A Systematic Approach to Evidence-Based Appliance Program Design

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ABSTRACT

Appliance programs are among the longest running and most successful of all energy efficiency programs. They reach hundreds of thousands of people in nearly every U.S. state and are embraced by customers and utilities alike. However, in late 2010, two of the country's largest programs reached a critical decision point. Program cost-effectiveness had declined sharply due to decreasing per-measure savings. These programs, like nearly all other appliance programs, provide cash incentives to end users for purchase of an efficient appliance. Program administrators knew they needed to evolve their strategies for achieving savings in their 2013-2014 programs, and beyond, that would incorporate both new approaches to program implementation and new measures.

This paper reports the process used to identify new appliance program strategies, an evidence-based, systematic approach that puts market characterization and process evaluation to use in new ways. The study, completed in March 2012, focused on four appliance categories: refrigerators, water heaters, pool pumps and motors, and clothes dryers. The paper also describes the regulatory and evaluation challenges to implementing some of the recommended strategies, focusing on the difficulties with midstream and upstream supply chain interventions. The paper concludes by recommending a new approach to evaluating midstream and upstream energy efficiency programs, including suggested research methods and the findings they will, and will not, produce.

Introduction

California utilities have offered energy efficiency programs to their customers for more than 30 years. Appliance programs are some of the longest running efficiency programs, and at Pacific Gas & Electric (PG&E) and Southern California Edison (SCE), these programs have changed little since their inception – a cash incentive is provided to purchasers of qualified products, and circuit riders visit retailers to provide point-of-purchase marketing materials and program forms. In 2010-2012, the PG&E and SCE Home Energy Efficiency Rebate (HEER) programs together covered 11 products (water heaters, insulation, refrigerators, dishwashers, clothes washers, furnaces, room air conditioners, pool pumps, whole house fans, ducted evaporative coolers, and cool roofs), although the programs differed in their mix of products, incentive amounts, and product qualifications.

PG&E and SCE commissioned this study to find new ways to implement appliance programs and decided to focus on four product categories with large energy savings potential, high household saturation (or both): refrigerators, water heaters, pool pumps, and clothes dryers. PG&E and SCE wanted to build on previous successes to design new programs that would be simple yet comprehensive, and make energy efficiency accessible to their customers while working within the existing supply chain infrastructure. They specified that the new program design ideas should be:

- As simple and easy to administer as possible;
- Easy for end users and supply chain partners to understand and participate in;
- Likely to generate savings that will be attributed to program activities; and
- Evaluable – meaning that evaluators will be able to identify and quantify the savings.

Below we describe the systematic, evidence-based approach that was used to develop the program design ideas. We outline the process, use refrigerators as a case study to explore the details, and show how the approach is content-neutral, meaning it can be applied to energy efficiency programs of any type, in any market.

Putting Process Evaluation and Market Characterization to Use

The program design ideas generated in this study were built on a foundation of market knowledge obtained from a process evaluation and a market characterization study. The process evaluation included a review of program documents and surveys of 153 retailers, 114 pool pump contractors, 507 program participants, and 141 nonparticipants. The market characterization included a literature review and in-depth interviews with eight manufacturers or brand representatives, one distributor, and 13 industry experts.

In both the process evaluation and market characterization, some findings proved more useful than others in guiding program design ideas. Table 1, below, identifies finding types and their use in developing the program design ideas, and can be used to guide future research designs.

Table 1. Process and Market Findings and Their Roles in Program Design

Research Task	Finding Type	Use in Program Design
Process evaluation	Participant and nonparticipant reasons for not buying an qualified product	• Identify barriers to adoption
	Participant and nonparticipant reasons for choosing a particular product model (for example, price, color, and size)	• Guide segmentation analysis of available products and program measures • Guide marketing materials
	Participant and nonparticipant source of information in making purchase decision	• Guide outreach and marketing channels • Target training
	Retailer/installer tools used to sell efficient product	• Guide tool, training, and marketing development • Guide transition away from incentive
Program data	Program measure data	• Identify underperforming product categories • Characterize program measures by key segment (for example, price point, size, place of purchase) to identify opportunities
Process evaluation and market characterization	Participant and nonparticipant place of purchase	• Target training, outreach and marketing

Research Task	Finding Type	Use in Program Design
Market characterization	Product availability at major retailers (for example, % of qualified models at various price points)	• Identify whether and where (which retailers, price points) product availability is a barrier
	Incremental cost difference for efficiency at major retailers, the product segments (for example, price points, sizes, configurations), and the size of the incremental cost	• Guide amount of incentive and to which products it should apply
	Characteristics of the purchase decision (for example, whether the replacement is planned or unplanned, whether the replaced product is working or nonworking, how the replaced appliance is disposed)	• Guide elements of implementation strategy, for example a year-round versus limited-time incentive • Identify opportunities for savings (for example, opportunities for product recycling/retirement) • Guide marketing and outreach
	Current market penetration of efficient product and trends in penetration	• Identify opportunities (for example, a product with a quickly growing market penetration may not be suitable for program intervention) • Guide marketing (for example, a product with low market penetration may need more marketing support or marketing that focuses on explaining the technology)
	Benefits of efficient products	• Guide marketing • Guide program strategy (for example, a product with abundant non-energy benefits or a short payback may be treated with an awareness-raising campaign but not an end-user incentive)
	Retailer/installer market insights Manufacturer/brand/industry expert insights	• Guide marketing, training • Identify energy savings opportunities • Identify implementation approaches • Identify barriers to adoption

A Systematic Approach

The project team used a systematic approach to move from evaluation findings and market research to program design recommendations in order to ensure the results were both comprehensive and equitable – in other words, that all program design possibilities had been considered equally. The process included four steps, and is an approach to program design that is content-neutral – it can be applied to energy efficiency programs of any type, in any market. The approach is primarily qualitative, but with quantitative elements, using a Microsoft Excel workbook-based tracking and organizational tool.

Below we describe each step of the approach, show a sample of the data consulted and findings, and explain how the step contributed to achieving evidenced-based program design ideas.

Step #1: Assess and Prioritize the Barriers to Energy Efficiency

The first objective in designing a program that is firmly rooted in market knowledge is to assess and rank the problems the program will try to solve. The team's approach to identifying barriers was both quantitative and qualitative, and specific to each product. The first task was to

identify the market penetration of efficient products to gauge whether the measures were at a saturation point or still had room to improve. Table 2 lists penetration findings for the four products studied.

Table 2. Market Share of Efficient Products

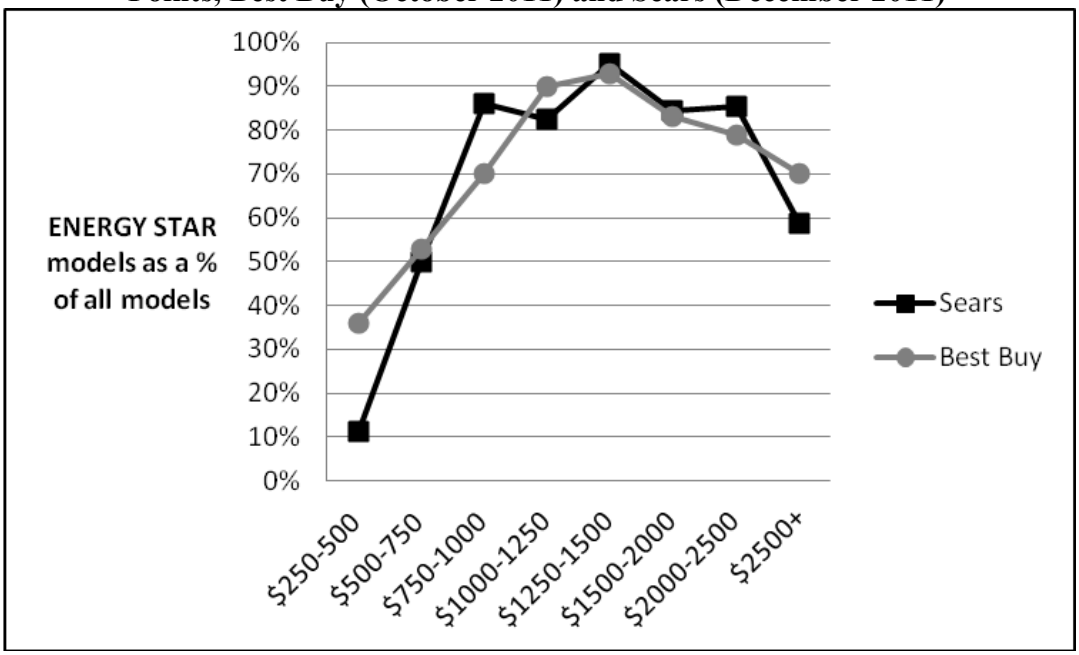
Product Type	Efficient Product Qualification	Market Share (Description)
Refrigerator	ENERGY STAR®	50% new unit sales, U.S. (2010) 31% new unit sales, Calif. (2009) 28% new unit sales, Calif. (2008) 36% new unit sales, Calif. (2007)
Water heater	ENERGY STAR storage (gas) Tankless Heat pump (electric)	12% gas storage sales, U.S. (2010) ~10% gas water heater sales, U.S. (2010) ~5% all water heater sales, U.S. (2010) 2% electric water heater sales, U.S. (2010)
Pool pump	Variable speed	May be up to 33% of all new unit sales, U.S. (2011) Contractors and manufacturers report variable speed pumps outselling two-speed pumps in Calif. and in the U.S.
Clothes dryer	Heat pump (electric) clothes dryer	0% new unit sales, U.S. (to date)

Sources: ENERGY STAR 2007, 2008, 2009; ENERGY STAR 2010a; ENERGY STAR 2010b; NEEA 2012; ACEEE 2011a.

Case study: Refrigerators. Penetration findings together with in-depth interviews, secondary research, and analysis of program measure data informed the product-specific assessment of barriers, the research questions, and eventually the program design ideas. The penetration of ENERGY STAR® refrigerators was low relative to other major appliances, at 28-36% prior to 2010. Yet interviewees reported few, if any, barriers to adoption. Interviewees reported that ENERGY STAR products were widely available, and awareness of the SCE program's rebates was high (PG&E did not offer a refrigerator rebate in the period under study).

Why, then, was ENERGY STAR penetration low? Interviewees noted that, in the refrigerator market, high sales volume occurs at the entry-level or "volume" price points ($399 and $499). An anecdotal review of refrigerator models by price point at two major retailers' websites showed fewer ENERGY STAR models at the lowest price increment (under $500), relative to all other price points (Figure 1), as well as a high incremental cost (around $100) relative to the rebate amount ($30) and the total product cost (the incremental cost was approximately 20-25% of the total product cost).

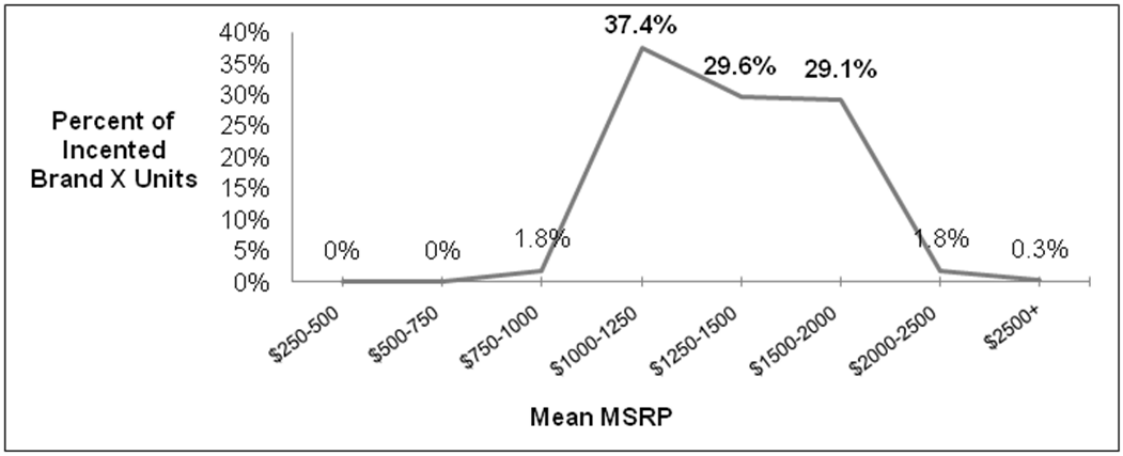
Figure 1. Percent of ENERGY STAR-qualified Refrigerator Models at Various Price Points, Best Buy (October 2011) and Sears (December 2011)



Sources: www.bestbuy.com (accessed October 27, 2011); www.sears.com (accessed December 14, 2011)

The process evaluation findings supported the market findings. More than half (57%) of SCE program participants said cost was the reason they did not buy a qualified refrigerator – the most common reason cited. Retailers, too, reported cost as a barrier. Measure data from the SCE program further supported the developing hypothesis that the biggest barrier to adoption lay at the low end of the price continuum. Because the SCE HEER program did not collect the retail price for incented measures, the manufacturer's suggested retail price (MSRP) was obtained from one of the top three refrigerator brands (referred to here as "Brand X") and matched with the model numbers of the incented units. A graph of the frequency of incented units by price point confirmed the hypothesis: among all Brand X units incented by the HEER program for which MSRP was available (n=6,555), 98% of units had an MSRP of $1,000 or more (Figure 2).

Figure 2. Price Point of Incented Brand X Refrigerators (2008-2010)



The analysis of program measure data for Brand X prompted an additional research question: Were there any reasons, other than incremental cost, that the program did not incent any Brand X refrigerators with a retail price less than $1,000? A second review of the websites of the three major retailers showed two findings with relevance for program design: Brand X did not manufacturer any ENERGY STAR units priced under $500, and availability of ENERGY STAR models with an MSRP between $500 and $1,000 was moderate to high (at the three major retailers, ENERGY STAR models made up 21-36% of all models with an MSRP of $500-750 and 55-83% of all models with an MSRP of $750-1,000).

Based on this evidence, the team concluded the barriers to adoption of ENERGY STAR refrigerators with an MSRP under $500 were low product availability, high incremental cost relative to the total product cost, and a small program incentive relative to the incremental cost. In the $500-750 price range, low availability was judged to be a barrier. Although program measure data showed extremely low incentive uptake among products priced between $750 and $1,000, the process and market data did not indicate clear barriers in this price range.

Prioritizing the barriers. After the team identified the important barriers for each product, they selected the single most important barrier. The process for prioritizing barriers was qualitative and subjective, and arrived at using the team's knowledge of efficiency program history and best practices to answer the question, for each barrier: "Can a program succeed *without* addressing this barrier?" Table 3 lists the key and secondary barriers identified for each product type.

With one exception, the team placed no restrictions on the identification or prioritization of barriers. However, based on the seminal 1996 market transformation Scoping Study (Eto et al. 1996), team members were not permitted to select "first cost" as a key barrier. This study argued that although first cost is a common barrier to the adoption of efficient products and services, it is typically the effect of another, more fundamental barrier. For example, the high cost of a product may result from the fact that few units are produced or from the high cost of a particular component. In addition, the study noted that programs that address **only** first cost run the risk that, "Discontinuation of the program would . . . result in a reversion to purchasing and operating practices that existed prior to the program."

Table 3. Barriers by Product Type

Barriers	Product Type			
	Refrig-erator	Water Heater	Pool Pump	Clothes Dryer
End user awareness/knowledge of energy efficient products or benefits lacking	X	X	X	X
First cost high, relative to baseline product (at some price points)	X	X	X	X
Retailer or contractor awareness/knowledge of energy efficient products or benefits lacking		X	X	X
Availability low at retail or wholesale	**#1**	**#1**		X
Energy efficiency not a key purchase criteria	X	X		
Enforcement of existing codes or standards lacking			**#1**	
Voluntary label lacking				X
Codes/standards/testing procedures disadvantage energy efficient products				**#1**
Early replacement aversion		X	X	
Technology unfamiliar		X	X	
Availability low from manufacturers				X

Barriers	Product Type			
	Refrig-erator	Water Heater	Pool Pump	Clothes Dryer
Product performance - requires different expectations from end-users				X
Rebates not key purchase criteria	X			
Retailers do not promote energy efficient products		X		
Space or structural requirements for energy efficient products are increased or different		X		

Step #2: Identify intervention points in the supply chain to address each barrier. The second step was to identify, for each barrier, where in the product's supply chain an intervention might be effective. "Intervention" was considered to be any potential activity undertaken by an energy efficiency program. The approach to identifying intervention points in the supply chain was qualitative and subjective, but based on findings from an overview of program best practices conducted as part of the market characterization. The best practice research identified successful appliance (and other end user) program models from around the U.S. The research team took each intervention point in turn and asked, "Do we have an example of a program that addressed this barrier at this intervention point, or could we imagine an activity that would do so, based on our knowledge of best practices?"

Table 4 shows an example barrier, the low end-user awareness of energy efficient products or their benefits, and the possible intervention points identified for each of the four product types. As the table shows for the low awareness barrier, and as proved true for the majority of barriers, intervention points across the products tend to be similar and differ only based on distribution. For example, products distributed through contractor/installer channels (water heaters and pool pumps) will differ in their intervention points from products distributed primarily through retail channels (refrigerators and clothes dryers).

Table 4. Leverage Points by Product, for Barrier "End user awareness/knowledge of energy efficient products or benefits lacking"

Product Type	Intervention Point							
	Manufacture			Distribution			Other	
	Com-ponent Supplier	Manu-facturer	Brand	Whole-saler	Contrac-tor/ Installer	Retailer	End User	Govern-ment Agency/ Other
Refrigerator			X			X	X	X
Water heater			X		X	X	X	X
Pool pump			X		X	X	X	X
Clothes dryer			X			X	X	X

Step #3: Identify program design ideas. The team drew on the market characterization research and their own experience to compile a list of more than 20 program design ideas. Depending on the needs of the program administrator and a project's timeline and budget, a similar list could be based on any number of data collection activities – for example, a formal best practice study, in-depth interviews, or market actor surveys. The program design ideas identified for this project are likely not comprehensive, and different design ideas would likely have been arrived at had different data collection activities been undertaken.

A Microsoft Excel workbook was used to track barriers, intervention points, and program design ideas. A single worksheet was created to track the intersection of program design ideas, barriers, products, and intervention points. The program design ideas were listed in rows (each was described concisely; for example, "Co-funded marketing with retailers"). Products, barriers, and intervention points were listed in columns. The team completed the matrix by evaluating each design idea tracking, cell-by-cell, the barriers, products, and intervention points to which the strategy applied.

Step #4: Prioritize program design ideas. The team used the matrix to rank each the potential design idea for every product based on criteria established at the outset of the project and determined by the program administrators' priorities. The criteria included: the existence of other, successful program models; direct indication by process evaluation and market characterization findings; ease of evaluability; good savings attribution potential; low administrative costs; potential to include cooperation with other entities; and potential to include collaboration with ENERGY STAR.

The ranking process was quantitative and binary. Program design ideas received one point for each criterion met. Ideas were ranked based on their total scores, with additional consideration given to program design ideas that, in combination, would yield a well-rounded program, could be applied across multiple product categories to streamline implementation, and drew on the HEER program's existing strengths. The ranking process can be adapted to fit the needs of any program administrator; for example, using different criteria and/or weighting criteria to reflect increased importance. The criteria used in this project reflect some level of conservatism, with preference given to programs with existing program models or best practices.

In total, the team considered upwards of ten strategies for most of the products. They included the application of incentives at various points in the supply chain and a wide range of marketing and training activities.

Case Study: Refrigerators. The findings from the process evaluation and market research and the assessment of barriers resulted in a high-level program goal for each product. This goal, or strategy, was used to guide the implementation recommendations for the program design ideas. For refrigerators, the goal was to increase sales of the most efficient units. The team selected this goal because market data showed program-qualified (ENERGY STAR) units were being manufactured at most price points and had at least some availability at major retailers (although this could be improved).

The ranking process resulted in three recommended (and highest-ranking) program design ideas, one of which was the recommendation to use incentives to reduce the incremental cost of efficient products and increase availability, particularly for products priced under $1,000. The team advised that a more systematic study of incremental price be conducted and used to guide the amount of the incentive and the product models to which it was applied. In order to address the attribution concern (the HEER program has in the past suffered from high free-ridership rates), the team recommended limited-time incentives to allow statistical analysis of

sales data pre-, post-, and during the intervention to be used to calculate attribution, either in combination with, or instead of, participant self-reports (the approach used in the past).

The team also recommended incentives to retailers and/or brands for sales of ENERGY STAR refrigerators with an MSPR under $500, to encourage manufacturers to design more of these units and retailers to carry them. This program design idea could be based on the midstream and upstream model being implemented by the Business and Consumer Electronics (BCE) program, operated by several West Coast sponsors.

Reality Check: Evidence-Based Program Designs Meet Regulatory Hurdles

The systematic process described above yielded several recommendations for midstream and upstream program designs, and other interventions (like marketing support and education, and training for midstream players) whose energy savings would be challenging to attribute using the typical participant self-report and/or measurement and verification approaches. Most significant among the challenges are the regulatory hurdles to implementing some of the recommendations. Having discussed the research process, we now turn to a policy discussion of the challenges, and potential solutions to, the problem of savings attribution in midstream and upstream programs.

The Problem with Net-to-Gross, or Why Bad Evaluation Requirements Happen to Good Program Design Ideas

Energy program evaluation in California is guided by The California Evaluation Framework (the "Framework"), a document published in 2004 (TecMarket Works et al.). The Framework is a valuable resource for evaluators and has no doubt improved the quality of evaluation across the U.S. However, some program design ideas, such as some of those suggested by this study, cannot be accurately evaluated according to the methods described in the Framework. The energy efficiency industry and California policy makers thus face the challenge of updating evaluation processes to meet the demands of efficiency programs targeting midstream and upstream players. In the refrigerator market, for example, the findings suggest that midstream and upstream incentives could be effective at encouraging retailers to carry and sell low-priced efficient products. In the water heater market, the study found low availability to be a major barrier to increasing sales of ENERGY STAR gas storage water heaters. Included among the recommendations was the implementation of a midstream incentive to increase the stocking of these products by retailers and installers.

Given the contentious nature of previous midstream and upstream program evaluations, program staff were hesitant to include the midstream and upstream program strategies recommended by this study into their 2013-2014 Program Implementation Plans, and rightly so. No one wants to run a program that does not have a clear path to success.

Why Aren't We Good at Evaluating Midstream and Upstream Programs?

The Framework uses net-to-gross evaluation to understand what would have happened "in the absence of the program." There are two approaches evaluators use to get at this hypothetical situation. Free-rider self-reports, surveys in which evaluators ask program participants a battery of questions to determine how likely a participant would have been to purchase and install the identical measure, absent the program intervention. Comparison areas

are a second approach, in which findings in a geographical area with less utility engagement stands in for the hypothetical non-program scenario. But neither of these approaches are viable for midstream and upstream programs. Their "participants" (retailers and manufacturers) do not meet the necessary conditions for use of the free-rider self-report approach. Nor is the there an adequate comparison geographic area in the face of today's national and international product markets (particularly for products most amenable to midstream and upstream interventions) and the increasing prevalence of energy efficiency programs.[1]

The self-report problem. The self-report survey, while admittedly hard to do, is at least on its face, a reasonable approach when it comes to studying end-user decision-making. Evaluators *have* begun to question the accuracy and usefulness of free-rider estimates obtained in this manner (Friedmann 2007; Peters and McRae 2008). Nonetheless, questions like, Would you have purchased the same refrigerator, even if you hadn't received the $50 rebate?, *are* answerable, despite the potential for bias. Consumer purchase decisions are typically made by a limited number of people (me, me and my spouse) within a relatively brief period of time (an hour, over a few days), and, in most cases, consumers have no external motive to withhold the answers to these questions from an interviewer. Additionally, there are a sufficient number of respondents such that responses from a sample can be generalized to the population at large.

The challenges of using free-rider self-report surveys with a retailer and manufacturer population are numerous. The number of participants is tiny relative to end-user programs – fewer than five manufacturers and retailers hold at least 80% market share for most consumer products. Decisions made by retailers and manufacturers, like a retailer's assortment decision or a manufacturer's product design decision, should not be interpreted as a single decision, but rather a set of many interrelated decisions. The decision maker may not even be a single individual, although we lack the market knowledge to say for sure. Even if there is a single decision maker, it is unclear that evaluators will be able to gain access to him or her, and will certainly struggle to identify and interview every individual involved in the decision-making process. Finally, the decisions evaluators care about may be an area of competitive intelligence, aspects of which respondents are unwilling to reveal in sufficient detail for evaluators to estimate a definitive program impact.

Given these realities, what is it possible to know, and what are the appropriate research methods? In-depth qualitative interviews along the lines of free-rider self-report surveys are still valuable, just not towards the goal of producing a quantitative impact statement or net-to-gross percentage. These interviews can be used to present a nuanced, deeply qualitative understanding of how business decisions are made – a descriptive study of a market characteristic. The interviews – provided they are of sufficient number, with the appropriate respondents – may also be used to assess market impact. However, they will answer questions about program impact that start with "How?" and "Why?" rather than "How much?" As one author put it, evaluators and regulators must change their standard of judgment to ask not whether interventions had a sufficient impact, but whether their intervention was necessary (Friedman 2011). The type of evaluations that will result from this shift will produce findings that are harder to quantify and resist binary reductionism, but will more accurately capture a program's true work in complex markets and will be of greater use to program managers and regulators in improving designs and performance moving forward.

[1] As of 2011, utility and public-benefits funded efficiency programs and policies could be found in all but three U.S. states – North Dakota, West Virginia, and Alaska (ACEEE 2011b).

The comparison area problem. If typical self-report surveys fall short as an approach to quantifying the impact of midstream and upstream programs, it may be tempting to place all of one's evaluation eggs in the comparison area basket. However, the comparison area approach is premised on the existence of a similar comparison area, preferably a non-program geographic territory that exists in an energy efficiency vacuum. As program managers across the U.S. are learning, such areas may themselves be hypothetical. Interest in energy efficiency is high at all funding levels – federal, regional, state, and local. The energy efficiency block grants funded by the American Recovery and Reinvestment Act starting in 2009 brought efficiency rebates and awareness to several states that could previously have been considered relative efficiency deserts. In some cases, like the assortment of consumer electronics products at retail stores, a comparison area may never have existed, given the propensity of the dominant retail chains to make assortment decisions at the corporate level rather than store by store.

The small likelihood of finding a comparison geographical area does not mean all econometric analysis of program impacts must be disregarded. On the contrary, it requires some creative thinking about how to define the control or baseline group. These will be unique to each program. For a midstream program targeting retailers, for example, one could attempt to perform econometric analysis on product sales data longitudinally (before and after program specifications changed), at same-chain stores in and out of the program area, and based on store-level or local promotional activities. Each of these approaches may yield findings about the impact of various program activities on product sales. They will not help evaluate the assortment decision that lies at the heart of the program theory, but they may shed some quantitative light on matters of ultimate concern – the impact of the program on sales of energy efficient televisions.

The comparison approach may still be feasible, but it will not be easy. Sales and market data will be needed at levels of specificity and frequency not previously required. Detailed assessments of program activities will also be needed, tasking program managers with even more accurate recordkeeping. Intervention strategies will also need to be designed with econometric goals in mind. An approach to evaluation will need to be decided up front, when the program theory is first made explicit, and data collection instruments and agreements specified before the program goes into the field. Even if all the requirements can be met, econometric analysis will be challenging to implement with truly upstream programs, such as those seeking to impact product design, as there will never be a measurable non-program group. Brands design for national, even international, markets.

What to do in cases where no comparison area exists? Surely not drop this promising program design approach. One viable alternative is to take up the qualitative, contextual approach of in-depth interviews described above. Provided of course that evaluators and regulators can let go of the need for quantitative net-to-gross estimates.

Next Steps

The program design process is under way for the 2013-2014 program cycle. The utilities' program managers are working to incorporate some of the new design ideas that resulted from this study and thinking about how best to work with evaluators and the California Public Utilities Commission to update the methods and measurements that will be used.

For example, the findings of low uptake for the efficient water heater portion of the HEER program, combined with the knowledge that the HEER program's rebate was much smaller than most other water heater programs, led the program team to hypothesize that an increase in the incentive amount was merited. Research into international program design, combined with the high free-ridership assessment levied on previous HEER programs, suggested

to the project team that offering incentives for a limited time, as opposed to year-round, had the potential to increase uptake and improve evaluators' ability to measure impact using sales data.

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