety outages. The purpose of the program is to power critical medical devices during an outage. Eligible customers receive direct outreach from PG&E and the third-party program implementers. A medical device energy assessment is completed, and one or more batteries are delivered to the customer if the assessment determines that the batteries could support the device's power requirements. Since 2020, PG&E has delivered over 28,000 portable batteries through the PBP with a 94% customer satisfaction score in 2025.

Also in 2020, in partnership with the California Foundation for Independent Living Centers (CFILC), PG&E launched the Disability Disaster Access & Resource (DDAR) program. This program supports older adults and people with disabilities before, during, and after wildfire safety outages. The program assists customers with developing an emergency plan, signing up for the Medical Baseline program, applying for backup power resources, and during PSPS events providing hotel accommodations, food replacement, and accessible transportation.

In 2021, PG&E launched the Generator & Battery Rebate Program (GBRP) which currently targets residential and businesses customers located in High Fire Threat Districts (HFTDs) or in areas protected by EPSS enabled circuits. The program offers a $300 rebate for the purchase of a qualifying product, with an additional $200 for income-qualified customers. Since program launch, over 14,000 rebates have been paid with a 2025 customer satisfaction score of 87%. Understanding that some customers may prefer permanent batteries to mitigate outages, PG&E launched the Permanent Battery Storage Rebate (PBSR) program in 2023. The program currently offers a $7,500 rebate to qualified customers impacted by frequent EPSS outages who have installed and interconnected a permanent battery. Over 1,200 rebates have been issued with a 2025 customer satisfaction score of 88%.

In 2022, as EPSS outages were becoming more frequent, PG&E launched the Residential Storage Initiative (RSI) program, which offered direct installation of a permanent battery for vulnerable customers to backup critical circuits within their home. Today the program targets Medical Baseline and income-qualified customers who have been frequently impacted by EPSS outages. In partnership with our third-party implementer, PG&E has installed nearly 4,500 batteries with a 2025 customer satisfaction score of 92%.

In addition to the suite of residential offerings described above, PG&E has also supported K-12 schools with rebates for permanent generators and ATS installations to mitigate the impact of wildfire safety outages on school communities. The future vision for these programs is to leverage the batteries for broader grid benefits, including participation in Virtual Power Plants (VPP), when not needed for backup power. This expanded use case was proposed in PG&E's 2027 General Rate Case.

Opportunities to Take a More Comprehensive Approach

Because behind-the-meter customer and grid resiliency often stem from the effective interaction of multiple systems and equipment types, taking a more comprehensive whole-building approach may enable DSM program administrators to better address resiliency goals while meeting energy efficiency and load flexibility targets. From a customer perspective, programs that incentivize performance-based whole-building efficiency strategies (particularly those focused on envelope measures such as air-tightness improvements, continuous insulation, high-performance triple pane windows, and elimination of thermal bridges) can result in resilient buildings that allow tenants to safely shelter-in-place while also minimizing damages from severe weather, storms, and fires. From a grid perspective, driving electric and/or gas load-flexibility programs at the household or building level, including the creation of VPPs, can support the resiliency of the local grid in severe weather events, minimizing service interruptions and outages.

To maximize success, these kinds of strategies necessitate a shift in thinking from an individual measures-based approach to a more performance-based whole-building approach. One example of an analogous whole-building performance-based solution is the *CEE℠ Residential New Construction Specification*, which not only provides increasingly stringent tiered efficiency targets at the building level, but also supports carbon reporting and includes connected criteria for load flexibility that can bolster grid-level resiliency (Figure 2; Torbert, 2025). Created through a collaborative effort with program administrators from across the US and Canada, this voluntary specification represents an approach to new construction that can directly support multiple overlapping objectives, and provides a potential model for more deeply incorporating non-efficiency goals into DSM program design.

CEE Market Transformation Tiers℠ New Construction Specification

CEE Level	Energy Rating Index (ERI)	Other Requirements	Optional Additional Quality Assurance
CEE Tier 1	≤ 55*	• ENERGY STAR® SFNH Version 3.2 • Carbon Rating Index Reporting† • CEE HPWH, ASHP, and EVSE Specifications OR ENERGY STAR Next Gen⁻	• DOE Zero Energy Ready Homes^
CEE Tier 2	≤ 45*		
CEE Tier 3	≤ 35		
CEE Advanced Tier	≤ 10		

* For Tiers 1 and 2, CEE provides recommended ERI target scores by climate zone.

^ CEE recommends additional quality assurance measures, such as DOE Zero Energy Ready Home Version 2 to address the complex building science considerations associated with highly efficient homes.

† CO2e reporting requirement per the ANSI/RESNET/ICC 301-2022 Addendum B-2022 CO2e Index (CRI).

⁻ Homes must include equipment that meets the active CEE Heat Pump Water Heater Specification, CEE Air Source Heat Pump Specification, and CEE Electric Vehicle Supply Equipment Specification or ENERGY STAR® NextGen™ certified or similar.

Figure 2. The *CEE℠ Residential New Construction Specification* goes beyond energy efficiency by also incorporating carbon reporting and load flexibility elements.

Conclusion

As utilities and program administrators shift from a focus on reliability to an expanded one that includes resiliency at both the grid and customer levels, there is a clear need to establish and integrate robust, consensus-driven metrics of success, share lessons learned, and adopt a more comprehensive approach to building efficiency that may further adoption of performance-based strategies.

From an evaluation perspective, some of the most promising resiliency metrics focus on areas such as thermal safety, health impacts, interruption costs, and property damage. Potential opportunities that could enable evaluation practices to better account for and capture resiliency impacts include:

- Collecting additional field data to corroborate simulated impacts (particularly with regards to thermal safety metrics).
- Focusing on better quantifying long-term resilience events and expanding hybrid survey and regional economic modeling (like POET) to other jurisdictions so long-duration outages are better quantified.
- Exploring and considering the limitations of weather file selection, particularly regarding evolving future climate scenarios.

By better capturing and integrating relevant resiliency metrics into DSM planning, utilities and program administrators may be able to realize a range of potential benefits for the grid, customer safety, affordability, and DSM program scalability. Doing so requires collaborative efforts, supportive regulatory environments, and crosscutting planning across multiple silos and organizational goals, but several organizations are already making critical progress in this area. As climate change and other stressors increasingly affect both customers and energy grids, a deeper focus on resiliency will enable utilities to meet multiple emerging challenges while effectively supporting their customers well into the future.

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