Increasing Participation in Demand Response Programs – A New Customer Engagement Model

Ellen Steiner, Opinion Dynamics
Erin Drouin, Opinion Dynamics
Olivia Patterson, Opinion Dynamics
Nick Minderman, Xcel Energy

ABSTRACT

Demand response (DR) programs allow customers to play a significant role in balancing demand on the electric grid by encouraging them to shift, shed, shape, and shimmy their electricity usage during peak periods. Gathering insights from nonparticipating customers can provide critical market intelligence to help grow existing DR programs and expose untapped market opportunities for new DR offerings. However, very little residential DR nonparticipant research exists. To support DR nonparticipant research, we developed a DR customer engagement model that utilizes a hierarchy of effects marketing model as the foundation. A hierarchy of effects model posits that audiences go through a variety of changes in responding to advertising and other persuasive marketing messages in their customer-decision journey to purchase an item, participate in a program, or acquire a service. The basic assumptions of this conceptual framework are that customers first become aware of an offering, then develop attitudes and beliefs about the offering, and as a result, are prompted to take action. However, for demand response programs, this customer decision-making process is more complicated in that there are two pivotal customer decision-making points—the decision to enroll in the DR program and the decision to change their behavior. In this paper, we discuss the engagement model and consider its usefulness as a conceptual framework for DR nonparticipant research.

Introduction

Demand Response (DR) programs have been a part of energy planning for over 40 years. Over time, traditional DR has evolved with the increasing availability of technologies that unlock more options for customer engagement. These new technologies, coupled with changing regulatory policies to address grid, customer, and climate needs, continue to drive demand response innovation. The last decade has marked an even more rapid evolution given the adoption of renewables, penetration of distributed energy resources (DERs), electrification policy objectives, and extreme weather events—creating a perfect environment to re-envision DR and the role of the DR for customers. With this evolution in program design and delivery comes a need to also test new approaches to evaluating the effectiveness of programs, especially how the programs can respond to differences in customer motivations and perceived value.

Demand Response Overview

Since 1970, DR programs have been evolving, albeit at varying timescales based on geographic, regulatory, and regional grid characteristics, highlighting an increasing need to

evolve customer engagement strategies. The Federal Energy Regulatory Commission (FERC 2023) defines DR as "changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized." The Lawrence Berkeley National Laboratory's landmark 2017 study put forth a novel framework for classifying Load Flexibility resources into four distinct "service types:" Shape, Shed, Shift, and Shimmy (Alstone et. al. 2017). This work standardized nomenclature around DR, effectively replacing the historic monolithic concept of event-based DR with a more nuanced Load Flexibility framework.

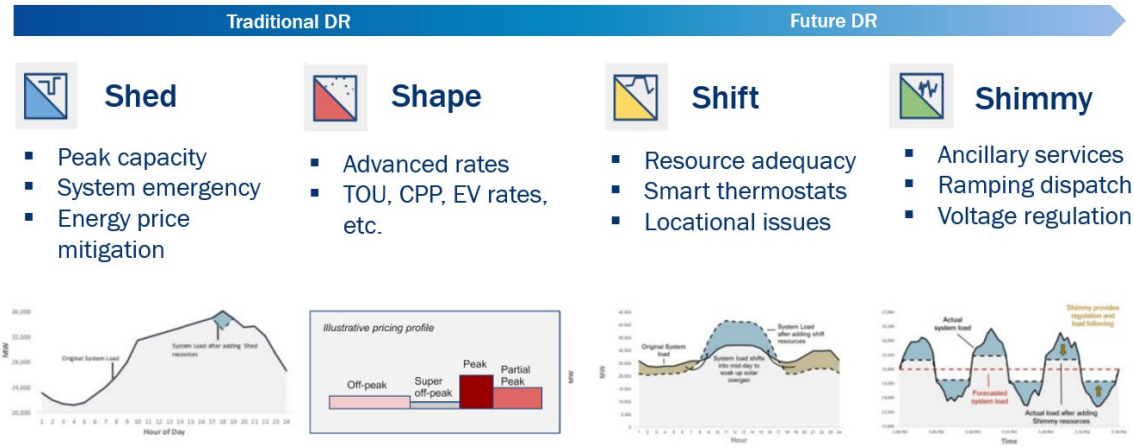

Figure 1. Lawrence Berkeley National Laboratory's Load Flexibility Framework
Source: Alstone et al. 2017

Across these different pillars, there are a range of different program interventions. In this paper, we specifically focus on load shifting and shedding. The practice of "shifting" can involve activities such as running certain appliances (e.g., washing machines) during off-peak hours when electricity prices are typically lower or when there is an abundance of renewable energy generation, such as during the day for solar energy or during windy periods for wind energy. The practice of "shedding" refers to the intentional reduction or curtailment of electricity consumption by consumers. The table below provides example products by primary service type.

Table 1. Example DR Products by Service Type

Product	**Product Type**	**Primary Service Type or DR Goal**
Time of Use (Home or EV)	Rate	Shape
Off-Peak EV Charging Incentive	Rebate / Bill credit	Shape
Critical Peak Pricing	Rate	Shape + Shed
Managed EV Charging	Rate and/ or technology control	Shape (non-dispatchable) or Shift (dispatchable)
Peak Time Rebates	Rebate / Bill credit	Shed
Direct Load Control	Technology control	Shed or Shift
Smart Thermostat Pre-cooling	Technology control	Shift

Why Develop a Customer Engagement Framework for DR?

Little research exists that taps into non-participating customers to understand attitudes, barriers, and decision-making for not only **enrolling** in DR programs but also **engaging** with them. Further, the aforementioned evolution in DR programs and intervention strategies emphasizes the critical role that customers will play in balancing demand on the electric grid, driven by increasing electrification, integration of renewable resources, and advancements in technology. In particular, this evolution will require program administrators and implementers to reconsider the following:

What we are asking customers to engage with. There are various DR programs and interventions a customer can engage with. We believe that the variety of DR programs will continue to increase alongside the increase in automation and program sophistication. A recent example is the transition from controlling residential air conditioning through switches to smart thermostats and managed charging through EVs. Further, the adoption of advanced metering infrastructure (AMI) creates additional DR program options, such as behavioral DR, critical peak pricing, and peak time rebates.

When and how frequently customers engage. DR is distinct from other clean energy program interventions in that it asks customers to continue to engage beyond a **single** purchase or installation decision. Not only does it ask for changes to behavior, but it also asks for customers to engage more and more frequently, either passively or actively. DR, as a result, is a quintessential behavioral program. In the past, DR was primarily used to provide energy and/or capacity when wholesale prices were unusually high; there was a shortfall in generation or transmission capacity, or during unexpected emergency grid operating situations. Notifications were manual, and there was little to no customer feedback on performance. However, as renewables integration and electrification adoption continue, the benefits derived from DR will move beyond a few "events" per year to the potential for 24/7 continuous management. As a result, depending on the DR program, a customer will have varying levels of customer engagement. Engagement can range from permanent habitual change to event-based temporary actions to changing energy-using patterns. The enabling technology will impact the level of effort and engagement required for customers.

Why customers engage. Value streams from DR (e.g., avoided generation capacity costs, reduced peak energy costs) may not be directly salient to a customer, while others may be appealing conceptually (e.g., enhancing system reliability or facilitating the integration of intermittent renewable resources). Importantly, many customers have no knowledge of why DR occurs and how it can benefit them. As a result, customer education about the value a customer receives, as well as thoughtful design of customer incentives and rewards, is critical to motivating customers to enroll. Getting customers to continue to engage and *remain* in the program (e.g., mitigate opt-outs or de-enrollment) will be critical, especially as the number of DR "events" increases.

Xcel Energy Colorado Residential Demand Response Programs

Xcel Energy Colorado has committed to reduce carbon emissions from the electricity delivered to customers by 80% in 2030 and to be 100% carbon-free by 2050. Xcel Energy consistently sees an evolved demand management portfolio as a key to achieving this goal, both to facilitate the integration of more non-dispatchable energy sources and to better leverage investments in an advanced electric distribution grid. Xcel Energy already has a highly diversified portfolio of offerings and wants to ensure that it is maximizing the pool of eligible and willing customers in these existing products while also understanding the needs of customers for whom no existing product is attractive. The figure below, from Hledik et al. (2022), shows typical DR program types and a comparison of utilities across the country that offer some portion of these program types. It's worth noting that no benchmarked utility includes all eleven DR types in its portfolio.

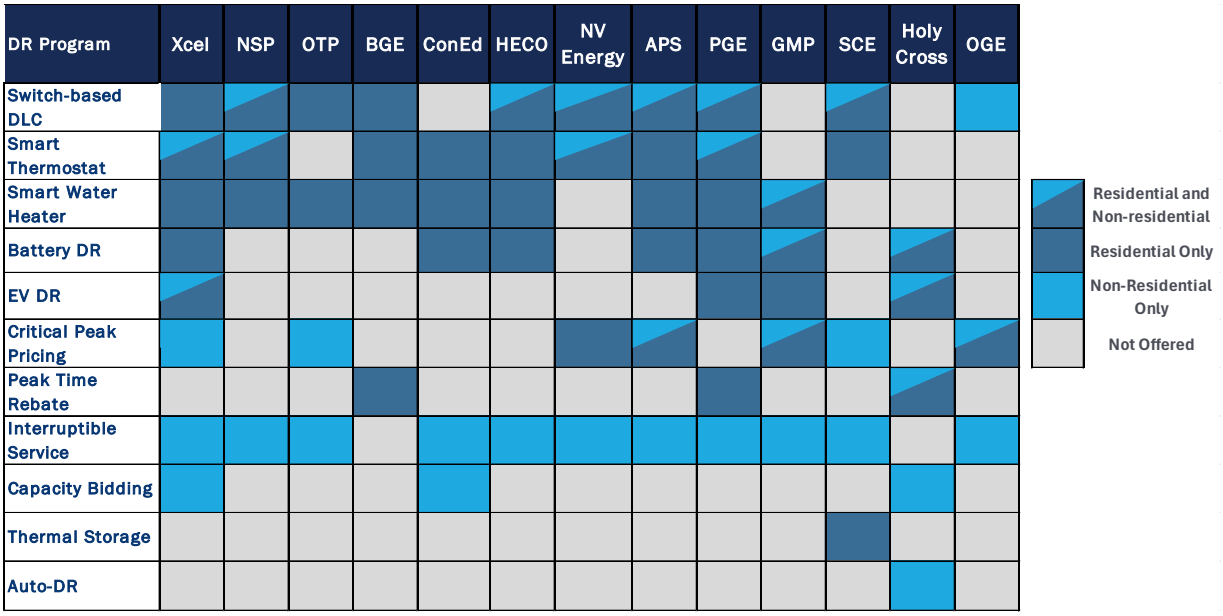

Figure 2. Matrix of DR Program Offerings at Selected Utilities.
Based on Brattle Review of utility websites and tariffs. NPS = Northern States Power, OTP = Otter Tail Bower, BGE = Baltimore Gas & Electric, HECO = Hawaiian Electric Company, APS = Arizona Public Service, PGE = Portland General Electric, GMP = Green Mountain Power, SCE = Southern California Edison, OGE = Oklahoma Gas & Electric. *Source:* Hledik et al 2022.

One of Xcel Energy's primary objectives for this research is to learn how to cost-effectively maximize the contribution of these programs without jeopardizing safety and reliability. This motivates Xcel Energy to gain a better understanding of the customers that participate in existing and new demand management offerings so that more robust predictions of customer habits can inform forecasts of the effect when control events occur.

Nonparticipant Research

Xcel Energy is motivated to seek different approaches to demand response program recruitment due to its customer population, which includes a smaller share of industrial customers compared to its peers. The figure below, taken from Hledik et al. (2022), illustrates this potential barrier to growing DR program enrollment and accentuates how the utilities that may be viewed as "best in class" for DR program capacity often rely very heavily on industrial customers to meet their goals. Please note that Xcel Energy Colorado is noted as PSCo in this figure.

Figure 3. Utilities with Primarily Large Industrial DR Portfolios compared to Xcel Energy Colorado.

Source: Hledik et al 2022.

Determinants of Residential Demand Response Engagement

Hierarchy of effects models provide a useful practical framework for planning, driving and assessing customer engagement. The hierarchy of effects model posits that audiences go through a variety of stages (cognitive -> affective -> conative) in responding to advertising and other persuasive marketing messages (Lavidge and Steiner 1961; Vakratsas and Ambler 1999; Sinh 2013). The basic assumptions are that customers first become aware of an offering, they then develop attitudes and beliefs about the offering, and as a result are prompted to take action. The most cited hierarchy response models include AIDA and the Lavidge-Steiner Hierarchy of Effects Model. Table 3 shows these models side by side and also includes the akAB model of behavior change, a hierarchy of effects model developed specifically for energy-efficiency-related behavior change (Lavidge and Steiner 1961; Vakratsas and Ambler 1999; Sinh 2013).

Hierarchy of Effects models provide a useful conceptual framework to think about customer engagement. However, they should not assume a particular sequence of responses. Using the model without requiring a specific sequence takes advantage of the usefulness of the model while allowing for the fact that neuroscience research indicates that emotion often operates independently of the rational brain to drive behavior.

Table 2. Hierarchy of Effects Models

Stages	AIDA	Lavidge-Steiner Model	akAB
Cognitive (Thoughts)	Attention	Awareness Knowledge	Awareness Knowledge
Affective (Feelings)	Interest Desire	Liking Preference	Concern Personal Responsibility
Conative (Behaviors)	Action	Conviction Purpose	Intention Behavior Change Maintenance

Note: The framework presented in the table is adapted from Belch and Belch 2009

Using the conceptual underpinnings of hierarchy effects models, we developed a new residential demand response conceptual model (Figure 3).

Determinants	Determinant Research Question(s)
Attention	How much does the person pay attention to paying utility bills, personal energy usage, interacting with their utility, reading about energy issues, etc.?
Energy Literacy	Does the customer understand basic energy concepts related to demand response? (e.g., Do they understand why the alignment between energy supply and demand is important?)
Awareness	Is the customer aware of demand response program offerings?
Attitudes	Do nonparticipants value the environment? Is nonparticipation driven by program specifics?
Investment	Do nonparticipants have the required technologies that enable participation?
Enrollment	How likely is the customer to enroll in a DR program?
	What attitudes and values influence likelihood to enroll and participate? (e.g., environmental attitudes, locus of control, trust in Xcel, etc.)
Behavior	How likely is the customer to follow-through with demand response behaviors? (e.g., barriers, intention, action)

Figure 3: Residential Demand Response Customer Engagement Model

We also utilized the Theory of Planned Behavior/Reasoned Action, proposed by Ajzen and Fishbein, which suggests that behavior is determined by intentions, attitudes (beliefs about a behavior), and subjective norms (beliefs about others' attitudes toward a behavior) (Fishbein and Ajzen 1975; Ajzen 1991). The main proposition of the theory is that the intent to complete a behavior is the most important determinant of whether someone will complete that behavior. The theory was later expanded to the Theory of Planned Behavior wherein perceived behavioral control (beliefs about one's ability to perform a behavior) and behavioral intentions predict behavior.

While the bulk of the scholarship related to demand response has focused on financial incentives to understand when or why people participate, there is prior work that has applied the Theory of Planned Behavior to the subject of demand response (Chen et. al. 2023). Specifically, when examining dimensions of how people enroll in DR programs, a social psychological lens provides insights into what factors lead to actual behavior. Considering that many individuals find DR programs favorable, but DR programs have relatively low rates of enrollment, it is important to understand what psychological factors may be preventing widespread participation. Past work found that attitudes towards energy saving were one of the largest contributors towards behavioral intention to engage in a demand response program (Chen et. al. 2023).

Here, we utilize a lens similar to the Theory of Planned Behavior to understand what factors are preventing participation in residential demand response programs. We built a framework that features various sociopsychological factors to understand nonparticipants. The factors in this framework cover the aspects of the customer journey and emulate the psychological processes that determine whether someone enrolls in a demand response program or not. Again, as we are utilizing a hierarchical framework, the order of these concepts are not meant to emulate linearity. Instead, we seek to understand the nonparticipant population in their consumer decision-making, which can provide future insights and strategies for marketing, education, and outreach when targeting them for enrollment.

Attention

When thinking about the myriad of factors involved in a customer's journey to participate in demand response programs, an underlying assumption is that the customer must, in some capacity, pay attention to their electricity usage. It's well-reviewed in the literature that, on average, people do not spend a substantial amount of time with their electric bill. The well-known Accenture study in 2016 found that consumers spend around 6 minutes each year thinking about their electricity bill (Tweed 2016). This sentiment is echoed in additional studies that have found that customers spend minimal time with their electric bill each month and also have a lower level of understanding of their home energy use (LeBlanc 2016). This presents a challenge for demand response programs, as they require that customers pay attention to their energy consumption. With this in mind, the first dimension of our framework measures how much customers pay attention to their energy use.

We operationalize attention as the amount of time a respondent has spent on a variety of tasks related to their utilities (e.g. interacting with a representative of their energy provider,

looking at and paying energy bills, tracking home energy usage). This is consistent with prior studies that have examined how individuals engage with energy information (Chen et. al. 2023).

Further, we include additional constructs that may function as barriers or drivers of participation. For instance, our measure asks individuals if they are the decision makers in their home energy decisions and if they are in charge of paying the electric bill. If a respondent's household role does not involve engaging with information regarding their utilities, they are unlikely to be someone to target for a demand response program. It is possible that individuals may not pay attention to their home energy usage if they do not have to open their bill each month. This could be a barrier to enrollment in demand response (DR) programs. If customers have their bills on autopay, they may not think about how much money they spend on electricity, which may contribute to their unawareness of their home's energy usage.

The insights from the attention dimension of the framework will allow us to target potential interventions to segments of the nonparticipant population. If findings yield that segments of the population do not pay attention to their utility information, Xcel Energy Colorado or other utilities could incentivize customers to engage with their energy bill in a meaningful way with targeted messaging and calls to action. Utilities could also use this data to prioritize those segments that do pay attention to drive greater return on investments of limited marketing resources. Customers in autopay, as well as home decision-makers, could also receive strategic communication about DR programs to facilitate participation.

Energy Literacy

We hypothesize that for most customers, understanding demand response is a prerequisite to enrolling in a demand response program. Or, at least, it's likely a customer who would enroll in a DR program would have some baseline understanding of home energy usage and basic grid fundamentals. Thus, our framework features a measurement of energy literacy. Specifically, we seek to understand if a barrier to demand response enrollment is a lack of requisite knowledge regarding home energy usage and demand response tenants.

The Department of Energy defines energy literacy as "an understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply this understanding to answer questions and solve problems" (DOE). That definition is accompanied by a series of behaviors such as "can communicate about energy and energy use in meaningful ways" and "knows how much energy they use, for what purpose, and where the energy comes from" (DOE). While there is variety in how professionals in the industry conceptualize energy literacy, there seems to be a consensus that energy literacy encompasses a baseline understanding of how energy works and how one's own behaviors relate to energy consumption (see Martins, Madaleno and Dias 2019 for review). While there is a wealth of information regarding how we can define energy literacy, there is, to our knowledge, no developed measure that examines energy literacy specifically through the lens of demand response. Thus, we developed a measure that examined how individuals understood their energy behaviors specific to DR.

DeWaters and Powers (2011) define energy literacy as energy-based knowledge coupled with application to everyday behaviors. In alignment with that conceptualization of energy

literacy, we chose to focus on behavioral metrics in our survey. Specifically, we ask respondents to identify which of a series of nine statements about home energy behaviors relevant to demand response are true or false. We believe that framing this knowledge through the lens of behavior may also be more accessible to participants because it is related to direct applications that they may encounter in their everyday lives. For example, participants were asked to identify if the following statement was true or false: "Energy costs more at 6pm than at 6am." This tests their energy literacy regarding their home behavior, but it is also relevant to demand response. Additional questions ask about demand response specifically, such as "An example of demand response is turning your air conditioner up a few degrees on very hot days." The measure also features distractor questions that test if participants know what is *not* relevant to demand response. For example, "My reusable water bottle helps the electric grid."

Awareness

There is one absolute necessity for an individual to enroll in a demand response program: they need to know that they exist. Thus, one of the core tenets of our framework is program awareness. The Smart Energy Consumer Collaborative surveyed a representative sample of Americans, and after describing demand response programs, a majority (51%) responded that they felt positively towards the programs. Further, 33% said that they would participate in a utility-led DR program. (SECC 2023). Despite the generally positive sentiment towards DR programs when people learn about them, analyses for many utilities have found that very small percentages of eligible customers participate.

We address awareness in two ways: (1) questions about awareness of demand response generally and (2) questions regarding awareness of specific Xcel Colorado's DR programs. First, we ask participants if they had heard of the term demand response prior to taking the survey. If they respond affirmatively, we then test that knowledge by asking them to describe demand response in their own words in an open-ended question. Participants who had never heard of demand response in any capacity are directed to a description of demand response and have their attitudes assessed (see below in the 'Attitudes' section for further description). If they answer affirmatively that they had at least any baseline familiarity with demand response, the survey is then directed to questions that give the name and short description of Xcel Colorado's five residential demand response programs. Participants are then asked to report their familiarity with each individual program. They are then asked to report where they have learned about Xcel Energy's demand response programs and where they would go if they wanted more information about Xcel Energy's DR programs.

Results will tell us whether customers are not aware of demand response in general, or if there are specific programs within Xcel's portfolio that need targeted marketing to draw participation. Further, we will be able to identify where those who are aware of Xcel's DR programs received their information, which will help us identify what sources of information are the most effective among the general public.

Attitudes

As mentioned in the previous section, the Smart Energy Consumer Collaborative found in a nationally representative survey that the majority (51%) of Americans reacted positively to the concept of demand response (SECC 2023). Considering the optional nature of Xcel Colorado's DR programs, an individual's attitude toward demand response is a likely determinant of one's willingness to participate in DR programs. There are various lenses through which we attempt to understand someone's attitudes towards demand response. Below, we outline what we determined to be the most relevant attitudinal dimensions to assess the likelihood of someone opting in for a DR program.

Conventional wisdom suggests that an individual's environmental attitudes likely contribute to their desire to participate in a demand response program. Research on demand response enrollment found many were motivated by environmental benefits. (Ferreira et. al. 2018). For our survey, we incorporated a series of questions meant to evaluate an individual's attitudes toward energy efficiency, demand response, and engaging in behaviors that benefit the environment. We ask respondents how knowledgeable they feel about energy efficiency, how energy efficiency does or does not play a role in the decisions they make regarding what to buy, and how they act at home. We also ask them how concerned they are about their energy use. Further, we use this section of the survey to describe demand response programs to them and assess their attitudes towards the concept of demand response by asking if they think the program sounds good for the environment and the community, is easy to participate in, and something they would be interested in.

We also use a subsequent part of the survey to understand respondents' reactions to Xcel Energy's portfolio of demand response programs. By that, if individuals have the requisite home characteristics, they are displayed a description of an Xcel Energy program (for instance, respondents that have an electric vehicle are shown programs that serve customers with EVs). We then ask them how interested they would be in joining that program. Individuals who responded that they have little to no interest in the program are asked to select a reason, based on the individual program eligibility components, as to why they wouldn't like to join the program (e.g., too low of an incentive, desire to use their device when they want to, etc.). This data will allow us to understand what components of specific DR programs within Xcel Energy's portfolio are more amenable to nonparticipants than others. Further, we will be able to understand if there are specific program components that could be adjusted to increase participation in the program. Included in this battery of items are questions about whether individuals who are not interested in program participation are concerned about relinquishing control over their home energy usage. That is to say that it's possible that a desire to have agency over one's home energy decisions is a determinant of whether someone participates in a demand response program or not.

Another important attitudinal component that adds to the customer's journey is that of trust in the utility. We defined trust as the promise of meaningful, mutually beneficial relationships between an organization and its stakeholders (Reichheld and Dunlop 2022). Considering that a key component of demand response is allowing the utility to, in part, take over control over when a person's appliances use electricity, an underlying assumption of

demand response participation is that of utility or aggregator trust. Prior work has echoed the sentiment that trust in the utility is a prerequisite for giving up control of how someone uses their electricity. Utilizing the work of Reichheld and Dunlop (2022), we developed survey questions gauging Xcel's performance on the four factors of trust:

1. Humanity: [Brand name] demonstrates empathy and kindness towards its customers
2. Transparency: [Brand name] openly shared information, motives, and choices in straightforward and plain language
3. Capability: [Brand name] creates quality products, services, and/or experiences.
4. Reliability: [Brand name] consistently and dependably delivers on its promises

Investment

To participate in many of the demand response programs, customers need to have the technical capability to shift loads effectively and efficiently. Many of the Xcel residential demand response programs must own or purchase investments in enhancing technologies, which may present a barrier to participation.

In investigating the nonparticipant population, we evaluate the extent to which respondents are willing to invest in new and advancing technologies, the type that is requisite for demand response programs. Diffusion of innovation is a popular theory that examines how and when technology spreads (Rogers 1962). Every time a new technology or innovation is introduced to the general public, it takes time for that technology to become commonplace. Most technology adoption happens in similar patterns based on what segments of the population choose to adopt that technology and when (Rogers 1962). Here, we attempt to assess if nonparticipants of demand response programs happen to belong to segments of the population that adopt new technologies later. Thus, we ask them questions about their technology adoption, the extent to which having the latest technology is important to them, and whether they need to wait to hear from others before adopting new products. This is a predictor of whether or not they are likely to invest in home improvements that allow them to enroll in demand response programs.

Enrollment

Ultimately, our framework proposes that the determinants featured in this framework will help examine what leads to customers making the decision to commit a behavior: enrolling in a demand response program. Through our survey of non-participants, we cannot measure if participants enroll in the demand response program. However, what we can examine is how easy it is for customers to enroll, as that may be a barrier to access. We ask respondents how they'd like to receive information from Xcel regarding Demand Response and see if the ways in which Xcel is currently marketing or distributing information about enrolling in DR programs match the way nonparticipants prefer to receive information. The prior sections of this paper ultimately hope to provide insight into what is preventing nonparticipants from participating in DR programs. We attempt to account for factors outside of the scope of our framework within the survey to offer participants an opportunity to identify why they would not want to enroll in specific DR programs. While we offer options for the individual program components as

responses, we also offer the option for open-ended responses to collect additional reasons why individuals may not actually enroll in the DR programs.

Behavior

To harness demand response's potential, customers need to engage in DR Programs actively. The act of enrollment and participating in demand response has some requisite behaviors. For instance, demand response programs that charge electric vehicle batteries at off-peak times do require some thought on the part of the participant. They must change their routines which does require some cognitive effort. There is evidence that with cognitive effort, individuals can engage in energy-saving behaviors with success (Corradi et. al. 2012).

Many demand response programs can be automated, so once a customer enrolls in the program, the behavior part of the program is automatic. For instance, for Xcel Colorado's Saver's Switch Program, once the device is installed on a participant's air conditioner, they do not have to put forth additional effort. The most cognitively taxing of demand response programs in Xcel Colorado's portfolio is that related to electric vehicle charging. Xcel Colorado's Optimize Your Charge program schedules a person's EV charging to off-peak hours. While this process is automatic, it does require a change to an individual's routine. With sustained effort and time, individuals can successfully incorporate energy-saving behaviors in their daily lives (Corradi et. al. 2012).

We cannot use our survey to assess how nonparticipants would behave in a DR program if they were to enroll. We can utilize some of the aforementioned measures to predict whether they may successfully engage in energy-saving behaviors if they were to enroll in demand response programs. For instance, one of our measures for attention asks individuals how much time they spend thinking about their home energy behaviors. This could function as a proxy to gain insight into how they may be able to extend the required cognitive effort that is needed to participate in a DR program successfully. Further, behavior in a DR program is likely associated with the extent to which someone endorses pro-environmental attitudes, which is potentially a predictor of their successfully engaging in demand response behaviors. Those with attitudes that endorse actions to help the environment are likely going to be more motivated to have their enrollment in demand response lead to actual behavior.

Future Applications

As previously mentioned, the nonparticipant population is a vital yet understudied group in terms of understanding how we can expand enrollment in demand response programs. Considering the majority of Americans are not enrolled in demand response programs, the rapidly expanding toolbox of ways to customize program offerings to customers' preferences presents an important opportunity. We expect that evaluating the effects of these new tools among previously under-represented customer groups will be more effective when research methods that are embedded in the products and tailored to emerging technologies are applied. Aligned with that intent, we use our framework to understand what the determinants are of both enrolling in a program as well as engaging with that program. This framework differs from a more traditional program evaluation framework for energy efficiency programs by shifting the

focus away from the program participant population and their interaction with Xcel Energy. The recurring nature of both financial incentives and events in Xcel Energy-Colorado's Demand Response Program implies that the existing population, by remaining enrolled is sufficiently engaged and satisfied to meet the objectives of current offerings. Xcel Energy has conducted DR product evaluations that relied on a more traditional approach and generally found that few customers in the residential segment were dissatisfied with aspects of the offerings (Xcel Energy-Colorado, 2019, 2021).

Our framework seeks to understand these nonparticipants through a holistic approach by investigating the barriers that prevent participation. Hypotheses that we will explore in our framework are codified in Figure 4. Our framework is diverse in its potential for application. For instance, our measurement of the extent to which nonparticipants are simply unaware of demand response programs offers the opportunity to develop direct interventions to close that gap. Every determinant within our framework of customer engagement will allow the utility to understand its customer base on multiple levels and, therefore, target its demand response program marketing, education, and outreach to address the major barriers preventing participation. Another benefit of this approach is the ability to generate dashboards that allow the utility to view program tracking information (e.g., new enrollments, enrolled capacity, etc.) alongside quantified customer sentiments to observe trends that may align with program recruitment and retention strategies. Our framework can potentially be applied by other utilities that similarly seek to grow their demand response programs by attracting new, harder-to-reach customers.

Determinants	Hypotheses
Attention	Individuals who do not pay much attention to paying utility bills, personal energy usage, interacting with their utility, and reading about energy issues are less likely to be good candidates for demand response participation.
Energy Literacy	Customers who understand basic energy concepts are more likely to be good candidates for demand response participation.
Awareness	Customers who are unaware of demand response offerings are unable to participate in those offerings until they become aware.
Attitudes	• Customers who value the environment are more likely to participate in demand response offerings. • Non-participants who have specific concerns with program specifics are unlikely to participate unless they are supported to change those attitudes through outreach and education.
Investment	Nonparticipants without required technologies are not likely to participate in demand response programs that require those technologies.
Enrollment	Customers with specific attitudes and values (e.g., environmental attitudes, locus of control, trust in utility) are more likely to participate in demand response programs.
Behavior	Customers with attention, high energy literacy, awareness, and relevant attitudes are more likely to enroll in demand response programs and participate if they intend to take action and change behavior.

Figure 4. Research Hypotheses by Residential Demand Response Customer Engagement Determinants

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