Enhancing Energy Modeling with Qualitative Methods: Understanding Energy Decisions Grounded in Lived Experience

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ABSTRACT

As the energy sector undergoes rapid transformation, understanding consumer behavior is critical to ensuring successful adoption of renewable energy and energy-efficient solutions. Traditional energy models and demand response (DR) algorithms often assume that monetary incentives are the primary drivers of behavioral change. Yet these models frequently overlook the social and contextual dimensions that shape household energy decisions, especially during extreme events or power outages. This paper draws on qualitative fieldwork in San Antonio, Texas to demonstrate how qualitative methods can enhance household energy modeling. Using a practice theory lens, we draw on focus group data and empirical findings to challenge the assumption that affordability is defined solely by cost. Instead, we reframe affordability as an outcome of everyday energy practices shaped by lived experience, cost-avoidance strategies, and perceptions of reliability and control, rather than a purely rational financial calculation. Rather than developing a new modeling framework in this article, we use affordability as an illustrative factor in household energy decision-making to show how qualitative analysis can unsettle existing behavioral assumptions and underscore the need for its incorporation into energy models that inform Demand-Side Management (DSM) program design to ground behavioral assumptions in real-world motivations and constraints. In doing so, it bridges theoretical and applied perspectives, reframing energy transitions as complex social processes rather than purely technical or economic challenges. This work highlights the need for integrating social science methods into energy modeling to produce more robust, accurate, and human-centered strategies for managing energy demand and supporting the evolving grid.

Introduction

As the U.S. energy sector undergoes rapid transformation with rising electrification, renewable integration, and more frequent extreme weather events, grid operators increasingly utilize Demand-Side Management (DSM)—particularly Demand Response (DR) programs—to maintain grid reliability, manage peak demand, and strengthen resilience during and after extreme events (Gellings and Parmeter 2017; Williams et al. 2023; Charan et al. 2024). Given households account for more than one-third of U.S. electricity consumption and contribute significantly to peak load variability, the residential sector is key to this type of energy system management (EPA 2025; Williams et al. 2023). Unlike commercial and industrial demand, existing energy scholarship and practice have identified human behavior and its impacts as the primary "constraint" on residential demand (Williams et al. 2023). This literature suggests that deeper knowledge of the social and contextual drivers of residential demand would therefore improve DSM modeling, benefiting the overall energy system. Thus, understanding residential consumer behavior—the complex relationship between human behavior, related outcomes, and impacts on energy use—is critical to DSM, ensuring successful adoption of renewable energy and energy-efficient solutions.

Despite widespread recognition that human behavior plays a central role in shaping residential energy demand, most DSM behavioral models and program designs continue to emphasize monetary incentives–such as price signals, rebates, and bill savings or credits—as primary mechanisms for increasing DSM program participation and customer load flexibility (Gyamfi et al. 2013; Gellings and Parmeter 2017; Good 2019). This framing often conceptualizes household energy decisions as rational individual responses to economic signals, focusing on price responsiveness as a key lever for demand-side participation (ibid.). While financial considerations and individual decision-making are certainly important, this approach can obscure the broader social and contextual factors that shape how households interpret and respond to energy costs, reliability, and risk—particularly during extreme weather events and power outages.

Rather than assume that price responsiveness alone explains DSM participation, this paper examines how households understand and manage energy affordability in practice. Drawing on focus group data and empirical findings from fieldwork in San Antonio, Texas, our analysis explores how energy practices—embedded in everyday lived experiences, family histories, and interactions with energy related programs—shape the ways households interpret energy costs and engage with DSM initiatives. Our qualitative analysis identifies three recurring dynamics in San Antonio: (1) cost-avoidance practices rooted in family histories, (2) the temporal management of affordability through payment plans and debt, and (3) perceptions of control and accessibility in DSM programs. We selected these three dynamics for analysis because they surfaced as recurrent themes across the focus groups, emerged from participants' explanations of household energy decisions, and unsettled the commonly simplified DSM modeling assumption that customer participation is a rational response to financial incentives. We interrogate energy "affordability" as a key concept influencing household energy decision-making, using this empirical evidence to challenge its common definition as a purely rational financial calculation (Strengers 2014; Chadwick et al. 2022). Instead, we mobilize "affordability" to show how energy-related decisions are grounded in energy practices that span generations, geographies, and lived experiences.

Energy affordability is often measured through a household's energy burden, defined as "the percentage of household income spent on energy bills." (ACEEE 2019, 1) In the United States, the average threshold that researchers and policymakers have set for identifying households with a high energy burden is spending 6% or higher of their household income on energy bills (ACEEE 2019, 1; Colton 2012). This threshold is derived from Fisher, Sheehan, and Colton's *Home Energy Affordability Gap Analysis*, which conceptualizes affordability financially, examining it "in terms of home energy burdens, bills as a percentage of income" (Colton 2012, 1). While the energy burden metric provides a useful benchmark for identifying financially vulnerable households, it treats affordability primarily as a financial calculation. Our findings suggest that households often interpret and manage affordability in their everyday lives through broader social, historical, and material conditions.

Our primary contribution is to reframe how affordability is analyzed in residential energy modeling and applied DSM research by drawing on empirical findings from San Antonio. Specifically, we argue that affordability is often understood too narrowly as a rational, cost-based calculation when approached through analytic frameworks that are not grounded in the study of everyday energy practices. Our qualitative analysis illuminates how households understand and navigate affordability, risk, and control through energy practices shaped by family histories, lived experience, housing conditions, and interactions with utility programs—dynamics that are often overlooked by incentive-based models of energy decision-making. In doing so, we bridge theoretical and applied perspectives, reframing energy systems as complex social processes rather than purely technical or economic challenges. We close by centering on the need for a framework that grounds energy models in lived experience by integrating qualitative findings into quantitative modeling workflows. Rather than propose a new modeling framework here, we utilize focus group findings to identify decision-making factors that unsettle existing DSM modeling assumptions, pointing to qualitative inputs that could be operationalized in future DSM modeling frameworks by informing modeling parameters, customer profiles, and potential survey instruments. Ultimately, this work highlights how integrating social science methods into energy modeling and DSM program design can produce more robust, accurate, and human-centered strategies for managing energy demand and supporting the evolving grid.

Limitations of Incentive-Based Energy Modeling

In energy systems planning, traditional approaches to modeling human behavior, particularly to inform residential demand-side management, have framed consumers as perfectly rational utility maximizers (Ball-Burack et al. 2025; McCollum et al. 2017; Good 2019). Key assumptions underlying these models include that decision-makers: (1) have preferences that are both known and fixed, (2) make utility-maximizing decisions, and (3) are fully informed about all available alternatives (McCollum et al. 2017). These traditional models place greater emphasis on financial factors such as return on investment and payback periods (Ball-Burack 2025). For example, discrete choice models are employed to estimate consumer response to price changes, allowing modelers to calculate price elasticity. (Venturini et al 2019)

Recent scholarship in decision science has pushed energy systems researchers to increase the “behavioral realism” of their models (McCollum et al. 2017; Venturini et al. 2019; Ball-Burack et al. 2025). Such calls for developing more realistic behavioral models have increasingly moved energy system modeling away from simplistic rational economic models towards a multidisciplinary understanding of human behavior. This shift marks a broadening of the traditional reliance on behavioral economics, such as prospect theory (Etesami et al. 2018; Mediwaththe et al. 2016) or loss aversion (Good 2019)), and game theory models that represent strategic interactions between rational or boundedly rational agents (Mohsenian-Rad et al. 2010; Samadi et al. 2010; Chen et al. 2014; Mediwaththe et al. 2016; Etesami et al. 2018). This field of research increasingly incorporates concepts and methods from social psychology, including social influence (McCollum et al. 2017; Chadwick et al. 2022; Ball-Burack et al. 2025), social norms (Chadwick et al 2022), and diffusion of innovation (Chadwick et al 2022), as well as general psychological factors such as attitudes and emotions (McCollum et al. 2017; Ball-Burack et al. 2025). Scholars have emphasized that integrating non-monetary, psychological, and other “situationally important factors” within agent-based models and population dynamics models could capture more of the complexity of “agent” interactions and their impact on the heterogeneity of consumer decisions, ultimately producing more realistic behavioral modeling outputs (Ball-Burack 2025, 2).

We turn to practice theory to widen the lens and deepen our understanding beyond both individual action and the economic dimensions of energy decisions. As defined by French social theorist Pierre Bourdieu (1977) and further developed by subsequent scholars, practice theory orients us toward the context and temporality in which everyday life takes place. By carefully studying these two elements, we can come to understand how people develop different strategies to navigate complex social, cultural, and economic contexts. As opposed to rational choice theory, which operates in a quasi-geometric reality where it is assumed that people have the necessary information and resources to make a "rational" decision, practice theory allows us to develop a more nuanced understanding of the empirical realities constraining people's choices.

Even though a substantial body of research in the energy field mobilizes practice-based terminology to explain individual or collective behaviors, it does so without engaging with practice theory and its associated conceptual and methodological framework. In many cases, these studies treat energy itself as the primary object of analysis.

Drawing on the work of Theodore Schatzki (1996, 2002, 2006, 2009, 2010; Schatzki et al., 2001), Warde (2005), and Shove and Walker (2014), we instead conceptualize energy as embedded in the performance of social practices, such as cooking, commuting, or watching television. From this perspective, energy demand is not understood as an isolated phenomenon but as an outcome of the organization and reproduction of everyday practices. Consequently, understanding trends and patterns in energy demand requires examining how social practices emerge, evolve, and intersect.

Although changes in practices are difficult to predict with precision, examining existing practices can help identify the constellation of factors that shape decision-making and everyday actions. In the context of energy demand, this perspective enables a more grounded understanding of affordability and consumption by situating them within the broader organization of daily life. Rather than interpreting decisions solely through financial considerations, a practice-oriented approach reveals how energy-related choices are embedded in routines, social expectations, infrastructures, and material conditions.

Practice theory provides the analytical foundation for this shift in perspective (Schatzki 2002, 2005, 2010; Shove 2010; Shove, Pantzar & Watson et al. 2012). In this paper, we focus on "affordability," understanding its meaning to be empirically grounded, collectively constituted, and often more expansive than a purely financial calculation. Practice theory allows us to ground the concept of affordability by turning to the aspects of everyday life that shape people's agency and decision-making.

This relationship is clearly illustrated by Shove and Walker's (2014) discussion of the British government's energy report *2050 Pathways Analysis* (Department of Energy and Climate Change, 2010). In projecting future trends in resource use and energy technologies, the report estimated that demand for hot water could range from a 50% increase to a 50% decrease relative to 2007 levels. For Shove and Walker, the key issue is not simply the breadth of this range, but the assumptions used to explain it. In the high-demand scenario, increased hot water use is tied largely to affordability: as incomes rise, households are assumed to purchase more appliances that use hot water and therefore increase consumption. This framing treats affordability primarily as a financial variable, without considering how such appliances are embedded in specific social practices or how those practices might evolve over time.

The low-demand scenario is structured by a parallel logic. Here, reductions in hot water demand are attributed to efficiency improvements and the elimination of waste. Yet these projections similarly overlook the possibility that practices involving hot water might change. It assumes that demand can be reduced through advances in technology and resource efficiency without considering the impacts of social practices such as bathing, laundering, or cleaning, and how they might shift over time. As Shove and Walker argue, both scenarios focus primarily on economic feasibility and technological efficiency while leaving the organization of everyday practices largely unexamined, an omission that obscures the social dynamics through which demand is produced and reproduced.

From this perspective, practice theory provides an analytical lens for understanding how historical, social, and cultural conditions shape the ways people navigate everyday decisions. Affordability, therefore, cannot be reduced to financial variables alone. Rather, it must be understood in relation to the broader contexts and temporalities that structure daily life and inform how practices are performed and sustained. Reframing affordability in this way allows the concept to better capture the complexity of social reality and opens new possibilities for improving models that seek to anticipate and forecast patterns of energy demand.

Research Context and Methods

The research study that informs this article examined the impact of residential energy usage and everyday routines on the stability of the electrical grid. This research included an investigation of household routines as well as how they change during and after extreme events such as winter storms. Employing a three-pronged interdisciplinary approach, we elicited qualitative and quantitative empirical data on human behavior before, during, and after an electrical outage, focusing on understanding residents' (1) communications access, practices, and networks, (2) mobility practices and access, and (3) energy access and use. Qualitative methodologies, informed by practice theory, offer insights into how learning and human behavior shape adaptive capacity and resilience within energy infrastructure contexts (Heidenstrøm and Kvarnlöf 2018). While the initial goal of this research was to understand community resilience and behavioral impacts on the grid, our findings shed light on issues of affordability as they relate to energy practices.

Our methodology aims to deepen current research (Shove et al. 2012, Sovalcool 2014, Heidenstrøm and Kvarnlöf 2018, Kuusaana et al. 2023) by employing an empirically grounded framework incorporating questionnaires and focus groups. The two questionnaires were utilized to gather quantitative, contextual, and demographic information to (1) recruit and down-select study participants by aligning them with predetermined selection categories, as well as (2) gather critical quantitative and contextual information that was better suited to a questionnaire than a focus group format. The focus groups were utilized to collectively identify causal factors and prioritize the amount of impact each factor had or has on their household's energy use, mobility, and communication. The study's methodological design was anchored in focus groups rather than semi-structured interviews to move beyond capturing individual experiences by gathering data on comparative experiences, capabilities, and understandings, developing collectively discussed meanings related to household routines, home electricity experiences (e.g., outages), and assistance programs. While affordability was not defined a priori as the study's object of analysis, it emerged as a critical analytic category through participants' comparisons of energy access, use, and management across households and neighborhoods. The collective discussion format therefore allowed us to identify shared and contrasting understandings of affordability that were co-constructed through conversations about household energy experiences and practices.

In partnership with the local municipal utility in San Antonio, CPS Energy, as well as several community-based organizations, our study was designed to compare lived experiences, capacities, and adaptive strategies across climate-vulnerable and climate-prepared communities in San Antonio, with particular attention to Winter Storm Uri in 2021. Data were collected through two questionnaires and four focus groups with local residents conducted in four San

Antonio neighborhoods—two identified as climate-vulnerable and two as climate-prepared. Neighborhood classifications were developed collaboratively with local parters, drawing on the impacts observed during and after Winter Storm Uri.

While Winter Storm Uri was used as a heuristic by providing a shared experiential reference point for all participants, the focus groups were not narrowly confined to household energy behavior during extreme events. Rather, we asked participants to reflect on a collectively experienced extreme event in order to elicit discussion of their everyday routines, and how those ordinary practices, schedules, and habits were disrupted, adapted, or reinforced during and after an extreme event. Methodologically, our study frames extreme events not as exceptional experiences disconnected from everyday life, but as increasingly common disruptive moments that unsettle and expose entrenched household orders, including routine energy practices, social relations in the home, material constraints, past experiences, and household coping strategies. The heuristic therefore helped render visible everyday energy practices and experiences, providing a shared frame of reference through which participants could collectively articulate how and why particular energy decisions were or were not made.

Our findings speak to affordability by showing how an extreme event reorganizes the conditions under which ordinary energy-related practices can be carried out. Rather than treating the outage as an exceptional episode detached from everyday life, we use it as a moment in which the usually taken-for-granted supports for routine practices become visible. The ability to heat a home, cook, bathe, charge devices, communicate, travel, work, care for others, and preserve food depends on specific combinations of infrastructure, appliances, money, time, skills, social networks, and mobility. When electricity is interrupted, households must reassemble these practices through alternative means, such as purchasing fuel, relying on generators, relocating temporarily, driving to charging or warming sites, depending on neighbors or family, or foregoing certain practices altogether. The uneven capacity to make these substitutions is where affordability becomes empirically observable. The issue is not only whether households can pay an energy bill, but whether they can access and sustain the material and social arrangements required to maintain everyday life under disrupted conditions. By comparing routines before, during, and after the storm, the study therefore identifies how affordability is produced through practice: which routines become more costly, which resources become necessary, which adaptations are available to some households but not others, and how these disparities between households shape energy demand and resilience.

In October 2024, NLR conducted fieldwork in San Antonio. First, 296 respondents filled out a recruitment questionnaire to down-select focus group participants based on their residence in the neighborhoods of focus, and confirmation of their experience of Winter Storm Uri in San Antonio. Selected participants completed a pre-focus group questionnaire to collect quantitative data about their typical energy and transportation use. From October 25th through 28th, 28 residents participated in the four focus groups. Focus group participants were asked questions about both their households' everyday routines and practices as well as those taken during and after extreme events. DSM questions—including participation in DR and weatherization programs—were incorporated into both the pre-focus group questionnaire, and the focus groups themselves.

Focus group discussions were recorded, transcribed, anonymized, and imported into MAXQDA, software for qualitative data analysis. Qualitative content analysis [QCA] was utilized to develop codes and categories that enabled the identification of key themes, patterns, and underlying meanings within the data (Miles and Huberman 1994; Elo and Kyngäs 2008;

Assarroudi et al. 2018). The coding process was iterative, beginning with deductive coding based on our literature review and conceptual analysis. Subsequently, we developed inductive codes that emerged from the empirical data via open coding that identified additional descriptive and thematic categories. This approach enabled us to conduct a systematic analysis of the empirical data collected, including the identification of recurring themes across the focus group discussions and gaining a deeper understanding of the social, cultural, and structural dynamics influencing energy decision-making.

Findings: Real-World Household Energy Decision-Making

The San Antonio case study reveals how energy-related decisions in households are informed by social practices, past experiences, cost-avoidance strategies, and perceptions of control. Our analysis also identifies nonmonetary and contextual factors influencing residential customers' participation in DSM programs such as weatherization and smart thermostat DR programs. Unlike rational-choice models that isolate decision variables, our findings show that household energy decisions emerge from the intersection of multiple factors embedded in historical, social, and cultural contexts. Consequently, our analysis reveals that concepts such as energy "affordability" cannot be solely defined by individual financial constraints; rather, they must be understood and interpreted through the histories and lived conditions shaping household decision-making, including their access to and use of resources.

The following subsections illustrate three recurring dynamics identified in the focus groups: (1) cost-avoidance practices rooted in family histories, (2) the temporal management of affordability through payment plans and debt, and (3) perceptions of control and accessibility in DSM programs. Together, these empirical examples demonstrate how "affordability" is produced through intergenerational practice, temporal strategies for managing costs, and experiences of control—or lack thereof—within DSM programs.

Cost Avoidance Strategies Rooted in Family Histories

Participants across all four focus groups emphasized that *past experiences*—including family histories and intergenerational knowledge—were a driving factor shaping how their household manages energy use. Their narratives reveal that participants' current cost avoidance strategies are embedded in multi-generational experiences and inherited practices. In these discussions, energy conservation practices were rarely framed as calculated responses to present-day electricity prices. Instead, they appeared as inherited habits and socially learned routines that continue to structure household energy behavior.

A conversation unfolded in one of the climate-resilient neighborhoods related to past and familial experiences in Europe shaping energy practices in their San Antonio homes. One participant explained that in her apartment complex utility costs are shared. As a result, although she and her roommate usually keep the air conditioner off, they do not directly benefit from the savings on their utility bills. However, while this participant lowers her energy usage due to comfort, preferring a warmer environment, she traces her roommate's actions to sociocultural roots, explaining:

> my roommate…she's from Spain… so…we unplug everything like after we're done using it—the Air fryer or whatever—I'll walk in and she'll just have…unplugged everything and I don't really mind…she says it's for the energy and I'm just like you do you, so I do, you know the stuff in my room, like my lamp and my like Google

> Home, I just leave those, but everything else be unplugged and I've just kind of been following her drift. But now that you bring it up, I do want to know if it's worth it.

This participant underscores how her roommate's energy practices stem from her Spanish background and reflect a commitment to energy conservation rather than cost savings. By contrast, the participant's own practices have been conditioned by her lived experience of cohabiting with her roommate. In her case, these habitual actions are not grounded in sociocultural traditions or financial considerations but instead arise from the everyday convenience of "following her [roommate's] drift." Here, affordability, as a factor impacting energy decision-making, is constrained by the structural conditions of their apartment complex, which limit individual agency over utility costs. Consequently, energy decisions are made not only in relation to financial considerations, but also in response to sociocultural habits and household dynamics.

Responding to this narrative, another participant shares her own culturally grounded approach to energy decisions. She reads the Spanish roommate's actions through a different lens, noting:

> I feel like your friend does it more because it's a habit that parents brought because we had the same. And the reason is that in Europe we have a different voltage. We have it higher and very often when we out of power and then goes back, it jumps and that's it. Your TV is gone. Whatever you have is gone. So, we do that. I do the same…unplug whatever I can. Because I know if we are out of power and then it goes back. You can get the jump…And it's like $500…on the TV [gone]…so it's more like a habit. Maybe she [the other participant's Spanish roommate] doesn't even know that it's a habit from her parents, and it's not for…saving it just for saving money or not losing stuff.

Intertwining her own personal history with that of her peer, this participant adds an additional layer of historical context to the original narrative. Separated from the space and time of their origins, this participant highlights that while the roommate's familial "habits" may appear to reflect a commitment to energy conservation, they were likely developed in response to the instability of earlier European energy systems, which damaged costly household appliances. Although those material conditions and their financial impacts may no longer exist, the habits that they inculcated into residents live on in the everyday practices of their children. Thus, this narrative highlights the temporal and geographic dimensions of affordability: cost avoidance strategies formed under past infrastructural and economic constraints in a different country continue to shape the energy practices and decisions of younger generations, even when they are no longer subject to the same systemic pressures.

Although this discussion of energy habits that reduce domestic consumption and mitigate the effects of blackouts emerged among residents of a neighborhood considered less susceptible to weather-related power outages, participants from more climate-vulnerable neighborhoods similarly described how past experiences shape their energy practices and decisions. One climate-vulnerable neighborhood participant connected her enrollment in the utility payment plan to her energy conservation practices, which she rooted in her family history:

> I pay $180 every month [on the payment plan]…when I started [four years ago, during COVID]…it was like $120…I always try to balance it out because at the end of the year, if you go over [the monthly amount]…you don't have to pay that last [month]…it takes…$100 off the next bill…since I get paid monthly…I budget

> it, I know everything…But the electricity, I guess it stems from when I was young again. I remember…with my mom. She was a single mom. We had several times where through the years when we were young that we didn't have electricity…recollections of everything that happened and how you survive came over to my adulthood…friends come over and they're like, 'Why is it so dim in here?' and if I ever went blind, I would be able to know everything is in my house…because I don't need to have like all these lights on. Even when I go put a load of laundry, it's repetitive. It's things you do every day…I have a little light on the stove. I can cook in the dark. I don't need to cut a tomato with the big old light on. So does my son. He doesn't like it. He says he don't like it because he'll see something that's dirty. He's just like me and I love my 19-year-old…we're the same. Take a shower and leave the door open. You have the outside light coming in…you know where the bar of soap is.

This participant, who utilizes the bill payment plan to maintain control over her monthly expenses traces her household energy conservation habits to a childhood without consistent access to energy. Her everyday habits of dimming lights and conducting domestic routines (laundry, cooking, showering) in the dark are all practices aimed at lowering and controlling energy usage. Here, both the affordability of her energy payment plan and the affordability of her household's intergenerational energy practices—passed from her mother to her son through her own habits—are less related to specific costs and more focused on controlling expectations of energy cost, usage, and access. Across these narratives, affordability emerges less as a calculation of price and more as a strategy of risk management shaped by memory, habit, and intergenerational experience. Thus, in this case, affordability as a factor impacting energy decisions is not defined individually but intergenerationally, collectively, and temporally.

Payment Plans, Credit, and the Temporality of Affordability

While the previous narratives illustrate how past experiences shape everyday energy conservation practices, participants also described how households actively manage the timing of energy costs. In these cases, affordability is negotiated through financial mechanisms—such as payment plans, debt, and credit—that redistribute energy costs across time. The temporality of affordability surfaced as participants discussed their household's approaches to maintaining energy access and the barriers they face to preparing for unexpected outages. Financial mechanisms that delay payment (loans or debt) or distribute payment over time (payment plans) were cited as useful tools to help participants overcome social, structural, and economic constraints. These mechanisms were not discussed as isolated factors driving energy decisions, but rather discursively intertwined with the social, cultural, and structural factors that shape their household practices.

One participant in a less resilient neighborhood shared how their energy affordability was tied to both access to a payment plan and their everyday household practices of lowering electricity usage in their home. When asked whether energy bills are a burden for their household, this participant explained:

> It's not a burden, but we're part of that the averaging bill for city public service. So when the cycle ends, sometimes we don't have to pay an electricity bill for like a month or two, because especially when it's cold, I don't run the air conditioner or when it's warm enough we don't run the heater, the central unit…it's called the averaging and…we know every month it will be about the same [cost]. The other

> thing that we do is we make sure and turn off the lights in the rooms that we're not using.

In their narrative, quotidian household practices of energy conservation are intertwined in their utility payment plan. This plan is useful because it not only evens out the financial burden over time, but it also creates space for household agency where more conservative energy use at particular times in the year (air conditioner/heater use) or throughout the day (turning off lights) provides cost savings in the future. In this sense, affordability is not understood as minimizing cost at a single moment but as managing financial predictability over time.

For other participants, affordability—particularly during an extreme event and long-term power outage—felt more tied to how costs can be delayed or deferred. A participant who presently lived in one of the neighborhoods identified as more resilient, had experienced a multi-day blackout during Winter Storm Uri when her family lived in Houston. To maintain access to electricity and water, her family rented a hotel room, incurring an extremely high and unexpected cost. Reflecting on what her family had learned from this lived experience, she explained:

> I feel[s] like it's so hard for a lot of families now to be prepared…I believe…over 60 or 70% live paycheck to paycheck, and it's really hard to stock up on food or gas or whatever if you're… on the budget for those two weeks…that's what happened to us at the time, my husband…was out of the job for two months I was getting paid like $17.00/hour. *Two kids, a dog, rent, everything…so little money that we're basically, we're like surviving…*I learned that*…for any situation you had to have at least one fully paid off credit card, that debt will help you*. Yeah you're going to get in debt, you can recover from it, but have that to…leave the state or…buy food or…pay for those crazy hotels…just have at least one [credit card] for the whole family to help you to survive because as you said, *it's not going to last forever*. It's like three, four, five days and you'll figure it out from there. [Emphasis added]

In her narrative, this participant emphasizes that for her family, surviving an energy crisis amidst existing social, economic, and structural constraints hinged on access to a line of credit. This strategy provides families access to essential needs—food, gas, a safe environment—in the absence of government safety nets. Affordability, therefore, as a factor impacting energy decisions becomes deeply enmeshed in existing household constraints – job insecurity, low wages, instability that impacts long-term family planning. These accounts demonstrate that some households evaluate energy affordability through their ability to maintain flexibility during crises—both personal and systemic—rather than through the immediate cost of electricity alone.

Trust, Control, and the Unintended Costs of DSM Program Participation

DSM programs are often designed around the assumption that households will modify their energy use in response to financial incentives, trading reduced consumption for cost savings. However, focus group participants described experiences in which DSM programs did not align with the physical conditions of their homes, their daily routines, or their expectations of control over household energy use. One of CPS Energy's demand response (DR) programs, their Smart Thermostat Program, automatically adjusts customer thermostats during "conservation events" to lower customer usage and mitigate peak demand, effectively reducing customers' electricity costs. On their website, Utility A states that their thermostat program is, "[a] great way to save electricity and lower your home energy bill" (CPS Energy 2026a). However, participants described how, in practice, this program presents challenges to households and does not necessarily reduce their energy burden. As one participant explained:

> Energy? Yeah, it's a burden…It's gone up a couple of times, but yeah, if there's opportunity to—they tell me we should save, and I'm on the thermostat program, but honestly…I have 100-year-old house. So, if it's 100°, it was 108° this year this summer and it went running until probably 4:00 in the morning. I had it at 78, or 76 and it kept on running till like 3:00 or 4:00. I finally heard it stop. I was like, gosh, what's my bill gonna look like?...But unplugging clocks and computers probably wouldn't do anything, or it's minimal. So, I'm on…the volunteer program, but when it's hot, I'm not gonna turn it off, I'll increase the temperature, but I'm not going to turn it off completely.

This participant calls attention to a disconnect between the DR program's design assumptions and the material conditions of their home. In poorly insulated aging housing, automated thermostat adjustments can increase uncertainty about energy costs rather than reduce them. Multiple participants described how such interventions sometimes shift energy use to times when the household perceives cooling to be unnecessary—e.g., when no one is home—and restrict cooling when residents are present and overheated. As a result, the perceived loss of control over household comfort and energy expenses often outweighed the potential financial benefits of DR program participation.

Concerns about control and unintended costs were not limited to DR programs. Similar frustrations emerged in participants' experiences with weatherization initiatives intended to improve household efficiency. CPS Energy's Weatherization program aims to assist "residential customers in reducing energy consumption in their homes" with weatherization "improvements [that] increase comfort, save energy, and help lower energy bills." (CPS Energy 2026b) However, after opting in, one participant lamented:

> they came over and completely tore up my house while I was living there. And underneath the house we got a walking space. They were putting insulation under there and they messed up my electricity at six different ports…And then they had nobody that could fix it…I paid like $500 worth to get them to, to fix my electricity and get it back. And then they're supposed to come back with the CPS and Casa Verde [Weatherization Program]. They supposed to come out and do a final check. They call me 4 times, and they never come out to do the final…it's been about least six months [and there's] still stuff that they've never fixed. They called me four times…I'm not a very busy man. You come over anytime…everything's not perfect, but if you're going to offer a program like this and you're going to do this and this…You should be able to follow it through until you get it done…I was very, very upset with that program.

Rather than reducing household costs, this participant described how program implementation generated new financial and logistical burdens. Unexpected damage to the home required out-of-pocket repair expenses and months of unresolved follow-up with the utility provider. Although the weatherization improvements may ultimately improve energy efficiency and thermal comfort, the program experience produced frustration and distrust. These accounts highlight how the desired affordability benefits of DSM programs depend not only on long-term energy savings but also on the reliability, transparency, and responsiveness of program implementation in the short-term.

Analyzed together, these experiences demonstrate that the perceived affordability of DSM programs in San Antonio is shaped not only by potential financial savings but also by households' abilities to maintain control over energy use, trust program implementation, and navigate the physical constraints of their homes. When automated controls conflict with daily routines or when efficiency programs generate unexpected costs, households may disengage from initiatives designed to reduce energy demand. These findings suggest that DSM models based primarily on price responsiveness at one moment in time overlook the social and material conditions that influence participation as well as the temporality of decision-making. Following practice theory, these accounts show how household energy decisions emerge from the interaction between various factors—including technological systems, housing conditions, and everyday routines—rather than from isolated economic calculations. Incorporating these lived experiences and the constellation of decision-making factors they reveal into program design and energy modeling could improve both participation rates and the accuracy of the behavioral assumptions underlying demand-side management strategies.

Discussion and Conclusion: Implications for Applied Research

Collectively, our analysis of participants lived experiences with San Antonio's energy system highlights how relationships between sociocultural, economic, and historical factors influence energy practices and decisions. Individual decisions are never made in a vacuum, and financial considerations are always tied to wider social contexts, structural conditions, and embodied memories that span generations and geographies. Analyzing this empirical data through the lens of practice theory, we understand domestic energy decisions such as turning off unused lights or raising the temperature on an air conditioner to be situated within broader decision-making environments. Rather than discrete behavioral events, these energy conservation practices derive from a wider context and temporality.

Grid operators, energy researchers, and policymakers often focus on key concepts such as energy affordability as decision-making factors that can be plugged into a model and targeted for behavioral intervention. However, developing a grounded representation of affordability that aligns with social reality requires broadening its definition beyond an energy burden threshold. Affordability is not just about economic resources or limitations but also about the habits and practices formed under specific material conditions. What these participants experience as realistic, inaccessible, or inconvenient is structured by their pasts, their familial histories, and housing and infrastructural conditions. Furthermore, these narratives reveal that affordability includes temporal maneuvering. The ability to delay payment or to distribute it over time is itself a form of capital. Those without temporal flexibility may find certain energy practices and DSM programs unaffordable. Finally, these accounts demonstrate that households do not calculate costs in a purely economic, rational-choice sense. Their sense of what is worth pursuing includes moral obligation (following a roommate's expectations), timing (being able to delay payment), and a sense of autonomy (maintaining control over their domestic environment). Thus, answering the question "is this affordable?" often requires a practical-moral judgment rather than a financial equation.

Empirically grounding concepts such as affordability in social reality can have concrete impacts on both energy systems models and DSM design. Our analysis, that originally focused on an extreme event, exposed household energy practices that often remain unnoticed or unquestioned by household members during ordinary life. By analyzing how participants described their routines before, during, and after the storm, our findings revealed that affordability is not a pre-defined financial limit, but rather a dynamic decision-making factor that is produced *through* practice, therefore holding a different meaning to different people. Identifying the nuances of everyday life shaping customers agency is key to understanding why residential customers make particular energy decisions at particular times, including participation in DSM programs. Our findings suggest that incorporating a qualitative approach into energy modeling and DSM program design would improve model accuracy and could increase DSM participation rates.

In other research currently under review, we have proposed a conceptual framework (Rosner et al. 2026) and methodological approach (Blanco et al., 2026) that integrates empirical qualitative data into quantitative models to develop more realistic behavioral models that improve DSM outcomes for both residential consumers and utilities. This approach leverages qualitative findings to inform modeling parameters, build customer profiles that are more closely aligned with real-world conditions and household relationships, developing a set of decision-making variables. These profiles and variables could be operationalized to inform the design a survey instrument that prioritizes decision-making factors for each consumer profile. Finally, the results of this survey could be incorporated into the underlying behavioral algorithm that informs DSM program design to develop more sensitive models that are tailored to consumer realities. The present article provides empirical foundation for operationalizing a modeling framework grounded in lived experience. While our qualitative findings have found some barriers to DSM program participation, it is the identification of decision-making factors that can help us design more responsive and rewarding program offerings for both utilities and their customers.

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Acknowledgements

This work was authored by the National Laboratory of the Rockies for the U.S. Department of Energy (DOE), operated under Contract No. DE-AC36-08GO28308. This work was supported by the Laboratory Directed Research and Development (LDRD) Program at the National Laboratory of the Rockies. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

We thank and acknowledge the invaluable contributions of our local partners in San Antonio, Texas: CPS Energy, community-based organizations including New Life Christian Center, Mya Jua Solutions, and Neighborhood Housing Services of San Antonio (NHSSA), and community representatives Saira Muniz, Peter Onofre, Sharron Brown, Gene Bargas, Judith Temple, Beverly Monestier, and Debra Ponce. For over a year, their knowledge and input helped shape the research questions and study design, as well as directly supported participant recruitment and focus group implementation, ensuring this work has local relevance and improving its methodological rigor. We would also like to thank all of the study participants, who generously shared their experience, expertise, and time with us. This research would not have been possible without all of your contributions.

Disclosure

AI-assisted tools used: ChatGPT, based on the GPT-5.3 model
Used for: Copyediting.
Extent: Light editing on specific paragraphs.
Human review: The authors reviewed and verified all content.