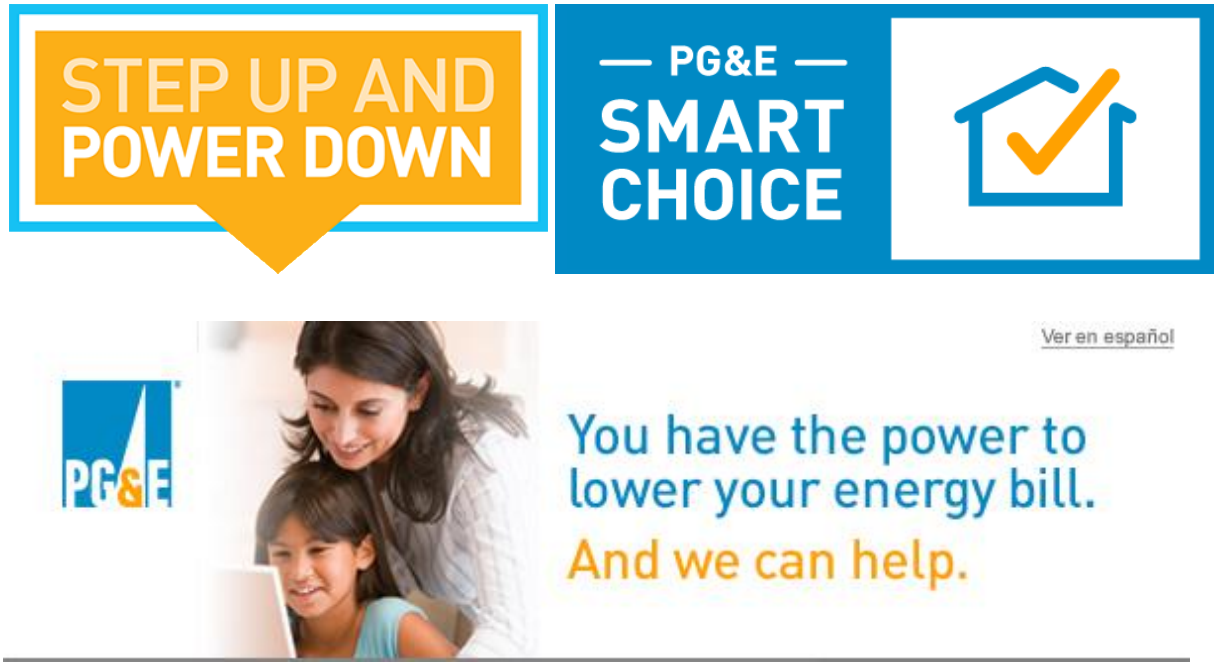
From Categorizing to Characterizing: A Landscape Analysis of Behavior-Based Energy Programs



ET Project Number: ET14PGE7791

Project Managers: **David Thayer, Kimberly Conley, and Jeff Beresini**
Pacific Gas and Electric Company

Prepared By: **Beth Karlin, Lea Lupkin, Hale Forster, Lisa Zaval, Sena Koleva, Rebecca Ford**
SEE Change Institute
414 Rose Avenue
Venice, CA, 90291

Issued: **March 2017**

Cite as: Karlin, B., Lupkin, L., Forster, H., Zaval, L., Koleva, S., & Ford, R. (2017). From Categorizing to Characterizing: A Landscape Analysis of Behavior-Based Energy Programs. San Francisco, CA: Pacific Gas and Electric.

Pacific Gas and Electric Company®

Acknowledgements

Pacific Gas and Electric Company's Emerging Technologies Program is responsible for this project. It was developed as part of Pacific Gas and Electric Company's Emerging Technology program – Technology Development Support under internal project number ET14PGE7791. See Change Institute conducted this technology evaluation for Pacific Gas and Electric Company with overall guidance and management from David Thayer, Kimberly Conley, Susan Norris, Jeff Beresini, and Laura Mogilner. For more information on this project, contact Pacific Gas and Electric Company at ETInquiries@pge.com.

Legal Notice

ABBREVIATIONS AND DEFINITIONS

BER	Business Energy Report
ESA	Energy Savings Assistance Audit
Ex Ante	An approach to savings calculation that uses impact projections *prior* to program execution to quantify savings
Ex Post	An approach to savings calculation that uses estimates of actual savings from a program to quantify savings
HER	Home Energy Report
MIDI	Middle Income Direct Install
PG&E	Pacific Gas and Electric
Quasi-experiment	Study design used when random assignment to conditions is not possible due to practical or ethical considerations
RCT	Randomized Controlled Trial – Study design that randomly assigns participants to receive treatment or control
SMB	Small-Medium Business
SSK	Simple Savings Kit
SUPD-C	Step Up Power Down - Commercial
SUPD-R	Step Up Power Down - Residential
Variable	Aspect of a program or participant that can be categorized and compared to assess program effectiveness

CONTENTS

EXECUTIVE SUMMARY

PROJECT GOAL

The primary objective of this report is to assess opportunities for identifying, improving, and expanding behavior-based energy programs across a utility energy efficiency portfolio. Energy conservation behavior could deliver up to 20% reduction in energy usage, but the initial definition of what constitutes a behavioral program in California has limited claimable savings to a narrow subset of behavioral interventions. This definition has expired, driving the need for a new framework to support utilities pursuing behavior-based energy savings. Social science research has demonstrated numerous behavioral strategies that have been used to change behavior in both governmental and non-governmental programs successfully. Utilities could benefit from additional insights into how to leverage behavioral science and methods more broadly to achieve untapped energy savings. By analyzing programs within the landscape of one energy utility, Pacific Gas and Electric Company (PG&E), the current report identifies a new method for categorizing and describing behavior-based energy programs. It concludes with a framework to guide future work in California to define, design, and evaluate behavior-based energy programs.

PROJECT DESCRIPTION

This study conducted a landscape analysis of behavioral efforts across PG&E's programs. Drawing on past behavioral program classifications and reviews, it took an innovative approach by shifting away from *categorizing* programs by strategy to *characterizing* them according to *key variables*. Specifically, this approach included:

1. Identifying existing programs that draw on behavioral science strategy to encourage customers to engage in one or more energy saving behaviors;
2. Collecting data about each program through structured interviews with program managers and content analysis of program materials (e.g., manuals, forms, flyers) and publicly available online resources (e.g., website, promotional ads);
3. Coding programs along five key characteristics referred to as the ABCDE model: Audience, Behavior, Content, Delivery, and Evaluation;
4. Analyzing similarities and differences across the programmatic landscape to identify opportunities for greater savings; and
5. Proposing a set of actionable recommendations to achieve energy efficiency goals through behavior-based interventions.

PROJECT RESULTS

Twelve energy efficiency programs were identified as "behavior-based" and analyzed in the landscape analysis. Through content analysis, fourteen program variables across five key characteristics were considered: audience (sector, income, ownership), behavior (specificity, specific behavior), content (strategy, framing), delivery (frequency, duration, timing, medium, messenger), and evaluation (study design, savings calculation).

Analyzing programs across these variables enabled a more granular examination of program characteristics when compared to past efforts to categorize programs into fixed groups. Descriptive findings based on program analysis along these characteristics include:

- **Audience**: Current programs primarily target residential customers, leaving potential untapped opportunities in the commercial sector.
- **Behavior**: May current programs promoted multiple energy conservation behaviors and/or a general "energy savings" message.
- **Content**: A diverse set of strategies supported by behavioral science were employed across the program landscape. However, only half intentionally or explicitly drew on behavioral science to design and test programs. Program messaging was primarily financial, suggesting additional opportunities to leverage research findings on non-financial messaging (e.g., Delmas et al., 2013, Frey & Oberholzer-Gee, 1997).
- **Delivery**: While some programs were one-time interventions, many had multiple touch points. Information was provided via in-person messengers for half of the programs; seven used more than one medium including direct mail, social media, websites, groups or institutions, and in-home displays. Most messages were delivered by the utility; some also used contractors or community members.
- **Evaluation**: Energy savings were calculated using a variety of methods: five programs used ex ante savings, three used randomized controlled trials, and one used direct meter measurements. Evaluation strategies measured program effects but were not consistently designed to support program optimization.

PROJECT RECOMMENDATIONS

This report offers three key recommendations for future energy behavioral program research and practice.

1. **Use insights from behavioral science to optimize programs.** There are a number of clear and generalizable opportunities for applying insights from behavioral science to improve existing programs, such as segmenting behaviors, asking for pre-commitments, and "gamifying" participation.

2. **Develop and test a systematic process to design and evaluate behavior-based programs.** Although a variety of behavioral strategies are currently being used, current program classifications prevent iterative development and testing of programs. We recommend a Behavior Program Framework with three key steps:
    - **Program Targeting** - Clarify audience and behavior goals upfront.
    - **Program Design** – Develop and pre-test content and delivery variables.
    - **Program Measurement** - Conduct pilots that test program attributes and collect sufficient data for evaluation and optimization.

3. **Develop capacity to support behavioral initiatives.** Utilities can achieve an integrated behavior program portfolio without staff all becoming behavior experts. Three types of capacity development are recommended: information capacity, internal staff capacity, and collaborative capacity.

Implementation and next steps. Using the Behavior Program Framework and ABCDE model to implement 2-3 pilots, utilities can further explore behavioral potential in energy programs and develop a roadmap for implementing it within California landscape. Enact a new behavioral energy program framework to fill the void currently facing utility implementers about what constitutes a behavioral program.

INTRODUCTION

Energy utilities within and beyond California have been successfully at implementing programs that achieve energy reductions through technical measures, such as appliance codes, rebates, and direct installations. However, as California becomes increasingly energy efficient (Sweeney, 2016), the savings available through these programs is decreasing. While opportunities for efficiency through efficient technologies remain, customer behaviors that affect the uptake and use of energy consuming technologies remain a key challenge for utilities. As a result, behavior-based energy interventions are increasingly regarded as promising opportunities to generate and capture previously untapped energy savings.

In 2009, California Public Utilities Commission (CPUC) Decision 10-04-029 opened the door to behavior-based programs, while restricting them to energy report programs tested via experimental design with ex post measurement. Using the definition from California Senate Bill (SB) 488, which defined comparative energy usage disclosure as when "an electrical corporation or gas corporation discloses information to residential subscribers relative to the amount of energy used by the metered residence compared to similar residences in the subscriber's geographical area", the CPUC limited the use of behavioral and evaluation approaches. This definition was upheld again in 2012 with the Decision 12-11-015.

Typical savings for Home Energy Reports across studies have been in the range of 1-3% (e.g. Allcott & Mullainathan, 2010; Allcott, 2011). While this is promising, research suggests that energy conservation behavior could lead to 16-20% reductions in energy use (Dietz et al., 2009; Frankel et al., 2013). As the need for demand-side savings grows, so too does the need for new approaches to behavioral programs. Research has identified numerous behavioral strategies beyond energy reports that can drive energy savings through a wide variety of behaviors (e.g., Gonzales et al., 2013; Ignelzi et al., 2013; SBST, 2016).

However, the original definition of behavior-based energy interventions has expired, leaving implementers unclear on what constitutes an approved behavioral program for savings. This gap, along with new research, drives the need for developing a new and broader approach to behavior-based energy savings. Past reports (e.g., Ignelzi et al., 2013; Todd et al., 2012) pointed out that the definition of behavioral programs should: 1) include strategies beyond comparative energy use, 2) expand testing methods to include quasi-experimental designs, and 3) measure savings using techniques including but not limited to ex post calculations. A recent IOU working paper (Karlin et al., 2016) synthesized past work and proposed a new framework for behavior-based energy interventions that replaced fixed categories with requirements to identify target behaviors, utilize theory to design programs, and measure savings using valid research methods.

To understand how this framework might work in practice, Pacific Gas and Electric (PG&E) embarked on a process to review current program offerings and identify opportunities to leverage behavior for energy savings. While drawing on the broader landscape of behavioral theory and evidence, a synthesized analysis of gaps and opportunities across programs was conducted. This report presents the findings and recommendations based on analysis of twelve PG&E programs that use behavior-based strategies to achieve energy efficiency goals. Through an assessment of the existing program landscape, this work provides a foundation to guide future development of behavioral portfolios at energy utilities.

REPORT OBJECTIVES

The primary objective of this report was to identify opportunities for expanding behavior-based energy programming across the PG&E energy efficiency program portfolio, and to use these findings to develop a roadmap for strengthening and expanding the utility's behavioral offerings. By analyzing gaps and opportunities for leveraging behavioral science theory and methods, the landscape analysis provides a foundation to guide the utility's future behavioral program design, optimization, and evaluation.

Specific steps taken to support this overall objective included:

1. Identify current PG&E programs that target energy conservation behavior and/or utilize social science-based strategies to drive savings.

2. Describe programs in terms of behavior-based strategies and methods employed.

3. Analyze the overall portfolio to identify gaps and opportunities for pilot testing new approaches and programs.

In addition to portfolio-level analysis, this landscape analysis also offers recommendations for strengthening the individual programs reviewed. While data from these individual analyses were used to inform the current report, individual program recommendations were provided directly to program managers and are not included herein.

BACKGROUND

This landscape analysis builds on past work to assess and expand behavioral efforts in the context of behavioral definitions, program classifications, and past behavioral program reviews. This section provides a selective overview of this influential literature.

UNDERSTANDING THE BEHAVIOR OPPORTUNITY

Although behavior-based programs have been narrowly defined in California, the social sciences provide a wealth of theoretically-based insights into how to change behavior. Research suggests that behavior-based energy savings can reduce residential energy consumption by up to 20% (Dietz et al., 2009; Frankel et al., 2013). Yet current behavioral programs reduce energy use by 1-3% in the residential sector (Allcott & Mullainathan, 2010) and little is known about the savings potential in the business sector. This limitation is, in part, due to the narrow definition of what constitutes a behavioral program.

Fundamentally, all utility programs are behavior change programs: they all seek to change a behavior, whether that behavior is the acquisition, use, maintenance, or disposal/replacement of an energy-consuming device. As such, all could benefit from the conscious application of social science insights to encourage that change in behavior. For operational purposes, though, "behavioral programs" are emerging as a separate class of utility programs. Traditional "widget" programs typically offer incentives and measure savings from replacing an inefficient device with an efficient device. Behavioral programs use a wider variety of behavior change tools, address a wider variety of behaviors, and, as a result, often measure savings in different ways. Behavior programs often measure the effect of an intervention on "conservation" behaviors, or curtailing energy consumption (by changing the way a device is used, for example). If the behavior involves installing an incentivized device, however, utilities must avoid claiming the savings in both the behavior program and in the traditional incentive program, known as double counting.

In order for utilities to move forward with incorporating these strategies and developing these new types of programs, they need regulatory approval, which requires a shared understanding of what constitutes a behavioral program. Developing such a common understanding is an evolving process, balancing the desire to leverage a wider range of social science-based approaches for maximizing behavior-based savings with the need for replicable and cost-effective approaches that lead to new savings opportunities.

Originally, California defined behavioral programs as those that use a single strategy (feedback and social comparison), and a single research design and measurement approach (experimental design with ex-post measurement). This definition provided an important starting point for clearly identifying behavioral interventions, while simultaneously addressing perceived risks of double counting savings, uncertainty around savings persistence, and the potentially controversial and costly monitoring for savings. However, this approach is limiting; since then a number of key pieces of work have contributed to the evolution of this definition to support the growing understanding and evaluation of behavior-based program opportunities.

BEHAVIOR-BASED PORTFOLIO INVENTORIES

Behavior-based portfolio inventories complement program-specific process evaluations to deliver insights for individual programs, as well as identify trends and opportunities across a utility or state portfolio as a whole. While classifying individual programs can serve to identify gaps and opportunities within each distinct program, a portfolio-based assessment can help strengthen elements across the entire landscape of programs and can provide a way to better support customers across a broader energy efficiency journey.

The NYSERDA inventory (Gonzales et al., 2013), for example, developed a theoretically-motivated classification of behavior intervention strategies, and then used this system to catalog behavior-based activities across NYSERDA's program portfolio. They further used this system to identify under-utilized intervention categories in each sector as opportunities for strengthening the portfolio's behavioral elements. The inventory included all residential and non-residential customer-facing programs, both with and without financial incentives for technology or structural upgrades and classification was performed at the level of the strategy rather than the program. Key recommendations focused on incorporating underused behavioral strategies, including loss framing, default setting, competitions, and frequent energy use feedback.

While portfolio-level inventories are far less common than individual program evaluations, they can provide a great opportunity to review programs as a whole at pivotal times of program transition. The current opportunity to redefine behavior-based energy programs in the state of California presents just such an opening, and therefore the remainder of this report presents a landscape analysis of behavior programs within the PG&E efficiency program portfolio.

CATEGORIZING BEHAVIOR-BASED PROGRAMS

Experts in industry and academia have been working to assess behavioral programs and classify the types of intervention strategies for over a decade (e.g., Abrahamse et al., 2005). The benefits of categorizing programs include facilitating a common definition of behavioral programs and providing a framework to reduce uncertainty surrounding program savings. Developing a program classification scheme allows the industry to compare similar strategies and identify best practices and opportunities for improvement, thus reducing the risk of this investment. In developing its framework, this landscape analysis drew on four key publicly available behavioral program categorization efforts, summarized in Table 1 below.

THEORETICALLY-BASED INTERVENTION CATEGORIZATIONS

One of the first contributions to address behavioral program categorization and extend the 2009 definition was made through a CEE paper (Ashby et al., 2010). This work summarized social science-based theoretical insights that have been, or could be, incorporated into behavioral program design to drive behavioral change. A number of behavioral insights and tools currently in use in CEE member programs, as well as innovative strategies for future inclusion, were identified (see Table 1). While the findings were not intended to be used

to classify interventions, they have been highly influential in terms of expanding the list of social science-based interventions that might be considered as contributing to behavioral programs.

In a similar fashion, Paving the Way (Ignelzi et al., 2013) was commissioned by the California IOUs to "define a full range of energy-related behavior intervention possibilities…and develop a set of intervention strategies". It identified "specific, promising behavior intervention strategies grounded in this social science theory." They reviewed contributions across social science to behavior change, building on the NYSERDA classification (Gonzales et al., 2013) to develop a list of 33 strategies across 12 intervention categories (see Table 1); strategies were further organized into antecedent and consequent.

TABLE 1. SUMMARY OF BEHAVIORAL PROGRAM AND STRATEGY CLASSIFICATION TYPES

CATEGORY	PAVING THE WAY REPORT 2013	NYSERDA PROGRAM INVENTORY 2013	ACEEE TAXONOMY 2013	CARD PROGRAM REVIEW 2015
Commitment	X	X		
Energy pricing	X			
Follow-through	X	X		
Framing	X	X		
Legal	X	X		
Leverage sunk cost	X	X		
Social norms	X	X		
Financial incentives	X		X	
In-person interactions	X	X	X	
Rewards or gifts	X	X	X	
Feedback	X	X	X	X
Education & Training			X	X
Games			X	
Communication efforts			X	
Home energy audits			X	
Installation			X	
Online forums			X	
Social media			X	
Community-based social interactions				X
Competition				X
Diagnostics				X

TAXONOMIC INTERVENTION CATEGORIZATIONS

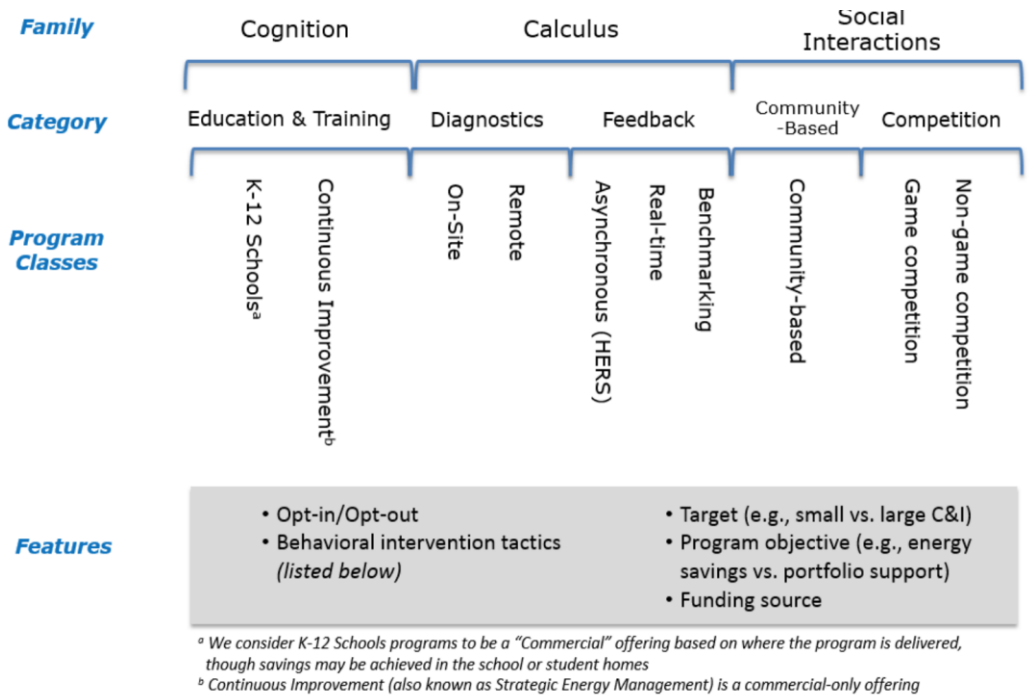
In addition to the theoretical contributions to support categorization, two key pieces of work extended this to create taxonomic structures. The first, an ACEEE report (Mazur-Stommen & Farley, 2013), reviewed 238 behavior-based programs conducted between 2008-2013 with the aim of producing an actionable classification scheme for program designers and other stakeholders. This work identified definitional confusion and unknown cost effectiveness for different types of behavioral programs as key barriers to behavioral program uptake, and explicitly developed a taxonomy of 20 program categories (see Table 1) across three families (p. vi):

1. **Cognition** programs focus on delivering information to consumers. Categories include general and targeted communication efforts, social media, classroom education, and training.
2. **Calculus** programs rely on consumers making economically rational decisions. Categories include feedback, games, incentives, home energy audits, and installation.
3. **Social interaction** programs rely on interaction among people for their effectiveness. Categories include social marketing, person-to person efforts, eco-teams, peer champions, online forums, and gifts.

Although taxonomic structures are traditionally defined by their ability to create mutually exclusive categories (like the breakdown of animals by kingdom, family, species, etc.), the authors recommended "stacked" programs that strategically include at least one strategy from each family.

Building on this work, Illume Advising and colleagues (2015) developed a working definition and taxonomy of behavioral programs, identified associated success metrics, and assessed 170 studies along these criteria to help inform the State of Minnesota's behavioral design and savings assessment. Their taxonomy further refined the ACEEE report presented above to focus on evaluated, acquisition-focused programs, separating them into the three families (cognition, calculus, social interactions) with nested categories and program classes underneath. Five program features were defined across these program categorizations (see Figure A). Each of the 170 reviewed programs was classified into the taxonomic structure and then summarized along evaluation methodologies, energy savings, and persistence within each program class.

FIGURE A. PROGRAM TAXONOMY EXCERPTED FROM THE MINNESOTA CARD PROGRAM REVIEW



LIMITATIONS WITH CATEGORIZING PROGRAMS

While the categorization schemas discussed in the previous section facilitate a common, and expanded, definition of behavior programs, they face three key limitations in their ability to help the industry compare across programs to identify best practices and opportunities for improvement.

1. **Orthogonality** - The categorization schemes used in prior research were often discussed in terms of mutually exclusive categories. However, it became evident when considering programs that many of these strategies are overlapping in nature. For example, feedback by definition includes some form of comparison (e.g., Kluger & DeNisi, 1996; Karlin et al., 2015) - typically historical (i.e., past usage), goal-based (i.e., set by the user or program) or social (i.e., peer usage). Thus, rather than classifying program strategies into a single "category," it seems that multiple "variables" may be required to describe the program in full properly.
2. **Description Beyond Strategy** - While many categories identified from past research described social science based "strategies" that can be implemented in programs, often they also referred to target population or behavior. Including those more explicitly, as well as evaluation strategy, would enable a more rigorous and thorough description and comparison of programs.
3. **Expanded Program Opportunities** - As multidisciplinary approaches become increasingly common, behavioral theories themselves evolve, thus it

cannot be expected that today's programs reflect the full nature of future opportunities. Expanding categories to include a variety of descriptive variables allows for interactions between them, which can, in turn, lead to an expanding number of program types and configurations.

Categorization of programs thus fails to adequately account for the multiple elements that make up programs and contribute to their success. Simply grouping the programs by strategies employed -- as has been done in prior work -- may miss out on fully understanding all the elements that comprise programs and the interactions among them. These groupings, in turn, make it difficult to explore systematic differences. Moving away from categorizing programs and instead toward *characterizing them according to key variables* provides a more useful method for describing, comparing, analyzing, and improving programs.

Within the scientific community, as well as in related applied fields (e.g., education, marketing, health behavior), programs are described and studied based on key variables instead of categories. These include message framing (e.g., Gallagher & Updegraff, 2012), medium (e.g., Li & Kannan, 2014), timing of intervention (e.g., Verplanken & Roy, 2016), target audience (Noar et al., 2007) or behavior (e.g., Frederiks et al., 2015), or other factors. Such an approach enables programs to be developed based on a constantly growing understanding of how and for whom behavioral interventions work best, and allows for continuous development and integration of research findings into program design. Findings can be applied both within and across programs to increase program effectiveness and efficiency, and lead to new approaches over time.

Therefore, the current report sought to develop and test a model for characterizing programs based on key variables instead of categorizing them in a fixed set of program "types," as had been done previously. The following characteristics of behavior-based programs were derived based on an analysis of past research, both within and beyond the energy efficiency space:

- **Audience** refers to the target audience for the intervention. This could be all residential customers, homeowners, low-income, or those who already have adopted energy-saving technology, such as solar panels or smart thermostats.
- **Behavior** refers to the target behavior(s) of the intervention. These could be specific (e.g., purchasing or installing a specific technology) or general (e.g., saving energy in the home).
- **Content** refers to the strategy and message framing of the intervention, including the language, design, and images used in communications.
- **Delivery** refers to the medium, messenger, frequency, duration, and timing that the intervention uses to interact with the audience.
- **Evaluation** refers to the way that the effectiveness of the intervention is measured.

This model eliminates the need to derive mutually exclusive program types and explores how interactions between variables can be maximized (leveraging behavioral science when possible) for program effectiveness. This report refers to this as the **ABCDE model**.

METHODS

The methodology for this program landscape analysis consisted of four key steps:

1. **Program Inclusion** - Identify programs that qualify for inclusion in the assessment.
2. **Data Collection** - Collect data about each program from key individuals and files.
3. **Coding** - Develop a coding guide to classify and analyze program characteristics.
4. **Analysis** - Explore similarities and differences and identify gaps and opportunities.

The following sections review each step in further detail.

PROGRAM INCLUSION

The goal of this report was to identify a process for developing and testing behavioral programs using a range of social science theories and methods. Thus, it was critical that the landscape analysis include a broad spectrum of programs that employed behavioral strategies beyond the current classification of "behavior-based energy programs." As such, the main criteria for inclusion were that the program encourages customers to engage in one or more energy saving behavior and draws on at least one strategy informed by the social sciences.

Suitable programs were identified through: (1) identifying and reviewing program literature available online to gain preliminary background knowledge (see background section above), and (2) meetings with utility staff to determine which programs matched inclusion criteria and to identify program leads for an interview. Suggestions were requested from staff within the following utility departments: Marketing, Customer Insights, EM&V, Core Products, and Community Programs. All recommendations were reviewed with the project team, and twelve programs were selected for inclusion.

Included programs spanned several utility departments including Marketing, Energy Efficiency (EE) programs, EE products, Rate Payer Assistance, and community partnerships. They differed widely in terms of how many years they had been in operation: from over 30 years to early stage pilot. Business cases also varied; some (Home Energy Reports and Business Energy Reports) were designated formally as "behavioral programs" according to the initial regulatory definition. Core "deemed" savings programs were included for analysis, as well as programs and pilots that were not yet deemed or could not show deemed savings. This diversity in program attributes allowed researchers to capture the range of contexts in which behavioral science strategies may be effective for further field study defined in a future project.

Table 2 summarizes the programs included for analysis, and Appendix A provides further descriptions of each one.

TABLE 2: PROGRAMS INCLUDED IN THE LANDSCAPE ANALYSIS

PROGRAM NAME	PROGRAM DESCRIPTION
Business Energy Report (BER)	Direct mail sent to businesses with social comparisons (benchmarking against similar businesses) and energy-saving recommendations.
Energize Schools	Three-week competition between schools to save energy, with a self-guided walk through audit component directed at teachers and students.
Energy Savings Assistance (ESA)	Program for customers who meet established qualifying income requirement. Trained, third-party Energy Savings (ES) technicians conduct audits, install energy efficiency measures and provide energy efficiency education.
Home Energy Report (HER)	Automatic residential enrollment program that provides enhanced bills to customers including personalized energy consumption metrics, information about the energy use of similar homes, historical usage data, and tips on how to save money and improve energy efficiency performance.
Home Upgrade	Program for eligible residential customers, primarily homeowners. Trained contractors conduct an energy assessment and recommend financing products. Once the customer selects upgrades, the contractor installs them.
Marketplace	Online search and rebate platform that aggregates and presents data on residential appliances featuring energy-efficiency ratings.
Moderate Income Direct Install (MIDI)	Program for customers who are just above the established qualifying income for ESA cutoff. Trained, third-party Energy Savings (ES) technicians conduct audits, install energy efficiency measures and provide energy efficiency education.
Simple Savings Kit (SSK)	Offers a "kit" of energy and water saving products worth $70 to customers for $10. While focused on the purchase (and installation) of products, the kit also includes tips for additional energy efficiency behaviors.
Smart Thermostat	Pilot program to explore the effect of direct install of smart thermostats on energy savings for residential consumers across three severe climate zones.
SMB Business Welcome Series	A series of 10 communication materials to engage new SMB customers in PG&E's Business Energy Savings Program and build a positive relationship.
Step Up Power Down – Commercial (SUPD-C)	A large-scale energy reduction campaign that targets businesses in specific communities with an emphasis on the office, hotel, retail, and food-service segments. The campaign employs multiple strategies and leverages existing programs to reach and engage businesses in reducing energy waste.
Step Up Power Down – Residential (SUPD-R)	A community-based social marketing initiative that encourages grassroots volunteerism and leverages community partnerships to increase the visibility of existing energy efficiency programs, as well as raise general energy efficiency awareness and conservation behaviors.

DATA COLLECTION

Researchers collected primary and secondary data for each program. Primary data included a structured interview with program managers (see Appendix B: Interview questionnaire), online resources such as the program website, internal materials such as training manuals, and customer facing materials. Secondary data consisted of reports and presentations provided by program managers and online resources. Data collected was predominantly qualitative in nature, however quantitative data, such as impact metrics, was also collected as available.

CODING

Codes were developed to describe and compare programs systematically. Initial codes were developed from past work (Ignelzi et al., 2013; Gonzales et al., 2013, Mazur-Stommen & Farley, 2013; Illume Advising et al., 2015), then followed an iterative process, during which codes were revised as programs were analyzed and additional codes were created as needed. The final codes are described in Table 3.

TABLE 3: VARIABLES INCLUDED FOR CODING

CHARACTERISTIC	VARIABLE	VARIABLE DEFINITION	VARIABLE TYPE
Audience	**Sector**	Which sector of customers the program is targeting	Categorical (e.g., residential, SMB)
	Income	Income level of customers (particularly residential)	Categorical (e.g., low income)
	Ownership	Whether target audience own or rent their property	Binary (e.g., rent, own)
Behavior	**Specificity**	The level of precision of the action promoted by program	Categorical (individual, group, general)
	Specific Behavior	Customer behavior(s) the program is attempting to shift	Open-ended
Content	**Strategy**	Describes the social science based intervention implemented	Categorical (e.g., feedback, training)
	Framing	Way in which information and messages are framed	Categorical (e.g., financial, social)
Delivery	**Frequency**	Frequency with which customers interact with the program	Categorical (e.g., real time, monthly)
	Timing	The point in time or customer life when the program is offered	Categorical (e.g., start of year, holidays, transition)
	Duration	The length of time that the program is offered	Categorical (e.g., one-time, time span, ongoing)
	Medium	The medium used to deliver program information / messages	Categorical (e.g., social media, in-person)
	Messenger	The individual / institution sending program information	Categorical (e.g., utility, retailer, peer)
Evaluation	**Study design**	The particular type of design used to evaluate the program	Categorical (e.g., experimental, quasi)
	Savings calculation	Indicates the way in which savings are calculated	Categorical (e.g., deemed, ex-post)

ANALYSIS

The codes from Table 3 were used to analyze programs individually and comparatively. Programs were analyzed across five key characteristics: audience, behavior, content, delivery, and evaluation. The analysis identified gaps and opportunities within and across programs, enabling behavior-based recommendations to be made.

RESULTS

The ABCDE model was used to organize the analysis findings across programs, as follows.

AUDIENCE

Audience refers to the target population for the intervention. The audiences targeted by the twelve programs varied across three key customer variables: sector, income, and ownership. In terms of sector, seven programs targeted residential customers, four targeted businesses, and one targeted schools. The fact that the majority of programs targeted residential customers is unsurprising as behavior change is seen as something that "people" do, and businesses are often seen as non-person entities, perhaps making it difficult to envision them as having a "behavior." Yet it is important to note that the energy use of a business is influenced by the people that own, manage, and work at the business. Thus behavioral strategies can influence decision-making and actions of business and residential customers alike.

In addition to residential vs. commercial, some programs had target audiences that were identified based on income. Namely, Energy Savings Assistance (ESA) is exclusively available to income-qualified households, and Moderate Income Direct Install (MIDI) is available to those who are just above the income cutoff for ESA. Two residential programs (Home Upgrade, Smart Thermostat) specifically target customers who are homeowners. The remaining residential programs target both homeowners and renters/tenants, which is notable given that the barriers and benefits of energy-efficient home improvements are likely to be rather different for these two groups. Indeed, there is a well-established split-incentive effect between tenants and homeowners (Krishnamurthy et al., 2015) that suggest a major opportunity for behavioral programs is potentially missed by failing to design them in a way that acknowledges, and leverages, these different barriers and benefits.

BEHAVIOR

Behavior refers to the energy saving action(s) encouraged by the program. Programs targeted a wide variety of energy behaviors, including acquisition, maintenance, and use of energy consuming products, ranging from lights and appliances to heating and cooling infrastructure. While some informal definitions of "energy behavior" are limited to daily energy behaviors (e.g., turning off lights when leaving a room), the social science community defines energy behavior much more broadly to include a wide range of behaviors.

Karlin et al. (2014) review "dimensions" of energy behavior and find the distinction between "behavior" and "efficiency" to be a false dichotomy, which defines the former as behaviors that are frequent and low-no cost and the latter as those that are infrequent and costly. This erroneous distinction masks potential high leverage behaviors that are both low-cost and infrequent, such as maintenance behaviors (see also Kempton et al., 1992; Kempton et al., 1984; McKenzie-Mohr, 1994; Stern, 1992; Van Raaij and Verhallen, 1983).

Additional dimensions of energy saving behaviors identified in the literature include:

- Distinguishing temperature adjustments from other "minor curtailments" (Black et al., 1985; Stern & Gardner, 1981)
- Dividing efficiency into high- and low-cost purchases (Nair et al., 2010; Opinion Dynamics, 2011; Stern & Gardner, 1981)
- Distinguishing between building envelope and energy consuming equipment (Opinion Dynamics, 2011)
- Breaking down categories into Weatherization, Equipment, Maintenance, Adjustments, and Daily behavior, or WEMAD (Dietz et al., 2009)

Most of the programs in this analysis targeted multiple behaviors. Habitual behaviors, such as turning off lights and changing thermostat settings were frequently encouraged, as were one-time actions, such as the purchase or upgrade of an appliance. For some programs, the target behavior was not an energy-consuming action in and of itself, but instead, it was the adoption of a service (e.g., an audit) or technology (e.g., a smart thermostat) intended to enable EE behavior. In a similar vein, several programs aimed to increase participation in other utility EE offerings, in addition to targeting energy behaviors directly.

Often the target behavior was not specified concretely; rather, the program had a generalized goal of "saving energy." On the one hand, this leaves room for programs to have a broad behavioral impact. On the other hand, it makes accurately measuring a program's effectiveness challenging, which can be detrimental to longevity and success. Another risk with being too general is that customers may think that they are saving energy when in fact they might not be. Indeed, programs that target narrow, non-divisible behaviors are easier to measure well, compared to those that target a multitude of broad, and thus difficult to assess behaviors. While most programs surveyed tended to target well known or low-hanging-fruit behaviors, opportunities may be greatest when behaviors are strategically selected and targeted in tandem for maximum effect. For example, it might be that a program that targets different aspects of the same general area (e.g. replacing incandescent bulbs with CFL bulbs and installing occupancy lighting sensors) is more effective than one that targets disparate areas (e.g. replacing light bulbs and turning down thermostat settings).

CONTENT

STRATEGY

A diverse set of behavioral strategies was employed across the twelve programs. The most commonly accepted behavioral strategy for energy efficiency is feedback, which is the primary approach currently sanctioned by the regulatory body (California Public Utilities Commission, CPUC). Receiving feedback on energy use enables customers to understand and benchmark their actions, leading to new habits that use less energy. Indeed about half of the examined programs included a feedback element. Most programs provided feedback on a monthly basis via reports or on a website, including Home Energy Reports (HER), Business Energy Reports (BER), Energize Schools, and the Step Up Power Down programs. However, the Smart

Thermostat pilot project, and to some extent the audit programs, enabled real-time energy use feedback, which research suggests may be more effective (Karlin et al., 2015).

Commitment and goal-setting were also used by several programs, either in the forms of individual pledges or commitments (in the case of most of the residential programs), or group commitments (in the case of SMB Welcome Series, Step Up Power Down, and school programs). Some commitments were private while others were public, the latter of which has been found to increase participation in energy programs (Yoeli et al., 2013). Reminders (encouragements to follow through with commitments) and cues or prompts (encouragements to take action) were also employed by several programs, but not always in a systematic and consistent fashion. Other programs used modeling of efficient actions and provided rewards or gifts for enacting changes or meeting commitments.

While the majority of the strategies identified are well known in the field, a few novel and lesser-known strategies were also observed. For example, the SMB Welcome Series specifically targeted customers at a so-called "moment that matters," i.e. when the business joins the utility as a customer. This approach is supported by long-standing research showing that behavioral change is most likely to occur when customers are in a transition, such as moving to a new home (Verplanken & Roy, 2016). Two other programs, Step Up Power Down Commercial (SUPD-C) and Energize Schools leveraged gamification, which recent reviews indicate have great promise for energy efficiency (Vine and Jones, 2015; Grossberg et al., 2015).

One key take-away from reviewing strategies is that most programs employed multiple approaches. The richest programs were by far Energize Schools and the Step Up Power Down Residential and Commercial programs (SUPD-R, and SUPD-C), which leveraged eight strategies (competition, commitment, feedback, goal setting, trusted messengers, modeling, reminders, and rewards). These programs operate at the organizational level (schools and businesses), as opposed to the individual household level. Use of multiple strategies within a program imposes a tradeoff between breadth and measurability. Diverse strategies may increase the likelihood that the program reaches customers with disparate priorities and habits. However, this catch-all approach makes it difficult to isolate and measure the impact of individual program components, which could increase total resource cost and/or improve the accuracy of measurement.

Framing

Framing refers to the way that messages were constructed within the intervention. The most common message frame was financial, whereby customers are encouraged to save energy so that they can save money on their bill. All twelve of the examined programs included a financial frame. Yet substantial research suggests that non-financial messaging may be equally if not more effective for motivating energy savings (Delmas et al., 2013, Gneezy & Rey-Biel, 2011), especially when the monetary amount saved tends to be small (as is often the case with energy costs relative to other monthly expenses like rent/mortgage or car payments. Financial incentives may even

backfire (Frey & Oberholzer-Gee, 1997). Researchers have identified several additional ways to frame energy efficiency that may be better at motivating individuals and organizations to change or adopt new behaviors. For example, value propositions such as comfort, ease of use, safety and health, may also increase motivation (e.g., Petrovic, Madrigano & Zaval, 2014; Pelletier & Sharp, 2008). Such frames were used by several of the studied programs; ESA, Home Upgrade, and Smart Thermostat emphasized comfort, while MIDI, SUPD-C, and Simple Savings Kit (SSK) emphasized ease of use.

Only four programs used an environmental frame (Energize, SSK, Smart Thermostat, and SUPD-R). In these the environmental benefit was presented in two ways: three programs framed in terms of current environmental benefit and one referred to preserving the environment for future generations. The future generations frame is relatively new but has been shown to be highly effective (Zaval et al., 2015), so it is recommended that it be used more often.

Two other types of frames - social and heuristic - were leveraged by several programs. Roughly a third employed a heuristic frame, such as choice architecture (BER, HER, and Marketplace), loss aversion (SSK), and personalization (BER, ESA, Home Upgrade, and MIDI). Of the social frames, the most commonly-used was social norms. Messages with this frame compare a customer's energy use to that of a peer group (e.g. neighbors for residential customers or similar businesses for commercial ones). Indeed, half of the examined programs employed this type of frame. However, there are many other ways in which social frames can be deployed and combined with other frames. For instance, programs could use participation or adoption rates as a benchmark for communicating social norms, and not just the amount of energy used or saved. This would be especially useful in situations where the recommended action does not have a large impact on monthly energy costs, potentially rendering a financial frame ineffective. For example, a residential household might be a lot more impressed to learn that 80% of its neighbors have signed up for a home energy audit rather than learning that 80% of its neighbors spend $10/month less on their energy bill. Identity framing and testimonials are additional forms of social frames that were underutilized. Identity framing was seen in only two of the examined programs (Energize and SMB Welcome) but has been shown to be highly effective in other settings (McKenzie-Mohr & Schultz, 2014).

DELIVERY

Delivery refers to how the program is delivered to the customer. Effective program delivery can be influenced by the timing of the intervention (*frequency*, *duration*, and other temporal considerations in communicating with customers), its format (*medium*), as well as the entity through which it is delivered (*messenger*).

These variables play key roles in determining the degree of audience acceptance and receptivity towards a program intervention. For example, research suggests that people are more likely to change their behavior when they feel a strong sense of affiliation with the individual/institution making a request or when the messenger speaks to their needs, has similar values, and has proven their credibility over time

(CRED, 2009). Additionally, the medium used to convey a message also influence acceptance, since customers can have strong attitudes and behavioral responses towards particular a medium. For example, in some contexts, direct mail can be viewed as less intrusive or irritating than unsolicited emails (Morimoto & Chang, 2006). The effectiveness of various mediums fluctuates depending on the characteristics of the intervention and the specific audience being targeted.

Even the most carefully designed intervention or communication is unlikely to succeed if delivered at an inconvenient time, by a messenger that the audience doesn't trust, or through an inappropriate medium. These variables are typically underexplored in the field of energy behavior interventions and often require precise and heavily controlled experimentation to identify their impact at different levels.

FREQUENCY

Frequency is the pace at which customers are engaged with or receive information; it can be classified as real-time, daily, weekly monthly, annually, etc. The most common communication frequency was monthly, although some programs provided information more regularly, such as weekly. Only the Smart Thermostat study was designed to provide feedback in real-time. However, it is unclear if customers actually make use of the available from their thermostat information daily. Some programs encouraged customers to sign up for other programs that offer more frequent or real-time feedback (e.g., Smart Rate, Energy Alerts). For some programs, the frequency is customer-driven (e.g., Marketplace, whenever they are searching for or purchasing a new appliance) or contractor-driven (e.g., ESA, MIDI, Home Upgrade), rather than utility-driven.

DURATION

Duration is the length of time that the program is offered. The Fogg Behavior Grid identifies duration as a key dimension of behavior and categorizes it in three ways: one time, span of time, or ongoing -- referred to as dot, span, path in his model, respectively (Fogg and Hreha, 2010). This same categorization can be applied to the intervention itself. Research suggests that the interventions are most successful when their timing matches the timing of the target behavior. However, this may not always be feasible.

With regard to duration, some programs were designed to be one-time interventions (Simple Savings Kits), others are designed as multiple touch interventions with a fixed period (e.g., Energize Schools), and some programs are ongoing (e.g., HER, BER, Marketplace). The audit programs (ESA, MIDI, Home Upgrade) as currently designed would be classified as one-time since customers receive the audit and upgrades/installations once. However, the oldest audit program has recently attempted to return to previous participants to encourage another round of upgrades. For purposes of illustrating the different duration types, a fixed period or ongoing version of an audit program might involve a membership program where customers can continue to advance to higher levels and improve.

TIMING

Timing refers to the specific time within the lifetime of the customer relationship that the program takes place. While most programs either did not include timing as a criterion or required customers to have a year or more of utility bills for evaluation purposes, two explicitly focused on timing in an effort to increase customer adoption. One program (SMB Welcome) leveraged a "moment that matters" by delivering their message at the time a business joins as a utility customer. Inducing behavioral change during such moments of transition might be especially effective, as customers are amidst setting up their accounts and thinking about their energy use (e.g., Verplanken & Roy, 2016). Another program (Simple Savings Kit) launched one of their marketing campaigns around the holidays to take advantage of the gift buying season.

MEDIUM

Medium refers to the format of the information being provided. The most common mediums in the programs studied were in-person (n = 6) and direct mail (n = 5), representing somewhat opposing ends of the spectrum from most to least "personal." Other mediums included social media (n = 4), websites (n = 3), institutions (n = 4) and, in the case of the Smart Thermostat program, an in-home display. A recent meta-analysis of feedback (Karlin et al., 2015) found that feedback provided via computer may be more effective than other mediums, but this finding was only marginally significant.

Seven out of the twelve programs used more than one medium, and four used a combination of three mediums. Depending on the customer segment or context, certain mediums may be superior to others for delivering different types of information. Software applications on mobile devices and in-home displays, in particular, represent novel and growing mediums to deliver information to customers.

MESSENGER

Messenger refers to the entity that delivers the program's message to the customer. This variable has a potentially powerful impact on the program's success because the same message can be more effective if it comes from a familiar and trustworthy source. For most of the examined programs (n = 9) the messenger was the utility company itself, but for a few (such as Home Upgrade) it was a contractor hired by the utility that communicated most directly with the customer.

Some programs could be seen as having different messengers for different aspects, or at different stages, of program implementation. In the case of Energize Schools, the utility provides an initial training and savings toolkit to school staff and student leaders, who then, in turn, develop and implement an action plan for savings with the rest of the students and staff. The trained teachers and student leaders then become the messenger themselves. Similarly, SUPD-C messaging comes from both the utility, as well as the individual "energy champions" within each participating business. While a

program may have multiple or changing messengers, the level of trust customers gain with one messenger that is interacting with them most directly and most extensively is an important factor to consider when designing a program, as it is likely to impact its effectiveness.

EVALUATION

Evaluation contained two key variables from the current California definition of behavior-based energy programs: 1) study design; and 2) savings calculation.

California's original narrow definition of a behavioral program -- ex-post, randomized controlled trials using comparative feedback (see Background section) -- means many of the programs reviewed fall outside this definition and either are not designed to measure savings or they measure via a traditional deemed savings approach. This section assesses the study design and savings calculation of these programs. Yet, given the limitations imposed by the definition that existed when these programs were designed and implemented, it is not expected that these programs will use the full complement of measurement approaches.

STUDY DESIGN

Study design refers to the groups that are included for evaluation. While RCTs are considered the "gold standard" for program evaluation both within and beyond energy efficiency (Todd et al., 2012), there are limits to the types of programs that can be tested via RCT. Limiting study design to RCT restricts the types of behavioral programs that can be deemed for savings. Within the observed studies, only three utilized RCTs in their study design (BER, HER, Smart Thermostat). In related fields, such as education and health, quasi-experimental methods are considered an alternative form of measurement when randomization is not feasible (Todd et al., 2012). Quasi-experimental was not used in any of the studies. It is also possible, given sufficient data, to utilize observational data or to deem savings from lab studies for research evaluation; however, caution must be used in inferring causality from either method. Observational designs and deemed savings from lab studies were employed in several studies.

SAVINGS CALCULATION

Savings calculation referred to how savings are calculated. The original definition required that behavior-based energy programs use ex-post measurement for savings calculation. Beyond behavior-based programs, ex ante (i.e., deemed) savings are also considered acceptable, although this has not yet been included in the formal definition of claimable behavioral programs. With the availability of frequently sampled smart meter data, measured or "pay for performance" savings can also be calculated for interventions in real-time, in addition to ex post and ex ante approaches. No current program uses such an approach.

Energy savings measurement varied greatly between analyzed programs. Ex ante savings (e.g., deemed) are used in five programs, ex post savings (e.g., RCT) are calculated in three programs, direct measured meter results are used in one program, and an impact evaluation study is used for one

program. Two programs used meter data analysis to estimate savings as an exercise only and did not seek to claim savings.

Data collection was identified as a challenge across programs for assessing the impact of behavioral strategies in programs. For programs that work to influence both product adoption/use and energy behavior, double counting reflects a challenge in differentiating between the impact of the physical product or measure itself compared to the behavioral approach employed to influence take-up rates, product or measure choices (e.g., deeper level savings), product use, and follow-up behavior. In some cases, the data that would otherwise be useful to performing a thorough evaluation is not captured at all (e.g. 3rd party purchases on the Marketplace are not tracked by default), or is captured, but not by the utility and the utility does not have access to the data. Accompanying data could be collected to enable these programs to be evaluated more rigorously.

Additionally, as discussed previously, several programs used multiple behavior-based strategies to change behavior. Most programs analyzed as part of this study are not set up to measure which of these strategies are contributing to success; this limits the ability to identify which elements are leading to savings and which are increasing program cost without a relative increase in savings.

DISCUSSION

Behavior-based energy programs offer the potential to deliver substantial savings through addressing the adoption, use, and maintenance of energy-consuming devices. The primary objective of this study was to identify opportunities for expanding behavior-based energy programs across the PG&E energy efficiency program portfolio, and to use these findings to develop a roadmap for strengthening and expanding the utility's behavioral offerings. This analysis identified many behaviorally-informed strategies that are currently being applied within PG&E programs. However, not all were explicitly "behavior-based" and not all were designed and/or tested systematically. Many programs incorporated behavioral strategies on the periphery but didn't leverage the full potential of social science-based approaches and testing methodologies. To better enable the development and testing of behavior-based energy programs, a model is proposed for strategically targeting, designing, and evaluating programs. The key to this approach is a shift away from *categorizing* programs by a strategy to *characterizing* them according to key variables along program targeting (audience and behavior), design (content and delivery), and evaluation.

In addition to the overall strategies implemented in a program (e.g. feedback, rewards), this study identifies key program design variables (e.g., framing, timing, medium, frequency, and duration) that comprise, interact with, and inform the success of a given strategy. For example, while a reward is a common behavioral strategy used across programs, how that reward is framed or delivered to users can vary, which can impact that strategy's effectiveness. Each of these variables should be considered in relation to behavioral theory as well as the target audience and behavior.

Finally, scientific evaluation can provide important information about how and for whom behavior-based interventions work best, helping to support learning beyond just whether a program worked relative to no intervention. Such analysis may help to identify opportunities for further improvement or refinement of programs.

The following sections synthesize and analyze this study's findings along the five characteristics in the ABCDE model before moving to specific recommendations.

AUDIENCE

Audience refers to both knowing the target audience, as well as personalizing treatment according to it, when appropriate or feasible. A body of work confirms that behavioral strategies and interventions can have vastly different effects depending on the individual or group being targeted. What works in some customer segments or contexts might not (and likely will not) work for others (e.g., Wilson & Dowlatabadi, 2008; Lavelle et al., 2015). For example, Costa and Kahn (2013) showed that home energy reports were 2-4 times more effective with political liberals than with conservatives.

The current study showed that some of the utility's programs did target specific customer groups, for example, income qualified residential customers. However, more strategic framing can improve customer satisfaction and engagement with programs. For example, audit and direct install programs like MIDI and ESA can have different materials and protocols for tenants than for homeowners. Additionally, knowing one's audience can lead to targeted message frames that may tap into

people's values beyond financial security (e.g., social norms, environmental benefits, California's future).

When it is not feasible for programs to tailor to individual audiences (due to lack of data or cost concerns), user-customization can promote a similar boost in customer engagement. For example, offering customers the opportunity to choose products or features that meet their personal preferences and needs (e.g., a customized welcome kit) could lead to greater product uptake. Allowing customization has been shown to promote engagement and reduce waste, making the customer an "active partner" and co-creator of value (Payne et al., 2008).

Moving beyond assumptions about how specific audiences behave requires collecting information about the target audience. This information can take the form of basic customer attributes, customer preferences, and attitudes, or recent online actions. Methods include reviewing relevant literature and reports, conducting focus groups and in-depth interviews, or conducting surveys with a random sample of the target audience. For example, for programs like the Simple Savings Kit, program designers can review existing customer research on personas to understand their implications for product preferences and analyze which demographic and psychographic variables interact with underlying preferences. This can be complemented by in-home interviews and focus groups that determine the most effective frames for outreach communications.

Currently, program offerings reflect implementation realities rather than a unified, customer-centric energy saving experience. From the utility administration perspective, there are many programs with similar goals and target audiences run by different administrators and vendors that do not connect or "talk to" each other. From the customer perspective, there are separate marketing messages, websites, application processes, and experiences for different types of savings behaviors. This "silo-ed" organization may reduce the efficacy of interventions, both because it creates barriers for customers as they try to navigate among programs and because it may dissuade utilities from designing programs that carefully optimize all elements of the ABCDE model. In the model, Audience comes first, because program designers must start the process with the customer - their behavior, their needs, their experiences. Models of human behavior and diffusion of innovation show that customers do not experience individual programs in a vacuum, but rather in stages across multiple related behaviors (also known as a "customer journey").

BEHAVIOR

The programs targeted a wide variety of behaviors, with many focusing on multiple behavioral outcomes. However, many programs did not operationalize specific target behaviors. Instead, outcome behaviors fell under more general goals, such as "saving energy," or representing the utility as a "trusted energy advisor." Behavioral programs likely employed this strategy because targeting a single energy-saving behavior is perceived as insufficient for meaningful savings and because regulatory restrictions currently prevent claiming savings for many of these programs.

Providing specific target behaviors (e.g., customer submits rebate application) has important benefits, however. First, it focuses program design, enabling the program to match strategies and behavioral components to more closely reflect objectives.

Second, it encourages cleaner research methods by focusing evaluation and data tracking resources. Finally, it generates clear, concrete, actionable behaviors for participants. Too many calls to action, or vague calls to action, can overwhelm the customer, leading to procrastination or inaction at best and frustration at worst. Instead of encouraging customers to take multiple actions at once, a sequence of actions is a more accurate reflection of models of human behavior. The behaviors can be directly energy-reducing or information seeking (e.g., getting an audit or downloading a tool).

This analysis found that individual programs often missed opportunities to promote "sister" programs or capture additional savings behaviors. It may be useful to research opportunities to provide immediate and convenient connections to additional programs and behaviors to enable "positive spillover" and foster an energy-saving identity within customers. Conversion to additional programs is an important aspect of scaling strategies and equipping customers to continue their energy efficiency journey.

CONTENT

A diverse set of behaviorally-informed strategies were implemented across programs. While half employed common strategies, such as energy feedback or financial rewards, some included lesser known ones, such as gamification and pre-commitment. Many implemented multi-pronged approaches. For example, Energize Schools implemented a combination of strategies, including feedback, goal setting, and competition. However, the majority of programs used very little behavioral strategy, and several programs did not match strategies to objectives. For example, one objective of the SMB Welcome Series was to encourage customers to view PG&E as a trusted advisor. However, it did not draw on the known behavioral strategy of using a trusted, local messenger, to achieve this objective. Whenever possible, a theoretical link should be made to explain why a particular strategy is predicted to change the target behavior for the target population, given the contextual features of the program environment.

While this work demonstrated that programs often layer multiple strategies, there is considerable variance across programs in terms of *how* a particular behavioral strategy is being applied. The body of research within the field of behavioral science is constantly growing and evolving, which continues to confirm the powerful role that human nature plays in the marketplace and, more specifically, in guiding energy-savings behavior. New applications and empirical results continue to shed light on when and how strategies are most effective. Thus, a closer integration and application of behavioral theory to meet specific program goals for a particular population can lead to more creative and effective behavior-based strategies.

From a customer journey perspective, strategies could be selected based on the customer's stage in the journey. For example, particular strategies utilized to encourage opt-in to a given intervention (e.g., an emotional appeal or default setting) may not be optimal for encouraging follow-through, spillover, or long-term behavior change.

Most programs use predominantly or exclusively financial frames to communicate messages (such as by emphasizing potential financial benefits). Although some programs do use frames that emphasize co-benefits (MIDI, Energize, ESA, Home

Upgrade), the impact of this method is unknown, since the co-benefit frame has not been evaluated empirically in comparison to a financial frame. It would be useful to explore how the use of different frames, or a combination of approaches, may tap into people's values beyond financial savings. It was also found that outreach message frames are sometimes generic across programs instead of being designed for the target audience or behavior. Identifying which message frames support engagement for different customer types can be accomplished via experimental pre-testing (e.g., a/b tests) or user testing before wide scale deployment.

DELIVERY

The timing of intervention delivery may impact intervention success, but few programs have systematically tested how frequency, duration, sequencing and other temporal variables impact its effectiveness. Exposing users to different interventions at different rates, durations, or orders (e.g., manipulating the order of individual messages in a Welcome Series) would reveal the potential effect of manipulating these variables throughout programs. Additionally, program design could capitalize more on delivering interventions during significant life events or key "moments that matter" (such as a residential move) as recent work suggests that customers will be most amenable to behavior change when routine and habitual behavior patterns are disrupted (e.g., Wood, Tam & Witt, 2005).

Many programs used multiple media to reach customers, with in-person and direct mail (paper or email) being the most common. In person and direct mail are excellent mediums because they can be highly salient to customers. In-person contact (also referred to as person-to-person interactions) is proven to be most effective in many contexts (Houde & Todd, 2011; Mazur-Stommen & Farley, 2013). However, it is costly and often infeasible. Social media is another medium that is used by the programs to a small extent, and it is unknown how effective this medium is for energy behaviors. Social media was tested in one program that sold a discounted bundle of efficient products; it was found to be ineffective. However, it is possible that the target behavior simply did not combine well with this medium. Texting is an underexplored medium that is salient, timely, and increasingly employed by many behavior-based programs outside of the energy space.

Contractors, a frequently used messenger, can be very effective since he/she is an expert and motivated to reach out, yet there were trust issues reported. Programs also use many vendors as messengers portrayed as the utility, which can be positive for creating a more consistent customer journey if done well. Programs should test more which messengers perform best at multiple stages -- initial reach, follow-through, and referral to additional behaviors. Other messengers that could be more effective but are under-utilized in programs are groups, organization, and social networks.

Systematically exploring how different media work together could improve programs' ability to target customers at moments that matter, when they may be most open to behavioral change. Experimenting with different media channels and messengers could further reveal how customers respond to the message, and in particular could shed light on the degree to which they trust the information, and how this is converted to action.

EVALUATION

The 2009 California definition of behavioral programs specified an evaluation strategy using experimental design with ex-post savings measurement related to energy consumption. While this approach quantifies program energy savings, it does little to inform ways to improve program effectiveness.

Enhanced program design and evaluation strategies could provide information about the optimal mix of program variables that lead to the most effective design, which can be accomplished through pre-testing and RCT experimentation. Testing different framing, timing, media, and messengers can help identify the underlying mechanism driving the success of an intervention so that it (or components therein) can be effectively scaled and/or replicated. For example, different segments of a population can be exposed to different *versions* of a single program depending on the variable being tested; the differential responses to these variations will provide insight into the specific mechanism driving the effectiveness of an intervention. Such real time testing encourages program design to match program components (e.g., strategies, messages, medium, timing) to the contexts in which they work best (e.g., audience, behaviors).

Only three programs (Smart Thermostat, HER, and BER) used the RCT method to measure savings. Among those that did use RCT, most measured "something" versus "nothing" (i.e., a pre-defined program approach was compared to a control group only, instead of other variants of the program approach). Although a control group is ideal for measuring savings, it should be complemented by additional experimental conditions (i.e. those that manipulate the role of contextual variables such as timing, medium, frame) in order to move beyond understanding just whether a program worked to understanding *how*, *for whom*, and under *what conditions* that program worked. Careful design, particularly during pre-testing, can support advanced learning and can help program managers determine which variables lead to the strongest impact prior to large-scale deployment. While some programs (e.g., SMB Welcome Series, SUPD-C) incorporated A/B testing into pilots, few of the programs perform user-testing prior to implementation to optimize program design.

Program design should also consider the program goals and target customer behavior in order to identify the appropriate metrics (e.g. call center feedback, survey data, social media insights) to explore opportunities for refining program variables and measuring positive spillover. This approach requires the collection of data beyond energy consumption metrics and the careful integration of data tracking sources. Currently, the many different vendors and data tracking systems across programs limit the ability to measure the effects that one program has on other programs. For example, for the SMB Welcome Series, descriptive call metrics from the utility's call center would have served as a viable metric for assessing the success of the Welcome Series, but the program team did not have direct access to call center metrics. Importantly, when extra-program behaviors can be tracked, the opportunity for positive spillover can be measured. The program design recommendations above, implemented at the portfolio level, will help behavior-based programs quantify spillover.

RECOMMENDATIONS

Based on this program landscape study, the results discussed above, and the current broader California energy efficiency space, this report offers three key recommendations for future energy behavioral program research and practice. The utility is implementing a large number of behavioral initiatives, and our recommendations suggest ways to systematize and optimize the way in which behavioral insights are incorporated in them. These recommendations build on the **ABCDE model** presented throughout this report, providing a systematic process for developing and optimizing programs. This supports program targeting (by considering the target **A**udience and **B**ehavior for the intervention), program design (by considering strategy and message **C**ontent and **D**elivery), and program measurement (by considering **E**valuation processes) to maximize effectiveness.

1. LEVERAGE INSIGHTS FROM BEHAVIORAL SCIENCE

This study identified clear and generalizable opportunities for further integration of behavioral theory across the characteristics in the ABCDE model. Several applications of such insights are described below. However, this is not an exhaustive list.

Audience

Conduct additional research to understand the customer journey. Assess the extent to which silo-ed program organization impacts customer experience and limits opportunities for optimizing audiences and behaviors. Identify ways to decrease obstacles to participation, increase opportunities for conversion and spillover, and address specific gaps in program offerings.

Tailor materials for lifestyle, age, region. Design materials that are customized for audience types to enhance participation and make it easier for program leaders to integrate into their activities.

Behavior

Encourage positive spillover (behavior, social). Give customers an immediate option at the end of an audit to refer friends, family, and neighbors to the program (e.g., text message or email prepared text to copy and forward, postcards to mail).

Behavioral segmentation: Emphasize a few high-impact behaviors as that may be more effective than providing an exhaustive list of possible actions (Bertrand et al., 2010). Group behaviors by end use (e.g., lighting, heating) or by action (e.g., purchase, maintenance, daily habits), as this may also reduce cognitive load and increase behavioral adoption.

Content

Offer group and individual rewards. In addition to group-wide recognition, reward individual participants to encourage participation. Rewards do not have to be monetary—they could come in the form of recognition or reputational benefits, such as certificates.

Leave behind a reminder. Leave behind a visual cue (e.g., sticker, magnet) to serve as a reminder to customers of the actions they agreed to take. This can also facilitate communication with other household members, encouraging norm development.

Emphasize comfort & self-efficacy. Research indicates that comfort, self-efficacy, and financing availability are important motivating factors for some participants. Build your messaging to emphasize theses additional benefits of participation.

Ask for Pre-commitments. Ask people to pre-commit to positive behaviors. Just as with retiring and saving, people are more likely to commit to performing an action in the future than today and are more likely to see it through.

Use Gamification. Reframe "shoulds" as "wants" by making these behaviors rewarding. Using gamification to reframe behavior change is a successful trend right now across disciplines because it works. For example, if you get points each time you do a "should" and these points build toward badges or even concrete rewards, the "shoulds" are more fun (or at least less negative) to engage in.

Delivery

Combat inertia using on-site sign up. Instead of giving information about follow-up behavior, enable customers to sign up on the spot using a tablet or form that they fill out and leave with the marketers or technicians.

Provide automated assistance. Create online training materials to enable programs to scale without significantly increasing cost.

Leverage key moments. Customers will be most receptive to changing their habits during major times of transition, such as a residential move, when new major appliances are purchased and installed, or when habits are already being disrupted, such as when needing to request a leak inspection or equipment replacement.

Follow-up. Send a personalized follow-up message to customers, thanking them for their participation, asking if they have any additional questions, and encouraging them to seal in savings with behavior change.

Evaluation

Use experimental or quasi-experimental designs to measure program effects. The most scientifically sound evaluations employ the "gold standard" RCT, which employs a control group to test for extraneous phenomena that may lead to energy savings. However, when a true experiment is not possible, there is a wide range of "quasi-experimental" methods that can be used in its place.

Test program variables, not just programs. While evaluating a program overall tells you whether it works, testing the variables that make up the program will help determine how and for whom it works. The latter enables program iteration and improvement, as well as generating insights that may be scalable and transferable to other programs and populations.

2. USE THE ABCDE MODEL TO GUIDE A SYSTEMATIC PROCESS

In addition to leveraging behavioral theory across each component of the ABCDE model (as described in Recommendation 1), the model can also be used to guide a systematic process for program development, filling the void currently facing utility implementers about what constitutes a behavior program. To develop programs that achieve behavior-based savings based on this model, the process should include targeting the appropriate audience and behavior (program targeting), refining the design of content and delivery mechanisms (program design), and optimizing evaluation opportunities (program measurement).

Program Targeting (Audience, Behavior)

Specify the target audience and behavior(s) the program is seeking to change.

Clarify and optimize program goals. As a best practice, before program design, conduct an internal launch meeting to review and optimize behavioral research goals and learning outcomes. All relevant stakeholders should be included during this process, and team representatives from programs targeting similar audiences should be available to offer feedback. During this phase, review the research plan and lead participants in a discussion to:

- identify target audience (clarify variables such as sector, income, ownership)
- identify primary and secondary objectives of the program
- select target behavior(s) for the program and identify the specific metrics that can be used for measurement
- create hypotheses on potential obstacles to target behaviors and develop strategies to overcome these barriers based on past research

Findings from the launch meeting can be used to draft a research and evaluation plan, data collection procedures, and analysis plan.

Example: A program has the goal of reaching residential customers across income levels that have participated in no or few EE programs in the past. Stakeholders identify schools and community incentives as having the potential to reach these target populations in their surrounding communities. The behaviors targeted could include the purchase, use, and maintenance of energy consuming technologies (e.g., homeowners purchase up to 10 efficient products from an approved list or commit to at least one energy saving action from a list of five).

Program Design (Content, Delivery)

Leverage theory to refine content and delivery -- including intervention strategies, message frames, medium, messenger, and timing --in order to optimize behavior among the target audience.

Conduct user testing to support program design. Qualitative and exploratory research will help ensure programs are designed in such a way to meet customer needs and program goals. User testing can aid program managers in isolate which variables should be tested in large-scale field trials, and which design choices can be made confidently and quickly.

A/B test to optimize program variables. Pre-test hypotheses to help refine program design before field testing. Experimental pre-testing can determine whether and how various aspects of the program design support desired customer response.

Example: Based on program targeting above, the main strategy selected is community incentives. However, within this strategy, there has been varied evidence about whether challenge or collaboration is a more effective frame to motivate action (Froehlich, 2015). A/B testing could explore whether framing the program as a collaboration or challenge would increase participation and product sales. User testing will be used to identify optimal mediums and timing for school messengers to reach homeowners.

Program Measurement (Evaluation)

Measure savings using study design and savings calculation that support program optimization and incorporate accepted methods to infer causality.

Conduct field tests (pilots) to refine program design. After results from pre-testing are applied to the program, strategies can be optimized for field testing (e.g., pilots). Additional testing during the pilot phase can continue to hone and improve the program while also demonstrating the success of the program. For example, test the effects of post-program follow-up communication on additional energy savings behavior by randomly varying the timing of communication and assessing pre-communication behaviors. Or, randomly assign customers to receive an additional strategy (such as a pledge or feedback) to optimize program strategies.

Collect sufficient data to inform program evaluation and optimization. Ensure that sufficient data is being collected to measure program success. Before launch, coordinate the collection of data from multiple sources (e.g., call center, web platform). If it is not possible to coordinate data collection across multiple sources, managers may need to amend its goals for the program so that they are evaluable.

Measure behavioral spillover. Behavioral approaches have the potential to influence energy savings beyond the behavior targeted by the program. Behavior-based programs that use non-financial messages to encourage behavior change may have even more potential for spillover than incentive-based programs. Current evaluation protocols restrict the ability to claim savings for this spillover but failing to capture it may underestimate program effects. A wide range of energy saving behaviors should be identified and measured to track potential spillover behavior.

Example: Once the program has been optimized via pre-testing, a pilot study can be conducted. An RCT or randomized encouragement design can control for self-selection bias, and data collection can extend from the school buildings to the students' homes to measure behavioral spillover. Pre-post data collection, as well as a comparison to a control group, allows for difference of difference analysis to infer whether savings can be attributed to the program.

3. DEVELOP CAPACITY TO SUPPORT PROGRAMS

To support program development using the ABCDE model, and the integration of behavioral theory more strongly into program design and delivery, it is important to develop change management across three key areas (Information, Staff, and Collaboration). This is a new approach and may require organizational changes within the utility to deliver on recommendations 1 and 2.

Information capacity
Information across the utility energy efficiency program portfolio should be consolidated to promote better integration, learning and sharing across programs to support customers' energy efficiency journeys. The utility should develop and maintain a master list of all behavioral programs, which would include key variables, such as which consumer audience is being targeted. This master list should also provide a summary of all research findings from across programs (e.g., results from an A/B message test), to foster new and innovative design built on existing information.

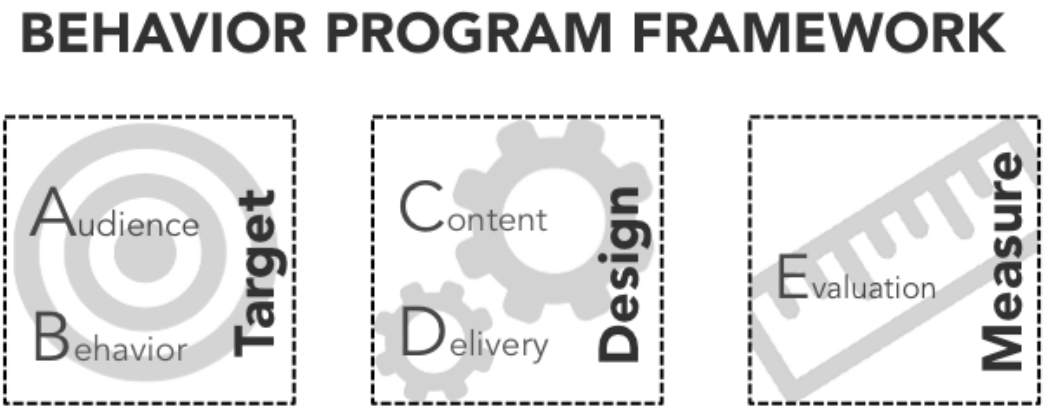
Staff capacity
Closer integration and application of behavioral theory to meet program goals for a particular population can lead to more creative and effective strategies for behavior-based programs. In order to continually apply practical insights from the literature to inform program design, the utility could benefit from creating a "behavioral insights" unit, comprised of internal staff trained in behavioral sciences and/or external consultants with expertise in behavioral science to provide guidance on program design across the portfolio of programs.

Collaborative capacity
Understanding behavior and how to apply theory in an evolving field is no simple task. There are benefits to collaborations with behavioral experts to support the integration of theory into practice. Ongoing relationships with those in this field may be an efficient means of ensuring that programs are optimized. Use informational and staff resources to facilitate the development of internal collaboration practices in program development. Consider regular staff summits, centralized documentation, and team shadowing as strategies to enable cross-program collaboration.

IMPLEMENTATION AND NEXT STEPS

The ABCDE model provides a process through which utilities can develop, optimize, or extend behavioral programs. This framework is depicted in Figure B and for the purposes of this report is titled **Behavior Program Framework**.

FIGURE B: BEHAVIOR PROGRAM FRAMEWORK BASED ON ABCDE MODEL



This report provides suggestions for how the model can be used in such a manner, and these recommendations can be further explored through the development of a set of pilot programs. This process would involve the creation of new programs and/or optimizing existing programs through incorporating behavioral science insights and deploying an evidence-based approach to testing both overall program effectiveness and the specific variables leading to energy savings. Through pilot development and implementation, the recommended process for both programmatic (recommendation 1 and 2) and organizational improvement (recommendation 3) can be tested in an applied setting, providing a roadmap for subsequent expansion and broad application.

Programmatically, pilots will provide evidence of the benefits of the ABCDE model for program effectiveness and develop a procedural roadmap for implementing the model in utility program development. Organizationally, the process of pilot development will help identify logistical and organizational barriers to incorporating the model into the existing program development process, increase capacity through collaboration with researchers, and identify staff capacity development opportunities. In the longer term, such an approach can be coupled with improved information capacity to support the integration of the ABCDE variables-based framework approach across the wider utility programmatic landscape.

CONCLUSION

This study provides a framework – based on the ABCDE model - for supporting utilities to develop behavioral programs in lieu of a comprehensive definition of what constitutes a behavioral program. This study utilized program landscape analysis to identify opportunities for expanding behavior-based energy programs at one California utility and beyond. Reviewing programs reinforced the potential for understanding how and for whom they are working and how strategies may work together across the program portfolio to support customers along the energy efficiency journey. Specifically, findings from this analysis suggest the following key recommendations:

Recommendation 1: Leverage insights from behavioral science to improve programs. The utility has incorporated many behavior-based program initiatives and is actively engaged in increasing this capacity. The initial 2009 definition of behavior and lack of a current definition are hampering the utility's ability to claim savings for behavioral work and reducing incentives to develop effective, evaluable behavioral programs. There are a number of opportunities to use insights from behavioral science to improve existing programs.

Recommendation 2: Develop and test a systematic process to design and evaluate behavior-based programs based on the ABCDE model. The "strategies" classification is insufficient to promote effective program design. Current behavioral program classifications may distract from the goal of developing cost-effective behavioral programs. Although the utility employs a variety of behavioral strategies in programs, there is no systematic method for selecting, testing, and optimizing behavioral initiatives. Furthermore, the previous ex-post, randomized experiment requirement limits approaches to evaluate and validate claimable savings. Use the ABCDE variables approach to classify and develop behavioral programs that overcome these barriers.

> **Target (Audience, Behavior):** Clarify program goals, especially those related to target audience and behavior, at the outset of program development.
>
> **Design (Content, Delivery):** Use insights from targeting to design a program that leverages social science and is empirically "pre"-tested before going to the field.
>
> **Measure (Evaluation):** Plan to include data collection in field implementation and pilot testing. Collect sufficient data to inform both program evaluation (did it work) and optimization (how and for whom did it work).

Recommendation 3: Develop capacity to support behavioral initiatives. Not all program designers need to be behavioral theory experts to develop an integrated behavioral program: building internal capacity will facilitate increasing integration of behavioral theory into programs. Develop three types of capacity to support behavioral programs and initiatives: information capacity, internal staff capacity, and collaborative capacity.

Implementation and next steps. Use the Behavior Program Framework described in this report to develop, optimize, or extend behavioral programs. Implement the recommendations above via pilot programs. Using the Framework and ABCDE Model to implement two to three pilots will provide evidence of the benefits of the model for developing effective programs, and provide a roadmap for implementing the model within existing program development practices.

As of 2016, there is no standard definition of behavior-based energy programs in California to guide program development and evaluation. Utilities and the regulatory agency have an opportunity to broaden their understanding of what constitutes a behavioral program. This report provides a case for a new framework, referred to as the Behavior Program Framework. In the immediate term, advances may be possible through the stronger integration of behavioral theory into existing programs. When designing new programs, application of the Framework and ABCDE model described in this report can add further benefits. This broader model will allow for more creative, innovative and iterative approaches to behavioral program design, deliver increased energy savings, and support utilities in strengthening and expanding their behavioral offerings.

AUTHORS' NOTE

The authors would like to thank all the individuals from Pacific Gas and Electric (PG&E) who generously shared their time and program data for this study, including Conrad Asper, Jillian Rich, Joanne O'Neill, Kari Binley, Karine McClosky, Mary O'Drain, Sabrina Lawrence Gomez, Shareghe Mehraheen, and Will Quinn.

Special thanks go to Susan Norris for having the vision and foresight to make this project a reality and to Laura Mogilner, David Thayer, Kimberly Conley, and Jeff Beresini for continued support and feedback throughout the project.

Finally, we are deeply grateful to our extended research team - Alexis Bunten, Shannon Hall, Matthew Ballew, Jason Kaufman, Erez Yoeli, and Allison Cook – for their contributions to the work presented in this report.

APPENDIX A. PROGRAM DESCRIPTIONS

A1. BUSINESS ENERGY REPORTS (BER)

HISTORY

Following on the success of the Home Energy Reports program (described in Appendix A4), the Business Energy Reports program was created to offer the same service to commercial customers. However, it differs from the HER program in that the savings cannot be claimed directly. The pilot program started in 2013-2014 with an RCT experimental design and was formally evaluated by Nexant. Pilot results were promising enough to warrant continuation into a full program. In 2015-2016, the program compared two variants of the report in 2016 to find out what helps SMBs save best, and plan to use the results from the year-long project to enhance the outreach that business customers receive. The two versions were provided by two different vendors, EnerNOC (bought by Yardi in mid-2016) and Opower. The software vendors analyze customer data to make personalized energy saving recommendations and savings estimates in the reports. In 2016, EnerNOC (now Yardi) conducted A/B testing within individual reports with a research partner to optimize the design.

GOALS

- Motivate Small & Medium sized businesses to pursue energy efficiency measures and save money.
- Test variations of the reports to enhance customer experience.

DESIGN

The Business Energy Report Program is just like the Home Energy Report program (described in Appendix A4), but for commercial customers. New small and medium business customers receive a Welcome letter stating that they will be receiving energy reports via direct mail. Over the following year, customers receive Business Energy Reports (BER) giving them feedback on their monthly energy usage, comparisons of their energy use to similar businesses, and several personalized energy-saving tips. The reports and online tools are "white-labeled" so that it appears they come directly from the utility. The program uses an automatic enrollment model; customers can voluntarily opt-out if they take the steps. In addition to personalizing based on energy usage patterns, the vendor also tailors some content to the industry vertical of the business (e.g. restaurants, hotel, etc.). More recently the vendor has begun investigating report personalization based on whether the business is an owner or a tenant of the building in which the business is conducted.

A2. ENERGIZE SCHOOLS

HISTORY
Energize Schools invites schools in PG&E service territory to participate in a three-week competition to save energy through working with school staff, curriculum, and a student led-conservation campaign. The three schools that save the most energy win prizes, and have a chance to receive an award for the most creative conservation action, best overall campaign, and most improved. The first competition took place in October 2014 with 46 participating schools, and the second competition was held October to November 2015 with 59 participating schools. Two competitions were planned during the 2015-2016 academic year, one in October for Energy Awareness Month and one in the spring for Earth Day. The program is implemented by Strategic Energy Innovations (SEI).

GOALS
- Help students discover the value of energy savings.
- Encourage and empower students and staff to reduce energy use in school buildings.

DESIGN
Energize Schools reaches out to schools and encourages them to participate with incentives (e.g., cash prize rewards, social recognition) and information about participating schools' savings from previous campaigns. Once signed up, participating school staff and student leaders attend a training webinar, which covers the importance of energy conservation, behaviors that can reduce energy use, and instructions for implementing the contest. School staff and student leaders are asked to create a conservation action plan that sets an energy savings goal and designs strategies to achieve that goal. Teachers are provided with a lesson plan, which introduces the competition, explains why saving energy is important, offers behavioral strategies, teaches goal setting, shows how to make an action plan, offers ideas for an energy savings campaign, and tells where to go to track savings. A toolkit is also provided to assist with a school audit and creating an action plan. By using the toolkit, teachers and students generate ideas about behaviors that can be taken to reduce energy usage. Students create energy campaigns designed to encourage others within the school community to reduce energy use. Participating schools receive "one-on-one" assistance from SEI staff upon request. School participants can monitor their daily, weekly, and overall energy savings progress, and can compare their progress with other participating schools using a customized building dashboard enabled by PG&E's Green Button feature. School staffers are asked to complete an exit survey requesting information on the energy behaviors adopted, as well as feedback about the usability and ease of program design. The program has measured success in past years based on the school's energy savings during the three-week competition.

A3. ENERGY SAVINGS ASSISTANCE AUDIT (ESA)

HISTORY

Energy Savings Assistance (ESA) is an audit and direct installation program targeting customers who meet specific income qualifications. ESA began in 1983 and has been refined over time with an increasing focus on energy savings. Since its inception, over a million and a half homes have been treated through ESA. The current program design began in the winter of 2000—when California experienced an energy crisis and rolling blackouts—resulting in a "rapid deployment" model to mitigate the impacts of rate increases and the energy burden on low-income customers. Under a mandate from the CPUC [Decision 07-12-051], PG&E is required to expand the reach of this program to all eligible customers by 2020. A specific goal of the 51,000 ESA audits in 2016 was needed to meet the milestone toward the 2020 goal. ESA's first priority is to reach homes for the first time [ESA I]. However, homes that were visited and received installations in the past (15-16 years ago) have outdated energy efficiency (EE) technology, as well as normal wear and tear, so they are eligible for a second visit [ESA II]. ESA is currently focused on reorganizing the program approach in an effort to connect customers to a larger portfolio of PG&E offerings.

GOALS

- Help income qualified customers to reduce their energy consumption and energy bills while improving health, comfort, and safety.
- Enhanced in-home energy education to provide customers with a deeper understanding of their energy and water use and savings.
- Reach 210,000 homes for the first time, reach 100,000 homes treated over eight years ago (of the 300,000 identified to be treated by 2020).

DESIGN

Energy Savings (ES) technicians receive training at the Energy Training Center in Stockton in the eight-day Energy Specialist course and three-day Installer course. Customers who would benefit from rate payer assistance are identified through the California Alternate Rates Energy (CARE) program. Customers learn about the program through direct contact by a representative, bill inserts, direct mail, and brochures. Marketing and outreach materials rely primarily on financial incentives, with additional messaging around efficiency, safety, and comfort. Trained technicians schedule and conduct an energy assessment of the customer's home. During the assessment, the technicians educate customers and determine which EE measures can be offered. Incentives include free upgrades, appliances, insulation, weatherproofing, and other products such as compact fluorescent lights. The energy education component teaches customers to read and understand bills, how the equipment they are being given works, and behavioral tips for increased energy savings. After the assessment, a follow-up appointment is set for a second technician to come to the customer's residence to install energy efficiency measures.

A4. HOME ENERGY REPORTS (HER)

HISTORY

The Home Energy Reports program began at Pacific Gas and Electric in 2011. It was the first behavioral program officially sanctioned by the CPUC that California utilities can use to claim energy savings in order to reach energy efficiency goals. The program explicitly employs and tests behavior-based strategies. Opower is PG&E's partner in implementing the HER program. Tested via RCT experimental design, the program has demonstrated savings of 1-3% reduction in average energy consumption. PG&E was one of the first utilities to pilot HERs, and they have since expanded all around the world. Over 1 million residential customers in the utility territory receive reports and participate in dozens of unique experiments, which are typically implemented by sending different versions of the reports to randomly assigned customer groups.

GOALS

- Encourage residential customers to save energy and save money
- Motivate customers to change behaviors and develop persistent energy conservation habits
- Increase customer engagement and awareness
- Leverage capabilities of SmartMeter™ (when applicable)

DESIGN

The Home Energy Reports (HER) program sends reports to households in combination with their monthly utility bill giving them feedback on their energy use. The report contains a chart detailing energy usage along with a monthly and/or daily timescale, comparisons to the energy use of similar homes in the neighborhood or the historical energy usage data of the same home, and energy saving tips. The comparative feedback was the primary pioneering behavioral strategy of this program and has since been proven effective by significant research. Customers can receive the reports via email or direct mail based on how customers have chosen to receive their bill. The Home Energy Reports use an automatic enrollment approach, yet customers can opt out if they take the necessary steps. The reports and online tools are "white-labeled" so that it appears they come directly from the utility. HER is the original model for the Business Energy Reports program (described in Appendix A1).

A5. HOME UPGRADE

HISTORY
Advanced Home Upgrade was piloted in August 2010 and became a program in 2011. In 2012, 2-4 unit homes were added to single family residential homes originally targeted by the program. By 2013, program awareness among the target population was at 34%, and over 5,965 households in PG&E's territory had received rebates over the first three years. The Basic path was revised and replaced with the Home Upgrade path. Over the years, incentives have changed, with the number of rebates increasing incrementally. In 2014, kickers for pool pumps and high-efficiency HVAC units in specific climate zones were added to the Advanced Home Upgrade path. Between 2014-15, the program increased the number of jobs completed by 20% at 5,827 homes served. In 2015, more accurate and user-friendly energy modeling software tools were introduced to the program via CALTrack. PG&E also enhanced the contractor experience to support program participation and success. In 2016, incentives were reduced in the Advanced Home Upgrade pathway.

GOALS
- Help Californians to take action to save energy and conserve natural resources.
- Make the home more comfortable while reducing electricity bills.
- Reduce demand pressure on the grid.
- Savings goals for 2016 were 4,000 kWh, 3,000,000 kWh, and 380,000 therms.

DESIGN
Customers typically enter the program triggered by (1) an emergency, like when a customer's HVAC or furnace breaks, and (2) when customers move into a new home, with program participation typically starting one year after moving in. Customers may learn about the program through traditional marketing methods, conversion from another PG&E program (typically the AC quality care or HVAC quality maintenance program), or by home contractors. Customers are encouraged to call a "performance advisor hotline" to speak to a trained professional who explains how the program works, provides a list of qualified Home Upgrade contractors, and advises customers to get more than one project bid. Contractors are trained in the "whole home" approach to energy efficiency and offered the Home Upgrade Brand logo and materials (postcards, business cards, flyers) for marketing.

A contractor or trained rater conducts an energy assessment in the home. Based on the findings from the assessment, the contractor works with the homeowner to put together a customized project plan/scope of work and set a budget. Energy Upgrade California offers two pathways for the customer to select measures to install: (1) Home Upgrade (minimum three deemed measures) and (2) Advanced Home Upgrade (calculated incentives with customized deep retrofit). Once the customer and contractor have set a budget and made a customized project plan, the contractor completes the application and reserves the incentive. After the measures are installed, additional opportunities for conversion to Home Energy Reports are presented in the letter accompanying the rebate check. Some contractors also offer solar installations to help the customer get their home to zero net energy. PG&E and the vendor, Build it Green, conduct quality control inspections.

A6. MARKETPLACE

HISTORY

The Marketplace program launched in March 2015 as a pilot project and a standalone micro-site. The online platform is considered a "kayak.com" for residential energy-efficient appliances and electronics developed by the vendor Enervee. The program established the site architecture and functions, and experimented with two outreach strategies —online ads and a social media campaign—but these were not continued. In its first year, rebate applications for non-rebated products dropped from 8% to 0.8% of all applications. 15-17% of total rebate applications were generated through the Marketplace. As of 2016, the program was past the pilot stage and beginning to integrate with other PG&E programs, such as Home Energy Reports. In 2016, the team aimed to offer more product categories, develop a new user interface, increase marketing efforts, and possibly conduct a study to assess marketing strategies for non-rebated products.

GOALS

- Serve as an exemplar within the utility space by:
  - Meeting customers on their [shopping] journey.
  - Making it easy for customers to find products that qualify for a PG&E rebate
  - Simplifying the rebate process for customers.
  - Inspiring more efficient product purchases with the help of energy information.
- Encourage retailers to promote more energy-efficient products as a result of increased demand and better customer insights.
- Make a case to the CPUC to claim energy savings as "resource acquisition" credits, particularly with non-rebated credits.

DESIGN

The Marketplace online platform aggregates data on residential appliances, including model information, energy use, cost, availability, energy savings over the lifespan of the product, and in some cases, rebate information. It also allows users to filter according to their needs and preferences. The program reaches customers through promotion on the PG&E main website, Home Energy Reports, and the Home Energy Checkup newsletter. Once a customer decides which product they want to buy, the website directs them to online or brick and mortar retail locations for purchase. Marketplace also allows for easier rebate processing once a product is selected for purchase. Customers can enter their information to receive an email, and they simply need to reply to the email confirming their purchase and sending the digital receipt. The program administrators submit the rebate forms on behalf of the customer, as well as gather customer data on preferences and shopping patterns to share with PG&E, evaluators, and retailers.

A7. MIDDLE INCOME DIRECT INSTALL (MIDI)

HISTORY

The Moderate Income Direct Install (MIDI) program offers energy upgrades to customers with incomes just above the cutoff for Energy Savings Assistance (ESA) eligibility (ESA is described in Appendix A3). MIDI was created five years ago out of PG&E'S rate payer assistance program to better link PG&E's ESA offerings to Local Government Partnership (LGP) offerings. MIDI is quite similar to the ESA audit program. The main difference is that it has a smaller list of product offerings (due to increased focus on Total Resource Cost) and does not have strict income verification thresholds. The audits are conducted by trained, third-party Energy Savings (ES) technicians; approximately 12 of the 30 vendors who implement the ESA program for PG&E also work for the MIDI program. MIDI formerly offered 10 types of technology for installations, but now the business case for the program only warrants the inclusion of CFL lights, stand-up lamps, faucet aerators, showerheads, CFL fixtures, and power strips. The program is beginning to transition from CFL to LED lights. MIDI is currently looking for ways to emphasize behavior change through energy efficiency education to meet its savings goals.

GOALS

- Reach targeted customers just above the ESA income qualification threshold, while remaining a cost-effective program.
- Conduct a comprehensive home site assessment, including energy-saving measures, direct installs, and behavioral changes.

DESIGN

MIDI Energy Savings technicians receive training via an eight-day Energy Specialist course and a three-day Installer course at the Energy Training Center in Stockton. They recruit primarily door-to-door in specified areas and offer MIDI to customers whose income is just above the threshold for ESA programs. Contractors use the Interactive Voice Response System (IVR) or the Central Inspection Program (CIP) to enroll customers. Outreach materials are primarily framed in economic terms, such as "save money on your utility bills." During audits, technicians review the customers' bill with them and conduct a home audit to determine areas for additional energy savings. They replace items with more energy efficient products and offer tips on how to reduce energy use after the audit. An "EE Education Form" lists energy-consuming appliances and items in the home, and has five blank spaces for customer commitments. At the end of the audit, technicians self-report installations and education completed to PG&E, and provide customers with a handout encouraging them to enroll in My Energy. The Central Inspection Program conducts a follow-up to see if installations were completed.

A8. SIMPLE SAVINGS KIT

HISTORY

The Simple Savings Kit program (SSK) offers a kit of energy (and water) saving products worth $70 to customers for $10. While focused on the purchase (and installation) of deemed products, the program also hopes to serve as a "gateway" to additional energy efficiency behaviors. SSK was launched with an initial email marketing campaign in November/December 2015, with messaging that focused on the California drought, and continued through June 2016. To rapidly deploy the kit, the first campaign was sent via email to 550,000 customers who had no previous engagement with PG&E and did not qualify for rate payer assistance programs. 3,323 kits were sold in the first campaign. The second campaign in February-May 2016 was aimed at a broader residential audience, including customers who had previous engagement with PG&E but still did not qualify for rate payer assistance programs. A total of 900,000 emails were sent. The program was also marketed via Home Energy Reports, PG&E's website and digital newsletter, online search engine marketing, and social media. Kits were sold via pop-up retail sales at in-person events. At the time of this report (May 2016), the program had reached 89% of its goal for online sales, but pop-up sales have not garnered much interest. Program managers are currently planning for the next generation of the kit, which includes replacing items that are not cost effective, and expanding its appeal and utility as a customer engagement tool.

GOALS

- Provide residential customers with the opportunity to reduce energy (and water) use through the installation of efficient products.
- Broaden awareness of PG&E's residential offerings.
- Drive customer satisfaction.
- Specifically, the program aimed to sell 25,000 kits through a combination of online (17,500) and pop-up retail (7,500) during an eight-month, two-campaign cycle from November 2015 - June 2016.

DESIGN

SSK markets one-time purchase of a Simple Savings Kit to customers via ads in Home Energy Reports, emails, online search engine marketing, PG&E's website and digital newsletter, and in-person pop-up retail. Products offered in the kit include a high efficiency shower head, two bath faucet aerators, a toilet tummy, leak detection dye tablets, and two LED light bulbs. The kit comes with a sheet that describes the products, how they work, and the time it takes to install each one. When customers purchase the kit online via the Techniart website, they are directed to links to MyEnergy and PG&E's drought resources webpage, and then asked if they would like to be notified about additional programs and products. Some customers were also encouraged to complete a Home Energy Checkup. When a customer purchases the kit at a pop-up retail event, they may also learn more about water and energy savings from the salesperson.

A9. SMART THERMOSTAT PILOT STUDY

HISTORY

Smart thermostats that can provide users with remote and/or rule based control of HVAC operation are beginning to proliferate in the market. Initial data provided by third party vendors suggest that smart thermostats can reduce home energy use by 3-5%. However, since each thermostat offers different features, this study explores how this variation impacts savings. Planning for the study took place in 2015. Smart thermostats were installed in homes in December 2015. The report will be complete by late 2016 or early 2017. The results of this study will inform PG&E's marketing around smart thermostat products. It will also provide information about the source of energy savings, and whether this stems from the thermostat itself, or the way the customer interacts with the product. If the study results in this kind of information, it can inform further research and design. However, it is too early to determine whether there would be phase II testing.

GOALS

- Gather and analyze data to inform the development of a deemed program for smart thermostat products.

DESIGN

A program did not yet exist around the smart thermostat product as of the time of this study in 2016. At an early stage in the market for this new technology, the utility wanted an opportunity to gather information that can contribute to product marketing and adoption for energy efficiency. Analyzing energy use data over the course of a year is a "first step" strategy to determine if further data is needed to develop a smart thermostat program. The pilot study follows a quasi-experimental randomized encouragement design because 1) not all of the homes assigned to treatment would agree to the installation, and 2) some homes in the comparison group are likely to "self treat" by purchasing a smart thermostat during the trial period. The study compares three different types of thermostats installed in 2,200 residential homes across three climate zones to a control group of 9,940 homes. The smart thermostats were given to customers in the treatment groups and installed at no cost, connected to wi-fi, and registered with the service provider. Twelve months of energy usage data are being collected for treatment and control groups to determine whether energy savings are greater in homes with a smart thermostat than those without. Thermostat vendors will also provide operational data, including set-point and runtime data at a customer level in aggregated form. Measurements include geo-fencing, occupancy sensing, optimization algorithms, and wi-fi/broadband consumption. This additional information can help the pilot study evaluator to determine why customers experienced increased or decreased energy use after installation.

A10. SMB WELCOME SERIES

HISTORY
The PG&E Welcome Series was designed to engage new small and medium business (SMB) customers and build a positive relationship with PG&E and engage them in PG&E's Business Energy Savings Program; a set of energy saving products, services, resources, and tools that can support SMBs in managing their energy use and expenses. The date of the first pilot wave of the SMB Welcome Series was June 2015, with the final wave occurring in December 2015. The SMB Welcome Series program is currently ongoing.

GOALS
- Raise SMB customers' awareness of the various products and services offered by PG&E as part of the Business Energy Savings Program.
- Encourage SMB customers to take action on the opportunities presented in each of the 10 individual touchpoints, ultimately leading to lift within each of the associated programs.
- Position PG&E as a trusted energy advisor and raise levels of satisfaction with the utility.
- Provide useful and engaging information such that there is a decreased need for customers to call into the service center.
- Leverage social science insights to test the impact of various messaging strategies implemented in the campaign in order to identify how to engage SMB customers more successfully.

DESIGN
The PG&E Welcome Series was delivered to customers in a series of 10 communication materials, or "touchpoints." Every two weeks, a new wave of SMB customers started their Welcome Series journey with PG&E, during which the 10 communication touchpoints were delivered over a time period of 32 weeks. Each touchpoint within the Welcome Series was designed to promote one of several energy management products and services included as part of PG&E's Business Energy Savings Program: (1) sign up for online portal, (2) sign in to online portal, (3) download tips and tools pdf, (4) visit Business Resource Center (5) sign up for online bill pay, (6) sign up for Business Energy Checkup, (7) sign up for assessment consultation, (8) sign up for outage alerts, (9) submit a rebate application, and (10) contact service representative.

Customers in the treatment group fell into one of two communication pathways, depending on whether they previously provided an email address to PG&E: business received communications either in the direct mail (in the form of a postcard) or via email. Further, the materials in each communication varied slightly, depending on whether the customer had previously enrolled in My Energy or not. The Welcome Series also provided a unique opportunity to leverage social science insights and optimize the messaging strategies implemented in the campaign: In addition to testing the effectiveness of overall participation in the campaign, the Welcome Series utilized A/B testing of multiple framing strategies to determine how to optimize messaging.

A11. Step Up Power Down Commercial (SUPD-C)

HISTORY
Step Up Power Down Commercial (SUPD-C) was inspired by a similar program in Charlotte focused on business energy engagement. Two cities were selected for the pilot campaign—San Francisco and San Jose. The pilot was implemented in 2015 with an emphasis on office, hotel, retail, and food-service segments. The campaign has undergone one process evaluation. When this behavioral program review was written, the campaign had exceeded enrollment goals but had not met energy-savings goals for both cities.

GOALS
- Increase customer awareness of the utility's current efficiency programs.
- Drive businesses to participate at increased levels in existing energy efficiency programs.
- Achieve a measurable decline in energy use through operational, behavioral, and equipment changes.

DESIGN
SUPD-C is a large-scale community engagement campaign that collaborates with businesses to reduce energy use through a portfolio of activities. The program design is multi-faceted and enlists numerous vendors in the design, implementation, and evaluation of the campaign. The design and vendors have evolved over the course of the pilot phase, so while it is summarized here, several elements have changed since. The campaign leverages existing PG&E programs, particularly incentives to upgrade equipment and Energy Solutions and Sales (ES&S) team's existing relationships. Community enrollment and energy savings goals were set for each participating city, and a $1 million contribution to local environmental projects was offered for meeting the campaign goals.

The program is marketed to businesses via the SUPD-C website, paid and social media, in-person outreach, branded giveaways, and trusted community organizations. Once businesses sign up, they are asked to assign a staff member to the role of "energy champion" to select and organize campaign offerings. This begins with a series of trainings that are customized to the building staff, office staff, and the designated business lead. Vendors provide ongoing support through in-person and online tools to assist customers with implementation. Customers can conduct self-audits, or vendors conduct an audit baseline assessment and provide tailored recommendations for energy-saving actions. Customers use this insight to develop an action plan. Toolkits are provided to support running office-wide campaigns that leverage competition and games to encourage new energy habits. Customers receive feedback and positive reinforcement from online energy management systems, monthly business energy reports, ongoing group meetings called sustainability circles, and public events to celebrate energy savings.

A12. STEP UP POWER DOWN RESIDENTIAL (SUPD-R)

HISTORY
Planning for SUPD-R began in 2014 and campaigns with partner cities formally launched April-May 2015. SUPD-R focused on creating a foundation for success by building visibility and partnerships within each community in 2015. The initiative established a main office in San Mateo County (serving Redwood City and San Carlos) and an office in Woodland to build relationships with city and community leaders, cultivate volunteers, and participate in public events (mainly PG&E Workshops). In 2016, the program hopes to meet its overall objectives and develop CBSM strategies tailored to each city. In June 2016, the initiative completed its first annual cycle of campaign activities.

GOALS
- Increase uptake of EE initiatives among residential customers through CBSM
- Empower local volunteers to initiate and implement their own events and campaigns with little assistance from the initiative staff
- Generate referrals to PG&E initiatives through community partnerships
- Demonstrate PG&E's collaborative commitment to efficiency and innovation
- Produce best practices that can be used across PG&E's service territory

DESIGN
SUPD-R is designed to meet residential customers at different parts of their customer journey and work with city leaders to gain buy-in. The initiative follows a basic design, yet takes a "test/learn/adapt" approach to continuous improvement. A few strategies for engagement were tested early to determine what might work best to engage local residents in different kinds of communities. For San Mateo cities, strategies focused more on reach, while Woodland focus more on the depth of engagement. This depth meant going beyond giving a presentation to a community group (e.g. Rotary Club) to spending one-on-one time with community members. For example, a partnership between contractors and faith based organizations in Woodland led to local contractors paying community organizations for referrals for home upgrades.

SUPD-R recruits volunteers to participate at multiple levels, ranging from leadership roles to talking to friends about simple steps they can take to reduce energy use at home. Community residents can learn about SUPD-R through word of mouth, earned media, social media, in person events and the campaign website. Campaign events primarily consist of energy education workshops at resource centers. At a typical campaign event, leaders aim to meet customers where they are at and educate them about online tools, rebates, initiatives, and behaviors. Attendees are encouraged to make a pledge to change their energy behavior, sign up for more information, and visit the campaign website. Volunteers contact attendees to see if they followed through, and ask if they would like to engage in further action. For example, a customer who signed up with MyEnergy might be asked if they have thought about a Home Upgrade, receive an offer for a contractor introduction, and shown where to find rebates. The website serves as a portal for sign up, purchase, and engagement. Visitors are directed to a survey that offers personalized suggestions for PG&E programs. Resources and recommendations direct residents to Home Energy Checkup, Home Upgrade, rebates and Marketplace, a game ("Catch Energy Vampires" directed at children).

APPENDIX B. PROGRAM MANAGER INTERVIEW INSTRUMENT

1. **Goals**: What, in your own words, are the program goals and activities for 2016?

2. **History:** When was this program first implemented? How long has it been in operation? How many times a year (if applicable)? Has the program experienced any changes during this time?

3. **Vendors:** Do you work with any vendors on the program? If so, who? How do you work with them?

4. **Customer Needs:** Tell us about the needs and situations of the target customer. How does this program help them address those needs? What are their motivations? (residential, commercial, other?)

5. **Customer Behavior:** What exactly are you trying to get the customer to do? How does the program get customers to change their behavior? *probe for single behavior, habits, attitudes, increased knowledge of customer outcomes. Probe to learn if behavioral interventions are singular or stacked. Brainstorm about where participant motivations come from, where they have gotten stuck, etc.* Is there a theory of change that underlies the program?

6. **Success and Failures:** Are the goals being met? Why or why not? What other things have worked well? Why? What hasn't worked well? Why do you think that is the case?

7. **Evaluation:** Has this program been evaluated? How? By whom? What data exists for evaluation? *Probe for potential data that can be gathered about the program for different kinds of testing and evaluation. (talk to team about what this might include)*

8. **Improvements:** If you could improve this program in 2016, what would you do?

9. **Research Potential:** If researchers were to work with you to make improvements to your program, how could they best help you?

10. **Observations About Other Programs**: Given other programs that you may have worked on that target similar customer behavior, do you have any insights to share? What do you see working in other programs? What do you see not working in other programs?

11. **Additional Questions:** Is there any other additional intel you would like to share with us about the program? *Inquire to determine what kind of information already exists about the program, e.g. customer-facing materials, website, description, presentations, logic model, internal documents, etc. that include information about program goals, behavioral levers, etc.*

REFERENCES

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*(3), 273–291.

Allcott, H, & Mullainathan, S. (2010). Behavior and Energy Policy. *Science*, 327 (5970), 1204-1205.

Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*, 1082–1095.

Ashby, K. V., Nevius, M., Walton, M., & Ceniceros, B. (2010). Behaving Ourselves: How Behavior Change Insights Are Being Applied to Energy Efficiency Programs. ACEEE Summer Study on Energy Efficiency in Buildings. Washington, DC.

Bertrand, M., Karlan, D., Mullainathan, S., Shafir, E., & Zinman, J. (2010). What's advertising content worth? Evidence from a consumer credit marketing field experiment. *The Quarterly Journal of Economics*, *125*(1), 263-306.

Black, J. S., Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, 70, 3-21.

California IOUs (2014). CA IOU Behavior Definition Proposed to the CPUC. Retrieved from https://library.cee1.org/sites/default/files/library/11659/CA_IOUs_Behavior_Definition_Proposed_to_CPUC.pdf

California Senate Bill (SB) 488 (2009). Energy Usage Information.

Center for Research on Environmental Decisions (CRED). (2009). The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public. New York.

Costa, D. and M. Kahn (2013) Energy conservation 'nudges' and environmentalist ideology: evidence from a randomized residential electricity field experiment. *Journal of the European Economic Association*, *11*, 680-702.

Decision approving 2013- 2014 Energy Efficiency Programs and Budgets - November 15, 2012 (D. 12-11-015).

Decision determining Evaluation, Measurement, and Verification (EM&V) processes and established the roles for and relationships between Energy Division and the utilities for 2010 through 2012 Energy Efficiency portfolios - November 20, 2009 (D. 10-04-029).

Delmas, M. A., Fischlein, M., & Asensio, O. I. (2013). Information strategies and energy conservation behavior: A meta-analysis of experimental studies from 1975 to 2012. *Energy Policy*, *61*, 729–739.

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences*, *106*, 18452–18456.

Fogg, B. J., & Hreha, J. (2010, June). Behavior wizard: A method for matching target behaviors with solutions. In *International Conference on Persuasive Technology* (pp. 117-131). Springer Berlin Heidelberg.

Frankel, D., Heck, S., & Tai, H. (2013). Sizing the potential of behavioral energy-efficiency initiatives in the US residential market. McKinsey & Company.

Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews*, *41*, 1385-1394.

Frey, B. S., & Oberholzer-Gee, F. (1997). The cost of price incentives: An empirical analysis of motivation crowding-out. *The American Economic Review*, *87*(4), 746-755.

Froehlich, J. (2015). Gamifying Green: Gamification and Environmental Sustainability. In Walz, S. and Deterding, S. (Eds.), *The Gameful World*, MIT Press.

Gallagher, K. M., & Updegraff, J. A. (2012). Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of behavioral medicine*, *43*(1), 101-116.

Gneezy, U., Meier, S., & Rey-Biel, P. (2011). When and why incentives (don't) work to modify behavior. *The Journal of Economic Perspectives, 25*(4), 191-209.

Gonzales, P., Peters, J.S., McClaren, M., Dunn, A., & Forster, H. (2013). Integrating more behavior change strategies into a portfolio. National Energy Services Conference, Orlando, FL. Phoenix, AZ: AESP.

Grossberg, F., Wolfson, M., Mazur-Stommen, S., Farley, K. (2015). Gamified Energy Efficiency Programs. Washington, DC: American Council for an Energy-Efficient Economy.

Houde, S., & Todd, A. (2011). List of Behavioral Economics Principles that can Inform Energy Policy. Report from Lawrence Berkeley National Lab and Precourt Energy Efficiency Center at Stanford University.

Ignelzi, P., Peters, J., Randazzo, K., Dougherty, A., Dethman, L., & Lutzenhiser, L. (2013). "Paving the Way for a Richer Mix of Residential Behavior Programs." Prepared for the California Investor-Owned Utilities: Pacific Gas & Electric, Southern California Edison, San Diego Gas & Electric, and Southern California Gas.

Illume Advising, LLC, Vine, E., & Mazur-Stommen, S. (2015). Energy Efficiency Behavioral Programs: Literature Review, Benchmarking Analysis, and Evaluation Guidelines for Conservation Applied Research & Development (CARD). Prepared for the Minnesota Department of Commerce, Division of Energy Resources.

Karlin, B., Davis, N., Sanguinetti, A., Gamble, K., Kirkby, D., & Stokols, D. (2014). Dimensions of conservation: Exploring differences among energy behaviors. *Environment and Behavior, 46*(4), 423–452.

Karlin, B., Zinger, J. F., & Ford, R. (2015). The effects of feedback on energy conservation: A meta-analysis.

Karlin, B., Lupkin, L., Ford, R., Bunten, A., Forster, H., Zaval, L. (2016). California behavioral definition: review and recommendations. Prepared for Pacific Gas and Electric Company.

Kempton, W., Darley, J. M., & Stern, P. C. (1992). Psychological research for the new energy problems. *American Psychologist*, *47*, 1213-1223.

Kempton, W., Harris, C. K., Keith, J. G., & Weihl, J. S. (1984). Do consumers know what works in energy conservation? In J. Harris & C. Blumstein (Eds.), *What works: Documenting energy conservation in buildings*, 429-438. Washington, DC: American Council for an Energy-Efficient Economy.

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory.

Krishnamurthy, C. K. B., & Kriström, B. (2015). How large is the Owner-Renter Divide in Energy Efficient Technology? Evidence from an OECD cross-section. *The Energy Journal*, *36*(4), 85-104.

Lavelle, M. J., Rau, H., & Fahy, F. (2015). Different shades of green? Unpacking habitual and occasional pro-environmental behavior. *Global Environmental Change*, *35*, 368-378.

Li, H., & Kannan, P. K. (2014). Attributing conversions in a multichannel online marketing environment: An empirical model and a field experiment. *Journal of Marketing Research, 51*(1), 40-56.

Mazur-Stommen, S., and Farley, K. (2013). ACEEE Field Guide to Utility-Run Behavior Programs. Washington, DC: American Council for an Energy-Efficient Economy.

McKenzie-Mohr, D. (1994). Social marketing for sustainability: The case of residential energy conservation. *Futures, 26*, 224-233

McKenzie-Mohr, D., & Schultz, P. W. (2014). Choosing effective behavior change tools. *Social Marketing Quarterly, 20*(1), 35-46.

Morimoto, M., & Chang, S. (2006). Consumers' attitudes toward unsolicited commercial e-mail and postal direct mail marketing methods: intrusiveness, perceived loss of control, and irritation. *Journal of Interactive Advertising*, *7*(1), 1-11.

Nair, G., Gustavsson, L., & Mahapatra, K. (2010). Factors influencing energy efficiency investments in existing Swedish residential buildings. *Energy Policy, 38*, 2956-2963.

Noar, S. M., Benac, C. N., & Harris, M. S. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin, 133*(4), 673.

Opinion Dynamics. (2011). Massachusetts cross-cutting behavioral program evaluation, - Volume 1. Prepared for Massachusetts Energy Efficiency Advisory Council.

Payne, A. F., Storbacka, K., & Frow, P. (2008). Managing the co-creation of value. *Journal of the Academy of Marketing Science, 36*(1), 83-96.

Pelletier, L. G., & Sharp, E. (2008). Persuasive communication and proenvironmental behaviours: How message tailoring and message framing can improve the integration of behaviours through self-determined motivation. *Canadian Psychology/Psychologie canadienne, 49*(3), 210.

Petrovic, N., Madrigano, J., & Zaval, L. (2014). Motivating mitigation: when health matters more than climate change. *Climatic Change, 126*(1-2), 245-254.

Social and Behavioral Sciences Team (SBST) (2016). 2016 Annual Report. Executive Office of the President and the National Science and Technology Council.

Stern, P. C. (1992). What psychology knows about energy conservation. *American Psychologist, 47*, 1224-1232.

Stern, P. C., & Gardner, G. (1981). Psychological research and energy policy. *American Psychologist, 36*, 329-342.

Sweeney, J. (2016). *Energy Efficiency: Building a Clean, Secure Economy*. Hoover Press.

Todd, A., Stuart, E., Schiller, S., & Goldman, C. (2012). Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations. SEE Action Network.

Van Raaij, W. F., & Verhallen, T. M. M. (1983). A behavioral model of residential energy use. *Journal of Economic Psychology, 3*, 39-63.

Verplanken, B., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. Journal of *Environmental Psychology, 45*, 127-134.

Vine, E., & Jones, C. (2015). A Review of Energy Reduction Competitions: What Have We Learned? California Institute for Energy and Environment.

Wilson, C., & Dowlatabadi, H. (2007). Models of Decision Making and Residential Energy Use. *Annual Review of Environment and Resources, 32*(1), 169–203.

Wood, W., Tam, L., & Witt, M. G. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology*, 88(6), 918.

Yoeli, E., Hoffman, M., Rand, D., & Nowak, M. (2013). Powering up with indirect reciprocity in a large-scale field experiment. *Proceedings of the National Academy of Sciences, 110*(2), 10424–10429.

Zaval, L., Markowitz, E. M., & Weber, E. U. (2015). How will I be remembered? Conserving the environment for the sake of one's legacy. *Psychological Science, 26*(2), 231–236.