Appliance Recycling Program Process Evaluation and Market Characterization Volume 1

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Southern California Edison
and
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EXECUTIVE SUMMARY

In California, the investor-owned electric utilities (IOUs)—Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E)—have participated in the statewide Appliance Recycling Program (ARP) for many years. Customers are offered a cash incentive to allow the IOU (through its contractor) to pick up a qualified refrigerator, freezer, or other appliance. The units are then dismantled and recycled in a prescribed, environmentally sound manner.

SCE and PG&E contracted with Cadmus to conduct a market assessment and process evaluation of the 2010-2012 statewide ARP. The two utilities specified three goals for this study:

- Conduct a process evaluation of the SCE and PG&E ARPs to benchmark processes and opportunities for improvements against existing program design and costs.
- Consider the validity of an alternative subprogram targeting second refrigerators/freezers.
- Measure performance against the ARP-specific Program Performance Metric (PPM), which relates to awareness, knowledge, and attitudes.

Cadmus addressed these goals by responding to the following set of research questions that established the study objectives:

- Has the program improved compared to findings from prior studies? How has it responded to prior evaluation recommendations?
- How has the market changed compared to previous market characterizations?
- What are the program implementation differences between SCE and PG&E?
- Why do households continue to increase the saturation of second refrigerators and freezers and how do they use them? Would they be willing to part with them?
- What enhancements, if any, should the IOUs make to the core ARP? Should the program also recycle other appliances?
- Should there be a subprogram targeting second refrigerators and freezers? If so, how should it operate?
- What is the baseline or difference in the awareness/knowledge/attitudes (AKA) for the program compared to the past?
- What are the non-energy benefits associated with the ARP?

ES.1 Methodology

This project encompassed a very extensive scope requiring multiple research methods and thorough analysis and integration of the findings. In the data collection phase, Cadmus built upon existing data to establish the context for subsequent findings and to identify any trends over time. To support the core research, we performed the following activities:

- Literature review of program documents, previous evaluations, and evaluations of other ARPs
- Implementer and utility data review

- Participant telephone survey[1]
- Canceler telephone survey[2]
- Appliance nonparticipant disposer telephone survey[3]
- Second appliance owner telephone survey[4]
- Stakeholder (e.g., program implementation staff) interviews
- Market actor (e.g., appliance retailer) interviews
- Secondary data collection, including statewide macroeconomic/demographic statistics

For the primary research, Cadmus developed instruments for use in the surveys and interviews. We fielded telephone surveys with participants and cancelers using tracking data provided by the program implementers; we fielded surveys of appliance nonparticipant disposers and second appliance owners using random digit dialing (RDD). We conducted some stakeholder and market actor interviews in person and others via telephone.

Cadmus assessed the process performance of the 2010-2012 ARP after analyzing the results from the secondary data and information review, surveys, and stakeholder interviews. We used data from all study components to analyze the ARPs' place in the market and conducted this analysis in three parts—a second appliance user profile analysis, a market characterization, and market diffusion modeling. The final core component of this project was to develop and run a model through which we ascertained the likely impact of a subprogram targeting second units.

In addition to these core research activities, Cadmus performed the following studies to support the utilities' overall study goals and research needs:

- Literature review of other ARPs: to inform the IOUs about possible enhancement to their ARPs.
- Inclusion of other appliances: to explore the viability of expanding the ARPs to also recycle other appliances (such as room air conditioners, dehumidifiers, clothes washers, clothes dryers, and consumer electronics).
- Quantification of non-energy benefits: to develop a comprehensive list of non-energy benefits that could credibly be attributed to the ARPs.

[1] A participant is a customer who recycled at least one refrigerator or freezer through the 2010-2012 ARP.

[2] A canceler is a customer who makes then cancels an appointment for an appliance pickup.

[3] A nonparticipant disposer is a customer who disposed of a refrigerator or stand-alone freezer within the past four years outside of the SCE or PG&E ARP.

[4] A second appliance owner is a customer who owns a working refrigerator (excluding very small or under-counter refrigerators) or stand-alone freezer in addition to the main refrigerator in the customer's kitchen. Customers who participated in the 2010-2012 ARPs were excluded from the second appliance owner sample.

ES.2 Major Findings and Conclusions

ES.2.1 Market Characterization

Effective implementation of the ARP requires an understanding of the households and decision makers targeted by the program. Through the market characterization we found:

- Since 2000, median household income in PG&E's and SCE's service areas has been relatively flat, varying between $50,000 and $60,000 (2010 dollars). The percentage of households below the poverty level has been consistently higher in SCE's territory than in PG&E's.
- Survey respondents in SCE's area are two to four times more likely than those in PG&E's area to live in multifamily units.
- Since 2000, SCE customer household average size has been fairly constant at around 3.1 persons. The average household size in PG&E's service area has been about 2.8 people.
- Statewide stock of residential refrigerators and freezers has increased steadily since 2000, peaking in the 2003 to 2005 period.
- Close to 43,500 refrigerators and roughly 3,600 freezers were recycled through SCE's 2012 ARP. These units represent about 16.3% of all working refrigerators and 6.5% of all working freezers disposed in SCE's service area in 2012.
- Roughly 16,400 refrigerators and close to 2,050 freezers were recycled through PG&E's 2012 ARP. These units represent about 8.3% of all working refrigerators and 3.6% of all working freezers disposed in PG&E's service area in 2012.
- The ages of appliances recycled through the ARPs have been declining over time, while the appliances' sizes have increased slightly.
- Nearly all units recycled were used year-round.
- Most participants disposed of primary refrigerators, rather than second units.
- Approximately 90% of respondents who disposed of an appliance replaced it with another unit.

Specific findings related to second appliances included the following:

- Second appliance ownership was around 30% for both participant and nonparticipant disposers. In both service areas, second appliance owners are less likely to live in multifamily housing.
- The most common reason for having a second appliance was "large family/need for extra space." The next two most common reasons were "buy in bulk" and "separate storage for beverages." For these reasons, it may be challenging to increase the quantity of second units recycled.
- In SCE's area, the proportion of replacement units purchased used was 20% for participants and 10% for nonparticipants, indicating an active used appliance market. For PG&E respondents, the used appliance market was less active: 9% of both the participants' and nonparticipant disposers' replacements were purchased used.
- Compared to ARP participants, nonparticipant second appliance owners were more likely to use their second units year-round, keep them nearly 70% full, and have larger families. Thus,

nonparticipants' second appliances likely consume more energy than the participants' units and the nonparticipants likely have a greater need to keep their second appliances.

- Because most second appliance owners bought their second units new (and therefore attach some value to their second units), they may be reluctant to dispose of their second appliances.

ES.2.2 Process Evaluation

Based on our review of recommendations from prior process evaluations, we found both SCE and PG&E had implemented recommendations from the 2004-2005 statewide evaluation, which led them to prioritize the removal of second refrigerators and to conduct research on the use of second refrigerators. Both IOUs also implemented retailer trials with Sears in 2010 in response to earlier recommendations. In addition, as recommended by the evaluation of SCE's 2006-2008 ARP, SCE took a substantial step to reduce pickup time by implementing the Enerpath logistics system .For the 2006-2008 program, this change resulted in reducing the average number of days between scheduling and pickup from ten (in 2006 and early 2007, prior to introduction of the system) to seven (from mid-2007 through 2008, once the Enerpath system was implemented). The wait time for the SCE program was further reduced during 2010-2012 when, on average, appliances were picked up four days after scheduling. However, SCE does not appear to have implemented the recommendation from the 2006-2008 evaluation that it increase the number of categories it uses to group appliances. This recommendation was intended to facilitate comparisons across program years.

During the 2010–2012 program cycle, SCE recycled 181,037 refrigerators, close to its goal of 184,800 units. SCE recycled 15,397 freezers, which was only about 60% of its freezer goal of 25,200 units.

During its 2010-2012 ARP, PG&E recycled 55,914 refrigerators, meeting a little more than half of its goal of 104,554 refrigerators. PG&E recycled fewer than half of the 16,269 freezers it had targeted, with 7,153 freezers recycled.

SCE staff reported two of the program's most important achievements have been the continuation and implementation of program enhancements and more stringent oversight during the program's long duration. SCE and PG&E staff said their biggest challenge is keeping the ARPs cost-effective, especially as the baseline for measuring savings has increased. Although some regulators and other stakeholders believe the market has been transformed since the program's implementation, SCE and PG&E interviewees believe use of rebates and education is still needed to remove inefficient units from the market.

Utility staff reported they are satisfied with established internal communications at their respective organizations, as well as with the performance of program implementers (JACO, ARCA, and Enerpath).

Retailers played a significant role in informing participants about the program; almost all participants in both areas reported retailers told them about the programs. However, since only 17% of SCE nonparticipants and 24% of PG&E nonparticipants said retailers told them about the ARPs, there is room

for strengthening retailer outreach. These differences demonstrate the important role retailers can play in promoting the program.

The program induced many participants to dispose of their appliance; roughly 25% of participants had not considered disposing of their appliances before hearing about the program. The primary reasons customers chose to participate were convenience and the incentive. In addition, two-thirds of participants who were knowledgeable about the environmental benefits of the program said environmental benefits had "a lot" of influence on their decision to participate. Participant satisfaction with the program in both utility areas was very high and consistent with past findings. The 2010-2012 participants reported slightly more, but statistically significant, positive experiences with the programs in comparison to the 2004–2005 participants.

Cancelation rates declined from those in previous years. SCE's average cancelation rate for the 2010-2012 program was 16% and PG&E's was 12%. This is in contrast to SCE's average cancelation rate of 19% during the 2006-2008 program, and the statewide average cancelation rate of 20% during the 2004-2005 program. Among SCE customers, reasons for cancelation remained similar to those reported in the 2006-2008 evaluation, with the unit not qualifying for the program being the most frequently cited reason. Thirty-six percent of PG&E cancelers reported issues with scheduling as the reason for their cancelations, compared with 18% of SCE cancelers.

Nonparticipant disposer awareness of the ARPs was consistent with levels found in the 2004-2005 evaluation: 56% for SCE and 36% for PG&E. However, this is a decrease in nonparticipant disposer awareness from SCE's 2006-2008 evaluation, when awareness was 70%. A substantial portion of nonparticipants who were aware of the programs (74% for SCE and 66% for PG&E) would have been more inclined to use ARP if they received higher incentives. Nonparticipants reported a variety of reasons for not participating in ARP: around 30% cited using a retailer pickup service as the reason for not participating. When told about the environmentally safe disposal practices of the ARP, about two-thirds of nonparticipant disposers said the program practices would make them much more likely to participate in the future.

Although a majority of second appliance owner respondents reported they would be very likely to participate when needing to dispose of their appliance, most would require an incentive of $75 to $95 to do so.

Most respondents to all of the surveys knew of the energy costs of appliances and environmental risk of improper disposal. They were more likely to know that refrigerant can be harmful to the environment than they were to know the cost of continuing to operate a refrigerator. Participants were more likely than nonparticipants to know of the harmful effects of refrigerants.

ES.2.3 Alternative Subprogram

Based on our research, Cadmus presents the following findings and conclusions about the proposed subprogram that would specifically target second appliances:

- Second appliance owners appear more aware of the cost of operating their current units than current ARP participants so appealing to the benefits from reducing this cost may provide an effective strategy for marketing the subprogram.
- Significant technical potential still exists for growth in the core program and subprograms. The core programs appear to be in decline and would require design changes to realize their full potential. A targeted subprogram could potentially recruit 3% to 10% of second appliances to be recycled under a subprogram using reasonable incentive and pickup times.
- Our analysis suggests that a targeted subprogram could be cost-effective, even under an aggressive design.

ES.2.4 Literature Review

Key findings and conclusions from the literature review of multiple utility ARPs include the following:

- SCE's peak harvest rate (2008, 2009) exceeded the rates of the other 11 utilities, except two. SCE's rate has been about two to three times the rate for PG&E.
- Innovative approaches employed by other utilities included targeted direct mail marketing based on customer segmentation analysis, bulk pickup of units from multifamily complexes in conjunction with property owners and managers, and inclusion of energy saving kits as an incentive.
- Programs focused on second units could be cost-effective but challenging to implement.
- Incentives have ranged from zero to $50 per unit; increases to incentives typically resulted in increased participation.
- Assumed measure lives for the California IOU programs from Database for Energy Efficiency Resources (DEER) have declined significantly since 2005. Measure lives used in ARPs outside of California are typically longer.
- The methodology used to calculate unit energy savings for the California ARP leads to the lowest savings estimate of all programs reviewed, except one.
- NTG values for California's ARPs are similar to those calculated for other programs.
  - NTG ratios increase as programs mature.
  - Programs with higher incentives also tend to have higher NTG ratios.
  - Programs accepting primary refrigerators tend to have higher levels of freeridership (and thus lower NTG ratios). However, programs accepting only second units generally have lower levels of participation, since fewer households are eligible to participate.
- The most recent total resource cost (TRC) for the California IOU programs is less than for any of the other programs reviewed. The cause of the smaller TRC is driven by differences in estimated savings, NTG, and measure life, among other factors.

ES.2.5 Inclusion of Other Appliances

Based on our research into the viability of including other appliances in the ARPs, we found:

- Room air conditioners (RACs), dehumidifiers, and set-top boxes do not appear to be good recycling program candidates.
- Televisions, personal computers (PCs), and monitors do not appear to be viable candidates for recycling due to logistical and technological reasons.
- Clothes washers may be moderately good candidates for an ARP-type program in both service areas.
- Clothes dryers appear to be a potentially viable candidate for a program in the PG&E area.

ES.2.6 Non-Energy Benefits

The ARPs produce a number of environmental and economic benefits that go beyond energy savings. Key findings and conclusions with regard to such non-energy benefits are these:

- Based on medium-scenario values for inputs, the combined gross environmental benefits of the ARPs for the 2010-2012 cycle were $23.9 million.
- Under the same scenario, the net environmental benefits were $10.5 million.
- SCE's net program environmental benefits ranged from 12% to 48% of the its program's average implementation cost per unit in 2012, and PG&E's net program environmental benefits ranged from 7% to 28% of the its program's average unit implementation cost. If included, these benefits could have a significant effect on the both programs' cost-effectiveness.
- The net employment effect of the ARPs was the creation of 171 job-years under the SCE program and 67 job-years under the PG&E program.
- The value added to each region's economy from the programs was $18.7 million for SCE and $5.0 million for PG&E.
- Per program dollar spent, each program contributed a net of $0.55 to $0.58 to the local economy.

ES.3 Recommendations

By most measures, the utility ARPs are well-implemented and well-received. However, their survival is at risk because of concerns raised by some observers that the market for environmentally sound appliance recycling may have been nearly transformed and the apparent cost-effectiveness of the programs is marginal. Our analysis of the 2010-2012 cycle has shown that there is still substantial participation potential for recycling refrigerators and freezers. In addition, there is little evidence that the market would completely implement environmentally sound recycling in the absence of the program. Our recommendations for the core program focus on ways to enhance cost-effectiveness:

- Marketing should continue to stress the convenience offered by the program.
- Messaging should also continue to focus on both the cost savings from removing an inefficient appliance and the environmental benefits of recycling through the ARP.
- The utilities should design and implement a pilot that temporarily establishes a higher incentive in order to assess the effect on participation and cost-effectiveness. The pilot could emphasize

convenience and the higher incentive, and it could target customers likely to sell their used appliance to other individuals.

- As general awareness of climate change, California's greenhouse gas programs, and concepts such as the carbon footprint increases, the utilities could use messaging about environmental benefits to educate customers and inform them of these specific program benefits.
- Environmental messaging also should include information about how the program reduces material going to the landfill.
- The utilities should continue to use direct mail for marketing purposes and should explore targeting based on segmentation analysis.
- The utilities should continue to work with retailers to encourage them to inform appliance buyers about the ARP.
- The utilities should expand the retailer pilot program to include other retailers and refine the retailer program based on lessons learned from the initial pilot.
- The IOUs should consider partnerships with other organizations that could benefit from appliance recycling, such as government agencies that have an interest in the non-energy environmental benefits attributable to appliance recycling and regional water districts that could realize benefits from recycling less water-efficient clothes washers (should the programs be expanded to include other appliances).

Our key recommendations for modifying the core program or implementing subprograms are:

- The IOUs should develop a pilot second appliance subprogram, marketing it separately as a pledge by participants to give up their second appliances. It should incorporate some form of follow-up visit linked to an incentive to verify that the participant has not purchased a replacement second unit.
- SCE should consider designing and implementing a multifamily bulk pickup program.
- Both IOUs should examine ways to increase recycling of freezers, as their savings potential is relatively large.
- Both IOUs should explore the logistics, costs, and benefits of including clothes washer recycling in their ARPs. PG&E should also investigate the logistics, costs, and benefits of including clothes dryers in its program.

Based on the calculated TRC, the current cost-effectiveness of the California IOUs' ARPs is marginal at best, very sensitive to key inputs, and excludes the non-energy benefits resulting from comprehensive recycling. Cadmus' offers these additional recommendations that may improve cost-effectiveness.

- The IOUs should refine the non-energy benefits calculated in this study and work with the California Public Utilities Commission (CPUC) on an approach for incorporating the non-energy benefits in the cost-effectiveness analysis of the ARPs.
- The IOUs should conduct research to derive improved estimates of the key inputs to the program cost-effectiveness calculation, including remaining measure life.

We offer two recommendations involving research and tracking data:

- SCE should record appliance age as a numeric value, not a category.
- The IOUs should continue research on the disposal of appliances outside the ARP because these units constitute the program potential.

1 OVERVIEW AND INTRODUCTION

1.1 Background

Refrigerator recycling programs have existed since the 1970s. Pacific Gas and Electric (PG&E) partnered with the Salvation Army in the late 1970s to pioneer one of the first such programs. Southern California Edison (SCE) implemented its first full-year program in 1994. Since then, utilities across the country have conducted similar pilot or full-scale programs. The underlying objective of the programs was to take inefficient, older refrigerators out of service to reduce electricity loads and to recycle the units in a way that reduced the amount of materials going to landfill and minimized damaging materials going into the environment. Over the years, different variations of the basic program concept have been implemented, including the addition of other appliances, and the programs are now generally referred to as Appliance Recycling Programs (ARPs).

In California, the investor owned utilities (IOUs)—PG&E, SCE, and San Diego Gas and Electric (SDG&E)—have participated in the statewide ARP for many years. Customers are offered a cash incentive to allow the IOU (through its contractor) to pick up a qualified refrigerator, freezer, or other appliance. The units are then dismantled and recycled in a prescribed, environmentally sound manner.

SCE and PG&E contracted with Cadmus to conduct a market assessment and process evaluation of the 2010-2012 statewide ARP. Significant changes have occurred in the market affected by the ARP over the years including shifts in demographics, changes in awareness and attitudes about energy efficiency and environmental impacts, changes in behavior (such as ever increasing saturation of second refrigerators and freezers), and changes in the characteristics of consumer appliances. In addition, the ARP itself has had substantial effects on the market by making increasing numbers of customers aware of the program and removing large numbers of targeted appliances. These changes have made it important to conduct the current study to not only analyze the current ARP and compare it to prior ARPs, but also to look at possible revisions in how the ARP is implemented and assessed going forward.

1.2 Overview of Appliance Recycling Program Process Evaluation and Market Characterization

1.2.1 Objectives

The utilities specified three goals for this study:

- Conduct a process evaluation of the SCE and PG&E ARPs to benchmark processes and opportunities for improvements against existing program design and costs.
- Consider the validity of alternative subprogram designs (e.g., a second refrigerator/freezer subprogram).
- Measure performance against the ARP-specific Program Performance Metric (PPM), which relates to awareness, knowledge, and attitudes.

Cadmus addresses these goals by responding to the following set of research questions that established the study objectives:

- Has the program improved in several specific areas compared to findings from prior studies?
- How has the market changed compared to previous market characterizations?
- How has the program responded to prior evaluation recommendations?
- What are the program implementation differences between SCE and PG&E?
- Why do households continue to increase the saturation of second refrigerators and freezers and how do they use them? Would they be willing to part with them?
- Should there be a subprogram targeting second refrigerators and freezers? If so, how should it operate?
- What is the baseline or difference in the awareness/knowledge/attitudes (AKA) for the program compared to the past?

1.2.2 Research Approach and Core Study Components

This project encompassed a very extensive scope requiring multiple research methods and thorough analysis and integration of the findings. Each chapter in this report and the separate appendices document provides details about the specific study methodologies and analyses. This introduction provides an overview of the methods and the core study components.

Data Collection

In the data collection phase, Cadmus reviewed the existing literature and data, designed a set of survey instruments and interview guides, and the conducted the surveys and interviews. We built upon existing data to establish the context for subsequent findings and speak to any trends over time. To support the core research, we performed the following activities:

- Literature review
- Implementer data review
- Participant telephone survey[5]
- Canceler telephone survey[6]
- Appliance nonparticipant disposer telephone survey[7]
- Second appliance owner telephone survey[8]
- Stakeholder (e.g., program implementation staff) interviews

[5] A participant is a customer who recycled at least one refrigerator or freezer through the 2010-2012 ARP.

[6] A canceler is a customer who makes then cancels an appointment for an appliance pickup.

[7] A nonparticipant disposer is a customer who disposed of a refrigerator or stand-alone freezer within the past four years outside of the SCE or PG&E ARP.

[8] A second appliance owner is a customer who owns a working refrigerator (excluding very small or under-counter refrigerators) or stand-alone freezer in addition to the main refrigerator in the customer's kitchen. Customers who participated in the 2010-2012 ARPs were excluded from the second appliance owner sample.

- Market actor (e.g., appliance retailer) interviews
- Secondary data collection

The secondary literature and data reviewed came from three main sources: previous literature, implementer/utility data, and statewide macroeconomic/demographic statistics. Our review process followed these general steps:

1. Reviewed all relevant prior studies, including the 2004-05 statewide market characterization, 2006-08 SCE process evaluation and market characterization, statewide RASS studies, and the current Program Implementation Plan (PIP). This information provided context for findings, guided survey and interview instrument development, and generated input data to trend analysis for various aspects of the study.
2. Compiled and reviewed raw implementer (JACO and ARCA) and utility data.
3. Summarized, by utility, over time, the following: program participation and appliance configurations, sizes, and ages.
4. Collected other relevant government or third-party data on macroeconomics and demographics across the region over time.

For the primary research, we prepared draft interview/survey instruments and received and responded to review comments. We then implemented the telephone surveys. The telephone surveys with participants and cancelers were conducted using tracking data provided by the program implementers. Surveys of appliance nonparticipant disposers and second appliance owners were conducted using random digit dialing (RDD).

Cadmus staff members familiar with the program theory and implementation of appliance recycling programs conducted the interviews. Some were conducted in-person, and others were conducted by telephone.

Analysis and Core Study Components

Given the extensive scope of this study, we employed multiple approaches to analyze the study data to address the research questions. The first step in the data analysis process was to summarize results from each of the data collection efforts.

Using the telephone surveys data, Cadmus summarized the following metrics and contrasted them with previous findings:

- Participant and nonparticipant demographics
- Participant decision-making processes
- Program awareness
- Program satisfaction
- Customer perceptions
- Motivations for second appliance ownership
- Nonparticipant disposal outcomes

- Participating appliance characteristics
- AKA of participants and nonparticipant disposers

Cadmus assessed the process performance of the ARP for the 2010-12 period after analyzing the results from the secondary data and information review, surveys, and stakeholder interviews. This assessment addressed the following issues:

- Program delivery
- Marketing and outreach
- Customer experience and satisfaction
- Barriers to implementation

We used data from across all study components to analyze the ARPs' place in the market. Our analysis comprised three distinct parts:

- ***Second appliance user profile analysis.*** This involved constructed profiles of second appliance owners with respect to demographics, socioeconomic status, geography, and attitudes. These profiles informed description of the potential impact of a subprogram targeting these customers, and provided insight into the future participation in the ARPs generally.
- ***Market characterization.*** This entailed a synthesis of all of our data collection efforts to create a picture of the current market (including the market for second appliances) and the ARPs' impact on the market for both primary and second appliances.
- ***Market diffusion modeling.*** We estimated market diffusion models using both primary and secondary data sources to provide a dynamic picture of how the ARPs have matured and estimate impacts of various programmatic and external factors.

The final core component of this project was to develop and run a model through which we ascertained the likely impact of a subprogram targeting second units. We estimated net and gross savings for such a program, as well as the expected cost-effectiveness. Examining various scenarios helped identify key program designs issues, program theory, inputs, and outputs.

1.2.3 Additional Study Components

In addition to the core research activities, Cadmus performed a set of additional studies to support the overall study goals and research needs of SCE and PG&E.

Literature Review of Other ARPs

To inform the IOUs about possible enhancements to their ARPs, we reviewed program design documentation, market assessments, evaluation reports, and other relevant documentation of successful utility-sponsored ARPs in other states. In addition to gleaning information about program designs, we examined how other ARPs incorporated positive and negative market effects into their savings and cost-effectiveness analyses. Cadmus documented the findings from this review.

Inclusion of Other Appliances

The IOUs were interested also in opportunities to include other types of appliances in their ARPs. Room conditioners have been included in some utility appliance recycling programs and replacing room air conditioners with more efficient new units and recycling the old units can provide the same type of benefits as refrigerator/freezer recycling programs: newer models consume less energy, and environmentally conscious recycling prevents refrigerants and toxic substances from entering the environment. Clothes washers and consumer electronics, such as televisions, are being recycled, but rarely through utility programs. Although older electronics are not necessarily less efficient than newer models, households may leave them plugged in, running or creating phantom loads, and they contain toxic materials that should be disposed of safely.

To explore expansion of SCE's and PG&E's existing ARPs to include such products, we did the following:

1. Reviewed the latest California residential appliance survey data to characterize the stock of such appliances.
2. Identified, reviewed, and documented relevant programs conducted by other utilities.
3. Reviewed energy and demand savings associated with the appliances and electronics under consideration for recycling.
4. Interviewed utilities and recyclers conducting such programs and reviewed program opportunities and options.
5. Interviewed government organizations involved in recycling, including the California Integrated Waste Management Board, to determine their policies, requirements, volumes, materials covered, and recommendations for utility programs.
6. Interviewed SCE and PG&E ARP staff about the option of including additional appliances.
7. Presented SCE and PG&E with an assessment of the various appliances that might be considered for inclusion in ARP.

Quantification of Non-Energy Benefits

Cadmus reviewed the utilities' methods for quantifying and monetizing the non-energy benefits associated with the ARPs. Cadmus spoke with the ARP implementation contractors and reviewed documents to develop a comprehensive list of non-energy benefits that could credibly be attributed to the ARPs. These included reductions in emissions of ozone-depleting substances (ODS) and greenhouse gases (GHG), and safe disposal of hazardous materials, the recycling of durable materials, and job creation.

The benefits of these actions are typically not quantified and included as program-induced benefits in cost-effectiveness analysis. Our review and updates to SCE's initial work in this area enabled us to demonstrate the potential effect of non-energy benefits on SCE's and PG&E's program cost-effectiveness.

In support of this effort, we also conducted site visits to the implementers' recycling centers to verify the decommissioning processes. Because this portion of the evaluation overlapped with the stakeholder

interviews, Cadmus incorporated facility process-related questions into stakeholder interviews described above.

Attribution of non-energy benefits to the programs was determined through a careful examination of the program counterfactual, combined with participant and nonparticipant survey data analysis.

1.3 Organization of this Report

We are presenting the results of this study in two volumes. This volume contains nine chapters in addition to this overview and introduction. The second volume contains appendices presenting detailed results from the four surveys we conducted, details on the subprogram analysis and non-energy benefits research, methodology and findings from the recycling facility process review (including site visits), and data collection instruments.

In this volume, Chapter 2 describes our literature review methodology and findings. Chapter 3 discusses the methodology used in the process evaluation and market characterization. Chapter 4 presents the process evaluation findings including AKA information for participants. Market characterization findings are presented in Chapter 5 and include survey results on recycling behavior and demographics. Chapter 6 presents our analysis and results related to a second appliance subprogram. Chapter 7 explores other appliances that might be considered for inclusion in the ARPs. Chapter 8 presents our assessment of non-energy benefits of ARP. The final chapter presents major study conclusions and recommendations.

2 LITERATURE REVIEW

2.1 Methodology

The California IOUs were among the nation's pioneers in offering refrigerator and freezer recycling programs to their customers. Other utilities have introduced appliance recycling programs (ARPs) to their energy-efficiency program portfolios over the years, often using the California IOUs' ARPs as models.

Cadmus conducted this literature review to inform SCE and PG&E of how ARPs outside of California have been designed to function successfully and cost-effectively. This effort involved reviewing program design documentation, market assessments, evaluation reports, and other relevant documentation from utility-sponsored ARPs.

Though the California IOUs' programs have been in operation longer than the other programs we examined, Cadmus found that the California IOUs' ARPs are similar in design to those offered elsewhere in North America. However, we observed a few differences between the metrics used by the California IOUs and those used by other utilities. The California IOUs used among the shortest measure lives, lowest unit-level savings, and lowest net-to-gross (NTG) assumptions of the ARPs we reviewed.

The results of our literature review are presented in the following sections:

- SCE and PG&E ARP histories
- Comparison of SCE and PG&E ARPs to other utilities' program designs, including comparisons of:
  - Program designs, implementation strategies, and program participation
  - Eligible measures
  - Program incentives
- Comparison of program cost-effectiveness inputs and results, including:
  - Program costs
  - Measure life assumptions
  - Evaluated energy savings
  - NTG calculations
  - Evaluated NTG ratios
  - Program cost-effectiveness results

2.2 Findings

2.2.1 SCE and PG&E ARP Histories

Inception

Refrigerator recycling programs have been in operation since the inception of demand-side management programs more than 30 years ago. The California IOUs were involved in early efforts to develop these programs, including a refrigerator recycling program in the late 1970s that they implemented in partnership with The Salvation Army. This early program accepted any refrigerator, whether working or not.[9] However, the IOUs quickly realized that accepting nonworking refrigerators reduced the program net savings, thereby reducing the program benefit/cost ratio. Utilities in other parts of the country emulated and refined this early ARP.

For over a decade, the California IOUs have continuously offered refrigerator and freezer recycling to their customers, though the programs have experienced many changes during this time, including changes in incentives, the inclusion/exclusion of different types of equipment, and changes in eligibility requirements.

Recent SCE and PG&E Programs

In order to highlight similarities and differences between SCE's and PG&E's respective program processes and impacts, Cadmus referred to SCE's and PG&E's ARP Websites for 2010-2012 program cycle information, and to the *Residential Retrofit High Impact Measure Evaluation Report* (HIM report) for 2006-2008 program cycle information. The overarching goal of both SCE's and PG&E's ARPs is to prevent the continued operation of older, inefficient appliances. They accomplish this by offering customers an incentive and free pickup service for the old unit. SCE and PG&E both use mass media, bill inserts, and earned media to disseminate information about the cost of operating older appliances and to encourage participation.

The 2006-2008 programs had three significant changes from prior programs:

1. ***Addition of room air conditioners:*** SCE and PG&E both added working, inefficient room air conditioners to the existing set of ARP appliances. This addition was suggested by the Program Advisory Group (PAG), and was based on market saturation and the potential for additional cost-effective, long-term, coincident peak demand reduction and energy savings. The addition of room air conditioners complemented the existing ARP portfolio and supplemented the ENERGY STAR®-qualified room air conditioner rebate offered through other utility programs. SCE and PG&E implemented the room air conditioner pickups following the best practice model established through the Keep Cool Bounty Program offered by the New York State Energy Research and Development Authority.

[9] "Working" means the unit's compressor is functioning and the unit has the ability to cool.

PG&E still includes room air conditioners (and dehumidifiers) in their 2010-2012 ARP. SCE limited its 2010-2012 ARP to refrigerators and freezers, because 2006-2008 room air conditioner participation was very low and costly to administer. (SCE had administered their ARP through an early replacement turn-in event structure).

2. ***Eligibility expanded to include small commercial businesses:*** The PAG recommended expanding the 2006-2008 ARP to include office complexes and industrial buildings that use standard, residential-size refrigerators and freezers. In response, SCE and PG&E began offering program incentives to select nonresidential customers, including office complexes, industrial customers, schools, and municipalities. Both SCE and PG&E continue to accept residential-size refrigerators and freezers from nonresidential customers in their 2010-2012 ARPs.
3. ***SCE's ARP began using the Enerpath logistics system for scheduling appliance pickups.*** SCE introduced the Enerpath system in mid-2007 to reduce the number of days between when an appliance's pickup was scheduled and when the appliance actually got picked up.

The 2010-2012 ARPs closely mirrored the 2006-2008 ARPs with these exceptions:

- SCE discontinued room air conditioner recycling
- SCE's freezer recycling incentive was $35 (rather than the $50 incentive for 2006-2008)
- Both programs increased maximum eligible refrigerators and appliances to 32 cubic feet
- Both utilities explored "non-core" opportunities for their ARPs

JACO Environmental (JACO) implements the ARP on behalf of PG&E, and shares implementation responsibilities for the SCE program with The Appliance Recycling Centers of America, Inc. (ARCA). During the 2006-2008 program period, SCE and PG&E offered incentives for all eligible ARP measures, though they varied slightly by utility (Table 1).

Table 1. Incentive Levels by Measure and IOU

Utility	2006-2008			2010-2012		
	Refrigerator	Freezer	Room Air Conditioner	Refrigerator	Freezer	Room Air Conditioner
PG&E	$35	$35	$25	$35	$35	$25
SCE	$35*	$50	$25	$35	$35	N/A

* SCE increased this incentive amount to $50 in 2008, which led to increased participation during that year.

Table 2 summarizes the 2006-2008 and 2010-2012 SCE and PG&E ARPs' performance.

Table 2. 2006-2008 SCE and PG&E ARPs' Program Performance

Program Performance Details	2006-2008		2010-2012	
	SCE	PG&E	SCE	PG&E
Number of Appliances*	220,112	116,582	196,434	63,769
Primary Unit Participation**	69%	62%	71%	70%
Second Unit Participation**	31%	38%	29%	30%
Number of days between scheduling and pickup	7***	N/A	4	11
Percentage of orders canceled	19%	N/A	16%	12%
Gross Portfolio Energy Savings	6.1%	3.0%	N/A	N/A
Gross Portfolio Demand Reduction	6.3%	2.9%	N/A	N/A
Weighted Average NTG	0.56	0.51	N/A	N/A

* For 2006-2008, this includes refrigerators and freezers: For 2010-2012 this also includes room air conditioners. Cadmus determined the number of units from the implementers' databases.

** Values are based on participant survey findings.

*** This value (7 days) is the average that applied after the Enerpath system was introduced in July 2007. Prior to the introduction of the Enerpath system, from January 2006 to June 2007, the average pickup time was 10 days. The average pickup time for the 2004-2005 program was 15 days.

2.2.2 Comparison of SCE and PG&E ARPs to Other Utilities' Program Designs

For Cadmus' literature review, we compared components of SCE's and PG&E's ARPs with components of other ARPs offered across North America. We reviewed our recent internal program evaluations, publicly-available program evaluations conducted by other professional organizations, and ARP-related papers from industry conference proceedings (full citations of these reports and papers are in the References section).

In total, we collected and compared information about the designs of 11 other utilities' ARPs over multiple program years (Table 3).[10] To supplement the historic program information found in our literature review, we conducted Web-based research to obtain information about the utilities' current program offerings. Currently, all but one of the programs are still in operation (the Northeast Utilities program has been discontinued).

[10] Where data were available, Cadmus included information from both older and more recent ARPs so that we could examine trends in program metrics over time.

Table 3. Appliance Recycling Programs Reviewed

Utility	State/Province	Program Years Reviewed	First Program Year
Ameren Illinois	Illinois	2009, 2010, 2012	2009
Commonwealth Edison	Illinois	2008, 2009, 2012	2007
Consumers Energy	Michigan	2010, 2012	2009
Massachusetts (National Grid, NSTAR Electric, Cape Light Compact, Western Massachusetts Electric Company)	Massachusetts	2009-2010	2009
Northeast Utilities (Connecticut Light & Power and United Illuminating)	Connecticut	2004*	2004
Ontario Power Authority	Ontario	2007, 2008-2009, 2010, 2012	2007
Pacific Gas & Electric	California	2004-2005, 2006-2008, 2010-2012	2002**
Pacific Power	Washington	2006, 2007, 2008, 2012	2005
PNM	New Mexico	2008, 2012	2006
Rocky Mountain Power	Idaho	2006, 2007, 2008, 2012	2006
	Utah	2006, 2007, 2008, 2012	2004
	Wyoming	2009-2010, 2012	2009
Salt River Project	Arizona	2009, 2012	2008
Snohomish Public Utility District	Washington	2006, 2012	2004
Southern California Edison	California	2004-2005, 2006-2008, 2010-2012	1994

* The Northeast Utilities program was discontinued, but both Connecticut Light & Power and United Illuminating continued implementing separate programs. Comprehensive information for those programs was not available.
** PG&E also operated an ARP in the 1980s.

Cadmus compared the following key program elements:

- Program design, implementation, and participation;
- Eligible measures; and
- Program incentives.

Program Design, Implementation, and Participation

All of the programs we reviewed were designed to decrease electricity consumption by encouraging customers—through education materials and financial incentives—to voluntarily recycle older, inefficient appliances. All of the ARPs target the residential sector. Only a few also allow small commercial customers to recycle residential-sized appliances (Ameren Illinois, Ontario Power Authority (OPA) in 2012, PNM in 2012, and PG&E and SCE).

Like SCE and PG&E, all of the sponsoring utilities contract with one of the two national appliance recyclers, JACO or ARCA, to disable, collect, and recycle the participating appliances in an environmentally sound manner.

Table 4 shows the total number of units collected for each of the utilities' programs. Program participation is contingent on many factors including the size of the utility's residential customer base, program marketing efforts, incentive amounts, among others. SCE's and PG&E's programs have among the largest volume. Starting with its 2008 program, SCE's ARP has also had one of the highest harvest rates (the total number of units recycled as a percentage of the number of residential customers). The only utilities that experienced higher harvest rates than SCE in recent years are Rocky Mountain Power in Utah and Pacific Power in Washington. The high level of participation in SCE's territory occurred during a major program marketing initiative, and SCE was able to shift additional funding to the 2006-2008 ARP to support this increased level of participation.

Table 4. Appliance Recycling Program Participation

Utility	Program Year(s)	Refrigerators	Freezers	Room A/Cs	Total	Residential Customers*	Harvest Rate**
Ameren Illinois	2009	2,752	1,096	N/A	3,848	N/A	N/A
	2010	7,762	3,422	27	11,211	1,049,264	1.07%
Commonwealth Edison	2008	8,438	3,076	465	11,979	3,439,455	0.35%
	2009	20,065	4,946	724	25,735	3,425,593	0.75%
Consumers Energy	2010	3,138	1,094	N/A	4,232	1,569,183	0.27%
Massachusetts	2009-2010	10,040	3,341	N/A	13,381	N/A	N/A
Northeast Utilities	2004	7,467	2,895	5,875	16,237	1,338,596	1.21%
Ontario Power Authority[†]	2007	36,172***	12,050	1,610	49,832	4,500,000	1.11%
	2010	48,887	16,584	2,351	67,822	4,636,355	1.46%
Pacific Gas & Electric[††]	2004	9,833	1,254	N/A	11,087	4,356,242	0.25%
	2005	13,216	2,076	N/A	15,292	4,388,140	0.35%
	2006	19,525	4,051	N/A	23,576	4,486,162	0.53%
	2007	42,655	7,288	N/A	49,943	4,544,498	1.10%
	2008	37,208	5,855	N/A	43,063	4,621,878	0.93%
	2009	26,473	3,818	265	30,556	4,574,196	0.67%
	2010	21,552	2,983	329	24,864	4,565,636	0.54%
	2011	17,945	2,123	275	20,343	4,574,094	0.44%
	2012	16,417	2,047	98	18,562	N/A	N/A
Pacific Power (WA)	2006	2,801	696	N/A	3,497	100,158	3.49%
	2007	2,160	460	N/A	2,620	101,245	2.59%
	2008	1,999	515	N/A	2,514	102,310	2.46%
PNM	2008	5,869	612	N/A	6,481	440,935	1.47%

Utility	Program Year(s)	Refrigerators	Freezers	Room A/Cs	Total	Residential Customers*	Harvest Rate**
Rocky Mountain Power (ID)	2006	615	179	N/A	794	53,148	1.49%
	2007	565	120	N/A	685	54,655	1.25%
	2008	515	184	N/A	699	55,818	1.25%
Rocky Mountain Power (UT)	2006	17,315	4,340	N/A	21,655	664,384	3.26%
	2007	17,689	4,141	N/A	21,830	681,587	3.20%
	2008	14,694	3,275	N/A	17,969	690,820	2.60%
Rocky Mountain Power (WY)	2009	738	158	N/A	896	107,777	0.83%
	2010	956	233	N/A	1,189	108,584	1.10%
Salt River Project	2009	3,829	838	NA	4,,667	851,755	0.55%
Snohomish Public Utility District	2006	2,532	1,207	N/A	3,739	281,749	1.33%
Southern California Edison†††	2004	44,740	5,537	N/A	50,277	4,034,569	1.25%
	2005	60,182	9,210	N/A	69,392	4,098,559	1.69%
	2006	59,590	9,578	N/A	69,168	4,166,496	1.66%
	2007	52,029	7,901	N/A	59,930	4,211,970	1.42%
	2008	80,215	10,606	N/A	90,821	4,231,943	2.15%
	2009	79,833	7,881	N/A	87,714	4,246,361	2.07%
	2010	66,952	5,779	N/A	72,731	4,269,757	1.70%
	2011	70,652	6,002	N/A	76,654	4,287,994	1.79%
	2012	43,433	3,616	N/A	47,049	N/A	N/A

* Source: Energy Information Administration.

** The harvest rate is the total number of units recycled as a percentage of the number of residential customers.

*** This number includes 919 smaller bar-style refrigerators and freezers.

† The 2,351 units shown in the "room A/Cs" column includes 1,233 room A/Cs and 1,118 dehumidifiers. The total number of residential customers in Ontario Power Authority's service area in 2010 was extrapolated from available data.

†† Source for refrigerator and freezer counts: implementer's database.

††† Source for refrigerator and freezer counts: SCE database.

Innovative Program Designs

Some of the innovative program design approaches being implemented for other ARPs across the country have these characteristics.

1. ***Targeted marketing campaigns:*** Commonwealth Edison (ComEd) used a direct-mail campaign that involved sending personalized letters and coupons to customers they targeted as being likely to have an appliance to recycle. ComEd identified these individuals using PRIZM software that was capable of profiling past ARP participants from ComEd's database. ComEd found that past participants had somewhat high education and income levels, and were considered empty-

nesters in specific communities. ComEd targeted customers who fit this profile in their ARP direct mailings. According to ComEd's PY2 evaluation report, their direct mail campaign had a 1.2% response rate, and was cited as the reason for the substantial improvement in ComEd's year-over-year harvest rate.

2. ***Inclusion of multifamily appliance pickups:*** Rocky Mountain Power and Pacific Power extended eligibility for their ARPs to apartment complex owners and managers who provided tenants with appliances. Renters were also eligible to participate as long as they owned the appliance being recycled. Although bulk pickups can increase participation, they can also require additional outreach and logistical efforts from program and implementation staff. (PG&E has also performed bulk pickups from multifamily and business customers.)
4. ***Inclusion of free energy-saving kits:*** In an effort to increase savings from their ARPs, Pacific Power and Rocky Mountain Power offered participants of programs in Idaho, Utah, Washington, and Wyoming a free energy-saving kit at the time of their appliance pickup. The kits included: two 13-watt compact fluorescent lamps, a refrigerator thermometer card, energy-savings educational materials, and information on other residential efficiency programs. They provided these energy-saving kits in addition to the financial incentives participants received for their appliances.

Eligible Measures

The key eligible appliances in all of the ARPs are residential refrigerators and stand-alone freezers. Select utilities—SCE (in 2006-2008), PG&E, Ameren Illinois (2010), ComEd, OPA, and the Northeast Utilities (2004)—include room air conditioners in their ARPs. In addition, OPA also includes dehumidifiers.

Table 5 lists the eligibility requirements for refrigerators and freezers recycled through the ARPs. Program eligibility is primarily dependent on appliance condition and size; some programs also use appliance age as an eligibility factor.

Table 5. Refrigerator and Freezer Eligibility Requirements

Utility	Program Year(s)	Condition	Minimum Refrigerator/ Freezer Age	Primary/ Secondary Restrictions	Size Restrictions (internal volume)
Ameren Illinois	2009 and 2010	Working/ plugged in	Prior to 1993	Secondary only	10 to 27 cubic feet
	2012	Working	None	None	10 to 27 cubic feet
Commonwealth Edison	2008-2011	Working	None	None	N/A
	2012	Working	None	Secondary only	10 to 30 cubic feet
Consumers Energy	2010	Working	None	Secondary only	Residential unit

Utility	Program Year(s)	Condition	Minimum Refrigerator/ Freezer Age	Primary/ Secondary Restrictions	Size Restrictions (internal volume)
	2012	Working	None	None	10 to 30 cubic feet
Massachusetts	2009-2010	Working	None	Secondary only*	N/A
Northeast Utilities	2004	Working	At least 10 years	Secondary only	At least 7 cubic feet
Ontario Power Authority	2012	Working	At least 15 years for refrigerators; at least 10 years for room air conditioners and dehumidifiers	None	10 to 27 cubic feet
Pacific Gas & Electric	2004-2005	Working	Prior to 1991	Secondary only	14 to 27 cubic feet
	2006-2008	Working / plugged in	None	None	10 to 27 cubic feet
	2010-2012	Working	None	None	10 to 32 cubic feet
Pacific Power (WA)	2006-2008	Working / plugged in	None	None	At least 10 cubic feet
	2012	Working / plugged in	None	None	At least 10 cubic feet
PNM	2012	Working	None	None	10 to 27 cubic feet
Rocky Mountain Power (ID)	2006-2008	Working / plugged in	None	None	At least 10 cubic feet
	2012	Working / plugged in	None	None	At least 10 cubic feet
Rocky Mountain Power (UT)	2006-2008	Working / plugged in	None	None	At least 10 cubic feet
	2012	Working / plugged in	None	None	At least 10 cubic feet
Rocky Mountain Power (WY)	2009-2010	Working / plugged in	None	None	At least 10 cubic feet
	2012	Working / plugged in	None	None	At least 10 cubic feet
Salt River Project	2009	Working	None	None	10 to 30 cubic feet

Utility	Program Year(s)	Condition	Minimum Refrigerator/ Freezer Age	Primary/ Secondary Restrictions	Size Restrictions (internal volume)
	2012	Working	None	None	10 to 30 cubic feet
Snohomish Public Utility District	2006	Working	N/A	None	10 to 27 cubic feet
	2012	Working	None	None	10 to 32 cubic feet
Southern California Edison	2004-2005	Working	Prior to 1991	Secondary only	14 to 27 cubic feet
	2006-2008	Working / plugged in	None	None	10 to 27 cubic feet
	2010-2012	Working	None	None	10 to 32 cubic feet

* Although this program's goal is the early retirement of second appliances, the evaluation found that 19% of refrigerators recycled through the program had most recently been used as the primary unit in the home.

Appliance Condition

All of the programs we reviewed only accepted appliances in working condition. Many also specified that the appliance must be plugged in at the time of pickup (or have been plugged in within 24 hours of being picked up). This enabled the appliance recycler to verify that the refrigerator/freezer was still functional.

Appliance Age

Refrigerator/freezer age is a key factor in determining how much energy can be saved by removing a unit from service. Newer appliances consume substantially less energy than older appliances. This is primarily due to increasingly stringent performance standards that have been placed on appliances over the past 30 years. The first set of federal efficiency standards applies to all residential refrigerators and freezers manufactured on or after January 1, 1993. A second set applies to units manufactured on or after July 1, 2001. These standards, coupled with voluntary ENERGY STAR standards that are stricter than the federally mandated minimum efficiency standards, have resulted in refrigerators today that consume as little as one-third to one-half of the electricity of units from 30 years ago.

Appliance age influences energy savings in two additional ways. First, as an appliance ages, its efficiency deteriorates, causing it to consume more energy than when it was new. Second, older appliances are likely to remain in operation for fewer years. Thus, age affects the measure life of a recycled appliance. This is especially important in jurisdictions that calculate a program's cost-effectiveness based on lifetime energy savings.

Although SCE's and PG&E's 2004-2005 ARPs, as well as Ameren Illinois' 2009-2010 and Northeast Utilities' 2004 ARPs, stipulated a minimum age requirement, none of these programs currently impose a

minimum age requirement. Of the utility programs Cadmus reviewed, only OPA still sets a minimum age eligibility requirement. Utilities with robustly cost-effective programs typically avoid restricting eligibility—with the exception that they require units to be operational—to maximize total program savings and customer satisfaction.

The effect of appliance standards is especially significant when considering second units. Primary refrigerators are typically located in kitchens and operate year-round. Second refrigerators and freezers are often stored in an unconditioned home area, such as a garage or basement, where they work harder to keep food cool in warmer months/climates. In some instances, second units operate for only part of the year and are only partially full. According to the U.S. Department of Energy (DOE), the prevalence of second refrigerators in U.S. households increased from 12% in 1984 to 22% in 2005.

In California, according to the 2010 Residential Appliance Saturation Survey (RASS), 24% of all residences had a second refrigerator.[11] This represented a substantial increase in the saturation of second units since the 2003 RASS, which estimated that 18% of households had a second refrigerator.

US DOE estimated that, nationally, 31% of second units are inefficient pre-1993 models. In contrast, they estimated that 16% of primary refrigerators are pre-1993 models (US DOE 2009). These estimates corroborate the California RASS finding that second refrigerators consume considerably more energy than primary refrigerators in single-family homes.

For this reason, several utilities limited program participation to second units. Two of the utilities—Ameren Illinois and Consumers Energy—initially limited program participation to second appliances, but have since eased those restrictions. Ameren Illinois' program was very cost-effective, and the utility determined that adding primary appliances would increase total savings without inordinately driving down cost-effectiveness. In 2012, only ComEd limited its program to second appliances. During Cadmus' interviews, ARP implementers commented on the difficulty of enforcing secondary-only restrictions. Such restrictions may encourage customers to be dishonest about their appliances' use, which places the appliance haulers in an uncomfortable position at the time of pick up.

Appliance Size

Currently, refrigerators and freezers in the 10 to 32 cubic-foot internal volume range are eligible for the SCE and PG&E ARPs. During the 2004-2005 program period, SCE and PG&E only accepted units in the 14 to 27 cubic-foot range.

The majority of other utilities' historic ARPs also required that appliances to be at least 10 cubic feet. In recent years, more utilities are specifying maximum as well as minimum appliance sizes. Most of the utilities with an upper limit require units to be no more than 32 cubic feet (presumably to prohibit the inclusion of commercial units).

[11] Saturation varied considerably by housing type in 2010, with secondary refrigerators found in: 33% of single-family homes, 18% of mobile homes, 14% of town homes, 10% of apartments in buildings with two to four units, and 5% of apartments with five or more units.

Program Incentives

Incentive Levels

Table 6 compares the utility ARPs' per-unit refrigerator/freezer and room air conditioner incentives. Recent ARP refrigerator/freezer incentives ranged from $0 for OPA's ARP, to $50 offered by Ameren Illinois, Consumers Energy, PNM, and Salt River Project. The other programs, including SCE's and PG&E's, offered $30 or $35 per appliance.

Table 6. Program Incentives for Recycled Refrigerators and Freezers

Utility	Program Year(s)	Refrigerator/ Freezer Incentive ($/appliance)	Room Air Conditioner Incentive ($/appliance)	Restrictions (annual)
Ameren Illinois	2009-2010	$35	$0	Up to two appliances
	2012	$50	N/A	None
Commonwealth Edison	2008-2009	$25	$25	Up to two appliances
	2012	$35	$10	Up to two appliances
Consumers Energy	2010	$35	N/A	Up to two appliances
	2012	$50	N/A	Up to two appliances
Massachusetts	2009-2010	$50	N/A	Up to two appliances
Northeast Utilities	2004	$50	$25	None
Ontario Power Authority	2012	$0	$0	One room air conditioner or dehumidifier, but only if also picking up a refrigerator or freezer
Pacific Gas & Electric	2006-2008	$35	$25	Up to two appliances
	2010-2012	$35	$25	Up to two refrigerators and/or freezers; one room air conditioner, but only if also picking up a refrigerator or freezer
Pacific Power (WA)	2006	$40	N/A	Up to two appliances
	2007-2008	$30*	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
PNM	2008	$30	N/A	None
	2012	$50	N/A	Up to two appliances
Rocky Mountain Power (ID)	2006	$40	N/A	Up to two appliances
	2007-2008	$30*	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
Rocky Mountain Power (UT)	2006	$40	N/A	Up to two appliances
	2007-2008	$30*	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
Rocky Mountain Power (WY)	2009-2010	$30	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances

Utility	Program Year(s)	Refrigerator/ Freezer Incentive ($/appliance)	Room Air Conditioner Incentive ($/appliance)	Restrictions (annual)
Salt River Project	2009	$30	N/A	Up to two appliances
	2012	$50	N/A	Up to two appliances
Snohomish Public Utility District	2006	$35	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
Southern California Edison	2006-2007	$35 for refrigerators; $50 for freezers	$25**	Up to two appliances
	2008	$50	N/A	Up to two appliances
	2010-2012	$35	N/A	Up to two appliances

* These incentives were reduced in mid-year 2007.

** The $25 room air conditioner incentive was contingent on the unit being replaced by qualifying new ENERGY STAR unit at an SCE-sponsored event.

With its Great Refrigerator Roundup Program, OPA picks up refrigerators, freezers, room air conditioners, and dehumidifiers for free, but has never provided a customer incentive for the units. Several OPA program stakeholders who were interviewed for an evaluation of the 2007 program (the program's first year) did not believe an incentive would be necessary. Nonetheless, program participation was greater than they had anticipated. Customers' participating in the OPA program did so for the convenience of the free pickup, or because of the environmental benefit of recycling.

As shown in Table 6, several utilities have varied their incentives over time. For example, Pacific Power and Rocky Mountain Power (in Idaho and Utah) reduced their program incentives from $40 to $30 in 2007 to improve the program cost-effectiveness. Several other utilities, such as Ameren Illinois and Consumers Energy, increased their incentives in an attempt to increase program participation. Consumers Energy saw a marked increase in participation after their July 1, 2012, incentive increase. Customers recycled 6,000 appliances in the first half of the year when the incentive was still $35, and by the end of 2012 had recycled an additional 16,000 appliances.

Quantity Restrictions

As shown in Table 6, almost all of the programs Cadmus reviewed limited the number of refrigerators and freezers that each customer could recycle through the program to two annually.

Incentives for Additional Appliances

Several utilities—Ameren Illinois (2010), ComEd, Northeast Utilities, OPA, PG&E, and SCE (2006-2008)—picked up operational room air conditioners for recycling; OPA also collected dehumidifiers. However, the utilities allowed such pickups only from sites where the recycler was already collecting a refrigerator and/or freezer.

Ameren Illinois and OPA provided no additional incentive to participants recycling an air conditioner, and OPA offered free pickup, but no incentive for recycled dehumidifiers. In contrast, ComEd (2008-2009) and Northeast Utilities offered participants a $25 program incentive for recycling a working room air conditioner, in addition to the $25 for their qualifying refrigerator or freezer (ComEd has since reduced its room air conditioner incentive to $10 per unit). In 2006-2008, SCE and PG&E offered $25 incentives for recycled room air conditioners. In 2010-2012, PG&E continued this incentive, but SCE did not offer an incentive for recycling room air conditioners.

2.2.3 Comparison of Program Cost-Effectiveness Inputs and Results

Each program, utility, and regulatory jurisdiction has unique costs, benefits, and analytical requirements that effect program cost-effectiveness. Without examining detailed cost-effectiveness inputs, it is difficult to understand the components of a program's total resource cost (TRC) test results. The many factors that affect a program's cost-effectiveness include the following:

- Participation level
- Program administration, implementation, and marketing costs
- Remaining measure life (or estimated useful life)
- Per-unit gross savings
- Freeridership and the resulting NTG ratio
- Avoided electric supply, transmission, distribution, and capacity costs
- Line losses
- Externalities, such as environmental benefits

The remainder of this section compares the cost-effectiveness input parameters used by the ARPs we reviewed (program participation levels and harvest rates were provided in Table 4 above). Since the procedures used to account for and categorize program costs vary widely by utility, we do not include a comparison of ARP in this discussion. Avoided costs and line losses were not readily available from the data sources we reviewed, and are therefore excluded from this discussion as well. After comparing SCE's and PG&E's input parameters to those of the other utilities, we present the TRC test ratios for each of the ARPs.

Measure Life Assumptions

For ARPs, measure life is an estimate of how long an appliance would have remained operational. Table 7 lists the assumed measures lives each of the utilities' used in its ARP cost-effectiveness analysis. As shown in the table, several programs (including the 2004-2005 SCE and PG&E ARPs) used measures lives in the 8-to-10 year range, though most programs' measure lives have been lowered in recent years. The other utilities that had available data used a five-year life. Like the 2006-2008 and 2010-2012 SCE and PG&E programs, Pacific Power and Rocky Mountain Power in Idaho and Utah based its five-year measure life on California's Database for Energy Efficiency Resources (DEER). Freezers and room air conditioners have shorter measure lives in many cases.

Table 7. Appliance Measure Life Assumptions

Utility	Program Year(s)	Refrigerator (years)	Freezer (years)	Room Air Conditioner (years)
Ameren Illinois	2009	N/A	N/A	N/A
	2010	N/A	N/A	N/A
Commonwealth Edison	2008	8	8	8
	2009	8	8	8
Consumers Energy	2010	N/A	N/A	N/A
Massachusetts	2009-2010	8	8	N/A
Northeast Utilities	2004	5	5	3
Ontario Power Authority	2007	9	8	4.5
	2010	5	4	3
Pacific Gas & Electric*	2004-2005	10	10	N/A
	2006-2008	5	4	3
	2009	5	4	3
	2010	5	4	3
	2011	5	4	3
Pacific Power (WA)	2006	5	5	N/A
	2007	5	5	N/A
	2008	5	5	N/A
PNM	2008	N/A	N/A	N/A
Rocky Mountain Power (ID)	2006	5	5	N/A
	2007	5	5	N/A
	2008	5	5	N/A
Rocky Mountain Power (UT)	2006	5	5	N/A
	2007	5	5	N/A
	2008	5	5	N/A
Rocky Mountain Power (WY)	2009	8.5	8.5	N/A
	2010	8.5	8.5	N/A
Salt River Project	2009	N/A	N/A	N/A
Snohomish Public Utility District	2006	8	8	N/A
Southern California Edison*	2004-2005	10	10	N/A
	2006-2008	5	4	3
	2009	5	4	3
	2010	5	4	N/A
	2011	5	4	N/A

* Cadmus obtained these measure lives from DEER.

Evaluated Energy Savings

Evaluated gross and net savings can vary based on the numerous inputs for each value, as well as on the methodologies used to derive them. The key parameters for measuring gross savings are:

1. ***Unit-Level Annual Energy Consumption:*** This is determined from one or more of the following data sources: a sample of appliances monitored within homes (*in situ* metering), lab tested appliances (metering based on the DOE appliance testing procedure), and/or engineering estimates using the characteristics (e.g., appliance size, configuration, and model year) of appliances collected through the program. Energy-savings estimates may incorporate degradation factors to account for older equipment that no longer operates as efficiently as when it was new, as well as interactive effects.
2. ***Measure Verification:*** Participants are typically surveyed to verify their participation in the program and key details about their recycled appliances (e.g., unit type, pickup date).
3. ***Part-Use Factor:*** Most methodologies apply a part-use factor (typically based on survey response data) that converts annual energy consumption into gross savings by estimating how many years appliances would have operated had the recycling program not existed.

Cadmus compared the gross unit average energy savings used by ARPs across North America, shown in Table 8. All of the values shown in table were adjusted for part use. With the exception of OPA's 2007 savings values (which were subsequently revised upward) and Massachusetts' 2009-2010 values, SCE's and PG&E's 2010-2012 appliance average unit energy savings are the lowest of those we reviewed.

Table 8. Gross Unit Average Energy Savings

Utility	Program Year(s)	Refrigerator (kWh/unit)	Freezer (kWh/unit)	Room Air Conditioner (kWh/unit)
Ameren Illinois	2009	1,522	1,247	N/A
	2010	1,467	1,331	N/A
Commonwealth Edison	2008	1,420	1,196	80
	2009	1,757	1,715	80
Consumers Energy	2010	939	1,011	N/A
Massachusetts	2009-2010	755	658	N/A
Northeast Utilities	2004	1,383	1,181	53 with replacement; 191 without
Ontario Power Authority	2007	605	470	N/A
	2010	1,126	1,045	371
Pacific Gas & Electric	2004-2005	1,647	N/A	N/A
	2006-2008	1,130	N/A	N/A
	2009	848	874	N/A
	2010-2012	848	874	N/A
Pacific Power (WA)	2006	1,556	1,513	N/A
	2007	1,454	1,441	N/A
	2008	1,461	1,399	N/A

Utility	Program Year(s)	Refrigerator (kWh/unit)	Freezer (kWh/unit)	Room Air Conditioner (kWh/unit)
PNM	2008	1,306	1,548	N/A
Rocky Mountain Power (ID)	2006	1,332	1,467	N/A
	2007	1,482	1,462	N/A
	2008	1,431	1,439	N/A
Rocky Mountain Power (UT)	2006	1,426	1,503	N/A
	2007	1,311	1,238	N/A
	2008	1,242	1,290	N/A
Rocky Mountain Power (WY)	2009-2010	1,158	900	N/A
Salt River Project	2009	1,248	780	N/A
Snohomish Public Utility District	2006	1,340	1,340	N/A
Southern California Edison	2004-2005	1,656	N/A	N/A
	2006-2008	1,087	N/A	N/A
	2009	737	917	N/A
	2010	737	917	N/A

Net-to-Gross Calculations

The NTG adjustment for ARPs typically discounts program savings to reflect the fact that some participating appliances would have been removed from service in the ARP's absence. NTG ratios for ARPs tend to be rather low—sometimes lower than 50%—resulting in diminished program energy savings.

As a program matures and the market it serves changes over time, the NTG ratio changes as well. Furthermore, over time, evaluators have refined and adjusted their approaches to measuring NTG for ARPs, resulting in some confusion over how specific NTGs were calculated. This section presents the results of information Cadmus compiled about some of the factors that contribute to changes in a program's NTG ratio.

The key parameters for determining net savings typically include:

- ***Freeridership:*** Freeridership represents the portion of participating units that would have been removed from service even in the program's absence. It is determined through analysis of participant and nonparticipant survey response data.
- ***Spillover:*** Spillover reflects any additional energy savings resulting from the customer's participation in the ARP. It is determined through analysis of the participant survey response data.
- ***Replacement:*** Replacement reflects a reduction in savings due to a participant replacing their appliance as a direct result of their participation in the ARP. Replacement is included in some more recent NTG analyses, and is determined through analysis of the participant survey data.

There are three ways that the program or parameters can change over time, ultimately affecting a program's NTG ratio:

1. Changes in appliance characteristics or changes in participant or nonparticipant behavior;
2. Changes in which parameters are included in the analysis; and
3. Changes in how one or more of the parameters are measured or estimated.

Evaluated NTG Ratios

As noted, many factors can contribute to variations in NTG over time or between programs, making direct comparisons across programs and jurisdictions difficult. Nevertheless, Cadmus compiled detailed NTG data from a variety of studies, and summarized findings of a meta-analysis that identified trends in NTG ratios among ARPs. Table 9 shows the evaluated NTG ratios used by ARPs across North America, drawn from publicly available studies conducted by Cadmus and other evaluators.

Table 9. Historical Evaluated NTG Ratios

Utility/Organization	Program Year	NTG Refrigerator	NTG Freezer	Evaluator
Ameren Illinois	2009	0.51	0.63	Cadmus
	2010	0.79	0.82	Cadmus
Commonwealth Edison	2008	0.70	0.83	Summit Blue
	2009	0.73	0.82	Navigant
Consumers Energy	2010	0.55*	0.55*	Cadmus
Focus On Energy	2008	0.57	N/A	PA Consulting
Massachusetts	2009-2010	0.69	0.59	NMR Group
Northeast Utilities	2004	0.84	0.79	NMR, RLW
Northern California Power Agency	2003	0.64	0.64	Robert Mowris & Associates
Ontario Power Authority	2007	0.48	0.50	Cadmus
	2008-2009	0.54	0.52	Cadmus
	2010	0.54	0.52	Cadmus
Pacific Gas & Electric	2004-2005	0.49	0.53	ADM Associates, Inc.
	2006-2008	0.51*	0.51*	(source: DEER 2011
	2010	0.51*	0.51*	Update)
Pacific Power (WA)	2006	0.60	0.56	Cadmus
	2007	0.62	0.63	Cadmus
	2008	0.67	0.57	Cadmus
PNM	2008	0.49	0.67	KEMA
Rocky Mountain Power (ID)	2006	0.67	0.48	Cadmus
	2007	0.53	0.40	Cadmus
	2008	0.51	0.60	Cadmus
Rocky Mountain Power (UT)	2006	0.68	0.69	Cadmus
	2007	0.62	0.63	Cadmus

Utility/Organization	Program Year	NTG Refrigerator	NTG Freezer	Evaluator
	2008	0.68	0.61	Cadmus
Rocky Mountain Power (WY)	2009-2010	0.57	0.58	Cadmus
Sacramento Municipal Utility District	2003	0.55	0.68	Heschong Mahone Group
	2006	0.58	N/A	ADM Associates, Inc.
Salt River Project	2009	0.61	0.71	Cadmus
San Diego Gas & Electric	2004-2005	0.52	0.76	ADM Associates, Inc.
	2006-2008	0.58	0.58	Cadmus
Snohomish Public Utility District	2006	0.52	0.52	Kevin L. Smit
Southern California Edison	1994	0.52	0.52	Xenergy
	1996	0.55	0.62	Xenergy
	2002	0.41	0.73	KEMA (Xenergy)
	2004-2005	0.68	0.72	ADM Associates, Inc.
	2006-2008	0.56*	0.56*	(source: DEER 2011 Update)
	2010	0.56*	0.56*	

* This is the combined or weighted average NTG across all types of appliances recycled.

Several observations can be drawn from the findings in Table 9:

- NTG varies greatly by utility, from a minimum of 0.40 (Rocky Mountain Power Idaho 2007) to a maximum of 0.84 (Northeast Utilities 2004).
- Considerable variation can occur from year to year within a given utility program.
- While some variation may result from different evaluators' favored approaches, (contingent, of course, on the direction provided by the utility or regulator), the variation in NTGs suggests no pattern related to the firm conducting the evaluation.
- On average among these studies, NTGs in California are not substantially different from those in other parts of the country.

Cadmus originally presented a meta-analysis of NTG results in a paper at the 2011 International Energy Program Evaluators Conference (IEPEC). Our analysis drew from a subset of the evaluation findings shown in Table 9 that contained reasonably complete and detailed data. This subset of programs shared evaluation methods that, although different in regard to specific wording and ordering of questions, were similar in logic and appropriate for comparison. For that IEPEC study, Cadmus used past NTG estimates to specify a regression model that predicted estimated NTG, subject to an array of explanatory variables related to the program and its participants. This regression allowed Cadmus to infer the most influential drivers of freeridership for ARPs. Two key findings from this meta-analysis may be of particular interest to SCE and PG&E:

1. Program maturity has a negative effect on freeridership. In other words, the longer a program exists, the lower the freeridership ratio. (Otherwise stated, more mature programs tend to have higher NTG ratios).

2. Incentive levels have a negative effect on freeridership. Programs with higher incentives also tend to have higher NTG ratios.

In a related study, Bushman, Kansfield, and Keeling (2011) examined the effect on NTG of restricting eligibility to second units. This research revealed that programs accepting primary refrigerators tend to have higher levels of freeridership (and thus lower NTG ratios). The tradeoff, however, is that programs accepting only second units generally have lower levels of participation, since fewer households are eligible to participate.

Program Cost-Effectiveness Results

Although SCE and PG&E's ARPs have been only marginally cost-effective in recent years, this has not been the case for other North American utility-sponsored ARPs, where program cost-effectiveness has remained well above 1.0. Table 10 lists the TRC test results of several of the compared programs. These results show that all of the programs Cadmus compared were cost-effective according to the analytical requirements of their respective jurisdictions. Cadmus' comparisons of the cost-effectiveness input parameters in the previous sections sheds some light on the *causes* of differing levels of cost-effectiveness. However, fully understanding the reasons for the TRC differences presented in Table 10 would require a careful review of all of the inputs.

Table 10. Cost-Effectiveness Ratios of Comparison Programs

Utility	Program Year(s)	Cost-Effectiveness Ratio (Standard TRC)
Commonwealth Edison	2008	2.58
	2009	3.06
Massachusetts	2009-2010	N/A
Pacific Gas & Electric	2004-2005	N/A
	2006-2008	N/A
	2010-2011	0.98
Pacific Power (WA)	2006	2.97
	2007	3.10
	2008	3.33
PNM	2008	2.61
Rocky Mountain Power (ID)	2006	2.02
	2007	1.85
	2008	2.00
Rocky Mountain Power (UT)	2006	2.43
	2007	2.34
	2008	2.51
Rocky Mountain Power (WY)	2009	2.67
	2010	3.15
Salt River Project	2009	1.59
Snohomish Public Utility District	2006	1.84*
Southern California Edison	2004-2005	N/A
	2006-2008	2.40
	2010-2011	1.46

* This program benefit/cost ratio was not specifically identified as being the result of a TRC test.

As noted above, Pacific Power and Rocky Mountain Power (in Idaho and Utah) reduced their program incentives from $40 to $30 in mid-2007 to improve the program's cost-effectiveness, which was successful (as shown in Table 10). Additionally, Pacific Power cut back on advertising for the 2007 and 2008 program years, which decreased program spending and increased the overall program cost-effectiveness.

3 PROCESS EVALUATION AND MARKET CHARACTERIZATION METHODOLOGY

Cadmus drew from numerous primary and secondary data sources in performing the process evaluation and market characterization study. This section describes all key sources of information, with additional methodological detail provided in subsequent sections.

3.1 Data Collection from Implementers' Databases and Utility Findings

Cadmus requested extensive historical data on program participation from implementers and from SCE and PG&E. Implementer tracking data included data from JACO, ARCA, and Enerpath. Additionally, we requested program materials and internal analysis from both IOUs. Cadmus reviewed all previous evaluation studies for both IOUs, including impact and process evaluations.

3.2 Interviews

In-depth interviews provided diverse perspectives on the ARPs, including IOU staff, implementer staff, and external market actors. In-depth interviewing involved conducting intensive interviews with a small number of respondents to explore their perspectives on the ARPs. In-depth interviews allowed Cadmus to collect detailed information about stakeholders' thoughts and behaviors, and provided context to other data (such as survey response data), offering a more complete picture of what happened in the ARPs and why. Cadmus developed detailed interview guides based on the research questions outlined in our research plan, and the IOUs approved interview guides prior to data collection.

3.2.1 Stakeholder Interviews

Cadmus conducted interviews with various program team members, including program managers, product managers, evaluation managers, and implementation contractors (at JACO, ARCA, and Enerpath). These interviews informed our analysis of program delivery, performance, and effectiveness.

We conducted in-depth interviews with program staff and implementation partners, exploring the following topics:

- Program history, design, and theory;
- Key program delivery aspects;
- Identification of targeted customers;
- Customer responses to program offerings;
- Program delivery issues, to date;
- Program role in implementer business models;
- Roles and responsibilities of staff and contractors;
- Lessons learned; and
- Recommendations for future efforts.

All interviews with IOU staff and senior implementation staff were conducted via telephone. Cadmus conducted several additional on-site interviews with implementation staff during the facility process reviews at JACO and ARCA's facilities.

3.2.2 Market Actor Interviews

Cadmus conducted interviews with market actors related to ARP. With input from the IOUs, Cadmus selected market actors in several key categories, including:

- New appliance retailers;
- Appliance disposal companies;
- Appliance manufacturers;
- Other utilities implementing ARPs; and
- Government agencies involved in tracking and regulating appliance disposal.

Cadmus' market actor interviews are listed in Table 11, according to the categories defined above.

Table 11. Achieved Market Actor Interviews

Interview Category	Organizations Interviewed	Individuals Interviewed
New Appliance Retailer	2	4
Appliance Disposal Company	6	6
Appliance Manufacturer	1	4
Other Utilities	2	2
Government Agencies	2	2

For retailers and manufacturers, Cadmus targeted the corporate officers involved in appliance recycling at the largest nationally influential companies – namely big box stores and major manufacturing companies. Cadmus' original research plan included a larger number of interviews with retailers and manufacturers. However, despite repeated attempts, only two major retailers and one major manufacturer were willing to perform interviews with us for this research. The reluctance of some companies to participate in interviews of this nature is a common barrier to performing market research for appliance recycling programs, and other evaluations both in California and other jurisdictions have encountered difficulty reaching a large number of willing interviewees who will discuss corporate policy and behavior with evaluators.[12]

Interviews aimed to identify characteristics of the used appliance market and ARP's role within this market, and to inform our development of a plausible program theory for alternative subprogram design. Interviews with appliance dealers and disposal companies also collected data on the life of

[12] As a partial remedy to this challenge, in addition to the interviews completed as planned, Cadmus conducted four additional calls to retail locations to enquire about services offered. These calls did not replace the interviews with additional big-box stores and manufacturers, but as we were not able to complete as many retailer interviews as planned, we opted to collect information about additional retailers through these calls.

nonparticipating appliances, including appliances collected by retailers through haul-away programs not affiliated with utilities. To improve our understanding of the recycling and disposal market's dynamics, the interviews also included questions regarding appliance disposal companies' business models.

Interviews with manufacturers aimed to whether and how considerations of recycling of used/disposed appliances, environmental concerns, and other life cycle analyses are included in the appliance design process. We collected data on manufacturers' perceptions of ARPs and on their impacts on the environment/landfilling.

3.3 Surveys

Cadmus conducted over 3,000 telephone surveys with SCE and PG&E residential customers. Cadmus subcontracted with the data collection firm Gilmore Research Group to conduct telephone surveys using their computer-assisted telephone interviewing (CATI) system.

Our team used information gathered through the kick-off meeting and stakeholder interviews to identify data requirements and to design process survey instruments that address all issues of interest. An extensive review of the survey instruments was also performed, gathering feedback and input from the IOUs, ED, and the statewide impact evaluation team. We submitted the draft participant survey instrument to the SCE and PG&E project managers and others specified for review, incorporating their suggested changes before pre-testing the survey instrument. Pre-test results and input from the utilities and other stakeholders were used to refine the survey instruments.

Table 12. Survey Completes

	Participant Survey		Canceler Survey*		Nonparticipant Disposer Survey		Second Appliance Owner Survey	
IOU	Target	Complete	Target	Complete	Target	Complete	Target	Complete
SCE	200	203	200	200	150	150	200	200
PG&E	200	200	200	200	150	152	200	200
Total, both IOUs	400	403	300	302	400	400	400	400

*Due to logistical limitations, Cadmus and the IOUs agreed to reduce the total target for the Canceler survey from the 400 originally planned to 300. However, the completed surveys for this survey still easily exceeded the 90/10 standard precision requirements.

All surveys included questions designed to inform our understanding of customer awareness, knowledge, attitudes, and behavior (AKA-B) regarding the program. These questions addressed customer awareness of ARP and its benefits, other IOU DSM programs, and energy efficiency in general, among other topics. We adopted the AKA-B battery from the 2011 General Population Survey Instrument, adapting questions to collect information specific to ARP, as necessary.

In order to minimize non-response bias, Cadmus instructed Gilmore Research Group to make up to five attempts to contact each customer, including calling at different times of day and different days of the week. Survey instruments were also designed including measures to reduce bias, such as reading

response options in a random and rotating order when necessary. Gilmore Research Group's interviewers were trained to read questions *verbatim*, and offered response options only when instructed. The instruments and final disposition reports for each survey are included in Appendix J.

3.3.1 Participant Surveys

Cadmus surveyed a representative sample of ARP participants for each IOU during July and August 2012, exploring topics related to participants' experiences with the program, including program satisfaction levels. We planned to survey 200 participants served by SCE, and 200 served by PG&E,[13] and as shown in Table 12, we met or exceeded our targets for the participant survey.

Participant surveys included questions designed to inform our understanding of participant awareness, knowledge, attitudes, and behavior (AKA-B) regarding the program. Our surveys also contained questions addressing customer awareness of ARP, other IOU DSM programs, and energy efficiency in general. We adopted the AKA-B battery from the 2011 General Population Survey Instrument, adapting questions to collect information specific to ARP, as necessary.

Our surveys addressed the following:

- How did the customer become aware of the program(s)?
- What were the reasons for the customer's decision to participate?
- What would have been the recycled appliance's natural trajectory, had the program not existed?
- If the customer replaced the unit, what motivated the appliance replacement decision?
- If they have replaced the unit, how is the new being used (primary/second) and what is its estimated annual energy use?
- Numbers of refrigerators and freezers after participation, and length of ownership;
- What are the levels of general energy-efficiency awareness and interest?
- What channels or sources of communication are preferred?
- What opportunities exist for improving the application process, including online options?
- What is the customer rating of the adequacy of incentives?
- How satisfied are customers with the ARP?
- Has the program influenced energy use or participation in other energy-saving programs/activities?
- What are participating customer demographics?

[13] These sample sizes were designed to be sufficient to provide overall confidence and precision levels of 95/5 and utility level confidence and precision levels of 95/10.

3.3.2 Canceler Surveys

In October 2012, Cadmus surveyed a sample of 150 customers from each IOU who chose to cancel participation. These surveys will be used to identify self-reported rationales for cancelations. We planned to survey 200 cancelers served by SCE, and 200 served by PG&E, and as shown in Table 12, we met or exceeded our targets for the cancelation survey.

This survey allowed us to assess cancelation drivers by comparing participants and canceling customers. Our analysis will encompass variables such as:

- Appliance types;
- Numbers of refrigerators and freezers, and length of ownership;
- Primary/second usage; and
- Demographics.

3.3.3 Nonparticipant Disposer Surveys

Cadmus surveyed nonparticipating appliance disposers from September to October 2012 to assess the actions and motivations of utility customers who opt to dispose of their refrigerators and/or freezers outside of the ARP. Due to logistical limitations, Cadmus and the IOUs agreed to reduce the total target for the nonparticipant disposer survey from the 400 originally planned to 300 as shown in Table 12. However, the 300 completed surveys for this survey still easily exceeded the 90/10 standard precision requirements.

Through these surveys, we collected data on the following metrics:

- Program awareness;
- Numbers of refrigerators and freezers, and length of ownership;
- Disposal methods;
- Criteria for successful resale (e.g., age, configuration);
- Resale market characteristics;
- Reasons for not participating in ARP;
- Incentive preferences (type and levels); and
- Program improvement opportunities.

3.3.4 Second Appliance Owner Surveys

In October and November 2012, Cadmus also conducted surveys with second appliance owners. This survey effort is described in detail in the Alternative Subprogram section. Cadmus completed 400 surveys with nonparticipant second appliance owners. Questions addressed: demographics, appliance use, and customer perceptions.

4 PROCESS EVALUATION FINDINGS

This section presents information gathered through interviews and surveys to describe the 2010–2012 programs from the following perspectives:

- Program staff
- Key stakeholders
- Market actors
- Participants
- Nonparticipants

Section 2.2.1 described PG&E's and SCE's program histories and 2010–2012 changes. This section addresses, whenever possible, survey response data across all four survey groups. Appendices A through D provide detailed results of each survey, including comparisons to prior survey results.

4.1 Program Status

4.1.1 2010–2012 Program Achievements and Challenges

During the 2010–2012 program cycle, according to implementer databases, SCE and PG&E collectively recycled a total of 260,203 appliances.

Table 13. SCE and PG&E 2010–2012 ARP Units Recycled and Orders Completed

IOU	Type	2010	2011	2012
SCE	Total Units Recycled	72,731	76,654	47,049
	Total Orders Completed	70,522	74,552	47,817
PG&E	Total Units Recycled*	24,864	20,343	18,562
	Total Orders Completed	23,074	19,099	17,698

* Includes 329 room air conditioners in 2010, 275 in 2011, and 98 in 2012.

SCE staff reported one of the program's most important achievements has been the continuation and implementation of program enhancements as well as more stringent oversight during the program's long duration. During the 2010–2012 program cycle, SCE's ARP recycled its 1,000,000th refrigerator: a substantial milestone, as noted by SCE staff.

SCE and PG&E staff identified keeping the ARPs cost-effective as their biggest challenge, especially as the baseline for measuring savings has increased (so the per-unit savings has decreased). Due to this challenge, PG&E staff reported some regulators and other stakeholders believe the market has been transformed over the period of the program's implementation (i.e., the efficiency of all units currently in use has increased), and the need for a utility-sponsored ARP has decreased. SCE and PG&E interviewees did not agree with this view, stating the program's effective use of rebates and education to incent customers to recycle their appliances continues to remove inefficient units from the market.

4.1.2 Program Management

Both SCE and PG&E program staff reported satisfaction with established internal communications among staff at their respective utilities. In fall 2010, PG&E restructured the way it manages its energy-efficiency programs, transitioning to a product- or program-focused management structure. PG&E program staff reported the shift has improved the internal management team's focus and has benefited the overall program.

In response to the CPUC's requirement that ARPs achieve statewide alignment, SCE and PG&E program staff reported conducting quarterly meetings with the other California IOUs to discuss program changes and future developments. To maintain consistency in statewide program delivery, the IOUs each contract with JACO and/or ARCA to implement their ARPs. PG&E staff reported increased communication during the filing period, when IOUs plan their next program cycles.

SCE's ARP is implemented by ARCA and JACO, with additional implementation roles fulfilled by Enerpath. ARCA conducts the majority of SCE's unit pickups and disposals, while JACO covers a smaller portion of SCE's territory. Enerpath provides data management, including a logistics system used for scheduling. PG&E's ARP is implemented solely by JACO. JACO handles all aspects of program implementation for PG&E.

SCE and PG&E program staff reported satisfaction with performance by the program implementers (JACO, ARCA, and Enerpath). PG&E staff particularly praised JACO's innovative methods for dismantling recycled appliances to reuse 99% of materials. PG&E reported the program's environmental benefits (which the assessment of the ARP's cost-effectiveness currently does not account for) as one of the ARP's great successes.

PG&E staff reported regular communications with JACO, including biweekly phone calls to discuss the program. SCE and PG&E agree the ARPs prove extremely vital to JACO's and ARCA's business models.

4.1.3 Inclusion of Other Appliances

SCE and PG&E program staff reported constantly discussing options to include other appliances (in addition to refrigerators and freezers) in their ARPs. Program staff from both utilities reported seeking opportunities for adding equipment that would cost-effectively provide significant savings. Cadmus conducted additional research, assessing possible inclusion of other appliances, as reported in this report's Section 6.

JACO and ARCA reported clothes washers as a possible option, though, as few customers have two clothes washers, the IOUs could only capitalize on replacing units. SCE staff reported investigating opportunities in consumer electronics recycling, tying recruitment to purchases of new, high-efficiency units. ARCA staff reported researching a pilot program for electronics, planning to partner with electronics recyclers in their area for pilot implementation. Though PG&E staff discussed including water heaters in the program, they could not be certain of the environmental benefits attributed to such a

program, given water heaters do not contain the same types of toxic materials as refrigerators and freezers.

PG&E's 2010–2012 ARP included room air conditioners (RACs) in its program offering. However, only customers recycling a refrigerator through the program were eligible for RAC recycling. Even with this stipulation, PG&E program staff reported including RACs has not proved cost-effective, and they plan to remove this appliance from future program years. SCE's 2006–2008 ARP included RACs, but the program experienced very low participation, and its early replacement turn-in event structure proved costly to administer. SCE eliminated RACs from its 2010–2012 ARP.

4.2 Program Goals

SCE's and PG&E's ARPs primarily seek to prevent the continued operation of older, inefficient appliances, which the programs address by offering customers an incentive and free pickup service for their old units. Table 14 lists SCE's and PG&E's 2010–2012 ARP goals as documented in each IOUs Program Implementation Plan for the 2010-2012 program cycle, along with achieved participation for the same period as documented in implementer databases.

Table 14. SCE and PG&E 2010–2012 ARP Goals and Achievements

IOU	Appliance	Participation Goals (Totals for 2010-2012)	Achieved Participation (Totals for 2010-2012)*
SCE	Refrigerators	184,800	181,037
	Freezers	25,200	15,397
	Room ACs	N/A	N/A
PG&E	Refrigerators	104,554	55,914
	Freezers	16,269	7,153
	Room ACs	1,099	702

*Achieved participation figures are included here for qualitative assessment of program performance versus goals; evaluation of participation and savings falls under the purview of the impact evaluation, which is being conducted separately.

4.2.1 SCE

SCE primarily uses data from the Database for Energy Efficient Resources (DEER) to establish the program's potential for energy savings and to set energy-savings goals. SCE's engineering team and Measurement & Evaluation (M&E) group also advise on goal development. SCE staff reported the program doing extremely well against its goals during the 2010–2012 program cycle, though according to the implementer databases the total level of participation fell slightly below goals.

JACO and ARCA staff reported SCE also sets process goals for them to track, including:

- The seconds required for the call center staff to answer a call;
- The days required to pick up an appliance; and
- The hours required to complete the pickup process.

4.2.2 PG&E

PG&E reported determining its goals based on past program performance, and accounting for additional efforts planned for the program year, such as marketing or extensions into other delivery channels. PG&E also cited monitoring and improving cost-effectiveness as the main goals for maintaining and improving the ARP's process. PG&E reported the program performed relatively well against its goals, given the lack of program marketing, though the program did not recycle as many units as initially anticipated. This is also reflected in the total participation level documented in the implementer's databases.

4.3 Target Audiences and Trade Allies

SCE staff reported the program generally targeted high energy-use customers, though all customers with appliances fitting the requirements detailed above can participate.

To increase participation, Best Buy, Sears, and Home Deport joined as trade allies for ARPs marketing the program, serving as important outreach channels in acting as a liaison between customers and the utilities.

4.3.1 Second Appliance Owners

JACO defined a "second appliance" as any unit not located in a home's kitchen. Both SCE and PG&E staff agreed the permanent removal of second appliances, rather than replacing older units with more efficient units, achieved the greatest energy savings for the program. PG&E staff reported trying to target second appliance owners, but did not know how effectively these efforts persuaded these customers to participate.

PG&E reported more families within their customer populations moving in together due to the prolonged economic crisis. More people living together means requiring more food; so more families look to buy food in bulk, and many of these families feel they need a second appliance for storage. SCE and PG&E staff cited this as a major hurdle to the success of the ARP targeting second appliance owners.

SCE reported its ARP will emphasize working second units in its next program cycle, seeking to expand the program's retail component to capture primary units, while using marketing to target working second units, especially second freezers. Though SCE staff reported over one million units in the market could be potential participants, they also noted possible difficulties in proving the recycled appliances truly could be considered second units.

4.3.2 Retailer Trial

Starting in 2010, to better utilize the retailer channel, the IOUs began a retailer trial to leverage opportunities with retail staff in the field delivering newly purchased appliances. Launched through participating Sears locations, the trial arranged for Sears staff to pick up a customer's old appliances during the delivery of newly purchased units. The trial sought to streamline the delivery and pick up process for customers so they only had to be present for a single visit. In addition, the retailer trial

decreased the cost per participating unit, as JACO or ARCA could pick up removed units in bulk from a Sears warehouse (rather than on a home-by-home basis).

Although Sears managed removal of the units from customers' homes, JACO and ARCA remained responsible for ensuring only eligible appliances were recycled through the IOUs' ARPs. SCE's and PG&E's program eligibility requirements included:

- The participant had to be an SCE or PG&E customer.
- The appliance had to be at their SCE or PG&E service address.
- The appliance had to work and cool at the time of pickup.
- The appliance had to be residential grade.
- The appliance had to have a capacity of 10 to 32 cubic feet.

To ensure high-quality service and ensure the program eligibility requirements were met, SCE staff reported Sears had to undergo random inspections at a selection of warehouses. SCE's inspection staff reviewed delivery truck manifests with the highest number of SCE pickups, and followed up with customers at the addresses on the manifest to ensure Sears' staff followed the program's policy and procedures. SCE reported this as an essential aspect of the trial's success, as Sears had previously used the program's pick up policies. SCE reported a 15% to 20% inspection rate for units participating through the retailer trial.

An in-store online signup application presented the only challenge PG&E reported from the retailer trial. According to PG&E staff, a firewall in place at retail locations slowed access to the signup for retailer staff, detracting from the turnkey service the retailer trial intended to provide for customers.

PG&E staff reported the retailer trial successfully utilized the retail channel, with the additional channel for removing appliances helping reduce program costs, and the bulk pickup process lowering per-unit processing costs. SCE reported planning to incorporate the retailer trial on a wider scale during the next program cycle. PG&E reported extending the retailer trial to gather additional data on the effects of energy-efficient appliance rebates and seasonal shopping trends on program participation before deciding whether to move forward with the retailer trial for future program years.

4.4 Marketing and Outreach

SCE and PG&E both used mass media, direct mail materials, and earned media to disseminate information about the cost of operating older appliances and to encourage participation.

PG&E staff reported the 2010–2012 ARP primarily relied on retailer marketing, rather than direct mailings, as it had in the past. PG&E also noted that, just previous to the 2010–2012 program cycle, PG&E did not advertise the program due to lack of a marketing budget.

SCE and PG&E reported providing participating retailers with customer-facing marketing materials, such as appliance clings, pamphlets, point of purchase displays, and posters. Although the program does not incent retailers to conduct marketing, they serve as an effective outreach channel for the program.

JACO also markets the ARPs. PG&E explained inherent value exists in refrigerant removed from the program's recycled appliances. PG&E's agreement with JACO allows JACO to claim the value of carbon emission reductions from recycling refrigerants from participating units; this further incents JACO to market the program and increase participation. JACO uses pamphlets, refrigerator magnets, online ads, and postcards to attract customers to the program, and reported its promotional refrigerator magnet serves as the ARPs' most effective marketing tactic—even more so than the IOUs' bill inserts.

4.4.1 Messaging

PG&E staff reported the ARP's customer-facing message proves effective as "recycling" is a buzz word that connects with customers. SCE noted some customers believe they recycle if they give their old appliance to someone else. The program has sought to dispel this message, further educating customers about recycling's true definition.

Other marketing messages both SCE and PG&E have used include: energy savings, environmental benefits, financial incentives, and savings and benefits associated with the costs of running a second appliance. PG&E reported messaging that encourages behavioral changes (such as recycling an old appliance) to reduce a customer's carbon footprint have successfully motivated customers to participate.

4.4.2 Customer Information Sources

Cadmus' surveys asked customers aware of ARP how they learned of the program. Figure 1 shows these results for SCE customers, by survey group. Most customers reported learning of the program via direct mail materials. This was particularly true for nonparticipants, whether they were disposers or simply second appliance owners. Participants and cancelers were more likely to learn of the program through word-of mouth. Participants were much more likely to hear about the program through an appliance retailer than other groups. Mass media advertising had a smaller, but more consistent impact across groups.

Figure 1. Where Appliance Owners Learned of the Program (SCE)

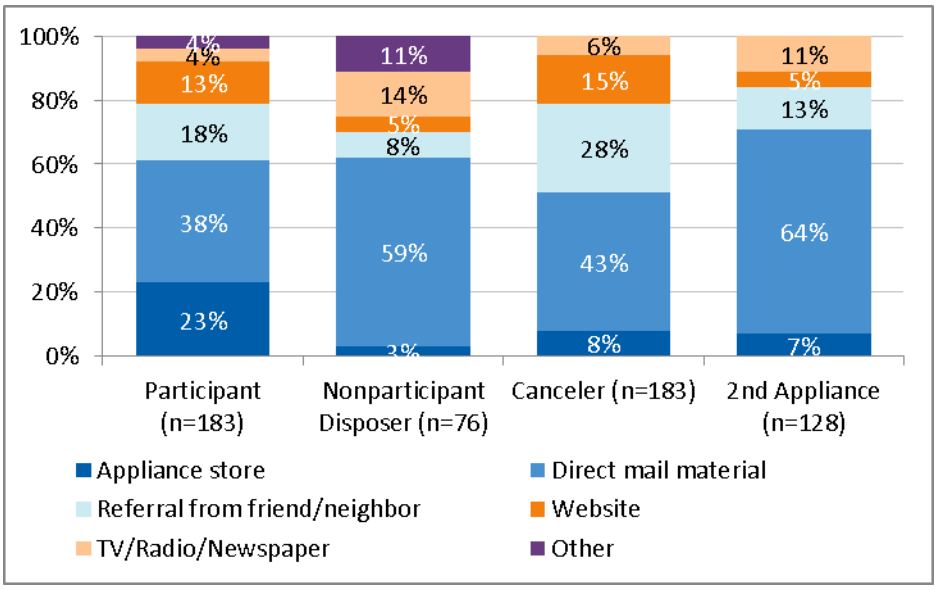
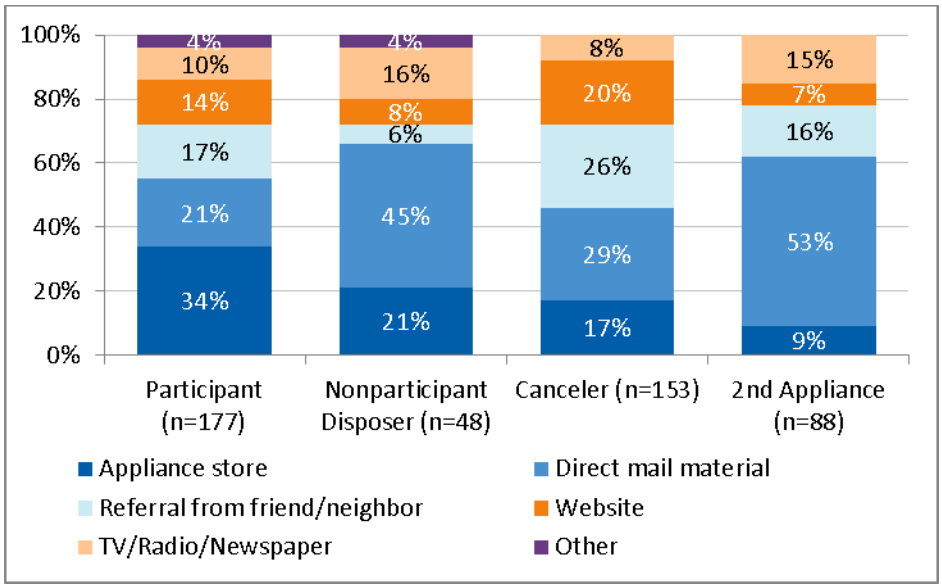


Figure 2 shows these results for PG&E customers. Exposure to the program through retail channels was more pervasive across both for participant and nonparticipant groups, with one in five disposers that were aware of the program reporting they learned of it through an appliance retailer. Direct mail materials played a smaller role for participants as compared to the other groups.

Figure 2. Where Appliance Owners Learned of the Program (PG&E)



4.5 Appliance Characteristics

4.5.1 Participating Units

The age, vintage, size, and configuration of refrigerators and freezers can have a big impact on the realized savings. The typical characteristics of participating units change as ARPs mature and older, less efficient units are culled by the program. The following section outlines changes in the characteristics of appliance recycled through the program since 2001 for SCE and since 2003 for PG&E (the first year of the program). Cadmus calculated average values using program tracking data provided by the IOUs.

As shown in Figure 3, participating refrigerators in SCE's ARP have historically been slightly younger than freezers. Average unit age steadily declined through 2008, where it settled around 20 years old for refrigerators and 21 for freezers.

Figure 3. SCE Unit Age by Program Year

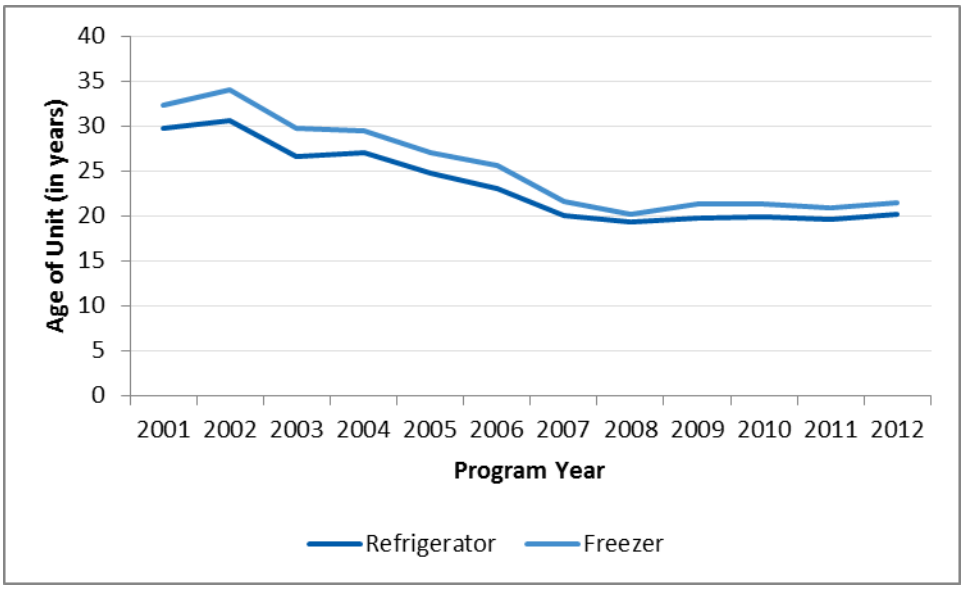
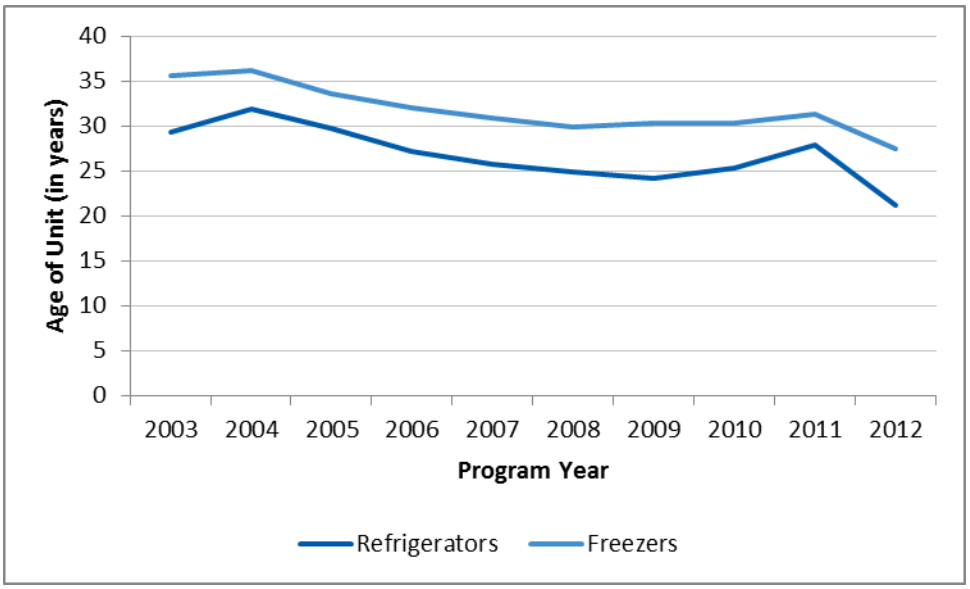


Figure 4 shows average unit ages for PG&E's program since its inception in 2003. PG&E average unit ages have declined at a regular rate, reaching 21 years old for refrigerators and in 2012. Freezers are notably higher; the average freezer recycled in 2012 was 27 years old.

Figure 4. PG&E Unit Age by Program Year



As shown in Figure 5, there has been some variation in the size of appliances recycled by SCE's program, though there has not been a strong trend in one direction. Refrigerators have increased slightly in size, from 19 to 20 cubic feet since 2001, while average freezer size has remained constant at approximately 17 cubic feet.

Figure 5. SCE Unit Size by Program Year

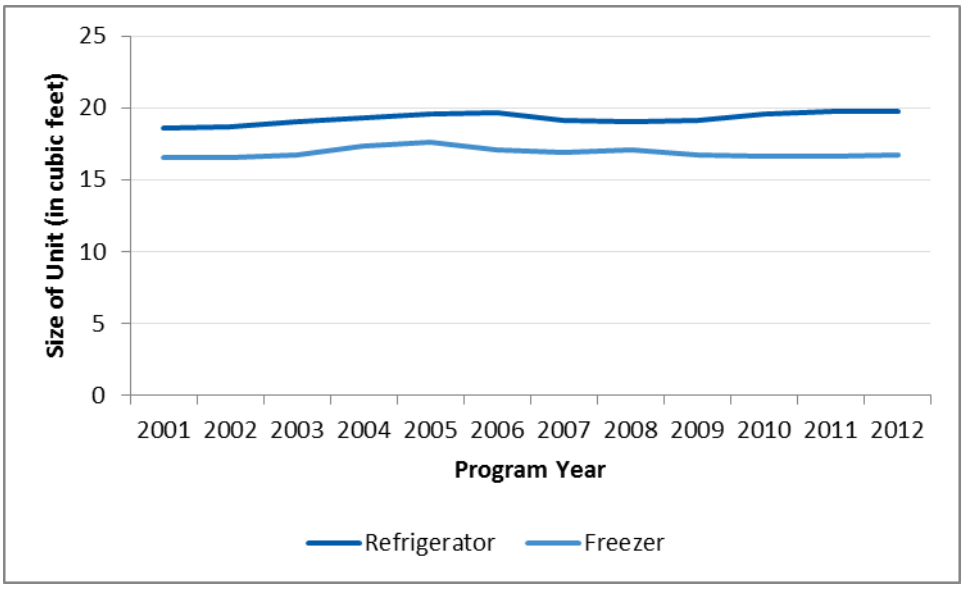


Figure 6 shows average unit sizes for PG&E. Unit size increased dramatically in the first two years of the program before leveling off. Refrigerators have increased to 20 cubic feet in 2012; freezers recycled in 2012 were approximately 17 cubic feet.

Figure 6. PG&E Unit Size by Program Year

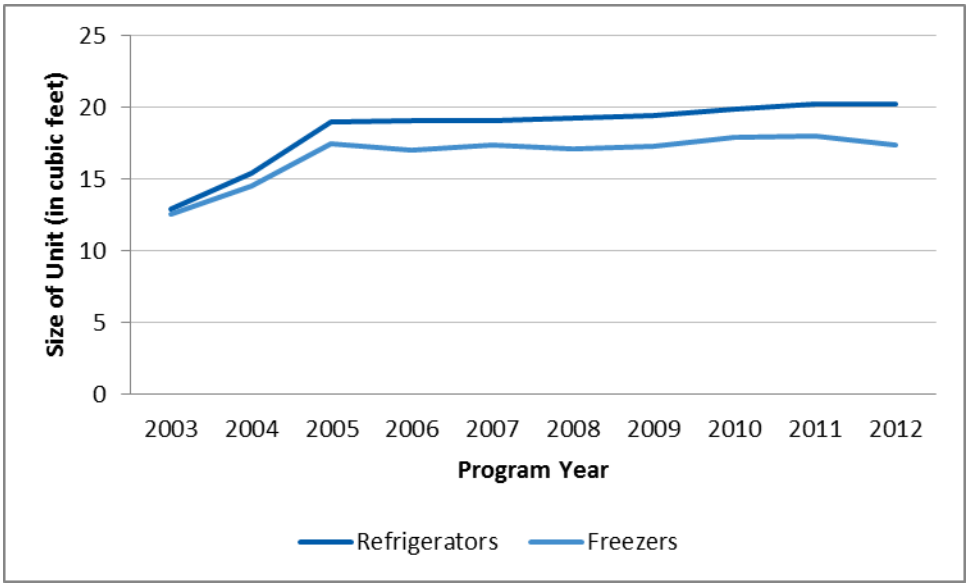


Figure 7 shows the distribution of refrigerator configurations for SCE's program since 2001. Top freezers and single door units have made up a decreasing share of program units over the life of the program, as side-by-side units have become more common. The exception to this is from 2006-2009, where there was a surge in the recycling of top freezer refrigerators.

Figure 7. SCE Refrigerator Configurations by Program Year

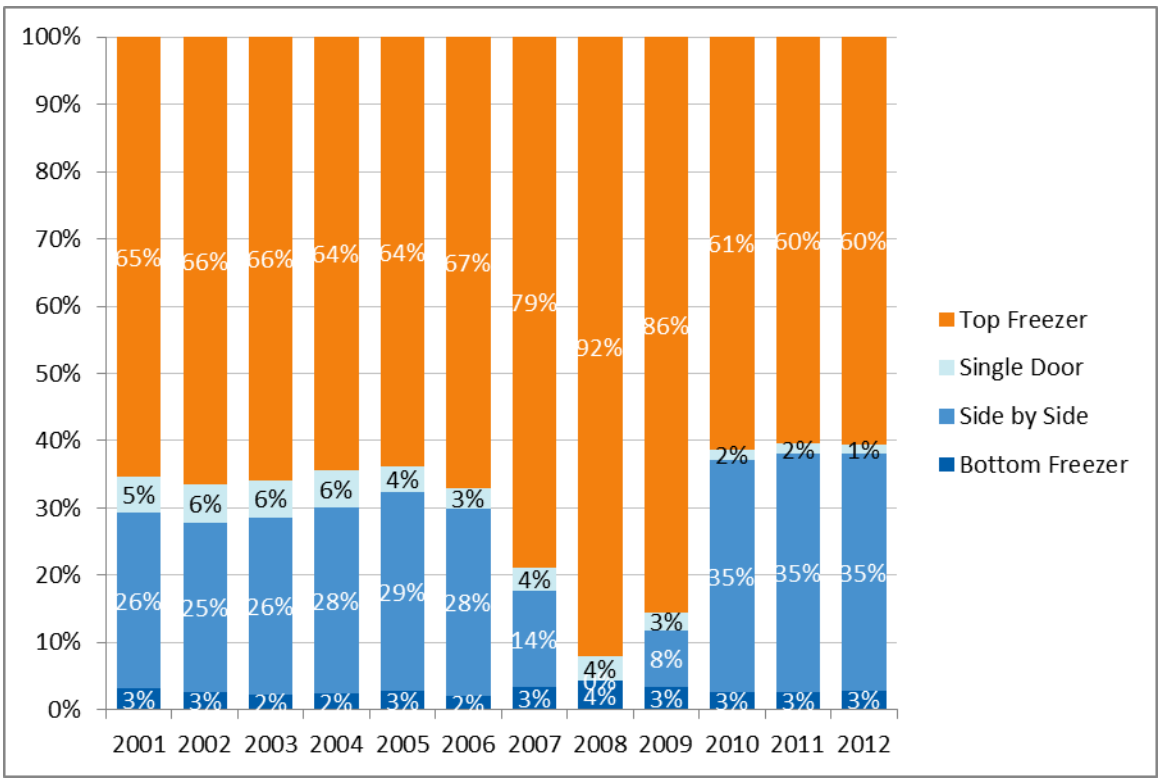
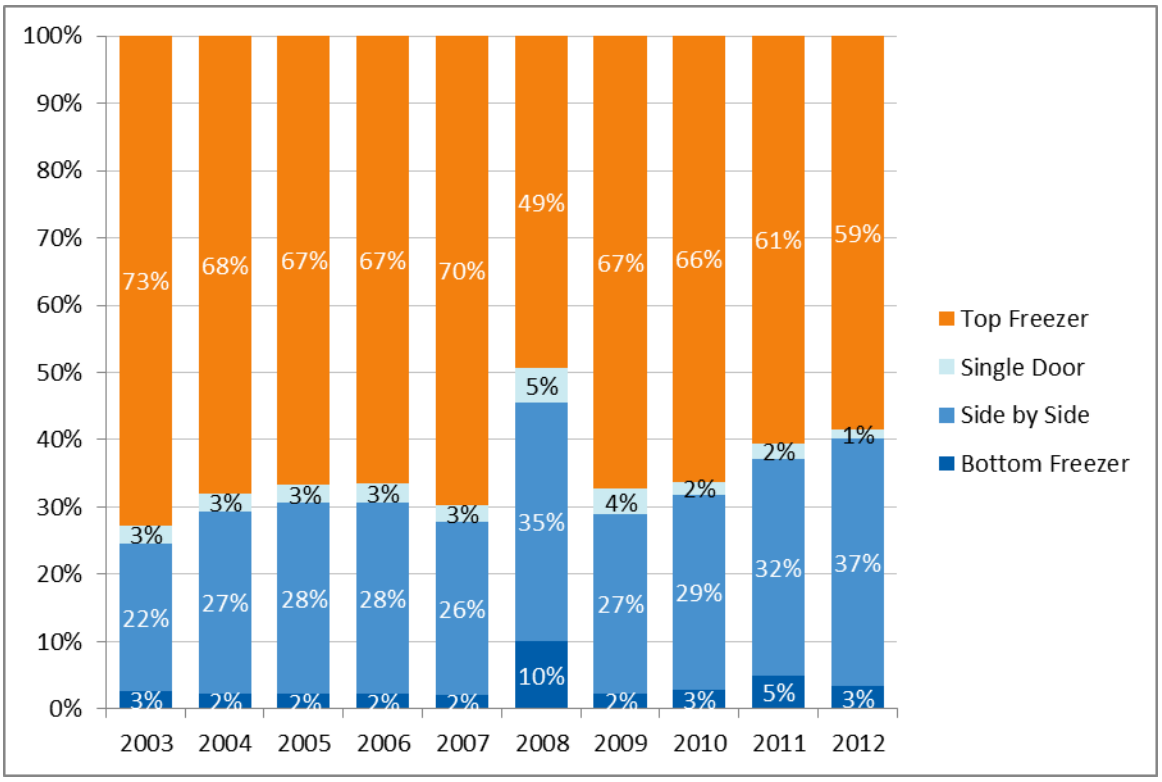


Figure 8 shows the distribution of refrigerator configurations for PG&E's program since 2003. We see similar trends in unit configuration to those seen for SCE. The exception to this is in 2008, where there was a drop in the recycling of top freezer refrigerators.

Figure 8. PG&E Refrigerator Configurations by Program Year



As shown in Figure 9, upright units have made up an increasing amount of SCE's freezers recycled.

Figure 9. SCE Freezer Configurations by Program Year

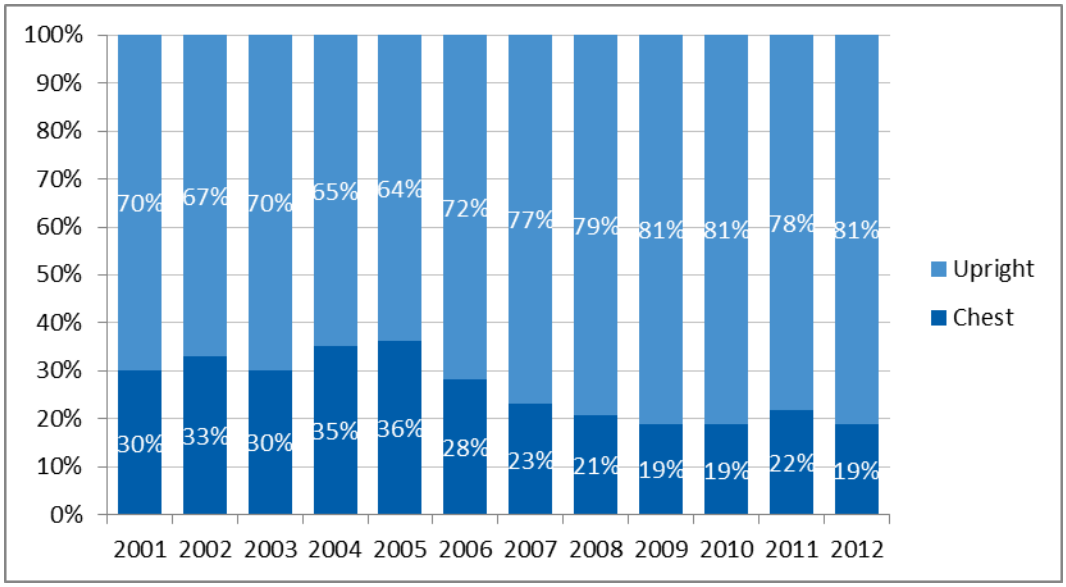
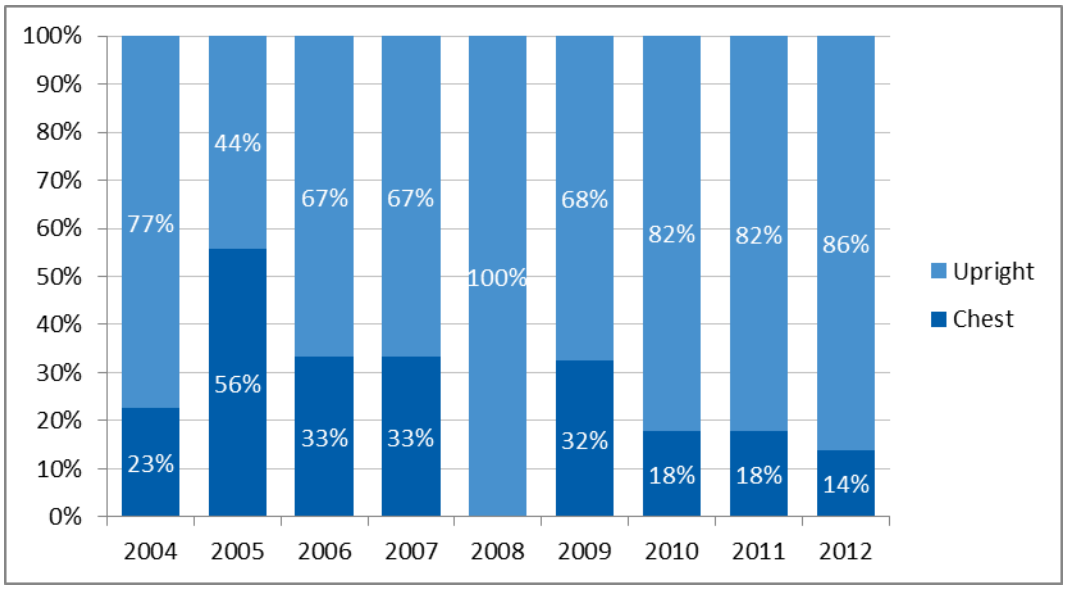


Figure 10 shows freezer configurations for PG&E's ARP since 2004 (configuration data were not available for 2003). While the trend over time is similar to SCE's ARP, the distribution has varied considerably over time.

Figure 10. PG&E Freezer Configurations by Program Year



4.5.2 Comparison of Survey Groups

Cadmus' customer surveys collected data on the characteristics of appliances recycled or (in the case of the nonparticipants groups) that could have potentially been recycled for each of the four survey groups.

Most customers surveyed discussed refrigerators; with the exception of the second appliance owner survey, freezers accounted for less than 10% of the units discussed in each survey group.[14] The types of appliances respondents discussed with us are shown in Figure 11 and Figure 12.

Figure 11 SCE Appliance Types Discussed by Survey Group

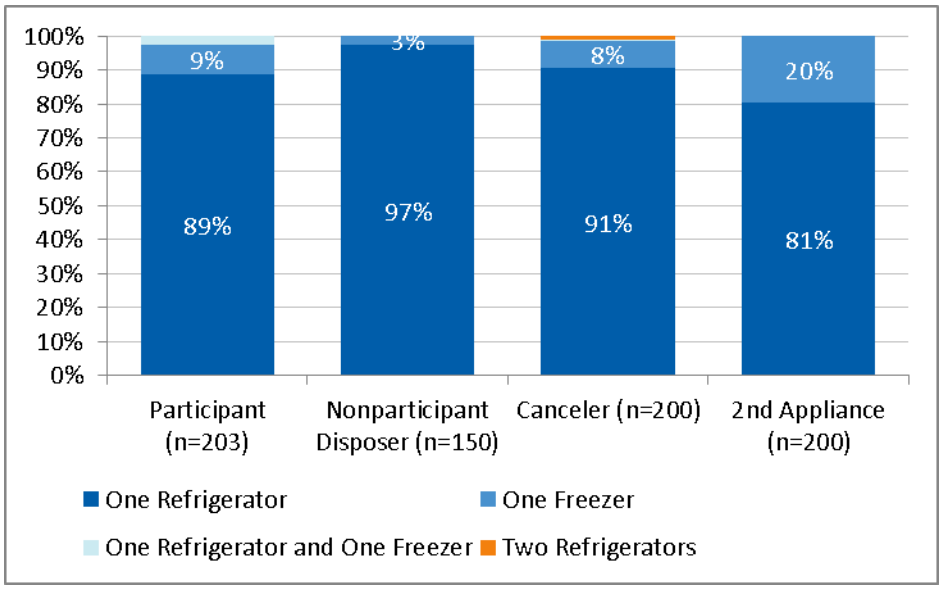
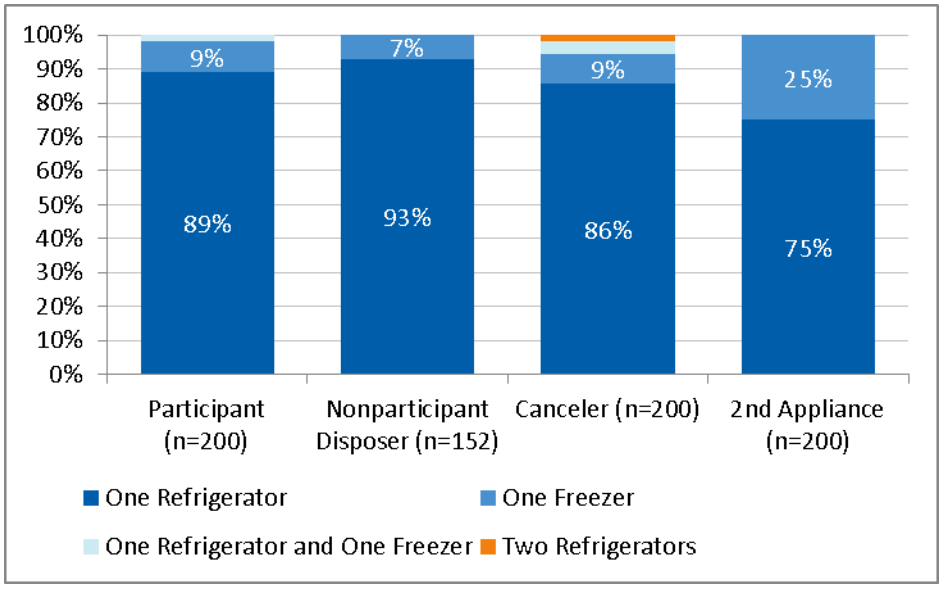


Figure 12. PG&E Appliance Types Discussed by Survey Group



[14] Customers with more than one appliance were asked to respond regarding only one of the relevant units. All findings on appliance characteristics reflect information about the selected unit.

When asked about the size of their appliances, customers reported a majority of the appliances as medium (17 to 20 ft^3) or large (20 to 23ft^3). Figure 13 and Figure 14 show the distributions of appliance sizes by group and IOU. On average, second-appliance owners reported slightly smaller units than customers in other categories, where primary units were more pervasive.

Figure 13. SCE Appliance Size by Survey Group

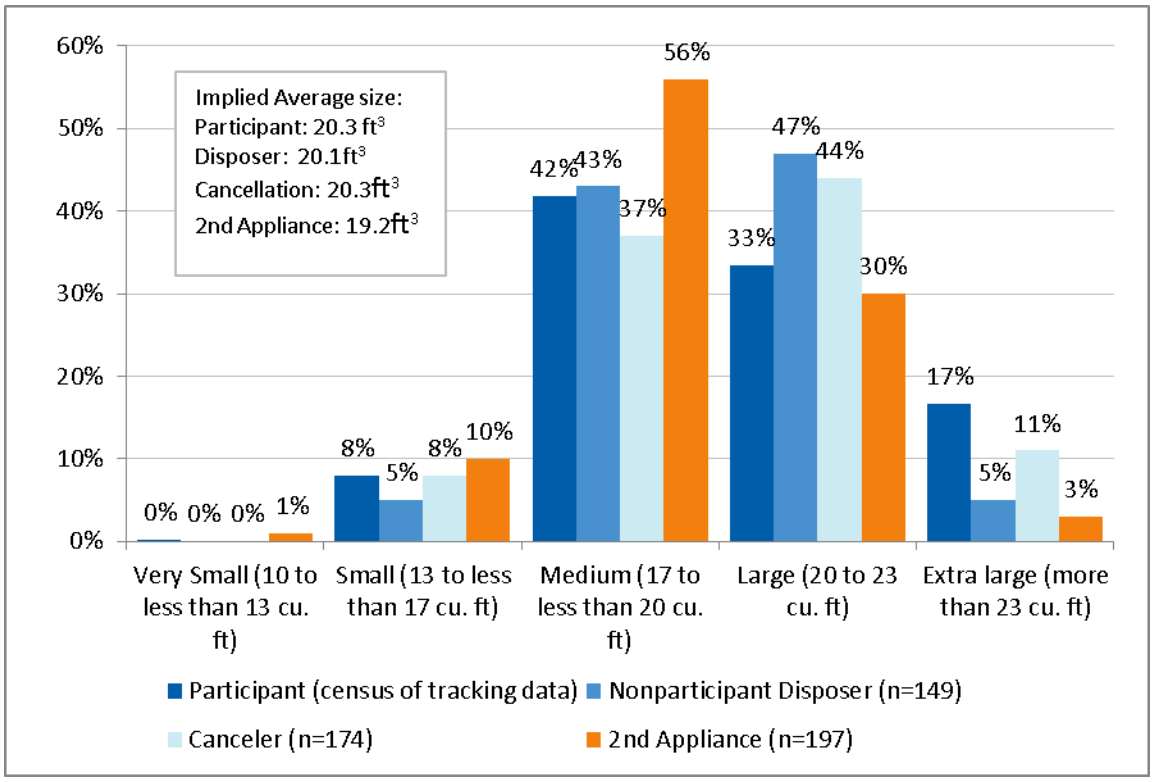


Figure 14. PG&E Appliance Size by Survey Group

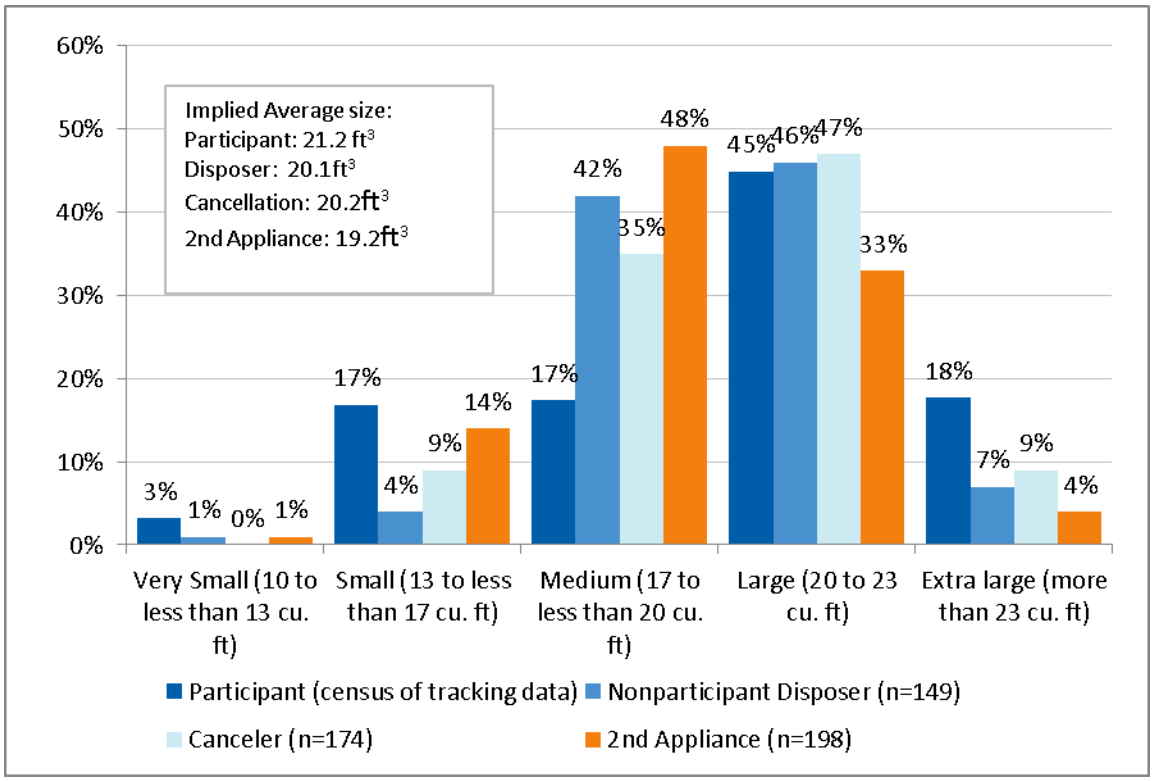
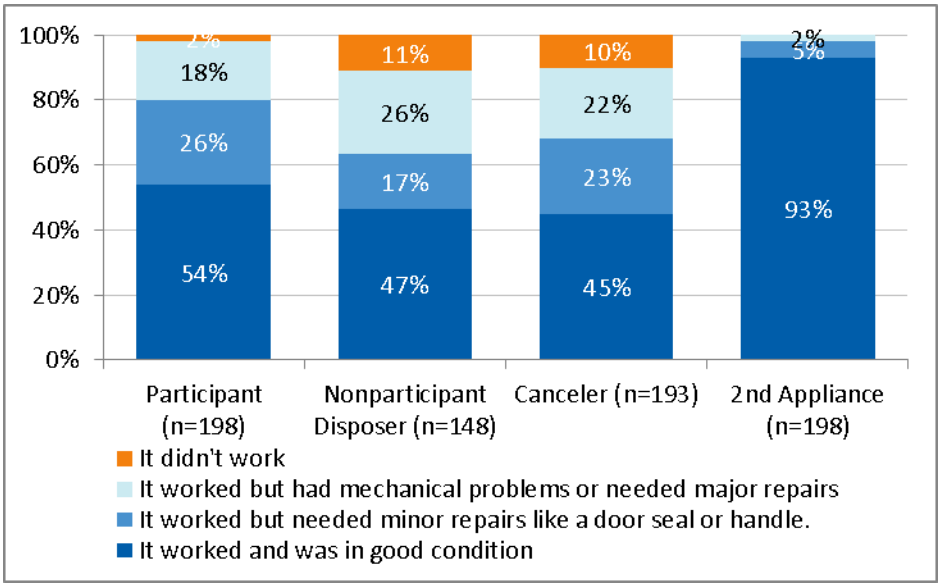


Figure 15 shows the self-reported condition of units either recycled or that could have potentially been recycled by the program for SCE customers. Second appliance owners with units still in use were more likely to appliances that were in good working condition when compared to the various types of disposers (participant, nonparticipant, or cancelers). When asked about the condition of their appliances, approximately one-half of the disposer group respondents reported that their appliance was in good working condition. Cancelers and non-participant disposers were most likely to have non-functioning units.

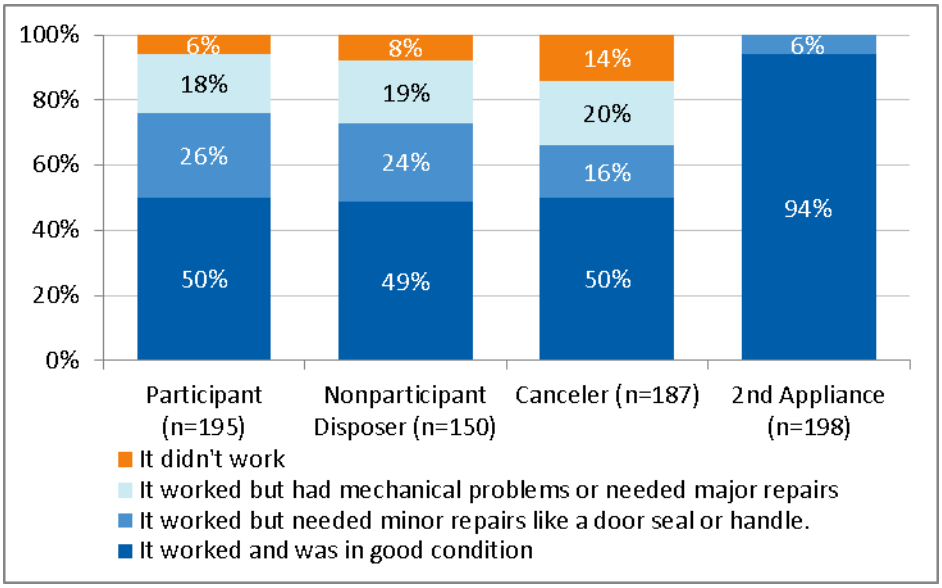
Figure 15. SCE Appliance Condition by Survey*



*It should be noted that units recycled through the programs are verified to be providing cooling; a process verified by both Cadmus and the IOUs.

Results were similar for PG&E, as seen in Figure 16 below. Cancelers were particularly likely to have fully non-functional units, perhaps reflecting the effectiveness of the screening process in removing these customers the program.

Figure 16. PG&E Appliance Condition by Survey*



*It should be noted that units recycled through the programs are verified to be providing cooling; a process verified by both Cadmus and the IOUs.

The vast majority of customers reported that their unit was plugged in and running full time. This reflects both the large number of primary units being recycled as well as the high usage of second units still in operation. Figure 17 and Figure 18 show these results by IOU and group.

Figure 17. SCE Appliance Use by Survey

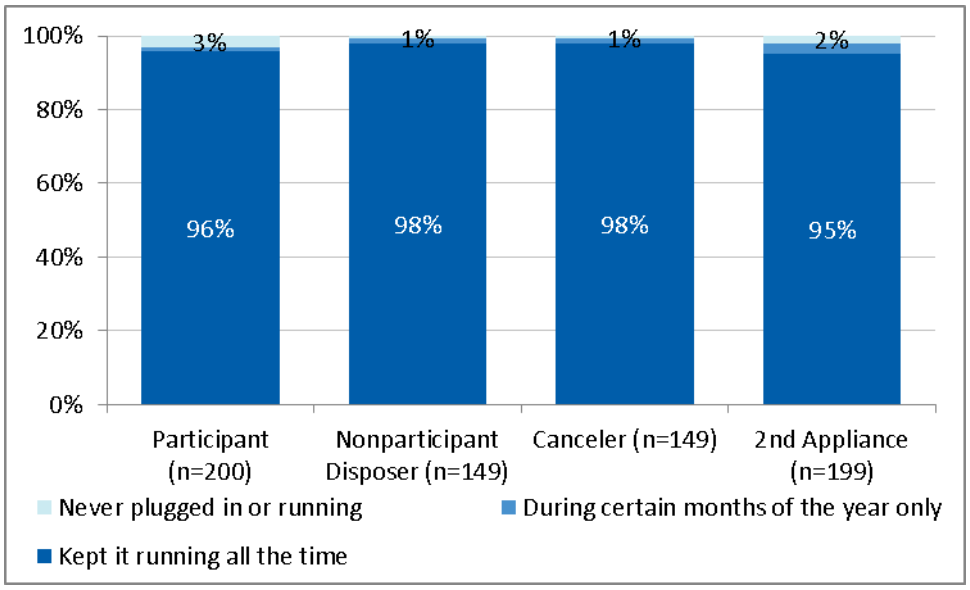
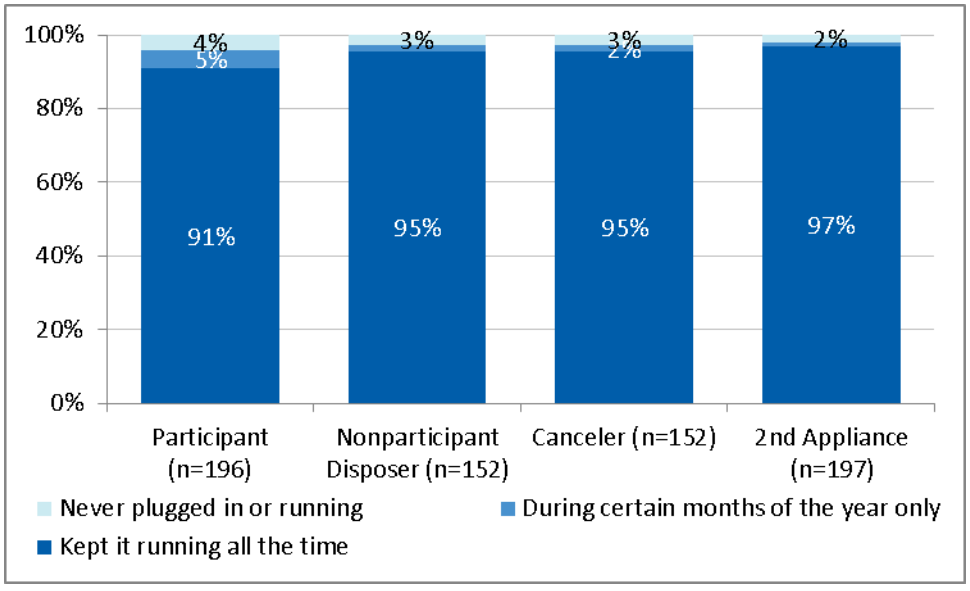


Figure 18. PG&E Appliance Use by Survey



Based on the response data shown in Figure 17 and Figure 18, Cadmus calculated the implied retrospective part-use factor. This factor represents the average proportion of the year that the appliance had been used historically. Overall use was close to full-time across IOUs and survey groups, as shown in Table 15.

Table 15. Implied Part-Use by Utility and Survey

Utility	Participant	Nonparticipant Disposer	Canceler	Second Appliance
SCE	0.97	0.98	0.99	0.97
PG&E	0.94	0.95	0.97	0.98

One of the areas where the ARPs can have a large impact is in the permanent removal of second appliances. The success that these programs are likely to have in permanently removing these appliances is in large part a function of these appliances' relative importance to the customers. One indicator of this importance is how full they keep these units.

4.6 Second Appliance Ownership

Second appliance ownership ran higher among all groups of customers surveyed than in the general population (estimated from the 2009 California RASS). Figure 19 compares the participants, nonparticipant disposers, and cancelers to the RASS results for SCE.[15] These saturations represent their appliance ownership at the time of surveying, accounting for the fact in most cases they had recently disposed of an appliance. All groups significantly exceeded the general population with respect to second appliance saturation. Participant and nonparticipants showed similar rates of second appliance ownership, while cancelers had slightly higher rates.

Figure 19. Second Appliance Ownership by RASS and Survey Groups (SCE)

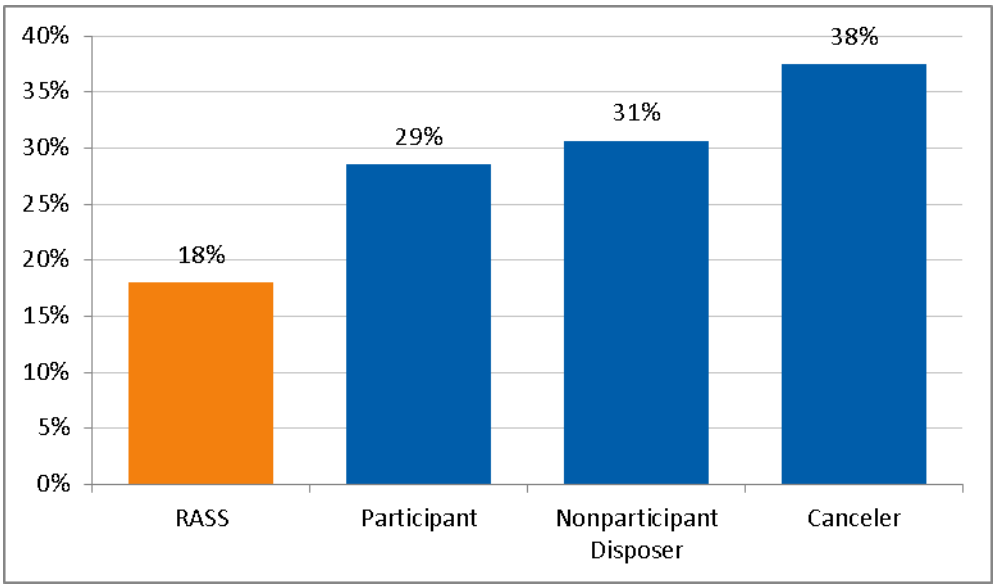


Figure 20 compares the three disposer groups to the RASS results for PG&E. Nearly one-third of participants and nonparticipant disposer continued to operate a second appliance after disposing of their appliance. Cancelers had slightly lower rates of ownership.

[15] Secondary appliance owners were excluded as, by design, they had saturations of 100%.

Figure 20. Second Appliance Ownership by RASS and Survey Groups (PG&E)

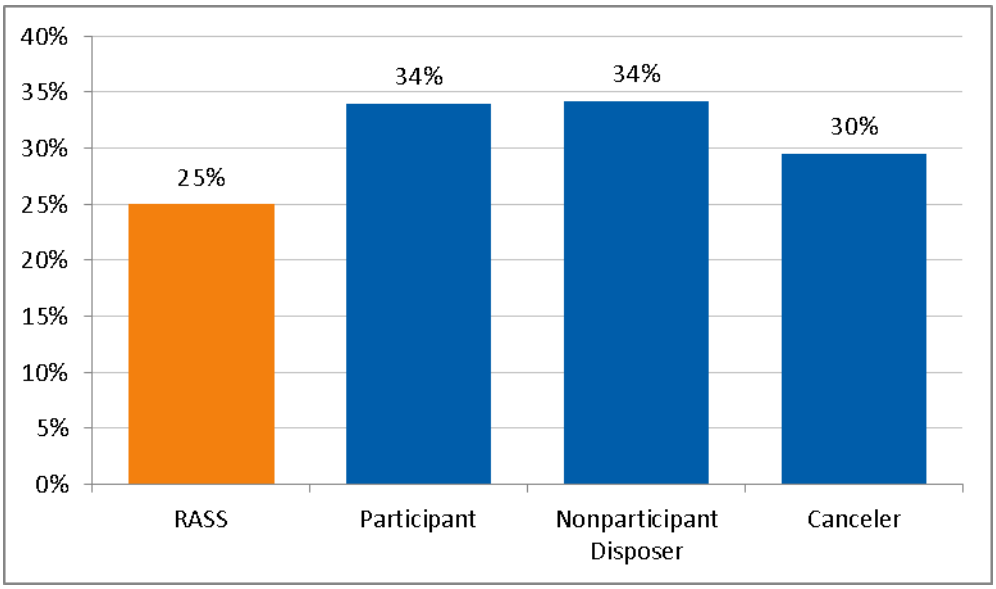
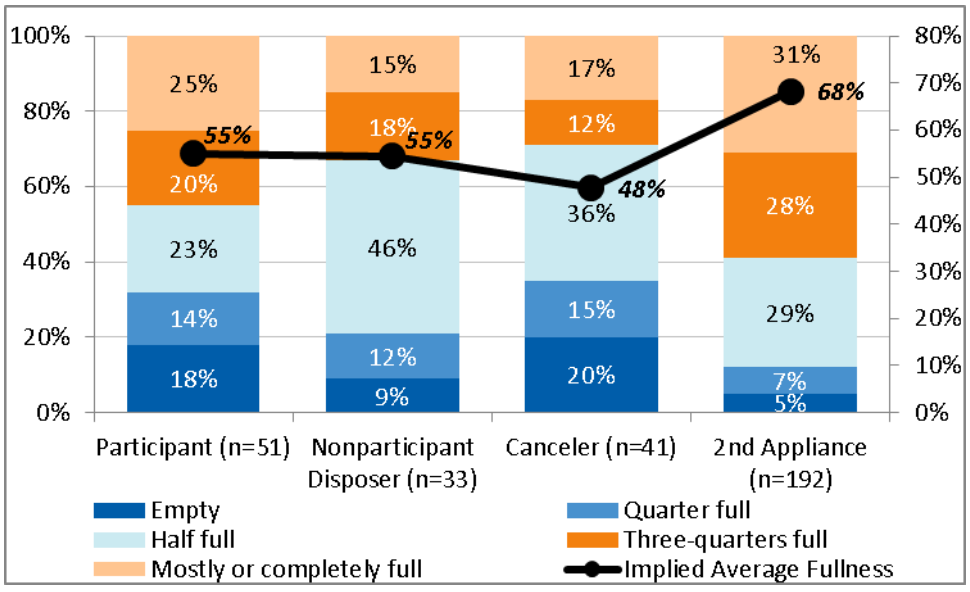


Figure 21 show customers' responses when asked how full they kept their second appliances. SCE respondents indicated average fullness of: 55% for participants and nonparticipant disposers; 48% for canceler customers; and 68% for second appliance owners. The significantly higher fullness of non-disposing second appliance owners may indicate a barrier to their recruitment.

Figure 21. SCE Appliance Fullness by Survey



As shown in Figure 22, PG&E respondents indicated average fullness of: 54% for participants; 68% for nonparticipant disposers; 57% for canceler customers; and 69% for second appliance owners. Nonparticipant disposers in PG&E's territory were similar the second appliance owners, suggesting that it was not the use of the second appliance that was presenting the barrier to participation.

Figure 22. PG&E Appliance Fullness by Survey

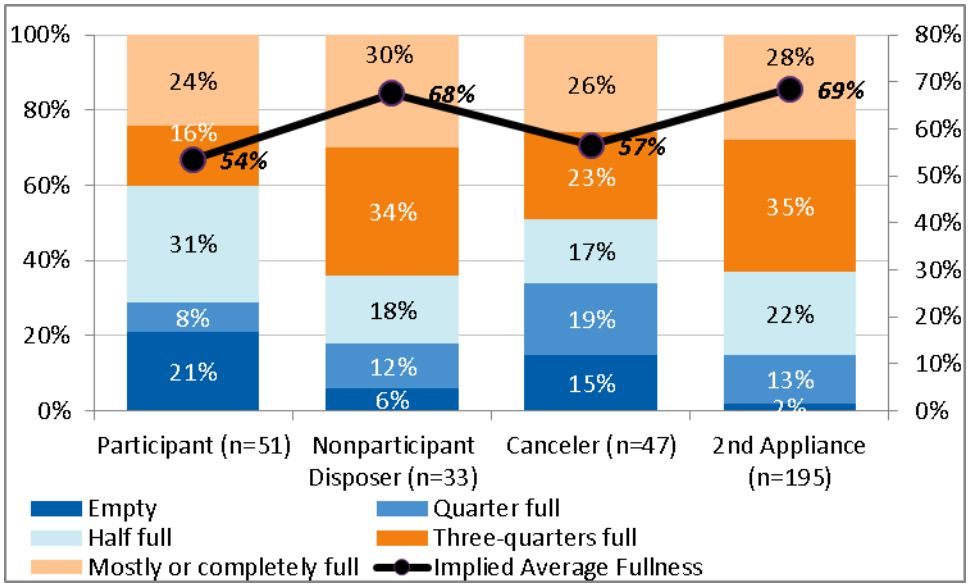
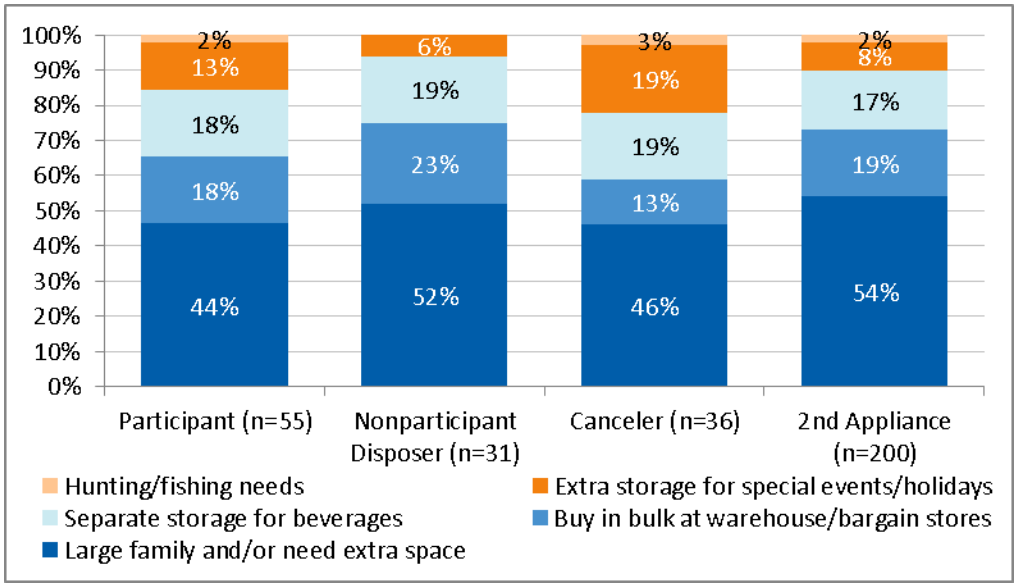


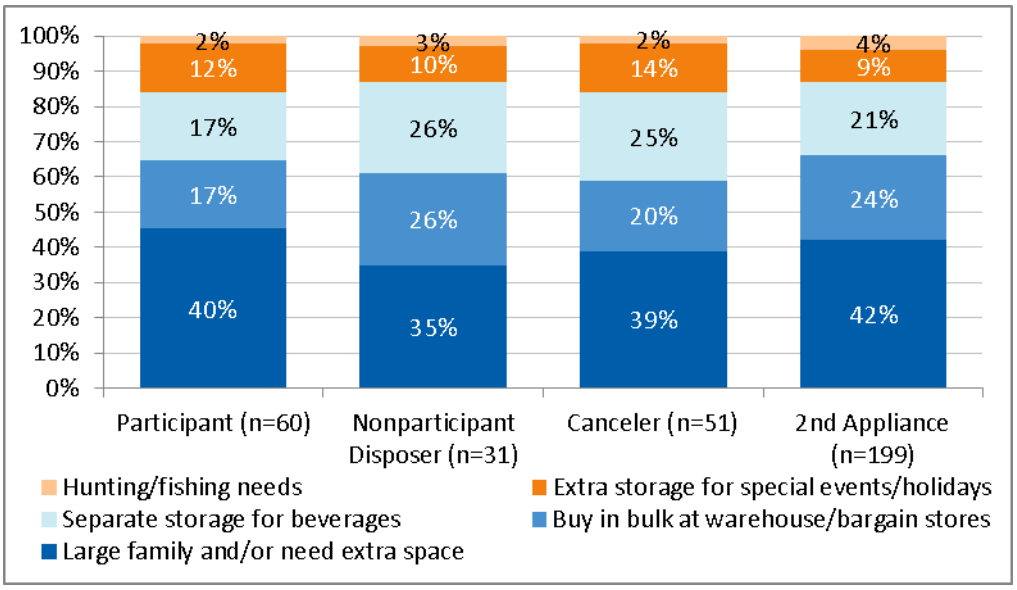
Figure 23 shows respondents' main use of their second appliances for SCE customers. Participants and cancelers had similar distributions, with a need for extra space due to large families cited approximately 45% of the time. Nonparticipant disposers and second appliance owners were more likely to cite large families as the reason for owning a second unit.

Figure 23. SCE Main Second Appliance Use by Survey Group



As shown in Figure 24, PG&E were less likely to cite large families as the reason for owning a second unit. PG&E customers' use of their second appliances was much more consistent between groups.

Figure 24. PG&E Main Second Appliance Use by Survey Group



4.7 Participation Decisions and Preferences

As part of our surveys, we asked customers that disposed of an appliance their reason for disposal. Figure 25 for SCE customers. Purchasing a replacement unit was the dominant motivation for SCE participation, while poor functioning of the existing unit was more often the reason for nonparticipants. This may be due in some part to disqualification of non-functioning units (particularly for cancelers).

Figure 25. SCE Reasons for Appliance Disposal by Survey

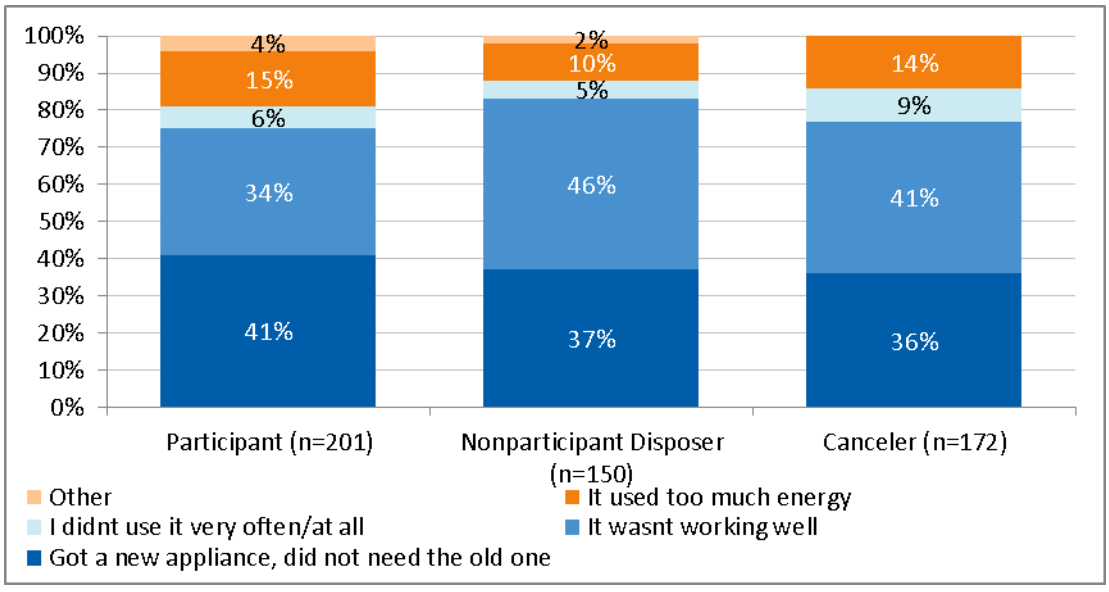
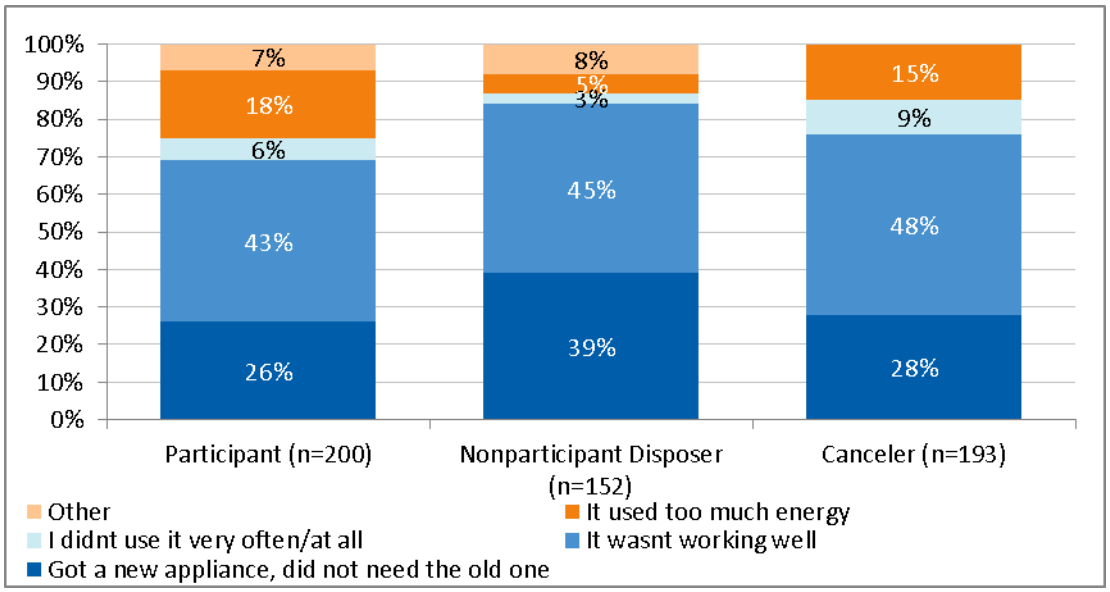


Figure 26 shows PG&E customers' motivations for disposal. Unlike for SCE, replacement was a more common motivator for nonparticipant disposers, while participants and cancelers more often cited poor functioning or the desire to save energy.

Figure 26. PG&E Reasons for Appliance Disposal by Survey



For both IOUs, nearly all participants surveyed were using the programs for the first time. As shown in Figure 27 and Figure 28, about one-quarter of PG&E and one-fifth of SCE nonparticipant disposers had previously participated in their respective ARP. Approximately one third of second appliance owners had also participated. This seems to suggest that there a fraction of previous participants are defecting from the programs.

Figure 27. SCE Previous Participation by Survey

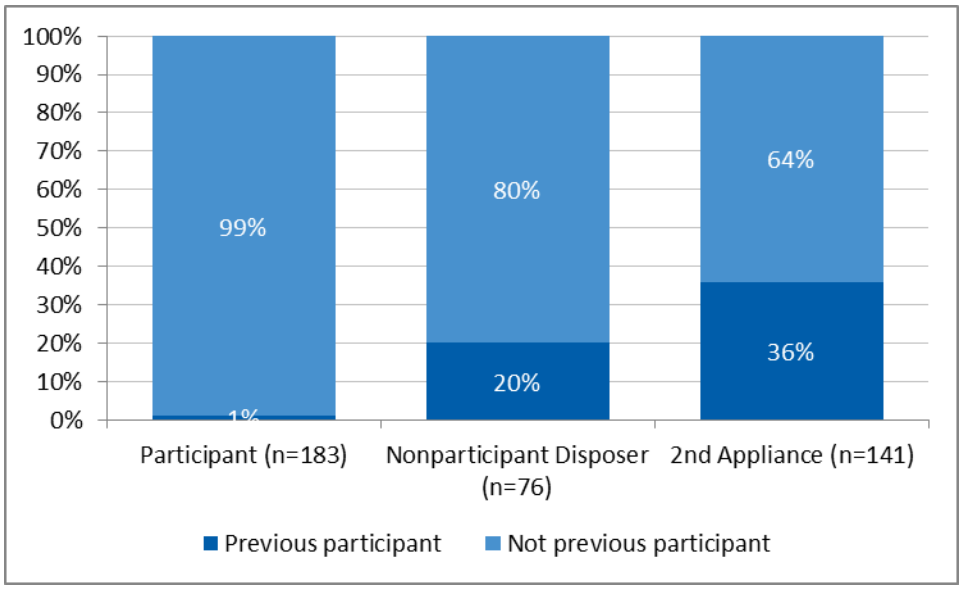
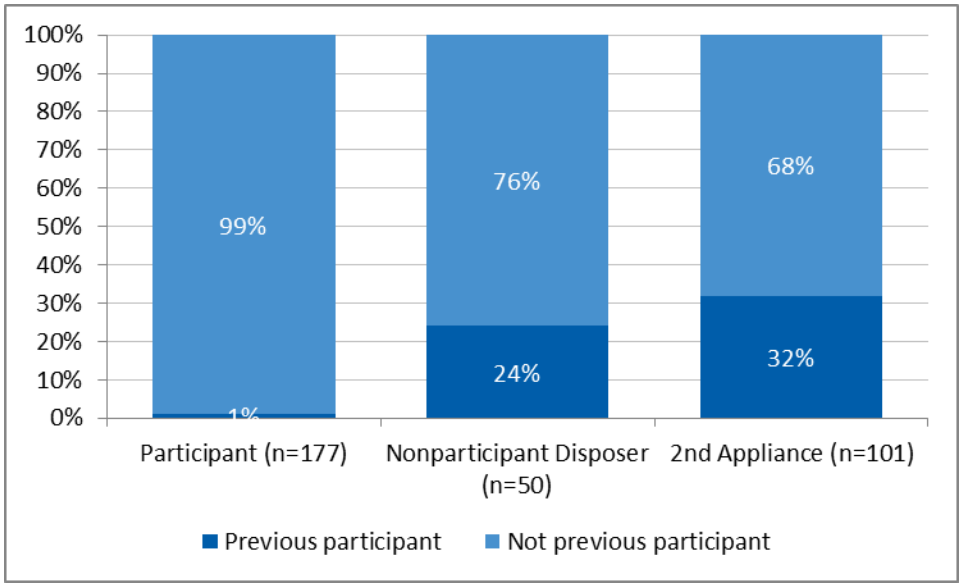


Figure 28. PG&E Previous Participation by Survey



4.8 Program Experience

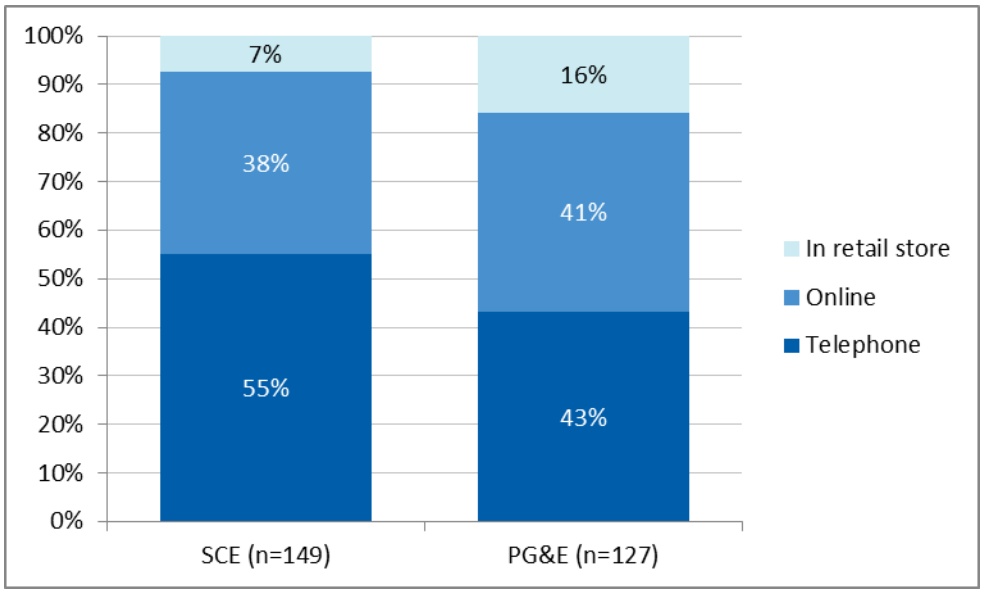
As part of the participant surveys, Cadmus asked participants a series of questions about their experience in the ARPs. These are outlined in the section below.

4.8.1 Program Delivery

Sign-Up Process

Participants used a variety of methods to sign up for the ARPs. As shown in Figure 29, just over one-half of SCE respondents reported signing up by the telephone and close to 40% signed up online. Among PG&E respondents, roughly the same proportion reported signing-up by telephone as reported signing up online (about 40% each).

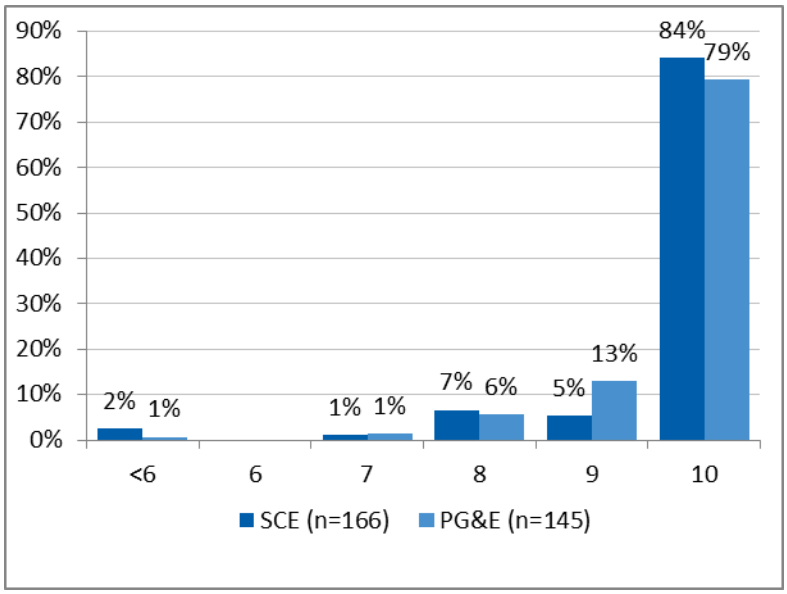
Figure 29. Participant Sign-up Methods



As shown in Figure 30, nearly all survey respondents from both utilities (95% overall) reported satisfaction with their sign-up experiences.[16] No significant differences occurred in satisfaction levels between sign-up methods.

[16] The evaluation gauged participant satisfaction for various program aspects using a 0 to 10 scale, with "10" meaning completely satisfied and "0" meaning not at all satisfied. A rating of four or less was considered less than satisfied; a rating between five and seven was considered a neutral response; and a rating of eight or higher was considered satisfied.

Figure 30. Participant Satisfaction with Sign-up Process



Telephone Signup

Across the two service areas, survey respondents most commonly signed up for the program via telephone (43% overall). All respondents signing up for ARPs by phone found the representatives they spoke with polite and courteous, and answered all of their questions (shown in Table 16). All but four respondents reported they could schedule a pickup at convenient dates and times.

Table 16. Participant Telephone Sign-up Experience

Question	Response	SCE	PG&E
Was the representative you spoke to on the telephone polite and courteous? (SCE: n=80, PG&E: n=51)	Yes	100%	100%
	No	0%	0%
Did the representative answer all your questions? (SCE: n=80, PG&E: n=54)	Yes	100%	100%
	No	0%	0%
Did you have to call more than once? (SCE: n=80, PG&E: n=55)	Yes	4%	5%
	No	96%	95%
Were you able to schedule a pickup appointment for a convenient date and time? (SCE: n=82, PG&E: n=55)	Yes	99%	95%
	No	1%	5%

Online Signup

About one-third of all respondents utilized the program Website to sign up for the ARP. The online sign-up option became much more common for SCE and PG&E customers over time: survey data collected for the 2004–2005 RARP study found only 8% of PG&E participants and 16% of SCE participants utilized online sign up.

As shown in Table 17, nearly all 2010–2012 respondents signing up online found it easy to find the sign-up screen on the Website, and reported the Website answered all of their questions about the

appliance recycling service. As with telephone enrollees, nearly all could schedule a pickup appointment for a convenient date and time.

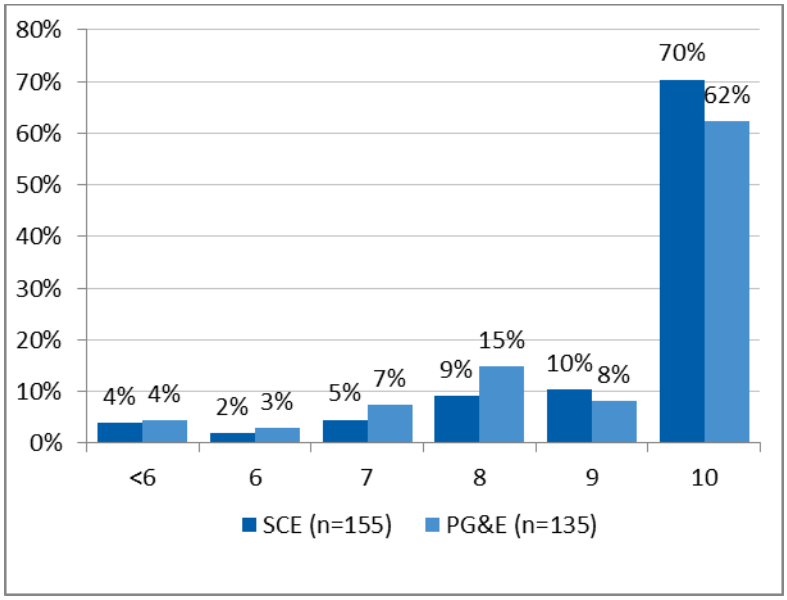
Table 17. Participant Online Signup Experience

Question	Response	SCE	PG&E
Was it easy to find the sign-up screen on the Website? (SCE: n=53, PG&E: n=49)	Yes	98%	96%
	No	2%	4%
Did the Website answer all your questions about the appliance recycling service? (SCE: n=55, PG&E: n=50)	Yes	98%	96%
	No	2%	4%
Were you able to schedule a pickup appointment for a convenient date and time? (SCE: n=56, PG&E: n=50)	Yes	98%	98%
	No	2%	2%
Did you receive confirmation that your signup had been successful? (SCE: n=52, PG&E: n=40)	Yes	96%	100%
	No	4%	0%

Over the past several years, SCE substantially reduced the length of time between customer sign-up and pickup dates. The statewide average pickup time during the 2004-2005 program was 15 days. SCE reduced the average pickup time for its 2006-2008 ARP from 10 days, prior to the introduction of the Enerpath logistics system in mid-2007, to seven days after the introduction of the system. SCE's ARP further reduced the average pickup time to four days for the 2010-2012 program. PG&E's average pickup time was 11 days for the 2010-2012 program.

Nonetheless, respondents' satisfaction levels dropped somewhat when asked about the length of time between their sign-up and pickup dates, as shown in Figure 31. Still, the vast majority rated their satisfaction with this process an 8 or higher on a 0 to 10 scale.

Figure 31. Participant Satisfaction with Time Between Sign-Up and Pickup



Pickup Process

Ninety-nine percent of all survey respondents who reported being home during their appliance pickups expressed satisfaction with their pickup experiences (defined as an 8 or higher rating on a 0 to 10 scale).

Nearly all respondents present during appliance pickup reported receiving a call in advance to confirm the appointment and/or let them know the pickup representative was coming. Table 18 lists reported recall of participants' experience with the programs' pickup representatives. Overall, participants recalled positive experiences, with a large majority of respondents reporting representatives arriving on time, being polite and courteous, and appearing neat and professional.

Table 18. Participant Pickup Experience

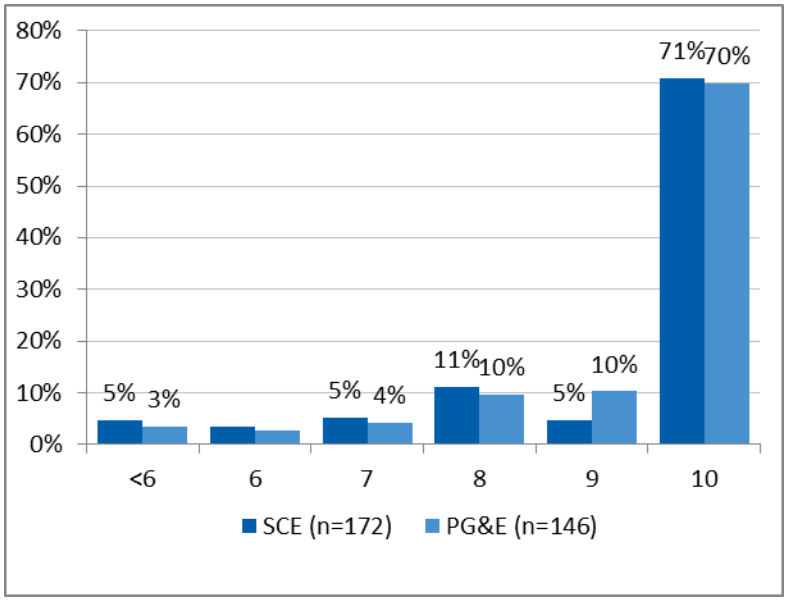
Question	Response	SCE	PG&E
Did someone call in advance to confirm the appointment or let you know they were coming? (SCE: n=147, PG&E: n=109)	Yes	99%	98%
	No	1%	2%
Did they arrive on time? (SCE: n=158, PG&E: n=139)	Yes	97%	99%
	No	3%	1%
Was the pickup representative polite and courteous? (SCE: n=160, PG&E: n=139)	Yes	98%	99%
	No	3%	1%
Did the representative appear neat and professional? (SCE: n=151, PG&E: n=132)	Yes	97%	98%
	No	3%	2%

Rebate Process and Amount

The majority of survey respondents (94% overall) had received a rebate check at the time of survey data collection. Many rebate recipients (37% for SCE, and 47% for PG&E) could not recall how long they waited to receive rebate checks after their appliance pickups. Of participants who could remember, 75% reported receiving the rebate check between two and four weeks after appliance pickup.

As shown in Figure 32, for both utilities, the majority of participants expressed satisfaction (on a scale of 0 to 10, where 10 is completely satisfied and 0 is not at all satisfied) with the time required for their rebate checks to arrive by mail.

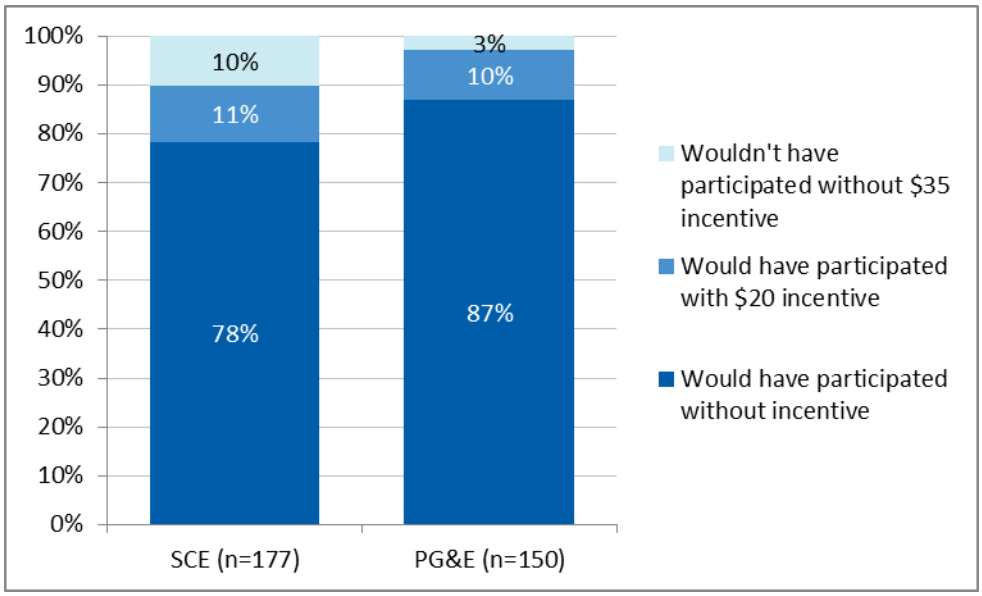
Figure 32. Participant Satisfaction with Rebate Wait Times



The survey also asked participants whether they would have participated in the program, had the incentive amount been lower or absent. Under the current program designs, respondents received a $35 rebate for participation. The majority of survey respondents (78% for SCE, 87% for PG&E) claimed they would have participated in the program had there not been incentives to participate. A larger proportion of PG&E respondents than SCE respondents said they would have participated without the incentive, as shown in Figure 33.

The 2006–2008 study presented similar results: when asked if the incentive proved essential to their participation, approximately 71% of SCE respondents said they would have participated in the ARP without the incentive. In the 2004–2005 study, 81% of SCE, PG&E, and San Diego Gas & Electric customers said they would have participated without an incentive.

Figure 33. Participant Influence of Incentive Amounts



Among respondents who would not have participated in the program without the $35 incentive (10% for SCE and 3% for PG&E), most said they still would have participated for a $20 incentive.

Comparison to 2004–2005 Program Delivery

As noted, SCE and PG&E 2010–2012 ARP participants reported high satisfaction with all aspects of the program delivery process. The same proportion of participants reported satisfaction with their sign-up experiences in the 2004–2005 study as in the 2010–2012 survey. Satisfaction with pickup and removal also saw similar results between studies, with 96% of 2004–2005 participants and 97% of 2010–2012 participants satisfied with the process. As shown in Table 19, other 2010–2012 program experience data remained consistent with past results.

Table 19. Comparison of Current and Past Participants' Program Delivery Experience

	2004–2005 ARP Participants*		2010–2012 ARP Participants	
	Yes	No	Yes	No
Scheduling	(n=665)		(n=131)**	
Was the representative you spoke to on the telephone polite and courteous?	100%	0%	100%	0%
Did the representative answer all your questions? ***	99%	1%	100%	0%
Were you able to schedule a pickup appointment for a convenient date and time?	97%	3%	97%	3%
Did you have to call more than once? ***	11%	89%	4%	96%
Pickup	(n=717)		(n=256)	
Did the representative call in advance to confirm the appointment or let you know they were coming? ***	96%	4%	99%	1%
Did the representative arrive on time?	98%	2%	98%	2%
Did the representative appear neat and professional?	98%	2%	98%	2%
Rebate Process	(n=1,018)		(n=367)	
Did you receive an incentive check?	95%	5%	94%	6%
Would you have participated in the program without the incentive check?	(n=895)		(n=320)	
	84%	16%	82%	18%

*These frequencies include responses from San Diego Gas & Electric customers.

**This value only includes participants signing up by telephone.

***Differences between evaluations were significant with 90% confidence.

Notable changes to reported program experiences since the 2004–2005 survey included:

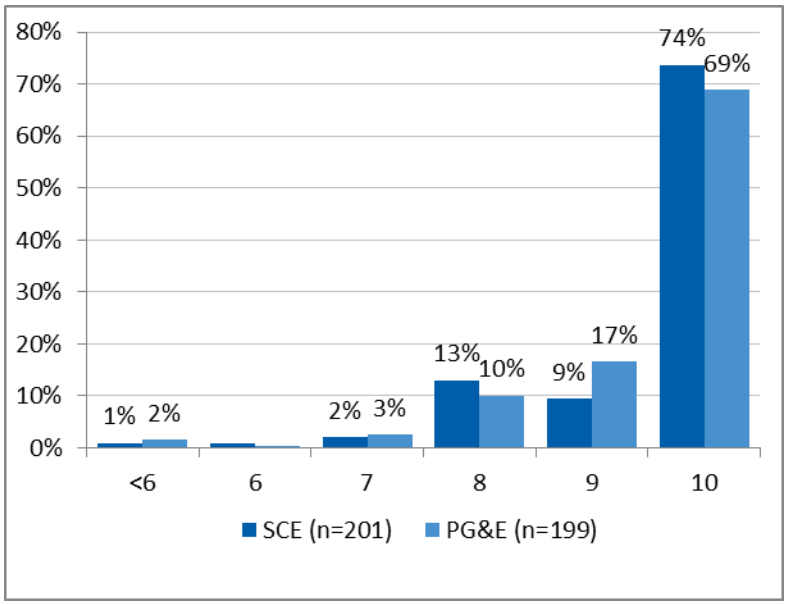
- The percentage of participants reporting having had all their questions answered by the telephone representative increased by 1%.
- The percentage of participants having to call the ARP sign-up hotline more than once decreased by 7%.
- The percentage of participants reporting their pickup representative called in advance to confirm the appointment increased by 3%.

4.8.2 Satisfaction and Program Improvements

Overall, 95% of 2010–2012 survey respondents reported satisfaction with their program experiences. The 2004–2005 RARP study saw similar findings, with 96% of participants reporting they were somewhat or completely satisfied.[17]

[17] This frequency included customer data from San Diego Gas & Electric's service territory.

Figure 34. Participant Overall Satisfaction with the Program



For 2010-2012, on a scale of 0 to 10, with 0 meaning not likely at all and 10 meaning extremely likely, 96% of both IOUs' respondents responded with an 8 or higher when asked how likely they would be to recommend the recycling service to a friend or family member.

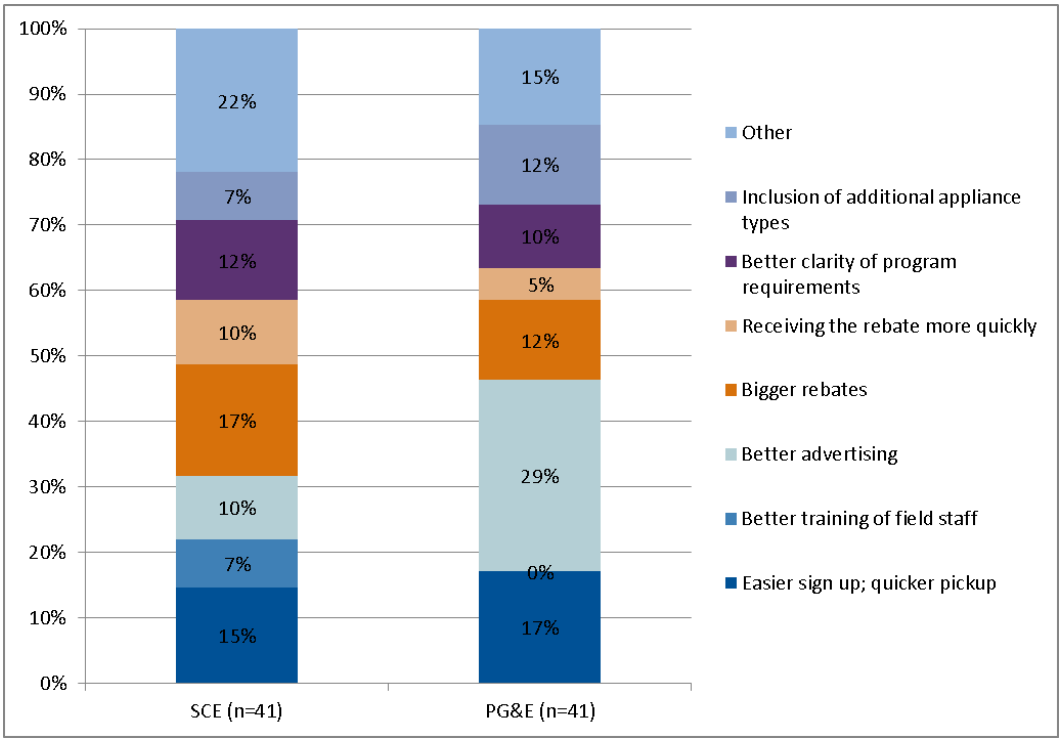
Twenty-six surveyed participants reported encountering problems during their ARP experiences.[18] Among this group, the most prevalent concern was not yet having received their rebates (cited by eight respondents). Other problems encountered included:

- Inconvenience with the pickup timing;
- Inconvenience with keeping the appliance plugged in to prove it functioned;
- Rude pickup staff; and
- Confusion regarding program requirements.

The survey also asked participants to provide suggestions for improvements to IOUs' recycling services. Most respondents—four out of five at both utilities—did not have any suggestions for improvements. As shown in Figure 35, of the 20% of SCE participants who had suggestions, the largest number (17%, or 7 respondents) suggested larger rebates. Twenty-nine percent of PG&E respondents (12 of 41 respondents) providing suggestions noted increasing awareness through improved marketing. In the 2004–2005 RARP study, PG&E customers also most commonly cited the need for more advertising.

[18] Roughly the same number of SCE and PG&E respondents reported problems with their ARP experiences. However, the sample remained too small to draw meaningful inferences about differences experienced by participants at each utility.

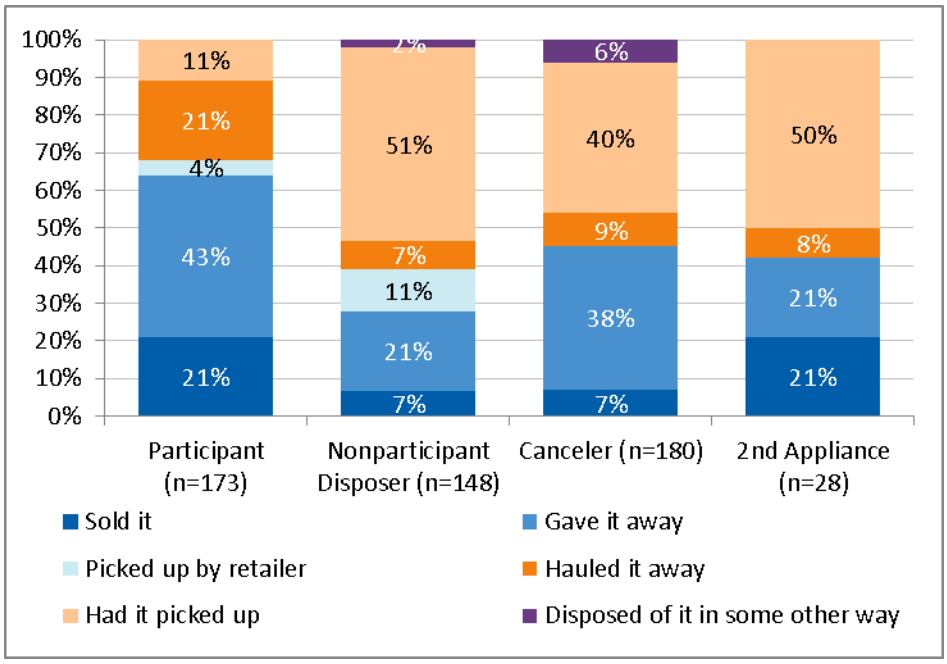
Figure 35. Participant Suggested Program Improvements



4.9 Alternative Disposal Methods

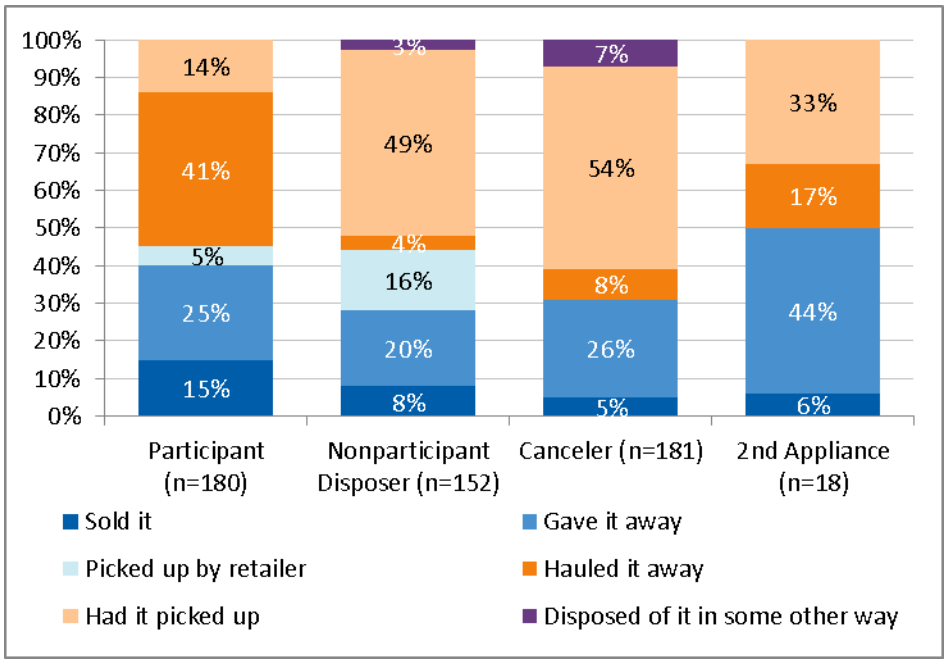
Figure 36 shows the alternate disposal methods either intended (in the case of participants) or utilized (in the case of nonparticipants) reported by SCE customers. When asked how they did or would have disposed of their appliances outside of the ARP, most SCE nonparticipants reported they had their unit picked up by someone else for dumping, or that they hauled it to a landfill, dump, or community waste service center themselves. SCE participants often stated that they would have given the unit away in absence of the program, while nonparticipants were much less likely to report doing this.

Figure 36. Non-Program Disposal Methods (SCE)



PG&E nonparticipant disposers offered responses similar to those groups in SCE's territory. However, second-appliance owners and participants differed. PG&E's second-appliance owners most commonly responded they would give the unit away, while PG&E participants reported that they would have hauled the appliance away themselves, as shown in Figure 37.

Figure 37. Non-Program Disposal Methods (PG&E)



4.10 Replacement of Disposed Appliances

Most customers who disposed of an appliance replaced their old appliance, and most replaced it with a new appliance. Nonetheless, 14% of SCE participants and 11% of PG&E participants did not replace their disposed units. As shown in Table 20, when buying new appliances, about one-half of SCE customers said salespeople told them about the ARP and how it could help remove their old appliance. SCE participants were twice as likely as nonparticipant disposers to replace their unit with a used one. Cancelers were less likely to replace their unit than participant and nonparticipant disposers, perhaps because they more often were discarding non-functioning units.

Table 20. Replacement of Disposed Unit (SCE)

SCE	Participant (n=203, 174, 130)	Nonparticipant disposer (n=150, 136, 112)	Canceler (n=162, 126, 85)
Proportion that replaced their disposed unit	86%*	91%**	78%**
Proportion of replacement units that were used	20%***	10%***	25%
Proportion that reported hearing about the program from a salesperson when purchasing a new unit	52%*	53%	36%*

* Differences between Participant and Canceler Surveys are statistically significant with 90% confidence.
** Differences between Nonparticipant Disposer and Canceler Surveys are statistically significant with 90% confidence.
*** Differences between Participant and Nonparticipant Disposer Surveys are statistically significant with 90% confidence.

Table 21 shows PG&E customers' responses to these replacement questions. PG&E customers were less likely to purchase used appliances, and there were no significant differences in this behavior between participants and nonparticipants.

Table 21: Replacement of Disposed Units (PG&E)

PG&E	Participant (n=199, 177, 140)	Nonparticipant disposer (n=152, 137, 109)	Canceler (n=167, 137, 94)
Proportion that replaced their disposed unit	89%*	90%**	83%*, **
Proportion of replacement units that were used	9%	9%	13%
Proportion that reported hearing about the program from a salesperson when purchasing a new unit	59%	53%	48%

* Differences between Participant and Canceler Surveys are statistically significant with 90% confidence.
** Differences between Nonparticipant Disposer and Canceler Surveys are statistically significant with 90% confidence.

4.11 Awareness, Knowledge, Attitudes, and Behavior

In Resolution E-4385, issued on December 10, 2010, the CPUC approved the following two Program Performance Metrics (PPMs) for SCE's and PG&E's 2010–2012 ARPs:

- ***PPM-1*:** Number of program appliance units by year, appliance type, model number (as available), age (estimated), and size. (PPM to be reported annually).
- ***PPM-2*:** Level of program participants' AKA (Awareness, Knowledge, Attitude) toward the ARPs. (PPM to be reported at the end of the program cycle).

SCE and PG&E have addressed PPM-1 outside of this evaluation as part of their regular reporting. To address PPM-2, Cadmus analyzed responses to specific questions in the 2010–2012 program participant and nonparticipant disposer surveys. The following sections present the methodology and findings for the 2010–2012 ARP PPM-2:

- Awareness
- Knowledge
- Attitude

Both surveys asked respondents about their awareness of, knowledge about, and attitudes towards the ARPs. The surveys also asked respondents about their awareness, knowledge, and attitudes regarding *benefits* associated with the ARPs (among other topics).

Cadmus used the nonparticipant disposer survey responses as a baseline, comparing participant responses to nonparticipant responses to similar questions to estimate the programs' effect, if any, on participant awareness, knowledge, and attitudes.

4.11.1 Awareness

Cadmus first analyzed awareness of the *program itself* by comparing the percentage of participant respondents who recalled signing up for SCE's or PG&E's appliance recycling service with the percentage of nonparticipant respondents recalling hearing about the utilities' appliance recycling services. As shown in Table 22, all participant respondents in SCE's and PG&E's service territories recalled the ARPs. Significantly fewer nonparticipants knew of the ARPs.

Table 22. Program Awareness

Utility	Participants	Nonparticipant Disposers
SCE*	100%	56%
	(n=203)	(n=148)
PG&E*	100%	36%
	(n=200)	(n=148)
Total, both utilities*	100%	46%
	(n=403)	(n=296)

*Significantly different from the participant responses at the 90% confidence level.

Table 23 compares program awareness among nonparticipant disposers to the results of previous studies on this question. As shown, awareness among PG&E nonparticipants remained at roughly the same level as found in the 2004-2005 study. Awareness among SCE nonparticipants increased during the 2006-2008 program cycle, but returned to 2004-2005 levels in the 2010-2012 program cycle.

Table 23. Nonparticipant Program Awareness: Comparison to Previous Studies

Utility	2004-2005 Nonparticipant Disposers	2006-2008 Nonparticipant Disposers	2010-2012 Nonparticipant Disposers
SCE	58%	70%	56%
	(n=465)	(n=400)	(n=148)
PG&E	35%	N/A	36%
	(n=491)		(n=148)

Cadmus next assessed awareness of the *program benefits* by examining participant and nonparticipant disposer answers to the following questions:

- Before you decided to dispose of your appliance, were you aware that a refrigerator or freezer in your home can cost up to $180 a year for electricity?
- Were you aware that the refrigerant in refrigerators and freezers is harmful to the environment if not properly disposed of?

To address awareness of program benefits, we compared the percentage of participants answering "yes" to these questions to the percentage of nonparticipants answering "yes." Table 24 shows that, while the majority of respondents in all categories knew of both these program benefits, more knew of the potential environmental harm of refrigerants than of appliance operating (electricity) costs.

Table 24. Awareness of ARP Benefits

Utility	Aware of…	Participants	Nonparticipant Disposers
SCE	Annual appliance electricity costs	63% (n=198)	71% (n=145)
	Refrigerant can be harmful to the environment	82% (n=200)	77% (n=146)
	Average	**72% (n=198)**	**74% (n=145)**
PG&E	Annual appliance electricity costs	66% (n=195)	67% (n=148)
	Refrigerant can be harmful to the environment*	91% (n=197)	81% (n=151)
	Average	**79% (n=195)**	**74% (n=148)**
Total, both utilities	Annual appliance electricity costs	64% (n=393)	69% (n=293)
	Refrigerant can be harmful to the environment*	87% (n=397)	79% (n=297)
	Average	**76% (n=393)**	**74% (n=293)**

* Significantly different from the participant responses at the 90% confidence level.

Comparing the results in Table 22 and Table 24 shows that both participants and nonparticipants are aware of the benefits delivered by the ARPs, but only about one-third to one-half of the nonparticipants are aware of the program.

4.11.2 Knowledge

Cadmus assessed participant *knowledge about the program* by asking respondents the main reasons they chose to dispose of their appliances through the program rather than through some other means. The open-ended question did not include a list of possible replies, so as to not influence the responses. If the participant cited a key program feature, we concluded the respondent had some knowledge of the program. Responses indicating a respondent's knowledge of the program included:

- Cash rebate payments.
- Free pickup service/others don't pick up/don't have to take it myself.
- Environmentally safe disposal/recycled/good for the environment.
- Savings on electric bill.
- Recommendation of retailer/dealer.
- Utility sponsorship of the service.
- Easy way/convenient.

The nonparticipant disposer survey did not include comparable questions; so Cadmus only used the participant survey to determine participant knowledge of the features of the ARPs. Table 25 shows most

participants in both utility service areas cited at least one relevant reason, and were determined to have some knowledge of the program features.

Table 25. Knowledge of ARP

IOU	Participants
SCE	93% (n=191)
PG&E	97% (n=195)
Total, both IOUs	95% (n=386)

Cadmus analyzed participant *knowledge of program benefits* by comparing participant and nonparticipant disposer responses to the following questions:

- Did you know that the appliances removed through the utility's recycling service would be completely taken apart, and the metals and glass recycled?
- Did you know that the coolant, motor oil, and insulation that might contain hazardous materials would be removed and recycled or destroyed?
- Did you know that almost none of the material from the units would go to a landfill?

Table 26 shows that over one-half of participants in both jurisdictions (and fewer than one-half of nonparticipant disposers who were aware of the ARP), knew hazardous materials from the appliances would be recycled or destroyed. However, less than one-half of participants and nonparticipant disposers knew the appliances' metals and glass would be all recycled, and that almost no materials from the appliances would go to a landfill. The specificity of these questions may contribute to fewer than 60% of respondents reporting knowledge of these program benefits.

Table 26. Knowledge of ARP Benefits

IOU	Knowledge of…	Participants	Nonparticipant Disposers
SCE	Metal and glass recycling	44% (n=201)	43% (n=82)
	Coolant, oil, insulation recycled or destroyed	53% (n=198)	44% (n=82)
	Almost no materials to land fill	28% (n=200)	28% (n=81)
	Average	**42% (n=198)**	**38% (n=81)**
PG&E	Metal and glass recycling*	48% (n=197)	34% (n=53)
	Coolant, oil, insulation recycled or destroyed*	59% (n=188)	25% (n=53)
	Almost no materials to land fill	37% (n=197)	25% (n=51)
	Average*	**48% (n=188)**	**28% (n=51)**
Total, both IOUs	Metal and glass recycling	46% (n=398)	39% (n=135)
	Coolant, oil, insulation recycled or destroyed*	56% (n=386)	36% (n=135)
	Almost no materials to land fill	32% (n=397)	27% (n=132)
	Average*	**45% (n=386)**	**34% (n=132)**

* Significantly different from the participant responses at the 90% confidence level.

Overall, participants proved significantly more likely to know of program benefits than nonparticipant disposers who were aware of the program. This is due largely to the difference in knowledge regarding recycling/destruction of hazardous materials.

4.11.3 Attitudes

Cadmus assessed participants' *attitudes toward the ARPs* by examining their overall satisfaction with the program and the likelihood they would recommend it to others. We asked participants to respond to the following two questions, and used the average values of the responses to determine overall participant attitudes toward the ARPs:

- Thinking about your experiences throughout the whole process, how satisfied were you with the service overall, using a 0 to 10 scale, where 10 means completely satisfied and 0 means not satisfied at all?
- On a scale of 0 to 10, where 10=extremely likely, and 0=not likely at all, how likely are you to recommend the utility recycling service to a friend or family member?

As shown in Table 27, most respondents expressed high satisfaction levels with the ARPs, and very likely would recommend the program to others: overall attitudes in both IOU service areas averaged a 9.6 out of a maximum of 10.

Table 27. Participants' Attitudes Toward ARP

Rank	Satisfaction with Program Service			Likelihood to Recommend Program			Overall Attitude		
	SCE (n=201)	PG&E (n=199)	Both Utilities (n=400)	SCE (n=200)	PG&E (n=197)	Both Utilities (n=397)	SCE (n=200)	PG&E (n=197)	Both Utilities (n=397)
0	0%	0%	0%	2%	1%	1%	1%	0%	1%
1	0%	0%	0%	0%	0%	0%	0%	0%	0%
2	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	1%	0%	0%	0%	0%	0%
5	0%	2%	1%	0%	1%	1%	0%	1%	1%
6	1%	1%	1%	1%	1%	1%	1%	1%	1%
7	2%	3%	2%	2%	2%	2%	2%	2%	2%
8	13%	10%	12%	5%	3%	4%	9%	6%	8%
9	9%	17%	13%	3%	5%	4%	6%	11%	9%
10	74%	69%	71%	88%	88%	88%	81%	79%	80%

To determine respondents' *attitudes toward program benefits*, Cadmus asked participants previously identified as having some knowledge of the program benefits (i.e., participants who knew about the program's metal and glass recycling, hazardous materials recycling or destruction, or that few/no materials go to landfill) the following question:

- How much did knowing that your appliance would be disposed of in an environmentally safe way influence your decision to dispose of it through the utility's service? Did it influence your decision a lot, did it somewhat influence your decision, or did it not influence your decision at all?

As shown in Table 28, the majority of participants in both utility programs reported knowing their appliances would be disposed in an environmentally safe manner influenced their decisions to participate a lot.

Table 28. Participants' Attitude Toward ARP Benefits

Rank	Influence Knowledge of Environmentally Safe Disposal Had on Program Participation		
	SCE (n=121)	PG&E (n=129)	Both Utilities (n=250)
Not at all	20%	16%	18%
Somewhat	16%	17%	16%
A lot	64%	67%	66%

Cadmus also asked nonparticipant disposers a similar, *but hypothetical*, question:

- The utility's recycling service ensures that all appliance parts are disposed of in an environmentally safe manner. Knowing that, how much more likely would you be to participate in the utility's appliance recycling service in the future? Would you be much more likely, somewhat more likely, or not at all more likely?

Table 29 shows comparable values for SCE and PG&E nonparticipant disposers, with a large majority of nonparticipants in both jurisdictions (more than two-thirds of all nonparticipant disposers) reporting that knowledge of the programs' safe disposal practices would make them much more likely to participate in the future.

Table 29. Nonparticipant Disposers' Attitude Toward ARP Benefits

Rank	Influence of Knowledge of Environmentally Safe Disposal on Likelihood to Participate		
	SCE (n=146)	PG&E (n=145)	Both Utilities (n=291)
Not at all	11%	8%	10%
Somewhat	19%	26%	22%
Much more	70%	66%	68%

4.12 Demographics and Home Characteristics

Figure 38 compares SCE's customers housing type by survey group. Most respondents said they are living in a single-family detached household. Second appliance owners were the most likely to live in single-family housing, while participants were the least likely.

Figure 38. SCE Home Type by Survey

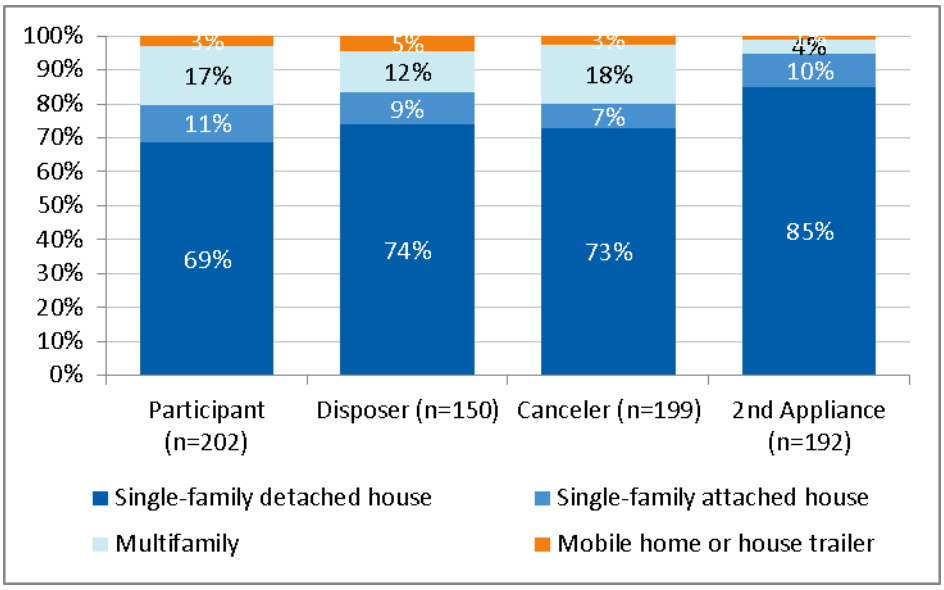


Figure 39 shows the distribution of housing types for PG&E customers. Participants and nonparticipants were very similar, with approximately 95% of customers living in single-family housing (whether attached or detached).

Figure 39. PG&E Home Type by Survey

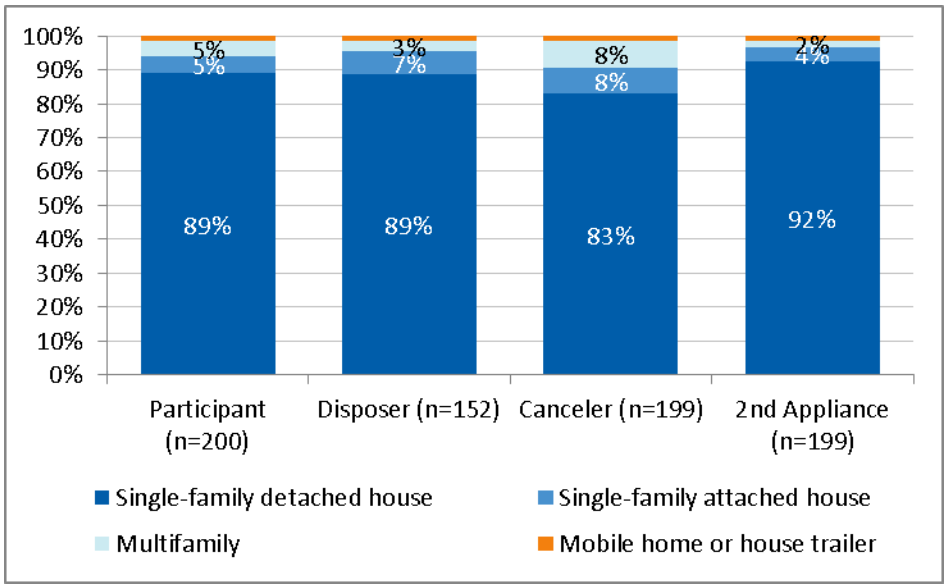


Figure 40 shows the number of people living in the SCE households, by age group. SCE customers were, on average, more likely to have older individuals living in their homes than PG&E customers. Nonparticipant disposers had the smallest households on average among the SCE groups.

Figure 40. Number of Occupants by Age Group (SCE)

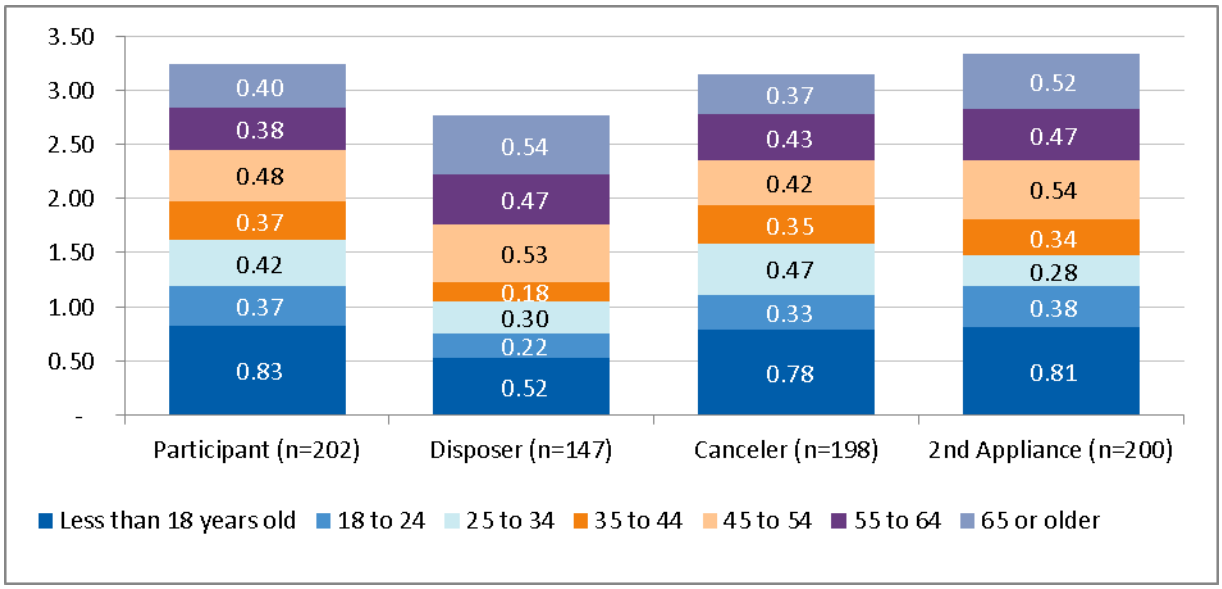


Figure 41 shows these distributions for PG&E households. PG&E customers had fewer people living in the household than SCE customers.

Figure 41. Number of Occupants by Age Group (PG&E)

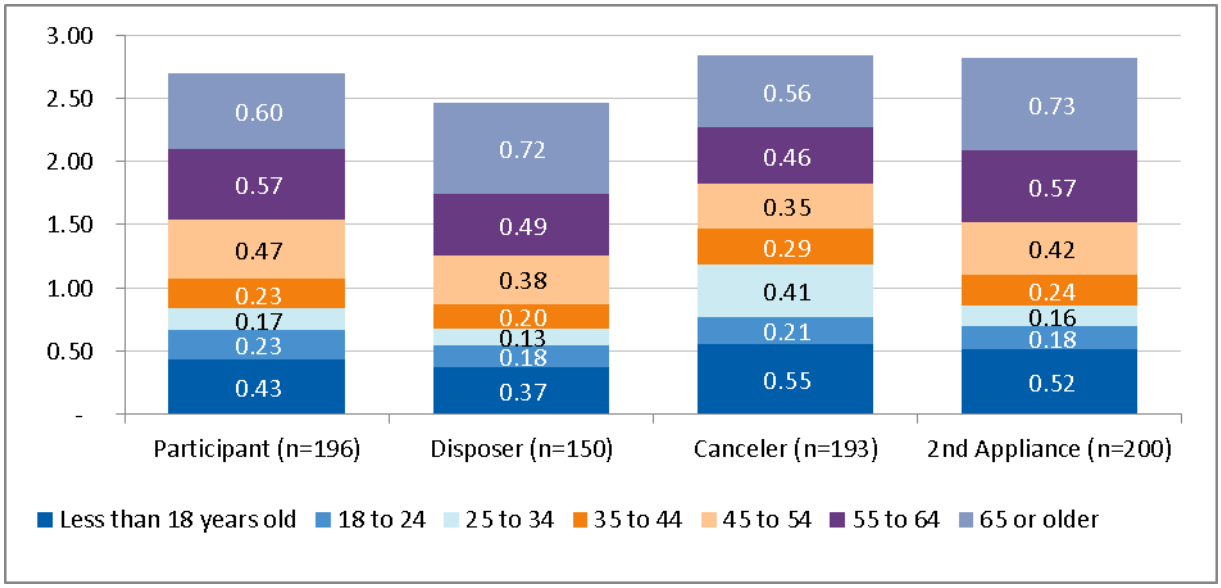


Figure 42 how SCE's survey groups compared to the 2009 RASS. All groups, save for nonparticipant disposers, had more people in the home than the average found in RASS (though these differences were not always significant).

Figure 42. Average Number of Occupants by RASS and Survey (SCE)

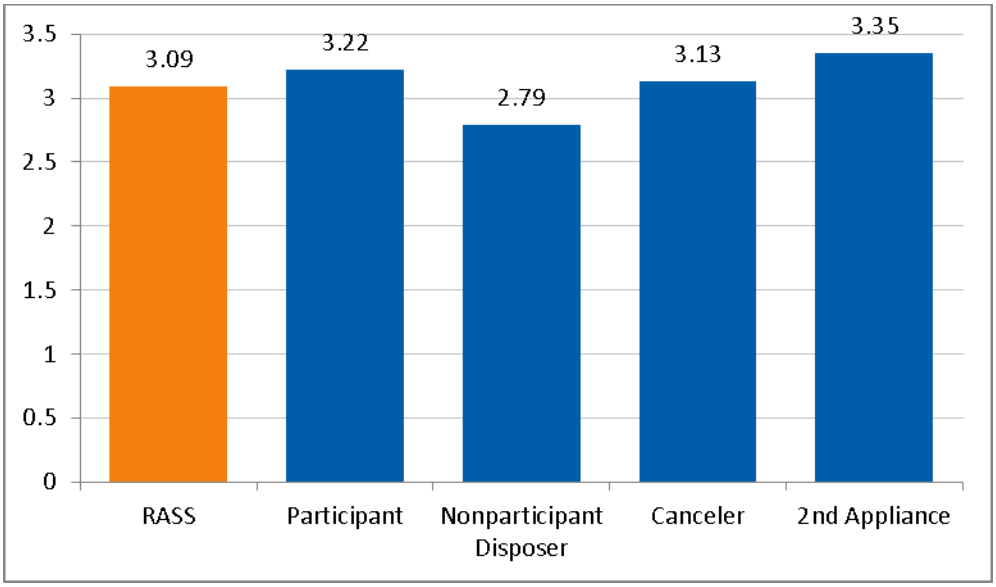
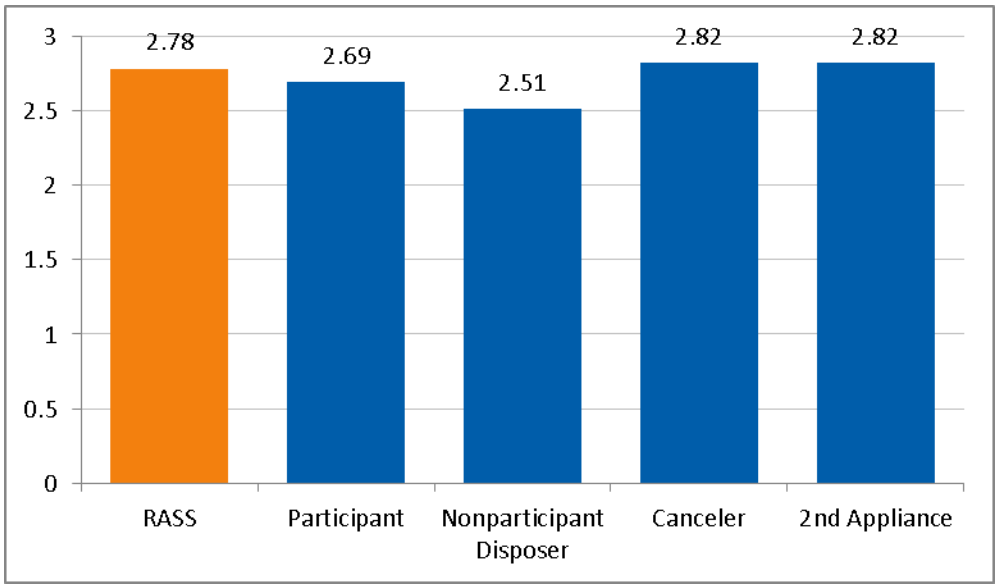


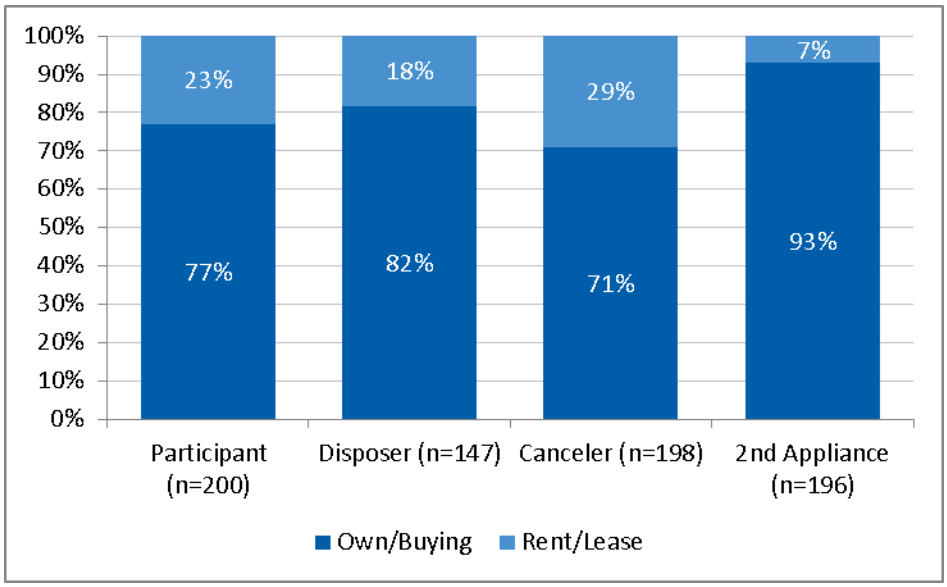
Figure 43 compares PG&E surveys groups to the average household size found in the 2009 RASS. Participant and nonparticipant disposers actually had slightly smaller households than those found in the general population, while cancelers and second appliance owners were similar to RASS.

Figure 43. Average Number of Occupants by RASS and Survey (PG&E)



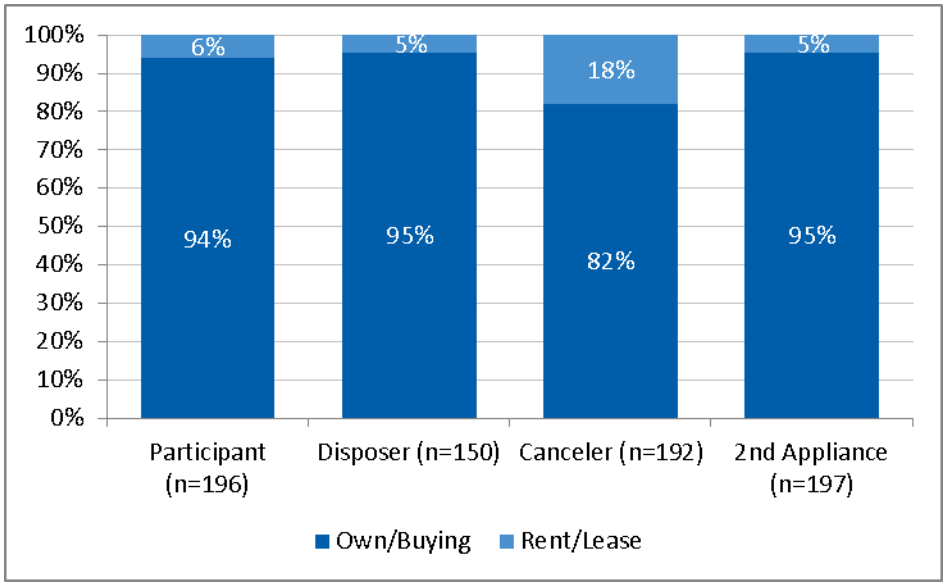
Customers across both IOUs were more likely to be homeowners than renters. Figure 44 shows the rate for homeownership for SCE customers. Second appliance owners were the most likely to own their home (93%), while approximately one in four disposers (participant and nonparticipant) rented.

Figure 44. SCE Home Ownership by Survey



This was not the case for PG&E customers, where approximately 95% of all groups, save for cancelers, owned their own home (Figure 45).

Figure 45. PG&E Home Ownership by Survey



About half of all survey respondents reported having a college degree or higher and almost all of the customers we spoke to had graduated high school or achieved further education. As shown in Figure 46 and Figure 47 educational attainment was relatively consistent between survey groups within each IOU.

Figure 46. Education Level Achieved by Survey (SCE)

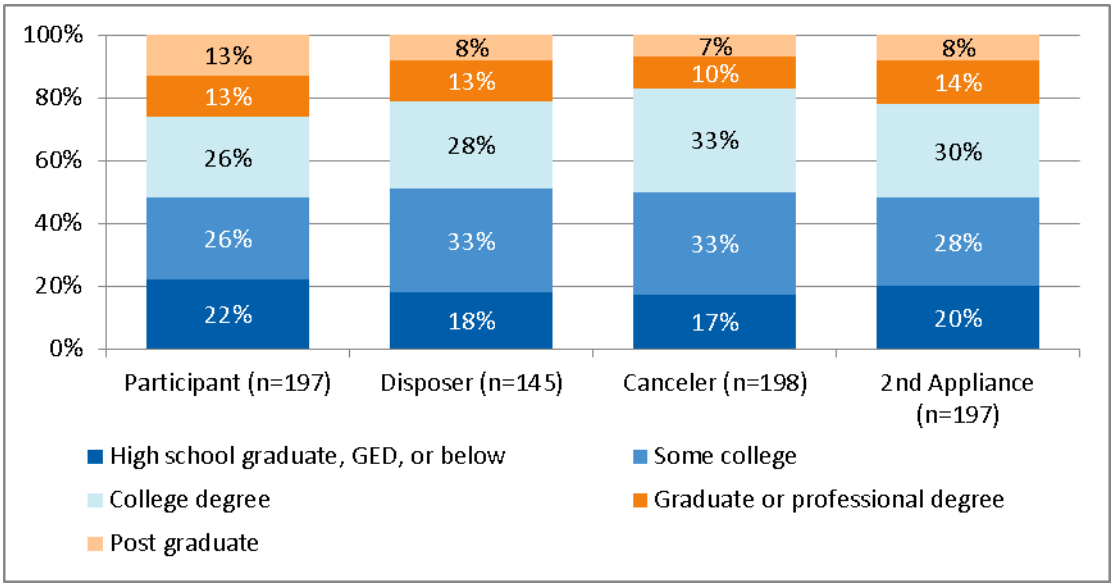
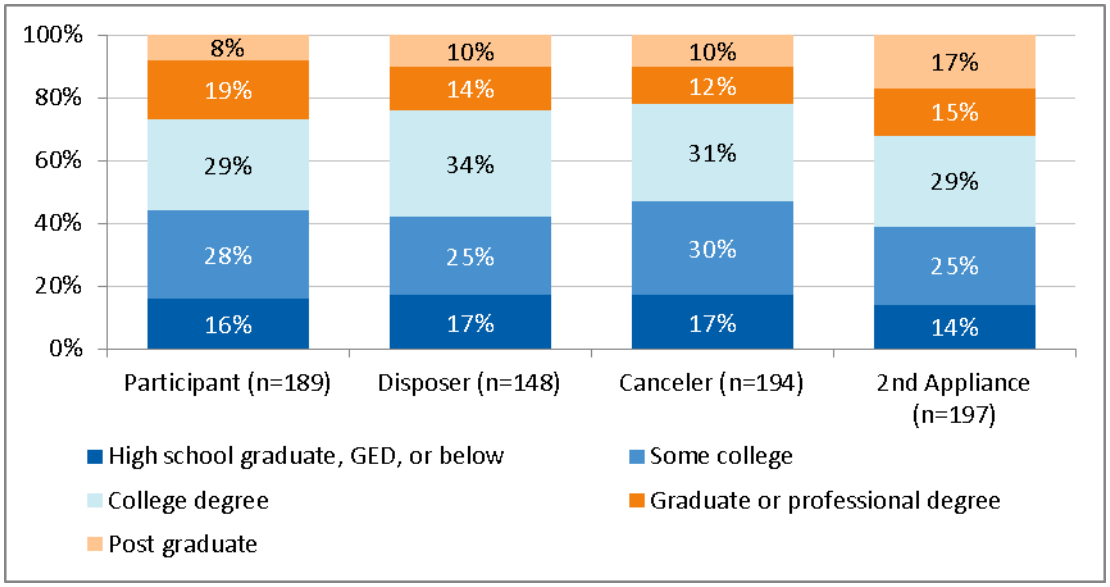


Figure 47. Education Level Achieved by Survey (PG&E)



5 MARKET CHARACTERIZATION FINDINGS

As part of our evaluation, Cadmus conducted a market characterization study to provide context on how the market for new and used appliances has changed over the lives of the ARPs. This study, covering 2000-2012, provides findings for each IOU on the number of appliances in use by type, the annual sales of new and used appliances, and the annual disposals by method. The study also provides historical context on participant and nonparticipant decisions on disposal methods, combining primary data collected as part of this evaluation with past evaluation results.

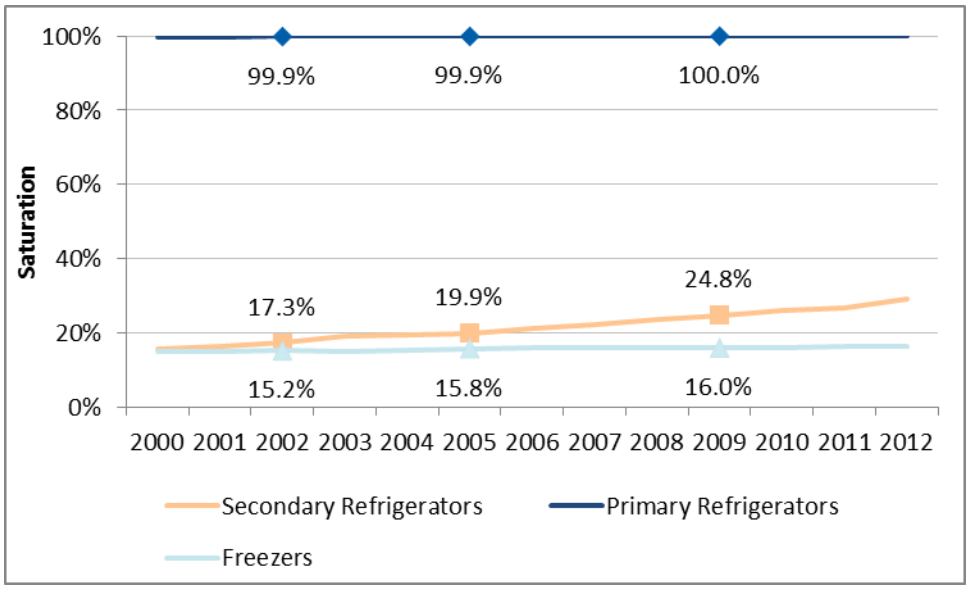
5.1 Appliance Ownership and Sales

5.1.1 Appliance Saturations

Cadmus determined second appliance ownership using the saturation rates for primary refrigerators, second refrigerators, and stand-alone freezers reported in the 2002, 2005, and 2009 RASS reports. Cadmus fit a trend line through the measured data points to extrapolate the saturations.

Figure 48 shows the estimated saturations of appliance saturations for SCE. Primary refrigerators are a modern necessity, and the saturation is currently 100%. The saturation of second refrigerators increased from 17% of homes in 2002 to nearly 25% in 2009, while the freezer saturation remained relatively constant.[19]

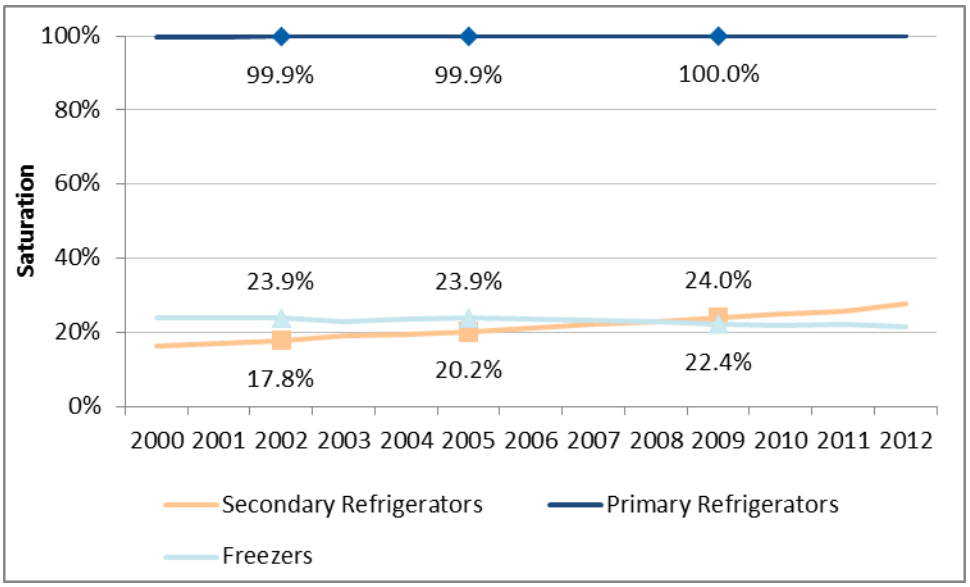
Figure 48. SCE Appliance Saturations



[19] Cadmus is not aware of any comparable time-series data from other utilities to which the SCE (and PG&E) trends presented here could be compared.

Figure 49 shows the estimated saturations of appliance saturations for PG&E. The saturation of second refrigerators increased from 18% of homes in 2002 to 24% in 2009. Freezer saturations actually decreased slightly, from 24% in 2002 to 22% in 2009.

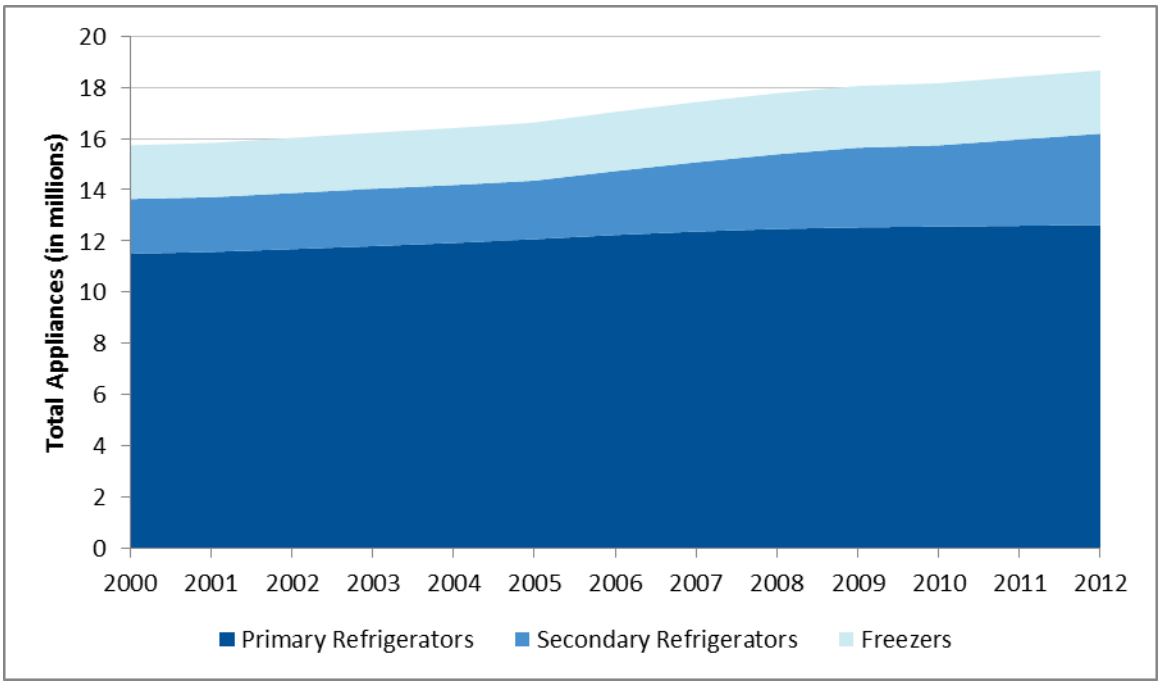
Figure 49. PG&E Appliance Saturations



5.1.2 Statewide Refrigerators and Freezers

To determine the total statewide volume of refrigerators and freezers in California, Cadmus combined U.S. Census American Community Survey data on the number and size of households with saturation rates calculated above. For all other years, Cadmus estimated saturation rates by calculating a linear trend between measured values. Figure 50 shows the total number of refrigerators and freezers in California households from 2000 through 2012. In 2012, there were over 16 million refrigerators and 2.5 million freezers actively used in California.

Figure 50. Statewide Total Appliance Population by Year and Type



5.1.3 Refrigerator and Freezer Sales Statewide

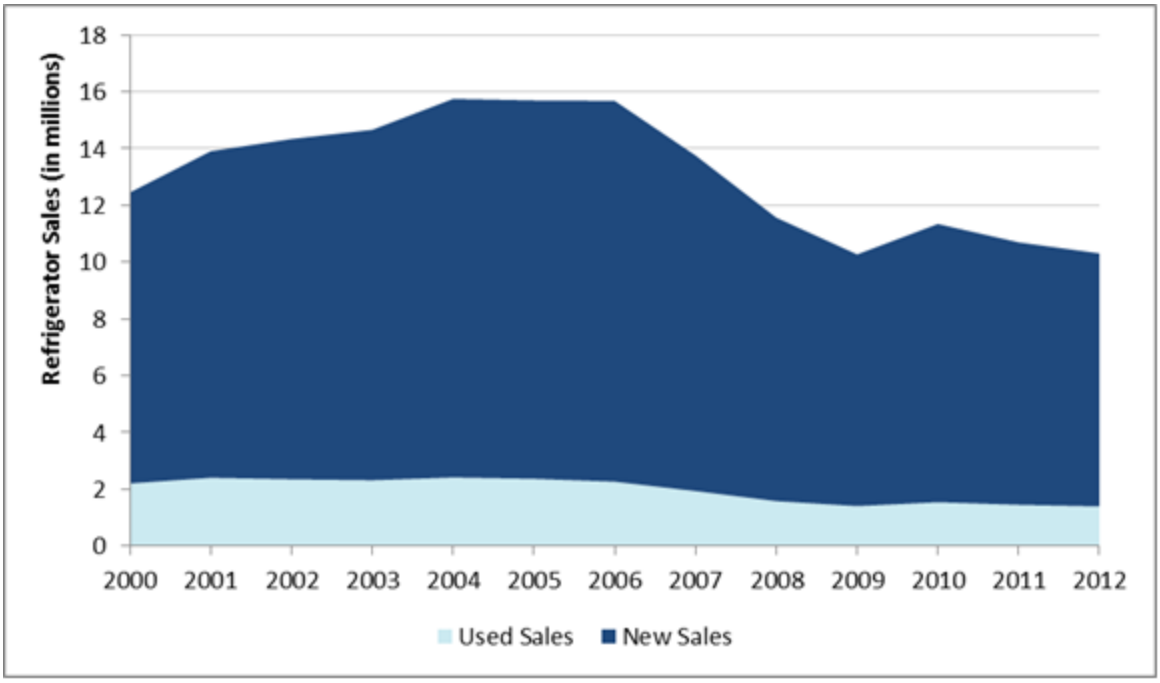
In order to estimate the number of new residential-style appliances going to existing homes, new homes, and commercial applications, Cadmus started by acquiring total statewide sales values for residential-style refrigerators and freezers from the Association of Home Appliance Manufactures (AHAM); appliance manufacturers report these estimates to AHAM. We estimated the sales of residential-style refrigerators for commercial use using the same methodology as the 2005 RASS report, which calculates sales based on the total square-footage of commercial space. The resulting ratio is 0.022 for commercial sales to total sales for California. We then multiplied this ratio by total sales to estimate yearly commercial sales.

To estimate the sales of refrigerators to new homes, Cadmus assumed the annual change in total households and new refrigerators were equal. To estimate the sales of freezers to new homes, we multiplied the saturation rate for each year by the annual change in total households.

To estimate used appliance sales, we asked ARP participants and nonparticipant disposers whether the replacement unit for the appliance they were recycling was new or used, weighting the two to arrive at territory-level values. We then used the weighted average response from SCE and PG&E customers for statewide values. The statewide proportions of new and used sales were estimated as 86% new units to 14% used. Based on the remaining sales of refrigerators and freezers after accounting for commercial

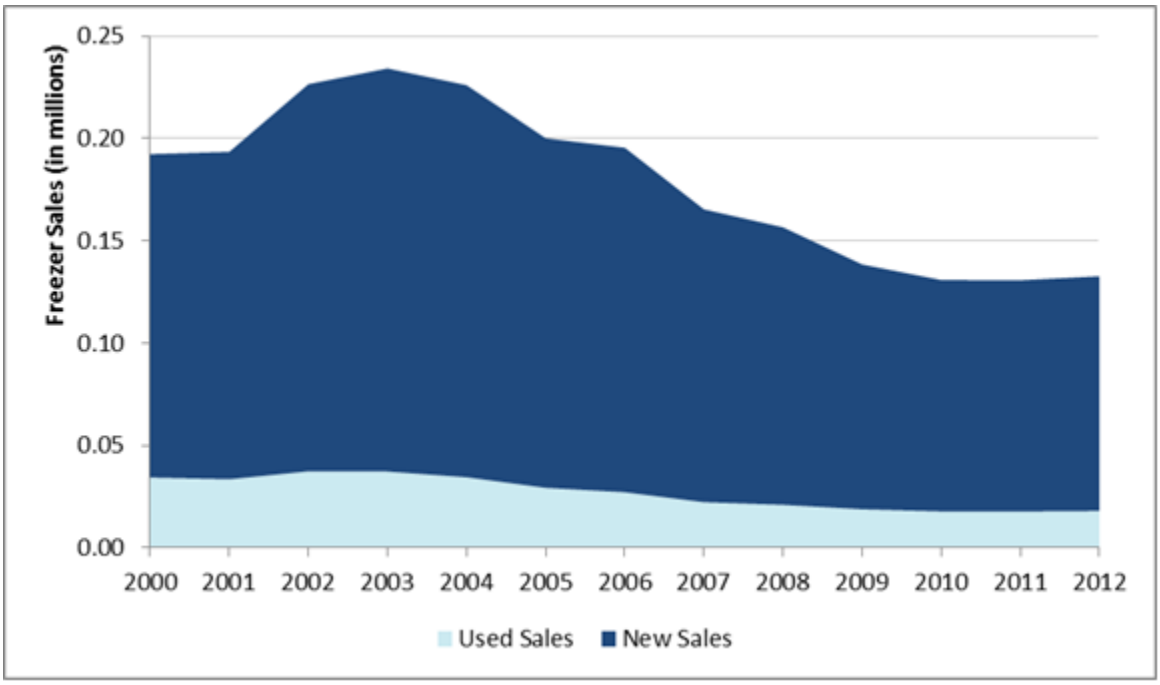
and new household sales, Cadmus calculated annual estimates of used sales using the survey-based proportions (Figure 51 and Figure 52).[20]

Figure 51. Statewide Refrigerator Sales by Year and Type



[20] The decrease in sales that began around 2006 is likely attributable, at least in part, to the economic recession.

Figure 52. Statewide Freezer Sales by Year and Type



5.1.4 Sales Within Utility Territories

Using the same methodology, Cadmus calculated the total number of refrigerators and freezers in use for each IOU territory using the number of residential customer accounts as reported in the IOUs' annual operations reports. Since some residential accounts cover more than one household, Cadmus applied the ratio of households to accounts from the 2005 RASS to calculate the number of households in each service territory. For both SCE and PG&E, this ratio is 1.02 households to residential accounts. From the total households in an IOU territory, Cadmus allocated the total number of units statewide to the IOUs for each year proportionally to the number of households in each service area.

Figure 53 and Figure 54 show the total number of refrigerators and freezers in use in IOU territories between 2000 and 2012.

Figure 53. SCE Total Population of Units by Year and Type

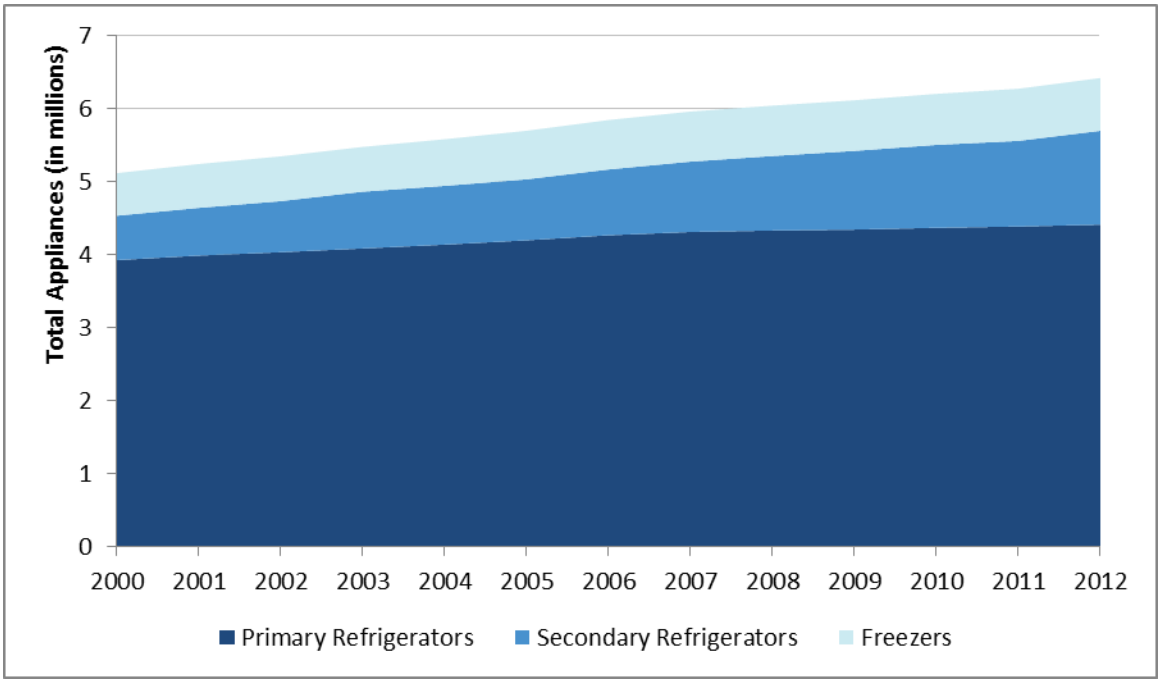
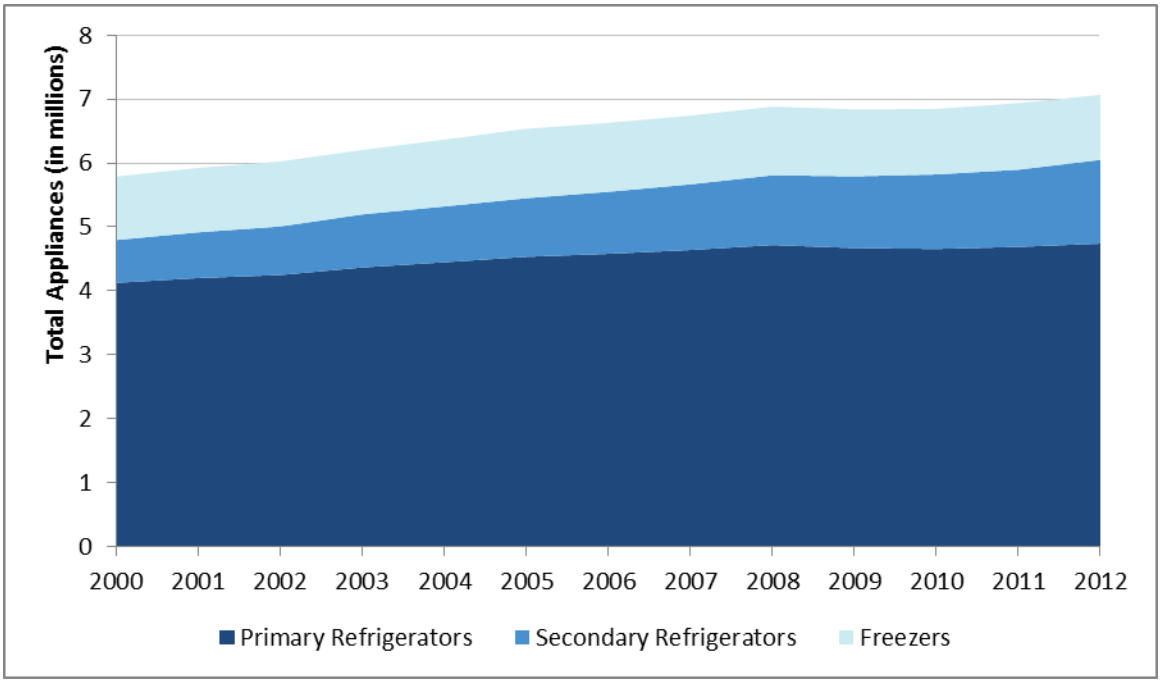


Figure 54. PG&E Total Population of Units by Year and Type



Following the methodology used for statewide sales, Cadmus used AHAM data to estimate sales within utility territories, which we proportionally distributed to each IOU territory based on households. When calculating used sales, we used the average surveyed ARP participants' responses for each utility. For SCE, these responses indicated 80% new units and 20% used. For PG&E, the proportions were 90% new units and 10% used (Figure 55 through Figure 58).

Figure 55. SCE Refrigerator Sales by Year and Type

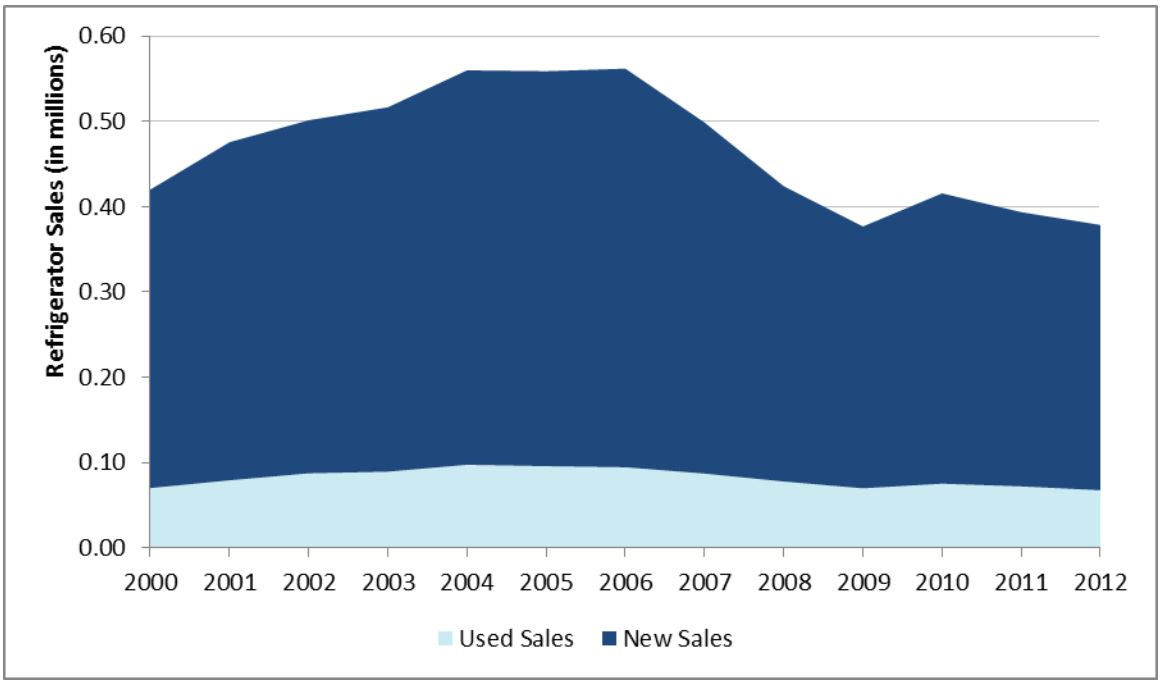


Figure 56. SCE Freezer Sales by Year and Type

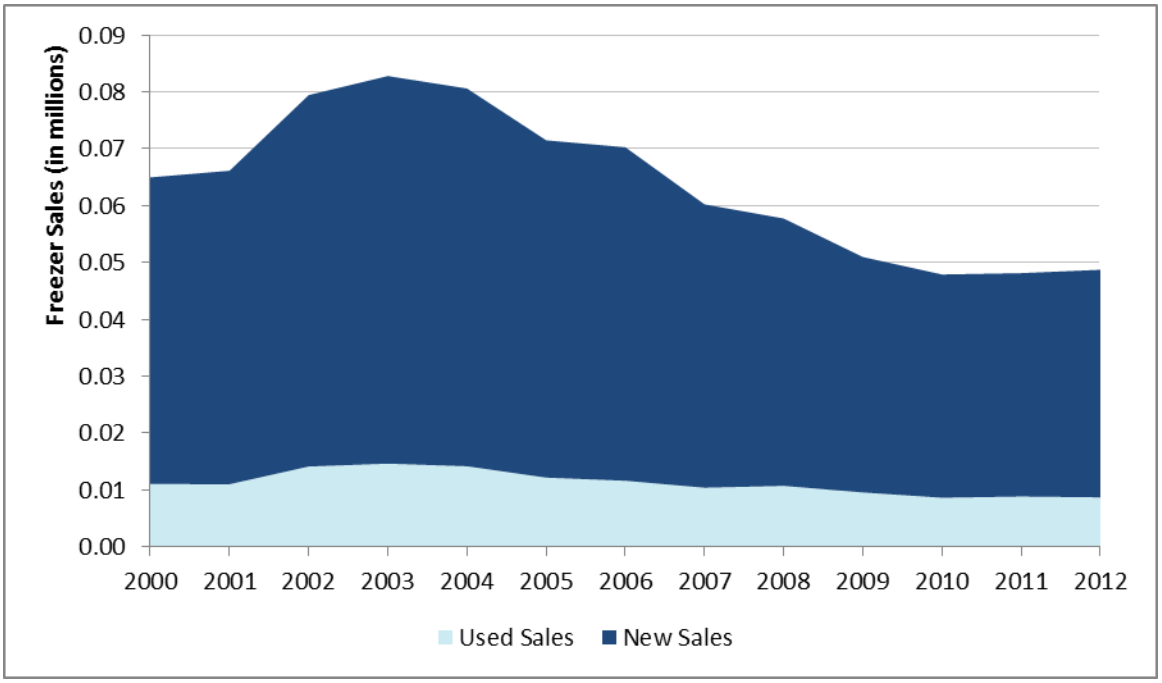


Figure 57. PG&E Refrigerator Sales by Year and Type

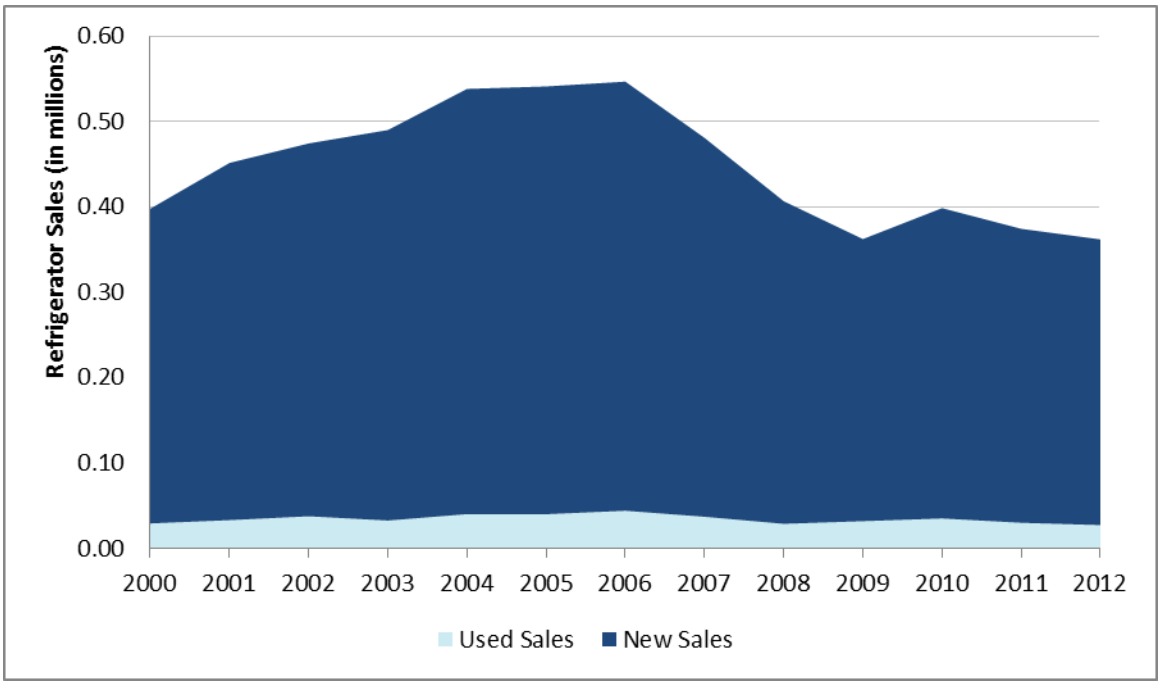
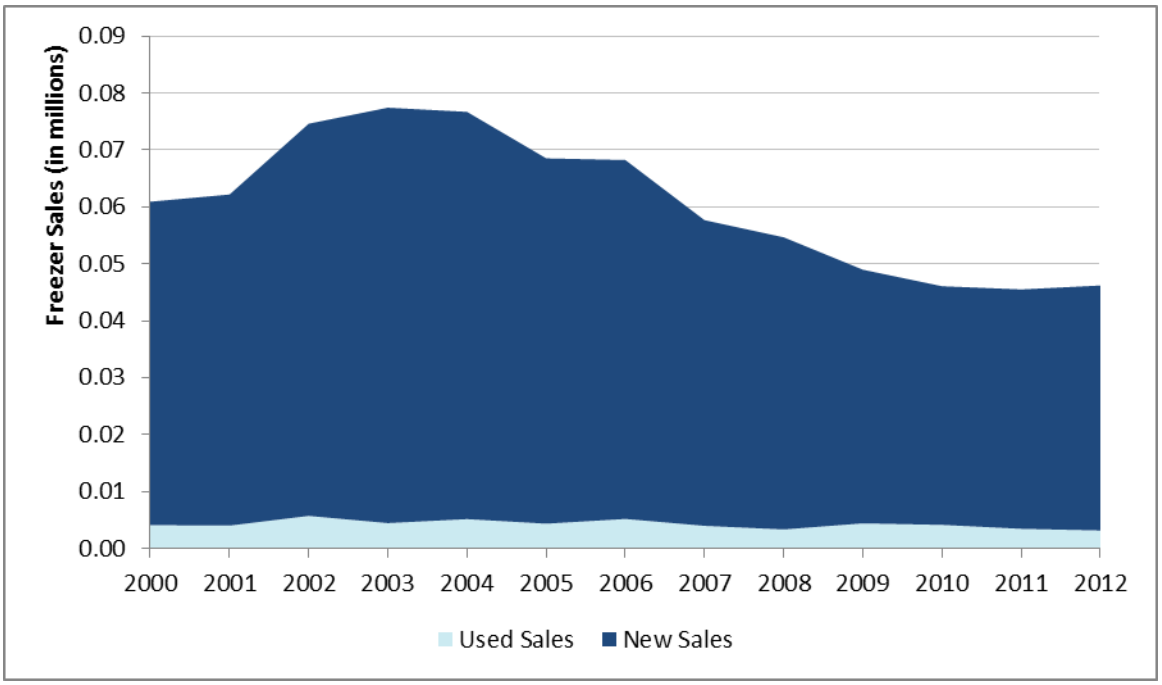


Figure 58. PG&E Freezer Sales by Year and Type



5.2 Participation Decisions and Preferences

5.2.1 SCE Participants

Through the participant surveys, Cadmus asked program participants about their motivation for deciding to participate in the program. We allowed multiple responses, which are combined in Table 30 for SCE.

SCE customers cited the incentive and the convenience of the pickup service as top motivators. This is consistent with the findings in 2004-2005 and 2006-2008. There does appear to be an increasing trend of the incentive as a top motivating factor.

The percentage indicating that convenience was a top motivator increased to the same level observed in the 2004-2005 study, after declining in the 2006-2008 study, which was statewide. The same was true for environmental benefits as a motivating factor.

Table 30. SCE Motivation for Participating*

Response	Statewide 2004-2005 (n=512)	SCE 2006-2008 (n=454)	SCE 2010-2012 (n=198)
Cash rebate payment	46%	55%	62%
Convenience	65%	44%	65%
Environment	22%	17%	22%
Savings on bill	0%	4%	5%
Recommendation of a friend/relative	1%	2%	5%
Recommendation of retailer/dealer	1%	2%	4%
Utility sponsorship	2%	3%	3%
Never heard of any other way to dispose	3%	6%	10%
Other	4%	2%	2%

* Multiple responses allowed.

5.2.2 SCE Nonparticipants

Cadmus asked surveyed nonparticipant disposers why they decided to dispose of their unit outside of the program. The portion of respondents indicating they had not heard of the program has declined dramatically since the 2004-2005 evaluation report, falling from 79% to just 7%.

Potential transfers to another user were the top reasons for not participating in the current program cycle, whether by selling the appliance, giving it away, or having the unit picked up by the dealer where respondents bought replacement units. A total of 18% indicated that the inconvenience, wait-time, or scheduling was a problem. A small portion of units, 6%, did not qualify or were not working. Finally, 2% said they had signed up for the program, but no one came to pick up the appliance.

Table 31. SCE Reason for Not Participating

Response	Statewide 2004-2005 (n=471)*	SCE 2010-2012 (n=177)
Dealer/retailer picked up the old one**	5%	32%
Planned to give away to friend/relative	7%	21%
Planned to sell the unit	1%	11%
Inconvenient	2%	11%
Had not heard of service	79%	7%
Wait time is too long	0%	5%
Unit was not working	2%	5%
Cannot be home when unit is picked up	0%	2%
Signed up/no one came to pick it up	0%	2%
Rebate is too low	0%	1%
Appliance did not qualify	N/A***	1%
Other	4%	N/A

* Table 5-13 in the 2004-2005 ARP evaluation report shows a total of 622 respondents, but the column numbers sum to 619. In addition, this table does not include "did not respond" or "did not have any appliances to recycle" responses, as they did not provide relevant information for comparison with the current study results.

** Retailer pickups include both working and nonworking units; ARP pickups include only working units that also meet other program eligibility requirements.

*** In the 2004-2005 report, the "appliance did not qualify" and "did not work" responses were combined.

5.2.3 PG&E Participants

PG&E's program was not evaluated in the 2006-2008 study, so we compared the 2004-2005 statewide study with the results of the current participant survey. The incentive was mentioned as a motivating factor more often in the current participant survey (Table 32). The most common reason for participating in PG&E's program, mentioned by 80%, was the convenience of the pickup service. Concern for the environment was the third most frequent mention, with a slight increase since 2004-2005.

Table 32. PG&E Motivation for Participating*

Response	Statewide 2004-2005 (n=512)	PG&E 2010-2012 (n=195)
Cash rebate payment	46%	55%
Convenience	65%	80%
Environment	22%	25%
Savings on bill	0%	7%
Recommendation of a friend/relative	1%	1%
Recommendation of retailer/dealer	1%	3%
Utility sponsorship	2%	5%
Never heard of any other way to dispose	3%	8%
Other	4%	3%

* Multiple responses allowed.

5.2.4 PG&E Nonparticipants

Cadmus asked nonparticipant disposers why they decided to dispose of their unit outside of the program. The portion of respondents indicating they had not heard of the program has declined dramatically since the 2004-2005 evaluation report; in that report, 79% of respondents had not heard of the program, compared to only 4% of disposer respondents in this evaluation (Table 33).

Potential transfer to another user was the top reason for not participating in 2010-2012, whether by sale or giving away. Those responses were followed by having the unit picked up by the dealer. A total of 11% indicated that the inconvenience or wait time was the reason they did not participate. A small portion of units, 2%, did not qualify or were not working, which is the same portion as in the 2004-2005 report.

Table 33. PG&E Reason for Not Participating

Response	Statewide 2004-2005 (n=471)	PG&E 2010-2012 (n=177)
Dealer/retailer picked up the old one*	5%	36%
Planned to give away to friend/relative	7%	27%
Planned to sell the unit	1%	20%
Inconvenient	2%	9%
Had not heard of service	79%	4%
Wait time is too long	0%	2%
Unit was not working	2%	2%
Other	4%	N/A

* Retailer pickups include both working and nonworking units; ARP pickups include only working units that also meet other program eligibility requirements.

5.3 Alternative Disposal Methods

5.3.1 SCE Alternative Disposal Methods

Cadmus asked SCE participant survey respondents how they would have disposed of their unit if they had not recycled it through the program. We compared the participant responses to the disposal methods reported by nonparticipant disposers (who are likely unfamiliar with ARP eligibility requirements); Table 2 shows the results.

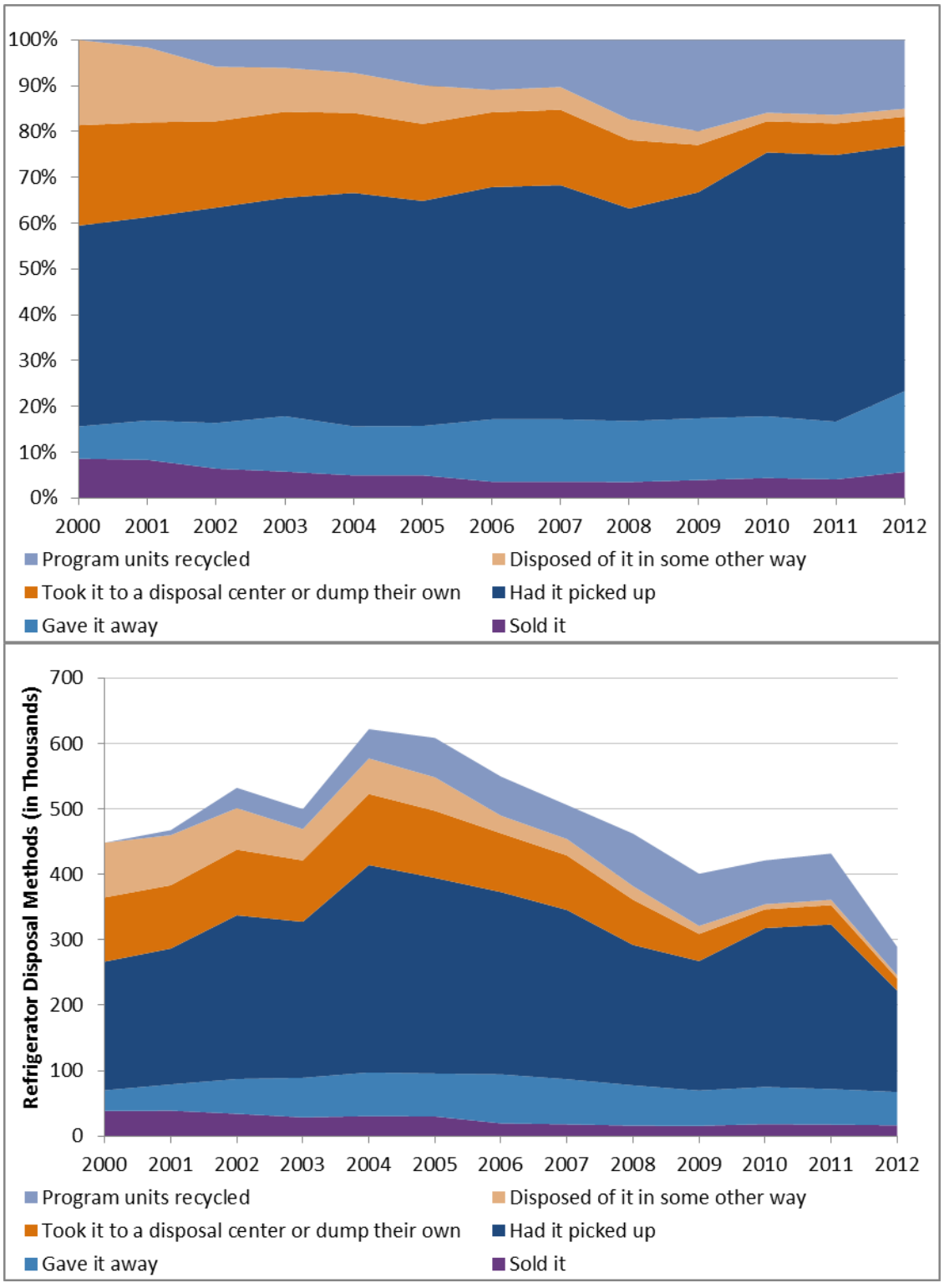
Table 34. SCE 2010-2012 Disposal Methods in Absence of the Program

Method of Disposal	Nonparticipant disposers (n = 148)	Participants (Hypothetical responses, n = 188)
Sold it	6%	20%
Gave it away	21%	39%
Had it picked up by someone else	51%	3%
Took it to a disposal center or dump on their own	7%	19%
Disposed of it in some other way	2%	11%
Had it picked up by the retailer	11%	8%

SCE participants anticipated being more likely than the nonparticipant disposers to have transferred the unit in absence of the program, with nearly 60% indicating they would have either sold or given their unit away. Participants mentioned each of those responses approximately twice as often as the nonparticipant disposers. This suggests that the majority of appliances recycled through the program would have been kept in use in the absence of the program.

Figure 59 details the disposal methods for appliances that were disposed of each year both outside and through the program. We used nonparticipant responses to allocate total appliance disposals, using linear trends to extrapolate years where no evaluation took place. Data are presented by year both expressed as a proportion of total disposals and in thousands of units.

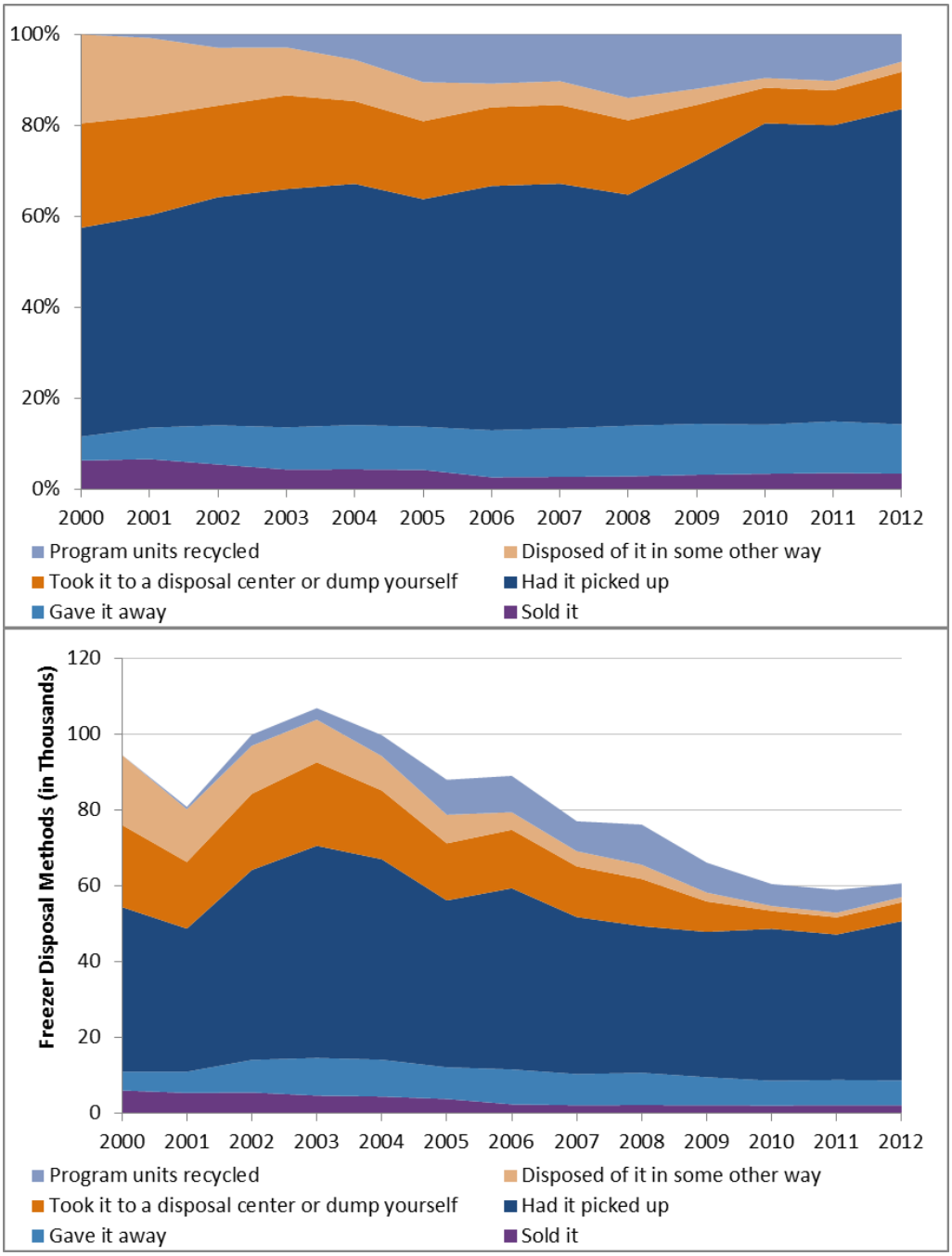
Figure 59. SCE Refrigerator Disposals by Method (Relative and Nominal)



By far, the most common method of disposal is having the appliance picked up, whether by a dealer, the local waste management service, or someone else. There was a marked decline in the number of units that are being taken to the dump or recycling center and a slight decrease in the number of units being sold that coincides with the increase in the number of units being recycled through the program. The ARP and other pickup services are taking up an increasing share of the proportion of total disposals.

Figure 60 details the disposal methods for freezers between 2000 and 2012. Again there is a decline in the number of units being taken to the dump or sold, while pickup services offered both by the utility and others is accounting for an increasing proportion of freezer disposals.

Figure 60. SCE Freezer Disposals by Method (Relative and Nominal)



5.3.2 PG&E Alternative Disposal Methods

PG&E participant respondents were more likely than the nonparticipant disposers to have transferred the unit, with nearly 36% indicating that without the program they would have either sold or given their unit away (Table 35). Having the appliance picked up by a retailer was mentioned much less frequently by participants. PG&E participants were much more likely than nonparticipants to have taken their unit

to the recycling center or dump themselves, suggesting that many of the recycled units would likely have been taken out of use even without the program.

Table 35. 2010-2012 PG&E Disposal Methods in Absence of the Program

Method of Disposal	Percent of Nonparticipant disposers (n = 152)	Percent of Participants (Hypothetical responses, n = 180)
Sold it	8%	14%
Gave it away	20%	22%
Had it picked up by someone else	49%	4%
Took it to a disposal center or dump on their own	4%	37%
Disposed of it in some other way	3%	12%
Had it picked up by the retailer	16%	11%

Figure 61 details the nonparticipant disposal methods for appliances that were disposed of each year both outside and through the program. The number of units being sold or given away has stayed relatively small, while the portion being taken to the dump or recycling center has remained high. Pickup services outside of the program are taking up an increasing share of total disposals.

Figure 61. PG&E Refrigerator Disposals by Method (Relative and Nominal)

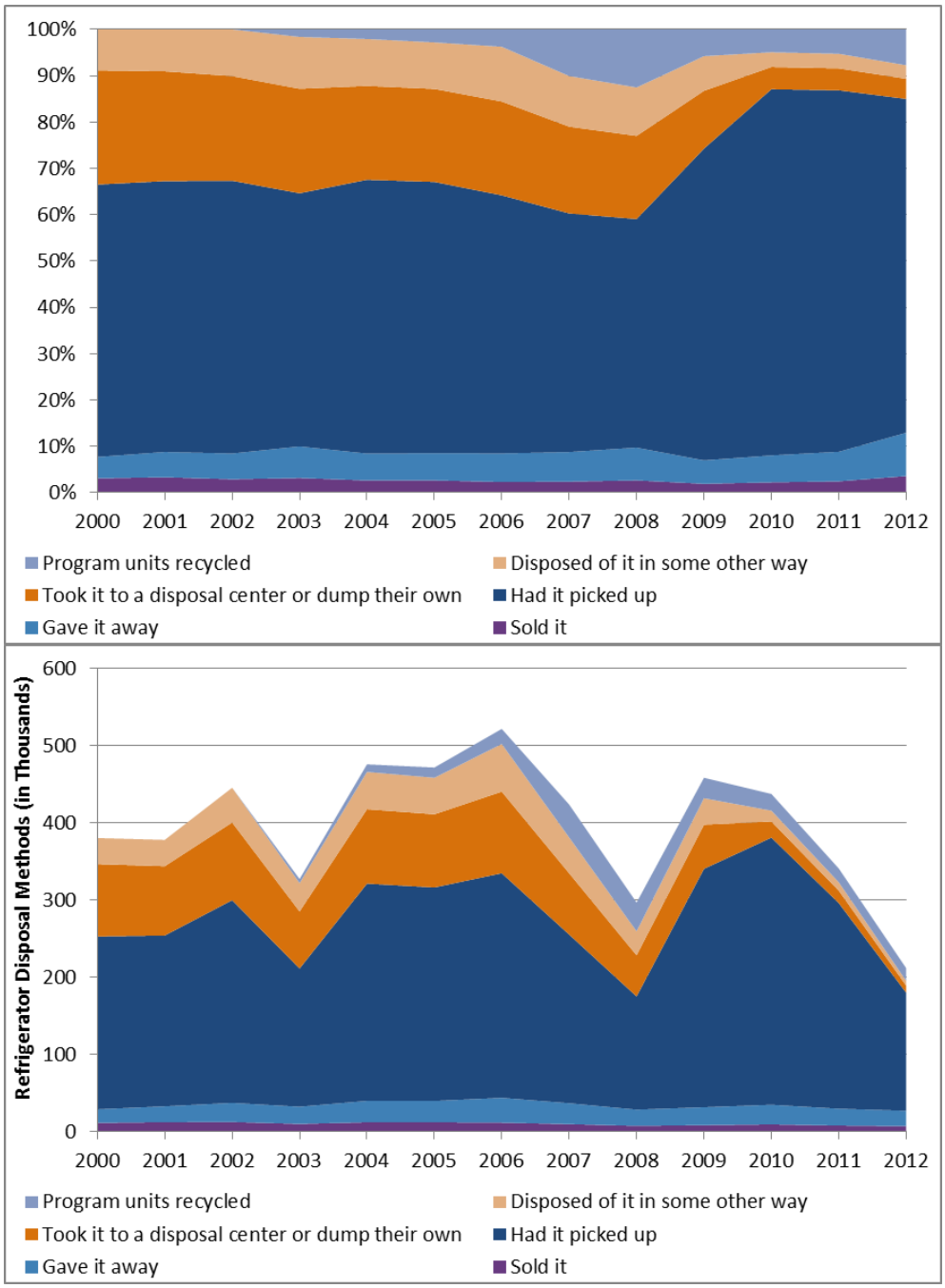
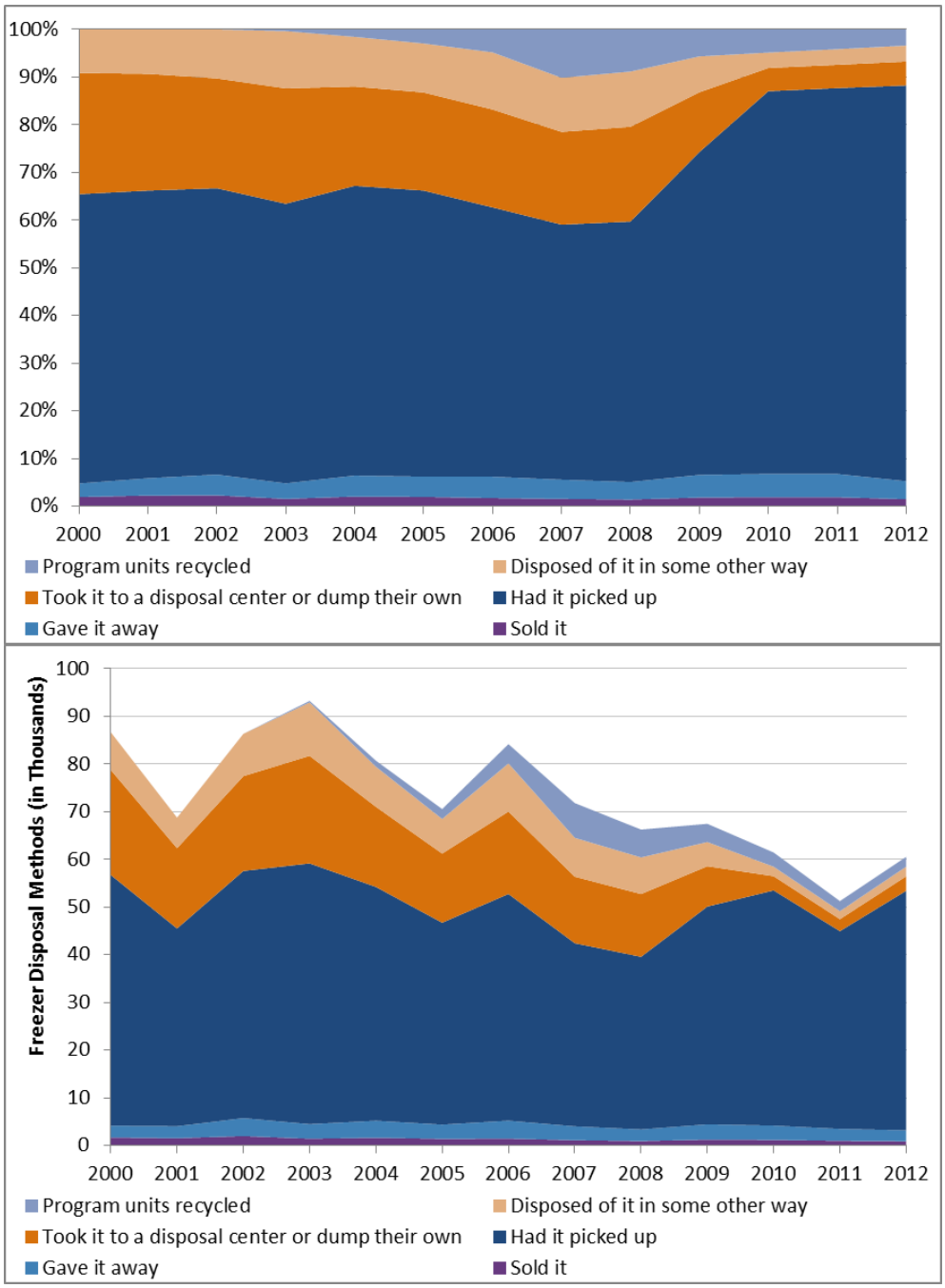


Figure 62 details the disposal methods for freezers between 2000 and 2012. Freezers being taken to the dump or recycling center have declined dramatically.

Figure 62. PG&E Freezer Disposals by Method (Relative and Nominal)



5.4 Replacements of Disposed Appliances

5.4.1 SCE Replacement

SCE program participants and the nonparticipants replaced their appliances at a similarly high rate, as shown in Table 36, although participants replaced their units slightly less often.

Table 36. SCE 2010-2012 Replacement Rates

Did You Replace Your Appliance?	Participants (n=199)	Nonparticipant Disposers (n=150)
Yes	86%	91%
No	14%	9%

Participants were twice as nonparticipants likely to purchase a used replacement than nonparticipant disposers (Table 37).

Table 37. SCE New or Used Replacement Appliance

Was Your Replacement Appliance New or Used?	Participants (n=174)	Nonparticipant Disposers (n=136)
New	80%	90%
Used	20%	10%

Participant replacement rates were also reported in the 2006-2008 report. Because the 2010-2012 replacement rates were relatively similar between participants and nonparticipants, and because participant replacement rates were listed in the 2006-2008 report, Cadmus used both sets of results to extrapolate a trend. We similarly allocated this trend to new versus used replacements based on the and appliance disposals.

Figure 63 and Figure 64 show that while the replacement rates are similar between participants nonparticipants, the number of appliance disposals decreased after 2008 while participation generally increased until 2012.

Figure 63. SCE Replacements – Nonparticipants

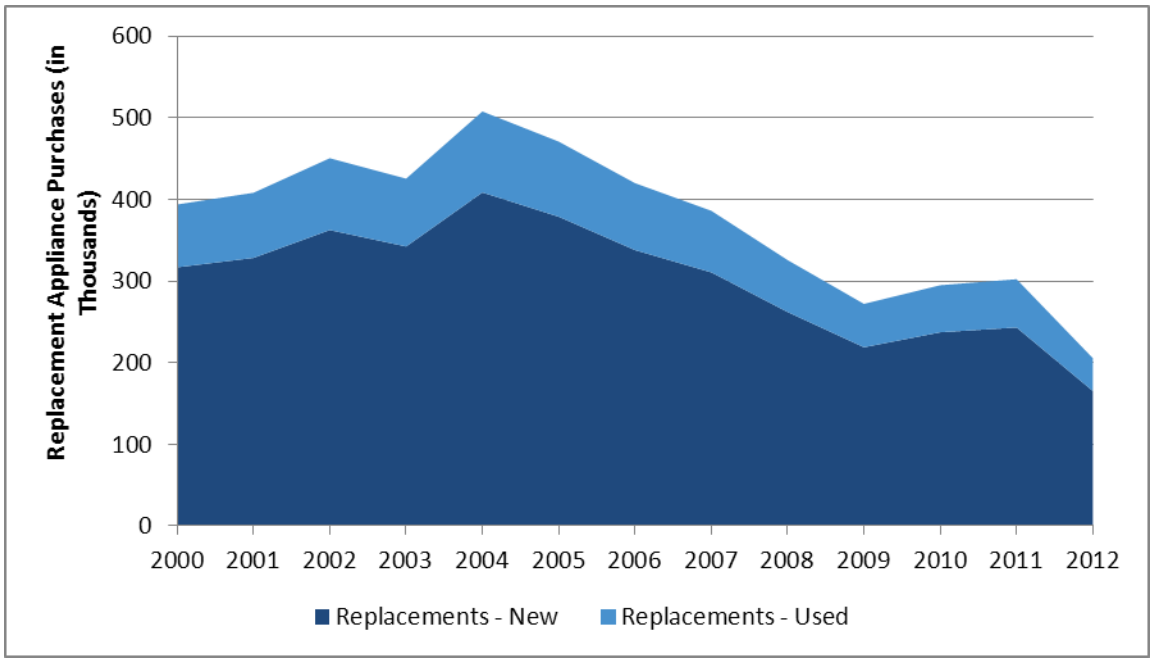
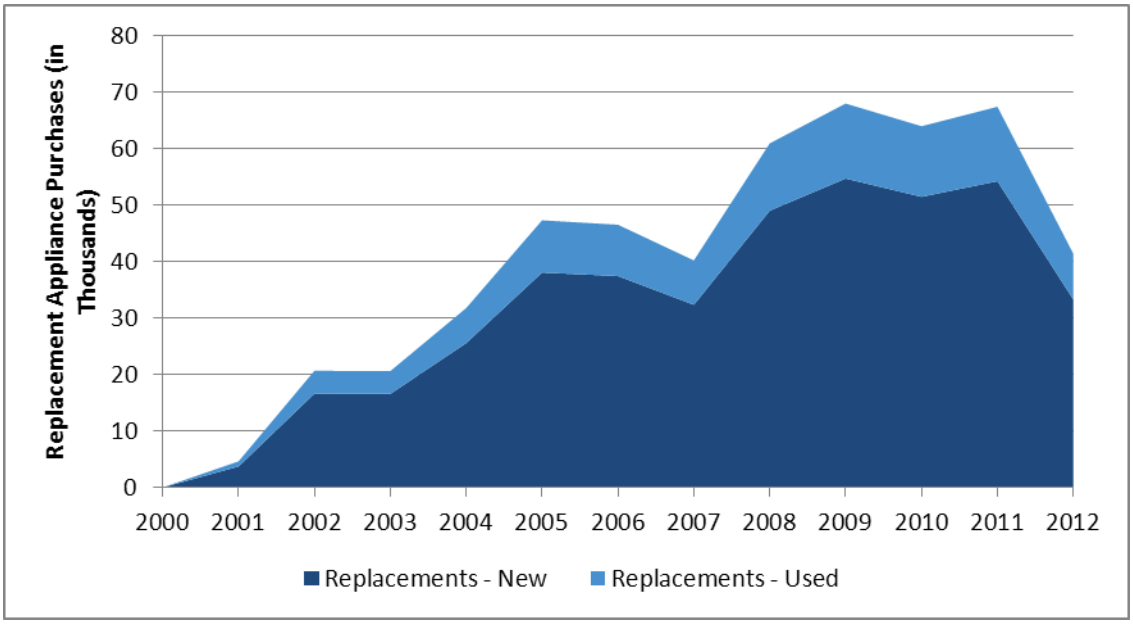


Figure 64. SCE Replacements – Participants



5.4.2 PG&E Replacement

The replacement rates in PG&E's service territory are very similar between participants and nonparticipants (Table 38). In addition, both segments of the population had a similar proportion of new and used appliance replacements (Table 39).

Table 38. PG&E 2010-2012 Replacement Rates

Did You Replace Your Appliance?	Participants (n=198)	Nonparticipant Disposers (n=152)
Yes	89%	90%
No	11%	10%

There was no difference between the participant and the nonparticipant disposer responses in the percent of units replaced with new versus used appliances. Both groups of respondents replaced appliances with new appliances 91% of the time.

Table 39. PG&E New or Used Replacement Appliance

Was Your Replacement Appliance New or Used?	Participants (n=177)	Nonparticipant Disposers (n=137)
New	91%	91%
Used	9%	9%

The number of nonparticipant appliance disposals (and hence replacements) decreased after 2008 (Figure 65), while participant generally increased until 2012 (Figure 66).

Figure 65. PG&E Replacements – Nonparticipants

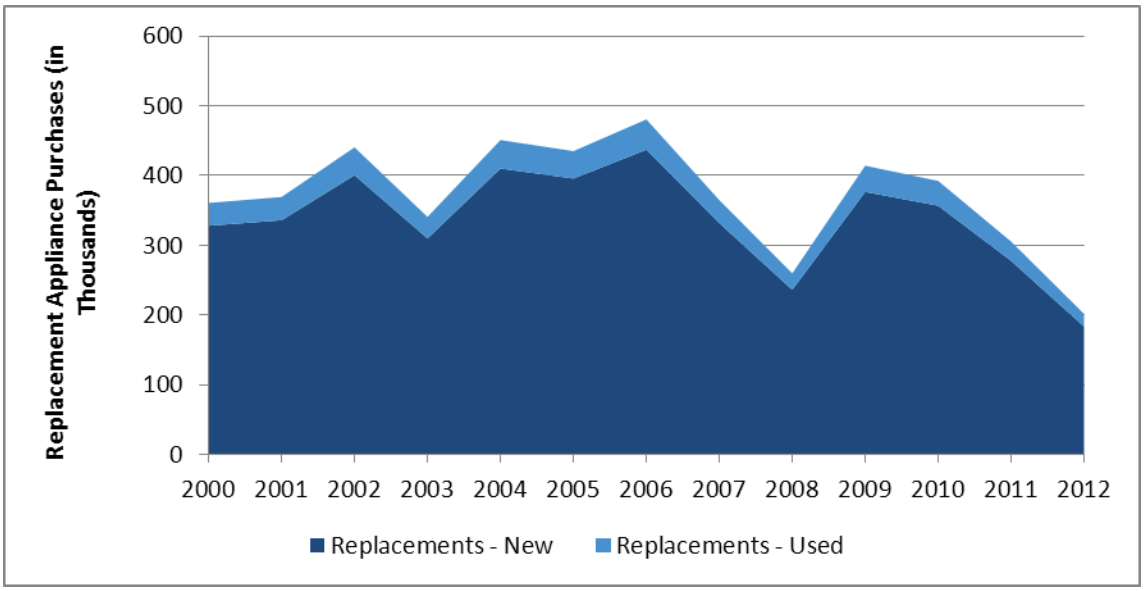
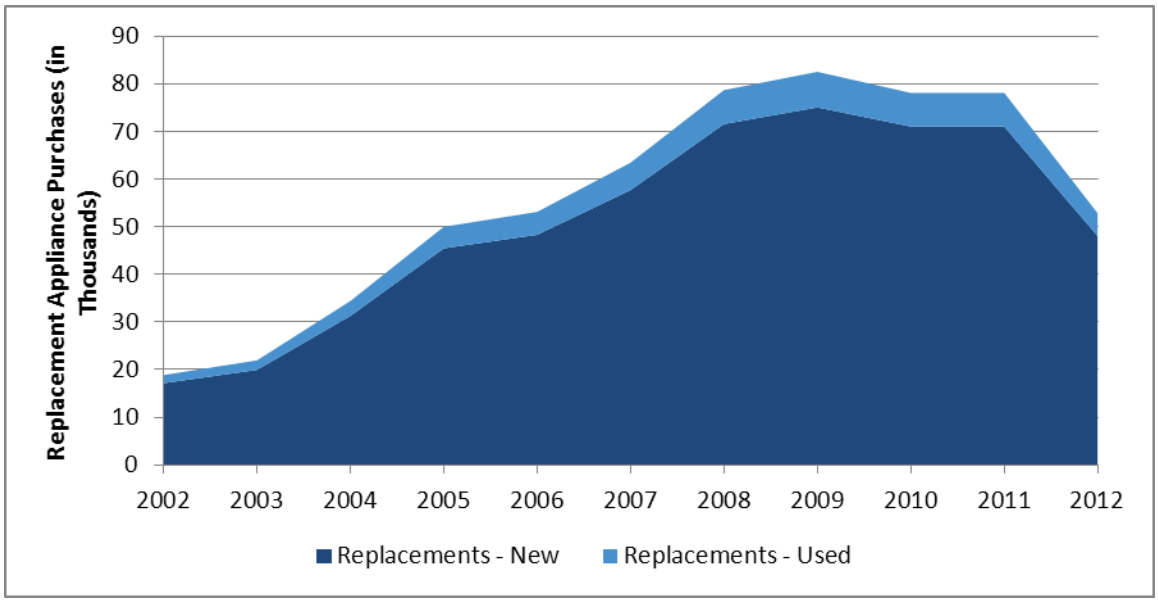


Figure 66. PG&E Replacements – Participants



5.5 Appliance Disposals and Program Potential

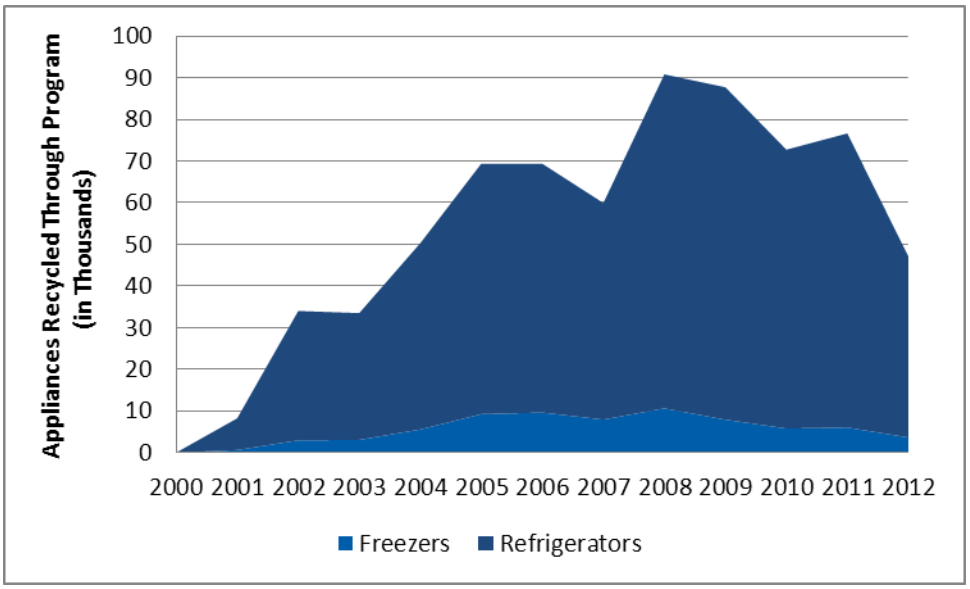
Cadmus estimated the total number of discarded appliances each year using new and used appliance sales data, census data providing the annual change in the number of households, and the 2009 RASS average number of appliances per household.

5.5.1 SCE Disposals and Potential Appliances

To calculate the number of disposed appliances each year, we assumed that replacements were equal to the total refrigerator purchases (adjusted for commercial sales) each year minus the growth in the number of households. The growth in households and purchases was one-to-one since the saturation of primary appliances is equal to one.

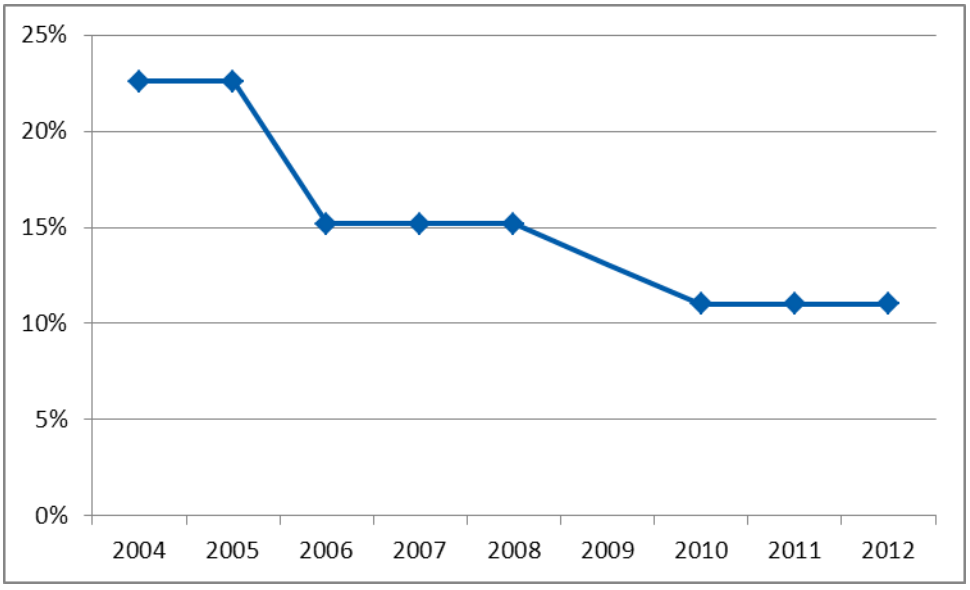
SCE's program picked up and recycled over 43,000 of 289,191 refrigerators disposed in 2012. This represents approximately 9% of the total of disposed appliances. The program also picked up 3,616 freezers; approximately 10% of an estimated 60,651 total disposals (see Figure 67).

Figure 67. SCE Program Units Recycled



Not all discarded appliances can be captured through the program; some appliances do not qualify. Cadmus adjusted the total disposals from 2012 to account for the portion of units that were not working or no longer able to cool and, therefore, would not qualify for the program. Cadmus fit a trend line through the results of the 2004-2005 report, the 2006-2008 report, and the current evaluation of nonparticipant disposer surveys (Figure 68).

Figure 68. SCE Percent of Disposed Units Not Working



Of the estimated total refrigerators disposed of in 2012, approximately 223,783 additional appliances could have been captured by the program (see Table 40).

Table 40. SCE Potential Refrigerators

SCE	Refrigerator Counts
Total Disposed Appliances	289,191
Recycled Through ARP	-43,433
Units Not Working	-21,975
Potential Refrigerators	**223,783**

Again, assuming that the proportion of freezers that are not working is similar to refrigerators,[21] there was an estimated potential 51,865 additional freezers in 2012 that could have been captured by the program (see Table 41).

Table 41. SCE Potential Freezers

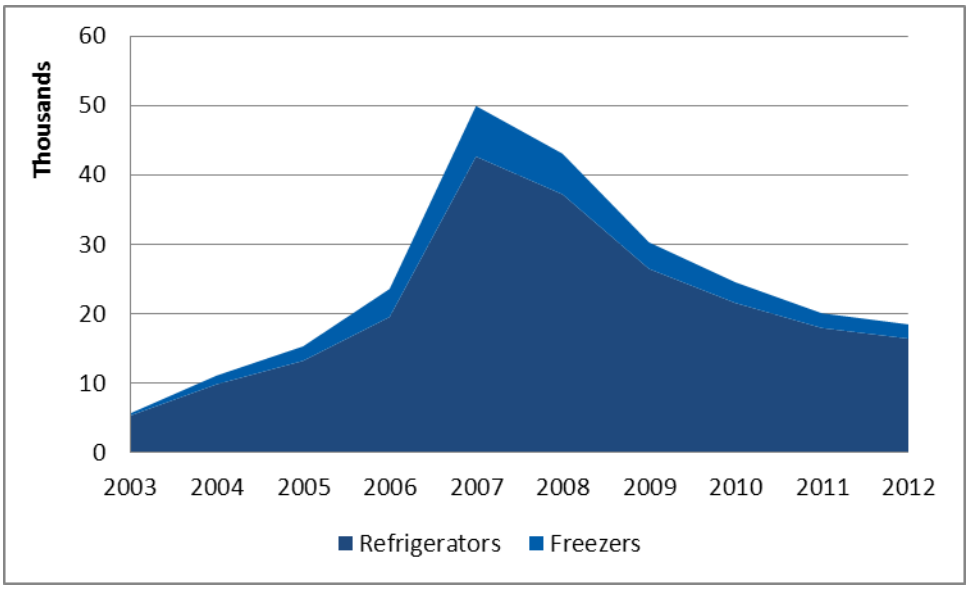
PG&E	Freezer Counts
Total Disposed Appliances	60,651
Recycled Through ARP	-3,616
Units Not Working	-6,274
Potential Freezers	**51,865**

5.5.2 PG&E Disposals and Potential Appliances

Figure 69 shows the total number of appliances recycled through PG&E's program annually starting in 2003, the first year that JACO provided tracking data for this study. PG&E's program picked up and recycled over 16,000 of 212,150 disposed refrigerators in 2012. The program also picked up 2,047 of the 60,532 total freezers disposed.

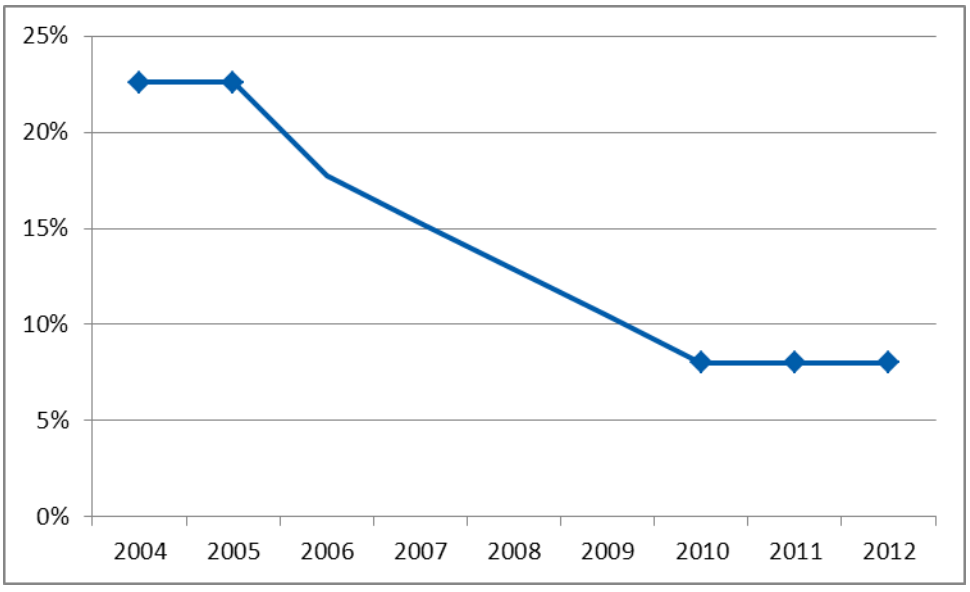
[21] The disposer survey sample only included a small number of respondents who had disposed of a freezer (four total in SCE's territory), thus we did not calculate a separate working/not working proportion for each appliance type.

Figure 69. PG&E Program Units Recycled



Of course, the program cannot capture all discarded appliances, and some appliances do not qualify. We adjusted the total disposals in 2012 to account for the portion of units that were not working and, therefore, would not qualify for the program. Using the results from the nonparticipant disposer surveys, Cadmus fit a trend line through the 2004-2005 and current evaluation results (Figure 70).

Figure 70. PG&E Percent of Disposed Units Not Working



Of the total 212,150 refrigerators disposed of in 2012, approximately 182,427 additional refrigerators could have been captured by the program (Table 42).

Table 42. PG&E Potential Refrigerators

PG&E	Refrigerator Counts
Total Disposed Appliances	212,150
Recycled Through ARP	-16,417
Units Not Working	-13,306
Potential Refrigerators	**182,427**

Assuming that the proportion of freezers that were not working is similar to the proportion of refrigerators that were not working,[22] approximately 54,406 additional freezers being disposed of in 2012 could have been captured through the program (Table 43).

Table 43. PG&E Potential Freezers

PG&E	Freezer Counts
Total Disposed Appliances	60,532
Recycled Through ARP	-2,047
Units Not Working	-4,079
Potential Freezers	**54,406**

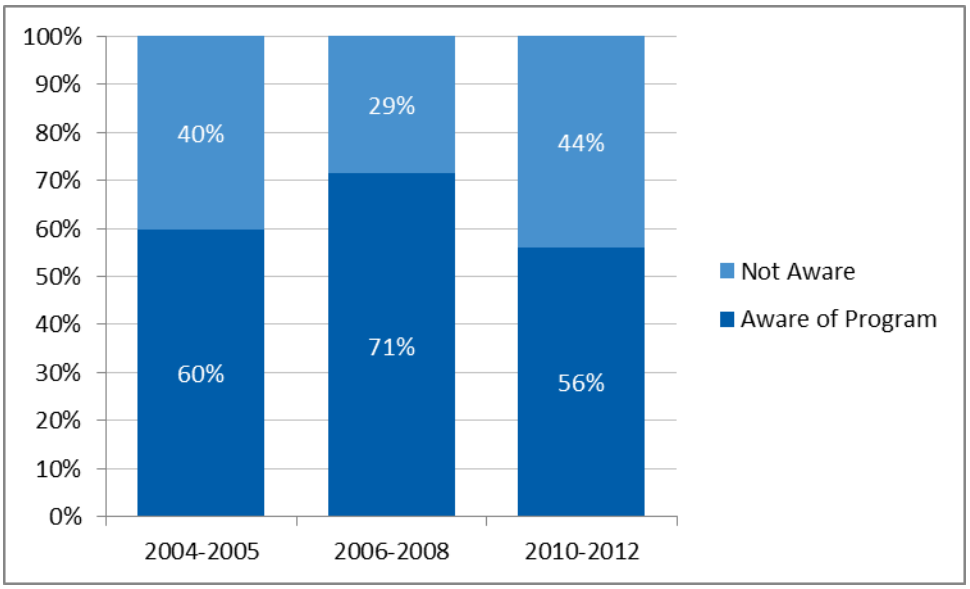
5.6 Program Awareness

5.6.1 SCE Respondents

Cadmus asked SCE nonparticipant disposers whether they were aware of the program before they disposed of their appliance. After program awareness peaked in the 2006-2008 evaluation at 71%, awareness declined slightly in the current cycle to 56%. The peak in awareness and subsequent decline coincides with the peak ARP participation in 2008 and the slight decline in 2009 and 2010.

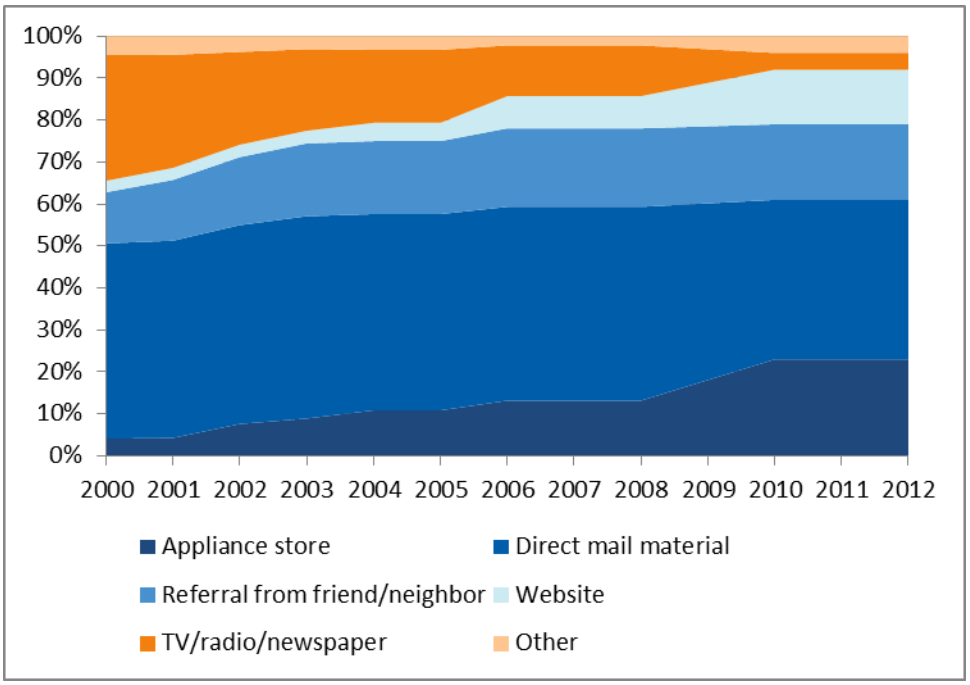
[22] The disposer survey sample only included a small number of respondents who had disposed of a freezer (11 total in PG&E's territory), thus we did not calculate a separate working/not working proportion for each appliance type.

Figure 71. SCE Program Awareness–Nonparticipant Disposers



SCE participants were asked how they heard about the program. Cadmus compared the responses between the 2004-2005 report, the 2006-2008 report, and the current evaluation. The proportions of participants indicating they had heard about the program from appliance retailers and from SCE's Website have increased steadily over time. On the other hand, respondents indicating they heard about the program through traditional media advertising, T.V., radio, and newspaper, have been decreasing over time. Direct mail continues to be the most common source mentioned, though it was mentioned by a small proportion of participants in the current evaluation.

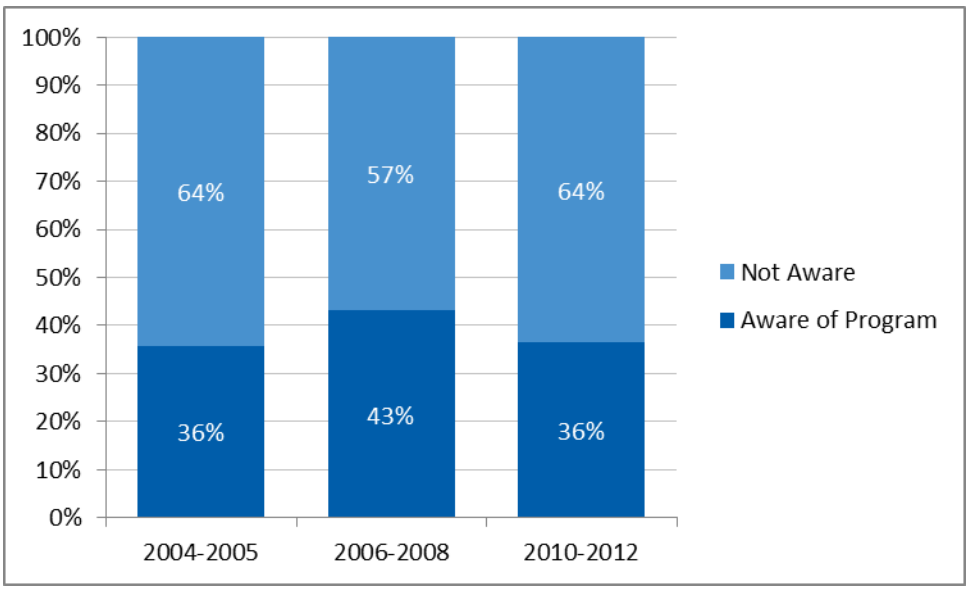
Figure 72. SCE How Participants Heard About the Program



5.6.2 PG&E Respondents

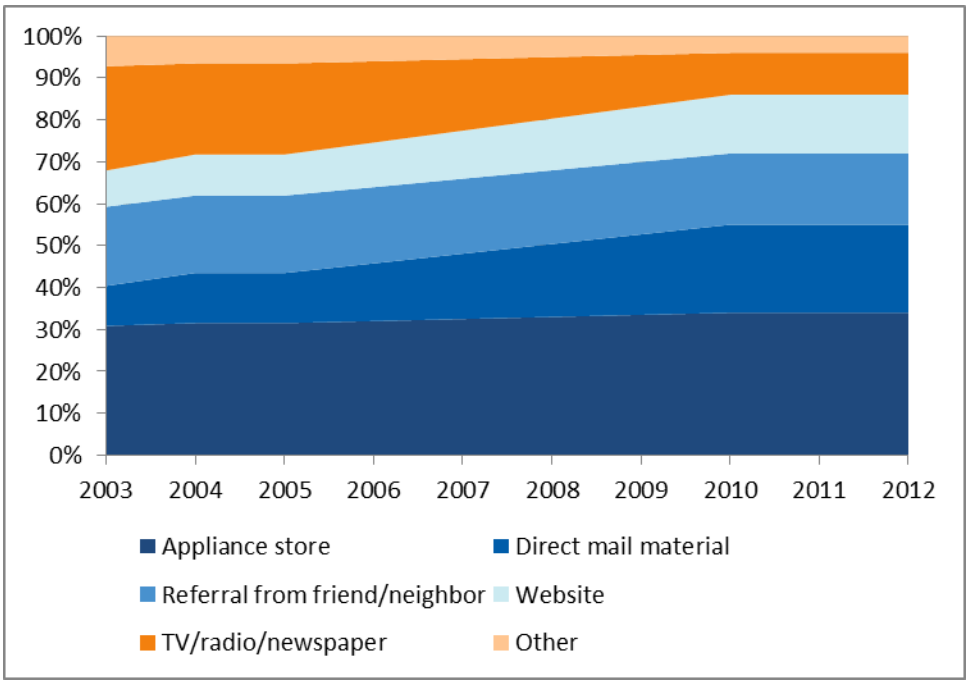
Cadmus asked PG&E nonparticipant disposers whether they were aware of the program before they disposed of their appliance. Overall, general awareness remains relatively low at 36%. Program awareness peaked in the 2006-2008 evaluation at 43% though awareness declined again to the 2004-2005 level in the most recent cycle. The peak in awareness and subsequent decline coincides with the peak participation in 2007 and decline beginning in 2009.

Figure 73. PG&E Program Awareness–Nonparticipant Disposers



PG&E participants were asked how they heard about the program. Cadmus compared the responses between the 2004-2005 report, the 2006-2008 report, and the current evaluation. Referrals from appliance retailers continue to be the most common source mentioned. The proportions of participants indicating they had heard about the program from direct mail and from PG&E's Website have increased steadily over time. Respondents indicating they heard about the program through traditional media advertising, T.V., radio, newspaper, have been decreasing steadily over time.

Figure 74. PG&E How Participants Heard About the Program



5.7 Demographics and Home Characteristics

Cadmus began a demographic analysis of program participants by compiling existing geographical information system (GIS) data layers. We downloaded the U.S. Census Bureau's 2010 TIGER/Line county shapefiles,[23] and integrated the county boundaries into Esri's ArcMap 10.1 software. We also received and incorporated electric service area GIS data from the California Energy Commission.[24] Using ArcMap, Cadmus mapped all data to the NAD_1983_California_Teale_Albers projection.

5.7.1 County Area Calculations

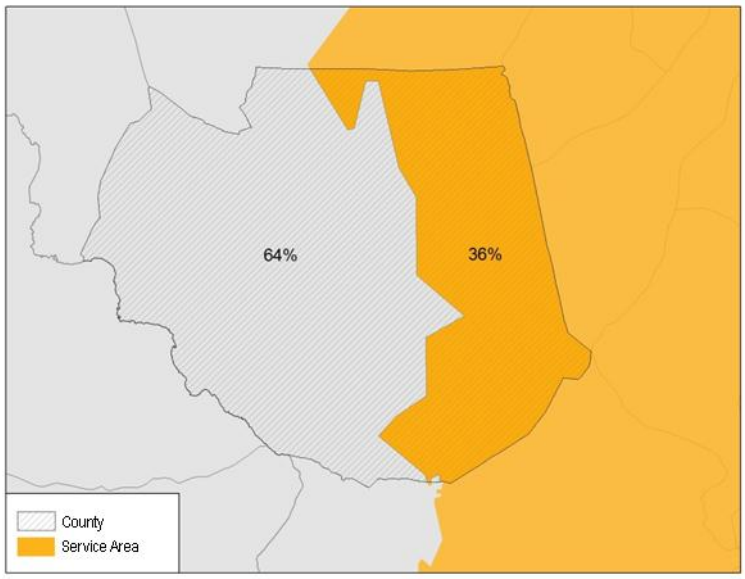
The SCE and PG&E service areas do not coincide exactly with county boundaries, so Cadmus determined the percentage of each county that overlapped a service area. Using the ArcMap union tool, we

[23] These shapefiles are available online: http://www.census.gov/geo/maps-data/data/tiger.html.

[24] The last update they provided for the electric service area data was dated October 30, 2012.

compared the area of each county to the area overlapped by a service territory (see Figure 75 for an example).

Figure 75. Map Showing Calculated County Area



As shown in Figure 75, 36% of the county outlined in hash marks is within the service territory. Assuming a uniform distribution of population, Cadmus computed the population of the county residing within the service territory by multiplying the county population estimate by 36%.

We downloaded demographic data from the online American Fact Finder database. Specifically, we collected median household income, the percentage of the population below the poverty level, and the average household size. Cadmus collected these data at the county level from the 2000 and 2010 decennial census and from the American Community Survey (ACS) for 2006 through 2009. We also obtained the ACS estimate of average household size in 2005.

We used our county area calculation to determine the population of each county in SCE's and PG&E's service territories. Cadmus then used the population estimate to weight each county and determine average demographic variables for the entire service territory for each year. We extrapolated estimates for 2011 and 2012 from the years data were available.

5.7.2 SCE Demographics

Figure 76 shows median income in 2010 dollars by IOU. The median income in SCE's service territory has been steadily declining since 2000, other than a small increase in 2007. The decline was more dramatic starting in 2008. Program participation does not appear to track to income trends.

The median household income in PG&E's service territory increased until 2007 then started to decline. The peak in the median income and subsequent decline coincides with the peak and decline in participation that was shown in Figure 69.

Figure 76. Median Household Income in 2010 Dollars by IOU

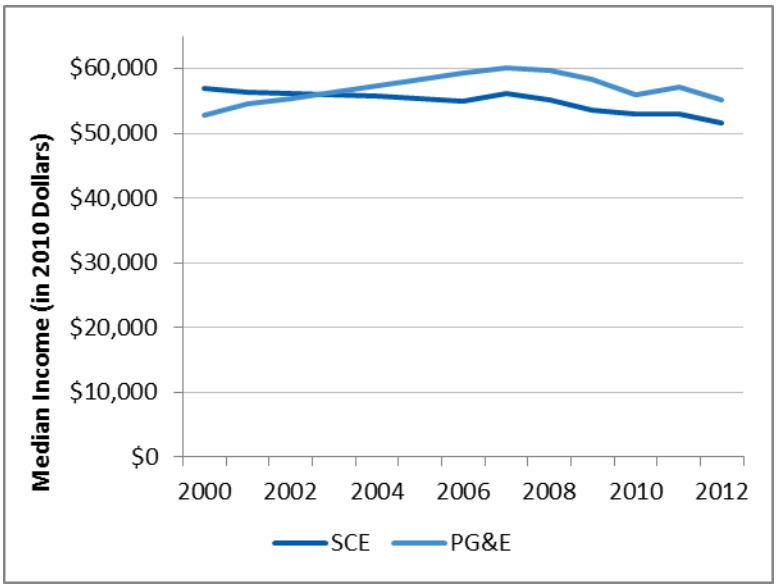


Figure 77 shows the proportion of households below the poverty level by IOU. The proportion of families under the poverty level for SCE has increased since 2000, although it dropped when median income peaked in 2007. The proportion of families in PG&E's service territory below the poverty level declined briefly in 2007, the same year the median income peaked, but then began to increase to 16% in 2010.

Figure 77. Percentage Below Poverty Level by IOU

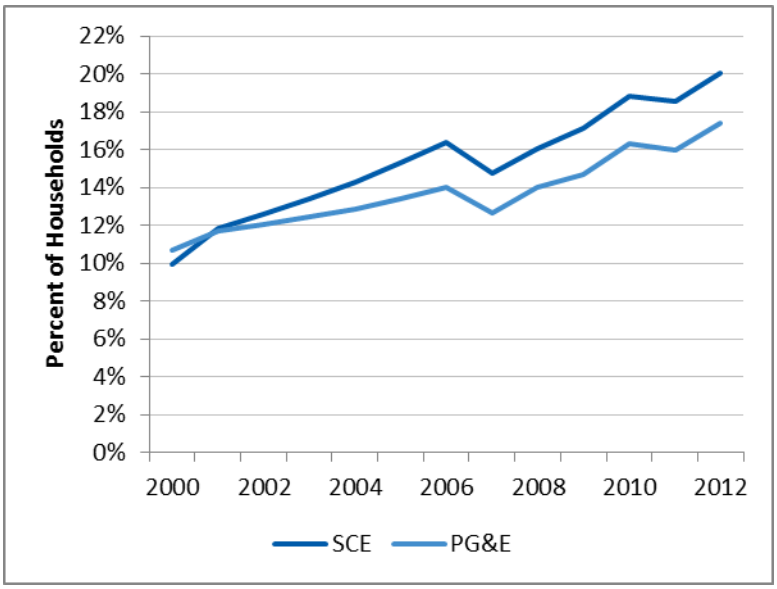
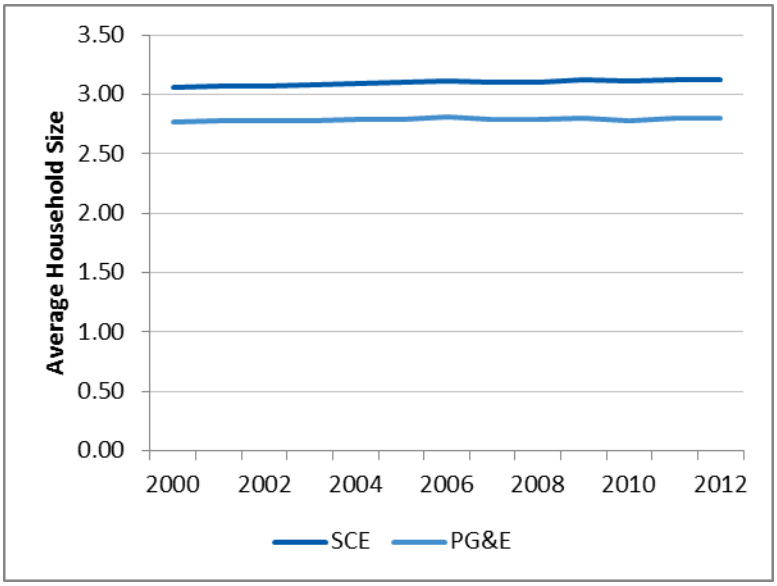


Figure 78 shows the average household size by IOU. The average household size estimates for SCE's service territory are close to those in the 2009 RASS report (3.09), although they are slightly lower than our participant survey findings (3.22) and considerably higher than nonparticipant disposer survey findings (2.79).

The average household size in PG&E's territory has remained around 2.79 people per household since 2005. Since 2009, these estimates have been very close to the 2009 RASS findings (2.78), although they are slightly higher than the estimates from the participant and nonparticipant disposer survey findings (2.69 and 2.51, respectively).

Figure 78. Average Household Size by IOU



6 ALTERNATIVE SUBPROGRAM

6.1 *Current and Proposed Subprogram Theories*

The current ARPs do not differentiate between primary and second units—instead, they generally seek to improve the efficiency of the overall appliance stock and minimize the ownership of little-used second units. As discussed in the Market Characterization section, second appliance ownership of refrigerators and freezers has increased steadily over the life of the ARPs, which raises questions about the role the program plays in customers' decisions regarding the number of refrigeration appliances they have in their homes.

6.1.1 *Current Program Theory*

Under current program theories, ARPs accept refrigerators and freezers without regard to their usage, aside from the requirement that the units operate. This means the ARPs do not discriminate between primary and second refrigerators; the programs simply aim to reduce the number of used refrigerators and freezers in the respective service areas.

The ARPs reduced the total number of used appliances in operation by convincing customers to recycle second units they currently operate or by preventing customers from transferring their units to other households (whether through the market or direct transfer). When a customer recycles a second unit, resulting energy savings simply equal what the unit would have consumed, had it remained in operation.

Establishing energy use for avoided transfers becomes slightly more complicated. Assuming a competitive market for refrigerators and freezers, avoided transfers either lead prices for used appliances to rise or, at the very least, make used appliances more difficult to locate. Potential purchasers of used appliances are then presented with three options:

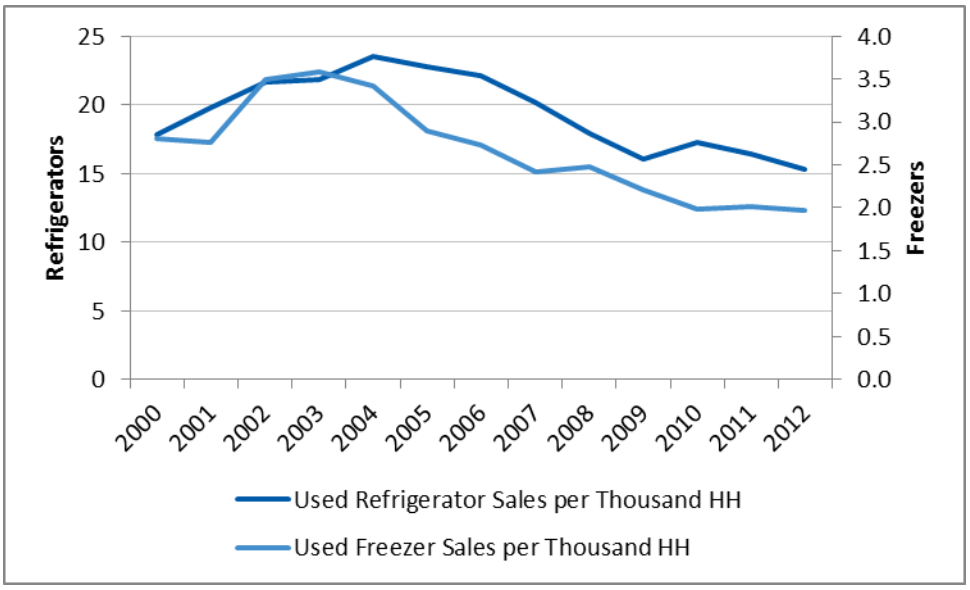
1. Purchase another used appliance (which are now scarcer).
2. Purchase a (presumably more expensive) new appliance.
3. Forego purchasing a new appliance.

Option 1 does not save energy, as the customer still chooses a used unit. Options 2 and 3 save energy at the grid level by increasing the average unit efficiency or by reducing the total number of units in use, respectively.

Recent trends in the use of second refrigerators and freezers seem to indicate the ARPs have not sufficiently convinced customers to discontinue current use and/or forego purchasing new, second appliances enough to level off demand. If the program theory is correct, we would expect increases in second appliance saturations to have increased even more were the program not in place. Unfortunately, establishing a baseline for second appliance ownership proves difficult without historical data on second appliance ownership trends prior to the programs.

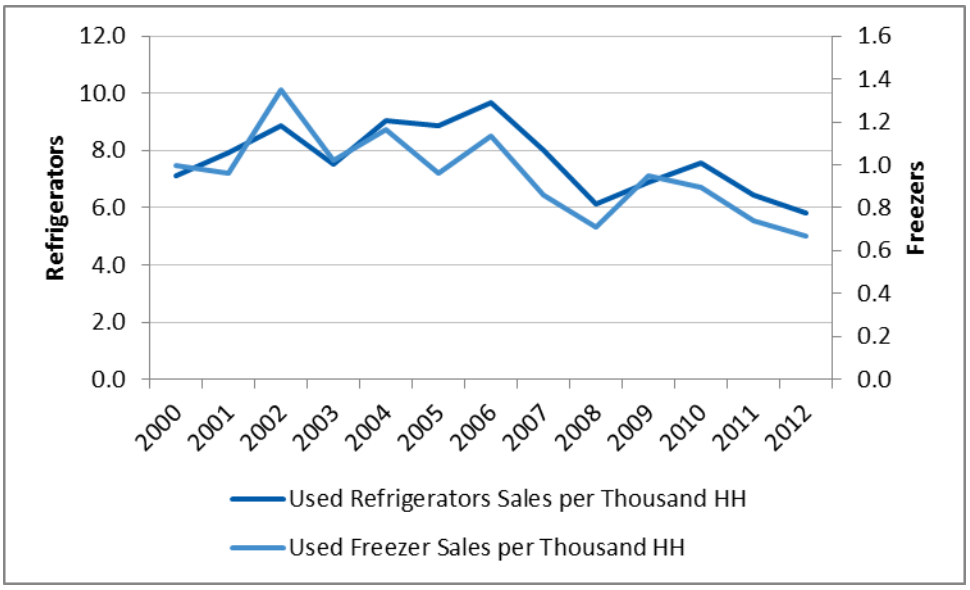
While saturations of second appliance have increased, used appliance sales have gone down. As discussed in the Market Characterization section, used appliance sales have declined substantially. As shown in Figure 79, sales of used refrigerators in SCE's service area (normalized for the number of households) have declined by 14% since 2000 and by 35% from their peak in 2004. Even more dramatically, sales of used freezer declined by 30% since 2000, and decreased 45% from their peak in 2003.

Figure 79. SCE Used Appliance Sales per Thousand Households



As shown in Figure 80, PG&E's used appliance market declined as well. Normalized for the number of households, used refrigerator sales fell 19% since 2000 and 40% from a peak in 2004. Used freezer sales fell 33% from 2000, and cut in half from their peak in 2002.

Figure 80. SCE Used Appliance Sales per Thousand Households



6.1.2 Proposed Subprogram Theory

With the hope of stemming (and perhaps reversing) increases in second appliance ownership, SCE and PG&E asked Cadmus to explore a potential subprogram, specifically targeting second appliances. This program would seek to convince owners of second appliances to forego use of those appliances and not replace them. If successful, such a program would have a much lower freeridership rate than a standard program offering and, therefore, would realize higher net savings.[25] The question remains whether such a program would prove viable.

Cadmus determined the viability of such a subprogram by addressing the following issues:

- What motivates customers to retain second appliances?
- What do they use second units for?
- What might motivate customers to dispose of their second appliances?
- How open would second appliance owners be to recycling their appliances?
- How effective would a targeted intervention be?
  - What level of participation could be expected?
  - How would realized savings differ from the core program?
  - How would program costs differ from the core program?

[25] As presented earlier (see Figure 17, Figure 18, and Table 15, above), we computed part-use factors of close to 1.0. The near full-time use of second appliances contributes to the higher expected subprogram net savings.

Cadmus addressed these questions using a combined bottom-up/top-down approach that combined survey data on customers' decision-making process with market-wide data from the market characterization task.

6.2 Subprogram Assessment Methodology

6.2.1 User Profiles

To support the bottom-up approach, we analyzed data from 400 completed surveys with second appliance owners. Questions addressed demographics, appliance use, and customer perceptions. Using survey results, we constructed user profiles of nonparticipant second appliance owners, enabling us to construct a theory of change from the bottom up.

Cadmus analyzed responses from the second appliance owner survey through the following steps:

- First, we examined responses to questions regarding the influences of factors such as incentives or convenience on potentially disposing of second appliances. We used question responses to inform aspects of the recommended subprogram design.
- Second, we compared awareness of program benefits between second appliance owners and participants to see if this may play a part in their choice to not participate.
- Third, we compared demographics between second appliance owners and participants, noting where significant differences exist.

6.2.2 Secondary Research

Using reports compiled through our literature review, we examined programs only accepting second units, reviewing the reports for process findings regarding possible implementation barriers or differences in program benefits from core programs.

6.2.3 Diffusion Modeling

Using a top-down approach, Cadmus leveraged the market characterization findings to conduct a market diffusion analysis of the appliance market in SCE's and PG&E's service areas. Having previously conducted such analyses in several contexts, we find market diffusion analysis provides critical insights into a targeted subprogram's viability. In addition to this study's market characterization results, we drew upon data collected from previous RASS and market characterization studies as well as ARCA and JACO tracking data to estimate changes in the market for appliance disposal.

According to diffusion theory, one would expect to see initial increases in program participation as information about the program spreads through the eligible population. As pent-up demand becomes exhausted, demand for program services should level off. Once the program reaches steady-state demand, it draws recruits from interested customers, newly ready to dispose of an appliance. Steady-state demand can be increased only through exogenous factors (e.g., demographic shifts, incentive levels) or through changing attitudes that drive customers' decisions to participate (whether through programmatic activity or otherwise).

The following research questions guided our diffusion modeling:

- What is the long-run steady-state demand for the program?
- To what extent do external factors, such as marketing and outreach, drive program participation, and to what extent do internal influences, such as word-of-mouth, motivate participation?
- Does the greatest program potential reside among new recruits through a targeted subprogram or through the core program?

Answers to these questions can help determine how to best use program resources to sustain steady-state demand through traditional channels and, perhaps, to boost uptake through a potential subprogram.

To model this behavior, we fit a Bass diffusion curve to participation data from the JACO and ARCA tracking databases over the program lifetimes. The Bass diffusion model, widely used in forecasting new product marketing, has proven highly predictive in this context. [26] The classic Bass model is typically described as:

$$\frac{f(t)}{1-F(t)} = p + qF(t)$$

Where:

f(t) = the probability of participating in time, t

F(t) = the cumulative probability of participating in time, t

p = a coefficient representing the rate of early adoption (e.g., new recruits)[27]

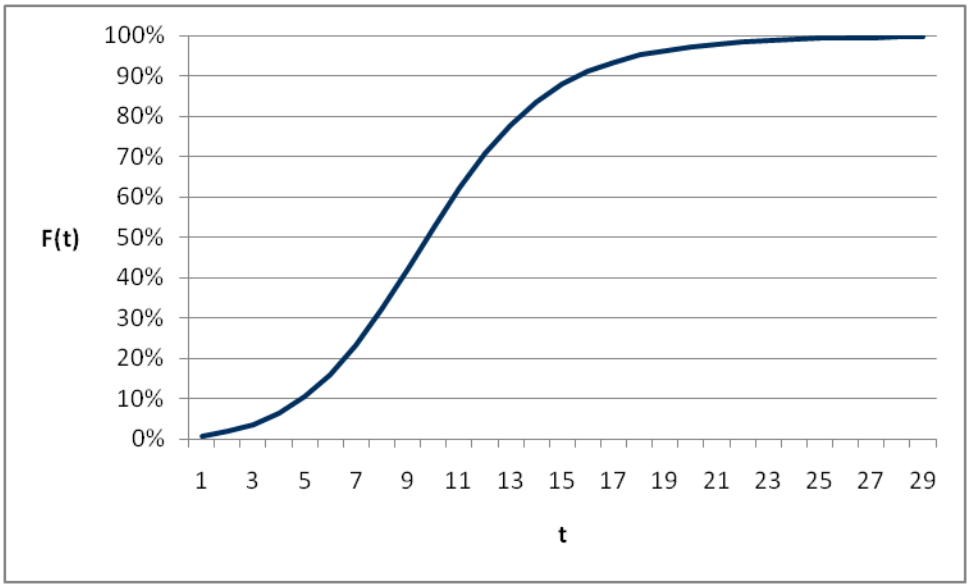
q = a coefficient representing the rate of imitation (e.g., recruits through word-of-mouth)

For *p* and *q*, this function describes adoption behaviors over time, assuming saturation follows the typical S-shaped curve shown in Figure 81.

[26] Bass, F.M. 1969. "A New Product Growth Model for Consumer Durables." Management Science 15, 215-227.

[27] Also called the coefficient of innovation.

Figure 81. Example: Bass Diffusion Curve (p=0.005, q=0.2)



Expressed in terms of nominal participation, the model serves as a function of maximum cumulative participation, defined as the parameter, *M*:

$$\frac{n(t)}{M - N(t)} = p + qN(t)$$

Where:

n(t)	=	participation in time, t
N(t)	=	the cumulative participation in time, t
M	=	the maximum possible cumulative participation

As the number of eligible units increases over time and past ARP participants can return to the program, *M* constantly increases, and, therefore, is expressed as a proportion of the total potential (defined in Chapter 5). Our model assumed that, given how the programs have been conducted, only a fraction of the total potential could be realized. This may result from personal preferences, incentive levels, or an inability to inform certain population segments about the program. This model for M is:

$$M = kP(t)$$

Where:

P(t) = the cumulative potential in time, t, defined as the cumulative appliance disposals and used sales after excluding non-working units

k = the maximum proportion of the cumulative potential expected to be achieved under the current program design.[28]

Under this model and the terminology of energy-efficiency potential studies, *P* can be considered the cumulative technical potential, while *M* can be considered the program's economic potential.

To estimate the diffusion curve econometrically, we used robust, nonlinear, least-squares estimation of the following equation:[29]

$$n(t) = (kP(t))\left(\frac{\left(\frac{(p+q)^2}{p}\right)e^{-(p+q)t}}{\left(1+\left(\frac{q}{p}\right)e^{-(p+q)t}\right)^2}\right)\left(month\ dum_1 + \sum_{i=2}^{12}\beta_i month\ dum_i\right)$$

Where:

month dum = a dummy variable equaling 1 in month, i, and 0 otherwise (where January=1, February =2, etc.)

Our final model, estimated at the monthly level, incorporated a dynamic *M* parameter, as described above, as well as a set of dummy variables adjusted for seasonal changes in the program and unrelated to the diffusion process.

We estimated models for each appliance type and utility to understand how diffusion rates differed between these populations. From this estimator, we determined *p*, *q*, and *k*. This model provided an estimate of the remaining potential from market diffusion.

Appendix F provides further description of the estimation and results.

6.2.4 Forecast Participation

Using the parameters estimated from the diffusion model, coupled with forecasts of future potential from the market characterization, we could forecast expected participation for the standard ARPs over

[28] For the purposes of this study, k is estimated as a static value and therefore represents the average value over the study period. A more in-depth study could potentially look at modeling k as a function of demographic and programmatic variables.

[29] The middle expression of the Bass model (excluding the seasonal adjustments) can be found in multiple sources in the literature, including Srinivasan and Mason (1986).

the next three years. These forecasts assumed market and demographic trends continued and programs continued to be run without changes in the core programs.

Presumably, introducing a new subprogram would follow a diffusion process similar to that experienced by the existing ARPs. To forecast incremental participation of an additional subprogram using this framework would require estimates for all diffusion parameters (*p*, *q*, and *k*) as well as an estimate of the technical potential (*P*). Given the program would draw from second appliances, we used the *p* and *q* parameters from the freezer models for each utility. This approach assumed the relative influence of external and internal behaviors of customers disposing of second refrigerators approximated that of customers disposing of freezers. We then estimated the economic potential as follows:

$$M_{sub}(t) = k(Sec(t) * a - N(t-1))$$

Where:

Sec (t) = the number of working second appliances in use in time, t

a = the likely proportion achievable, given the subprogram design

As discussed, this defines economic potential as a proportion of the total, second appliances in use. While we estimated the *k* parameter econometrically from the diffusion analysis, we estimated the *a* parameter using data collected from the user profiles, factoring in responses addressing the willingness to forego use of units. We examined low, medium, and high scenarios for the *a* parameter to reflect the uncertainty around this estimate. The model also corrected for (presuming that the program operates effectively) the number of forecasted second units decreasing by the number of units recycled to date (represented by *N(t-1)* in the equation above).

6.2.5 Forecast Unit Savings

Cadmus forecasted unit savings using a combination of DEER and the forecasted mix of refrigerators and freezers. We used DEER per-unit savings values for final per-unit gross savings estimates for each program. We calculated per-unit gross savings values as the weighted average IOU-specific DEER 2013–2014 planning values for refrigerators and freezers. For the core program, we used DEER's appliance type-specific NTG ratios to calculate net savings.

Freeridership can present a major issue for ARPs, as many program participants would have disposed of their unit in a manner leading to its destruction. The subprogram, however, should not find freeridership an issue, assuming it operates according to its program theory. The subprogram specifically targets reducing the number of units that otherwise would continue to be in use in a home, and, therefore, are not freeriders. Nevertheless, Cadmus included an adjustment for participant noncompliance, defined as participants misrepresenting their intentions regarding disposal. As with the participation forecast, we created low, medium, and high scenarios for NTG ratios.

6.2.6 Estimated Program Cost

The subprogram's implementation presumably would require a greater funding level than expended for a standard program offering. Our analysis only examined the incremental cost per unit recycled, thus, ignoring fixed costs for initially setting up the program (as these are sunk costs and should not be a factor in cost-effectiveness in the long term).

We conducted analysis of program costs by examining each component of implementation costs in the standard program offering, and scaling these up, according to differences between the two program designs. Per-unit program costs can be decomposed as follows:

$$Unit\ Cost = Administrative\ Cost\ per\ Unit + Marketing\ Cost\ per\ Unit + Implementation\ Cost\ per\ Unit + Incentive\ Amount$$

We adjusted each component of these costs based on findings from the user profiles and adjustments made in the program design. For example, Cadmus selected the incentive amount based on self-reported data on the compensation required to forego use of a unit as well as on the decision to include an incentive in follow-up verification visits.

6.2.7 Cost-Effectiveness

The final step in the analysis provided inputs to cost-effectiveness tests for each utility. While Cadmus did not directly calculate benefit-cost ratios for each IOU's subprogram, we provided relative changes in per-unit costs and benefits, as compared to the standard program offerings. These comparisons show the subprograms' relative strengths and weaknesses.

6.3 Subprogram Assessment Findings

6.3.1 User Profiles

Likelihood to Participate

As shown in Table 44, the majority of second appliance owners in both service territories reported large families as the primary reason for owning a second appliance. This particular segment of the eligible population likely remains out of reach for the subprogram, as they use second appliances based on need, not simply for occasional use. Nevertheless, respondents also frequently cited the need for extra storage, due to bulk shopping or for special events. These customers might be more likely to participate in the subprogram.

Table 44. Primary Reason for Owning a Second Appliance

Reason for Having Second Appliance	SCE (n=200)	PG&E (n=199)
Large family and/or need extra space	43%	37%
Buy in bulk at warehouse/bargain stores	19%	24%
Separate storage for beverages	17%	21%
Extra storage for special events/holidays	8%	9%
Hunting/fishing needs	3%	4%
Convenience	11%	5%

To estimate the proportion of the population likely to participate in the subprogram (the *a* parameter in the forecasting equation described above), we identified the proportion of second appliance owners susceptible to recruitment, categorizing responses to survey questions regarding disposal of second appliances into low, medium, and high likelihoods of being recruited to participate. We assigned low, medium, and high likelihood respondents weights of 0, 0.5, and 1, respectively. We then calculated the average weight to arrive at the proportion of the second appliance owner population considered susceptible to recruitment. We adjusted this proportion for the proportion of respondents reporting they would still replace their second appliance if disposing of it. This provided an estimate of the respondents eligible and susceptible to be recruited for the subprogram. Table 45 shows the resulting distribution.

Table 45. Estimation of Proportion Susceptible to Subprogram Recruitment

Have you ever considered disposing of the refrigerator?	SCE (n=199)	PG&E (n=199)	Likelihood of Recruitment
Yes	19%	12%	High
No	81%	88%	See below
Why haven't you considered disposing?	**SCE (n=157)**	**PG&E (n=171)**	**Likelihood of Recruitment**
I need the extra storage	68%	70%	Low
I like having the extra storage	17%	20%	Low
It would be too much hassle to get rid of it	1%	1%	High
I don't want to pay to dispose of it	1%	1%	High
I have never thought about disposing of it	6%	3%	High
Brand new / works well	6%	4%	Medium
Other	1%	2%	Medium
Likely Proportion Susceptible to Recruitment	**28%**	**18%**	
Would you get appliance to replace the spare you disposed of?	**SCE (n=36)**	**PG&E (n=22)**	
Would replace	39%	41%	
Likely Proportion Eligible and Susceptible to Recruitment	**11%**	**8%**	

As shown, we estimated the proportion of eligible and susceptible second appliance owners to be 11% and 8% for SCE and PG&E, respectively. However, the proportion of these customers that actually participate will result from program design and delivery. Based on the responses from the survey, the incentive amount and the speed with which the program is delivered represented the program aspects

with the most influence. Our survey asked customers to report the incentive levels and timeframes under which they might be willing to participate. We binned these responses into three categories (shown below), representing limited, moderate, and aggressive program scenarios.

Table 46. Program Design Components Needed to Participate

Incentive	SCE (n=54)	PG&E (n=42)
$50.00	41%	41%
$75.00	63%	63%
$100.00	94%	94%
Maximum Wait Time (in days)*	**SCE (n=166)**	**PG&E (n=182)**
2	95%	99%
4	72%	84%
7	61%	68%

*As the subprogram would require additional verification to ensure proper delivery, wait-times will likely exceed those seen in the current programs.

Combining results from the tables above, we calculated likely proportions for each case as: the likely proportion of eligible and susceptible to recruitment, multiplied by the proportion willing to accept the program design cases. Table 47 shows the final program design parameters and our estimates for the proportion of customers willing to participate under these parameters. SCE's respondents appeared slightly more likely to participate than PG&E's, particularly under the aggressive program design.

Table 47. Estimated Likely Proportion to Participate by Case (*α* Parameters)

Case	Incentive	Maximum Wait Time (in days)	Likely Proportion to Participate	
			SCE	PG&E
Low	$50.00	7	3%	2%
Medium	$75.00	4	5%	4%
High	$100.00	2	10%	7%

Awareness of Program Benefits

While data on appliance use sheds some light on recruitment barriers for second appliance owners, another barrier simply may be a lack of awareness of program benefits. If so, the subprogram should emphasize these benefits through its marketing.

Table 48 compares second appliance owners to participants in SCE's service area. These results seem to indicate that, in many cases, second appliance owners knew or were more aware of program benefits than participants. Notably, second appliance owners proved significantly more aware of the costs of running their units and of the environmental hazard refrigerant poses to the environment. Only in terms of details addressing the ARP's hazardous waste disposal were participants more aware of the program's impact.

Table 48. SCE Comparison of Awareness of Program Benefits

Were you aware that...	Response	Second Appliance Owner (minimum n=143)	Participant (minimum n=202)
...a refrigerator or freezer in your home can cost $180 or more a year for electricity?*	Yes	78%	61%
	No	22%	39%
...the refrigerant in refrigerators and freezers is harmful to the environment if not properly disposed of?*	Yes	90%	81%
	No	10%	19%
...the recycling service takes apart and recycles all of the metals and glass from the appliances it collects?	Yes	40%	44%
	No	60%	56%
...recycling service removes, and recycles or destroys the coolant, motor oil, and insulation from the appliances it collects?*	Yes	42%	52%
	No	58%	48%
...almost none of the materials from the appliances <SCE/PG&E> recycles go to a land fill?	Yes	27%	28%
	No	73%	72%

*Indicates statistically significant difference with 90% confidence.

Table 49 compares second appliance owners and participants in the PG&E program, with the results for PG&E customers being similar to those for SCE customers—with second appliance owners significantly more aware of the costs from running their appliances. As with SCE, program participants were more likely to know of how the program properly disposes of hazardous materials. Otherwise, awareness of program benefits was fairly similar between the populations.

Table 49. PG&E Comparison of Awareness of Program Benefits

Were you aware that...	Response	Second Appliance Owner (minimum n=102)	Participant (minimum n=188)
...a refrigerator or freezer in your home can cost $180 or more a year for electricity?*	Yes	76%	66%
	No	24%	34%
...the refrigerant in refrigerators and freezers is harmful to the environment if not properly disposed of?	Yes	92%	91%
	No	8%	9%
...the recycling service takes apart and recycles all of the metals and glass from the appliances it collects?	Yes	41%	48%
	No	59%	52%
...recycling service removes, and recycles or destroys the coolant, motor oil, and insulation from the appliances it collects?*	Yes	42%	59%
	No	58%	41%
...almost none of the materials from the appliances <SCE/PG&E> recycles go to a land fill?	Yes	27%	37%
	No	73%	63%

*Indicates statistically significant difference with 90% confidence.

Table 50 compares the self-reported influence of knowledge of these benefits on decisions to participate between second appliance owners and participants in SCE's service area. A full 91% of second appliance owners reported that hearing about the ARP's benefits made them more likely to participate in the future; more than 80% of participants reported awareness of these benefits affected

their decisions to participate. This indicates messaging targeted at emphasizing program benefits may prove a successful component of marketing SCE's subprogram.

Table 50. SCE Impact of Knowledge of Program Benefits on Participation

Knowing about these benefits, how much more likely would you be to participate in the appliance recycling service in the future?	Second Appliance Owner (n=195)	How much did knowing that your refrigerator/freezer would be disposed of in an environmentally safe way influence your decision to dispose of it through the recycling service?	Participant (n=129)
Much more likely	69%	Influenced decision a lot	64%
Somewhat more likely	28%	Somewhat influenced decision	16%
Not at all more likely	9%	Not influenced decision at all	20%

As shown in Table 51, a large proportion (89%) of PG&E's second appliance owners reported that hearing about the ARP's benefits made them more likely to participate. Slightly fewer (84%) participants reported that awareness of these benefits influenced their decisions to participate (with differences between the groups not statistically significant with 90% confidence).

Table 51. SCE Impact of Knowledge of Program Benefits on Participation

Knowing about these benefits, how much more likely would you be to participate in the appliance recycling service in the future?	Second Appliance Owner (n=195)	How much did knowing that your refrigerator/freezer would be disposed of in an environmentally safe way influence your decision to dispose of it through the recycling service?	Participant (n=129)
Much more likely	69%	Influenced decision a lot	67%
Somewhat more likely	20%	Somewhat influenced decision	17%
Not at all more likely	10%	Not influenced decision at all	16%

Demographics

Cadmus compared the demographics between second appliance owners and ARP participants to identify any possible underrepresentation occurring under the standard program offering.

Table 52 compares a set of demographic variables between second appliance owners and the participant populations for each IOU. Across most measures, demographics remained relatively similar, with few significant differences. Household sizes were not significantly higher (with 90% confidence) in the second appliance owner populations, as one might suspect. The only notable differences emerged for SCE's customers, where participants were significantly less likely to be homeowners or live in single-family homes. This may be representative also of higher income levels in the second appliance owner population. This may support the idea that higher incentives may be needed to recruit these customers. This pattern was not evident for PG&E's customers.

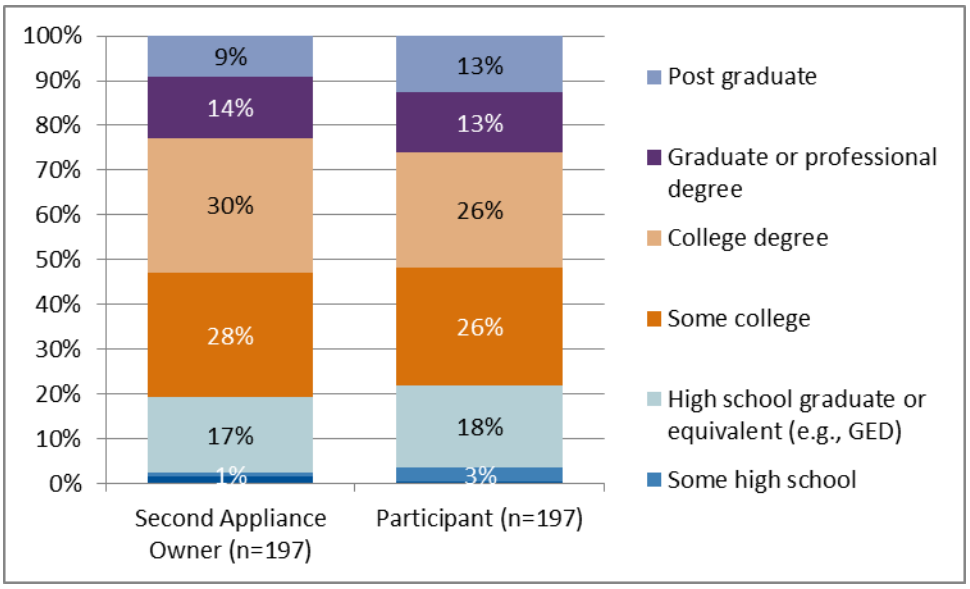
Table 52. Selected Demographic Comparisons

SCE Demographics	Second Appliance Owner (minimum n=190)	Participant (minimum n=189)
Household size	3.35	3.22
Homeownership rate*	93%	77%
Proportion in single-family home*	95%	80%
Proportion of respondents self-identified as non-white	28%	32%
Proportion living in home where English is not the primary language spoken	8%	10%
PG&E Demographics	**Second Appliance Owner (minimum n=186)**	**Participant (minimum n=181)**
Household size	2.82	2.69
Homeownership rate	95%	94%
Proportion in single-family home	96%	94%
Proportion of respondents self-identified as non-white	11%	15%
Proportion living in home where English is not the primary language spoken	3%	3%

*Indicates statistically significant difference with 90% confidence.

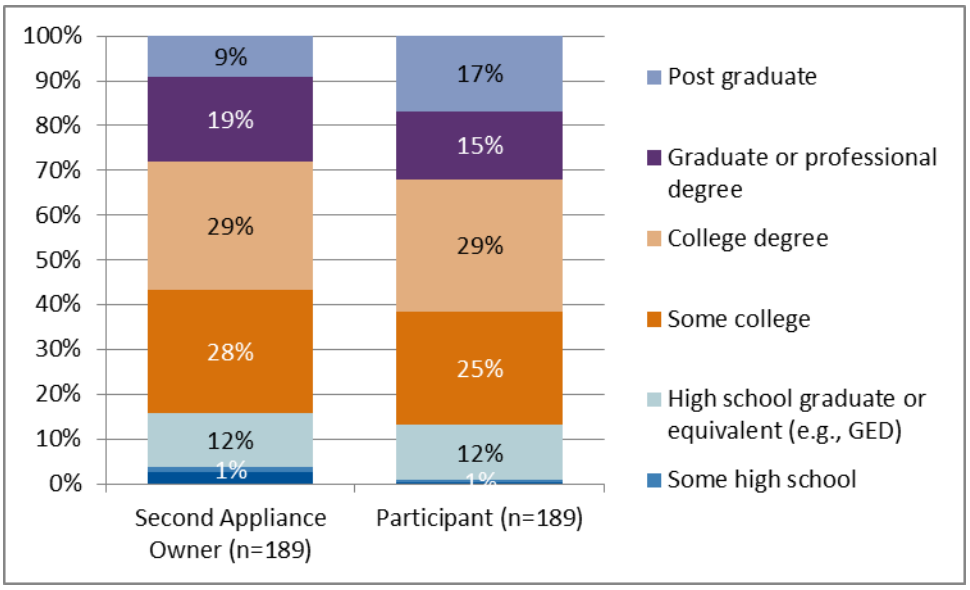
As seen in Figure 82 education levels were fairly similar between SCE's populations. In both populations, roughly 50% of respondents had a college degree.

Figure 82. SCE Participant and Second Appliance Owner Education Levels



Similar populations also appeared in PG&E's service area, as shown in Figure 83, with 57% of second appliance owners and 61% of participants having a college degree (the difference between these populations did not prove statistically significant with 90% confidence).

Figure 83. PG&E Participant and Second Appliance Owner Education Levels



6.3.2 Secondary Research

The key finding from our literature review relating to the subprogram design was: past ARPs historically have had difficulty in enforcing second-only programs that discourage the replacement of existing units. Our interviews with implementation staff supported this, indicating these guidelines can be difficult to enforce, and lead to situations where customers often feel they have to lie to the pickup staff.

For this reason, our planning estimates include additional spending for targeted marketing and follow-up visits (with accompanying incentives). While these program design changes may impact program costs, they will help to ensure the program achieves its goals without placing customers or program implementation staff in an uncomfortable position. By framing the program as a pledge to reduce energy, and including additional incentives for follow-up visits, the program creates a sense of reciprocity between the IOUs and the customers, leading to a higher likelihood of achieving lasting energy savings. Since it is unclear how effectively this could be implemented, we recommend running a pilot program of limited duration to test different implementation strategies.

6.3.3 Diffusion Modeling

The diffusion analysis of program participation indicated the programs are quite mature, with both ARPs already passing their peak participation levels (both in nominal terms and relative to potential).

Historical Achieved Potential

The key measure in a diffusion analysis is the proportion of the eligible population adopting the innovation over time. For our analysis, we defined the eligible population as the total units disposed or sold into the secondary market in a given period.

Figure 84 shows the proportion of cumulative potential achieved by the SCE program since 2001. The share of achieved potential has grown steadily over the program's life, beginning to level off in 2011. Under its current design, the program's steady-state participation rate runs around 13% of total potential. The share of freezer potential achieved was markedly lower than for refrigerators, at a little less than 10%, compared to around 13% for refrigerators.

Figure 84. SCE Proportion of Cumulative Potential

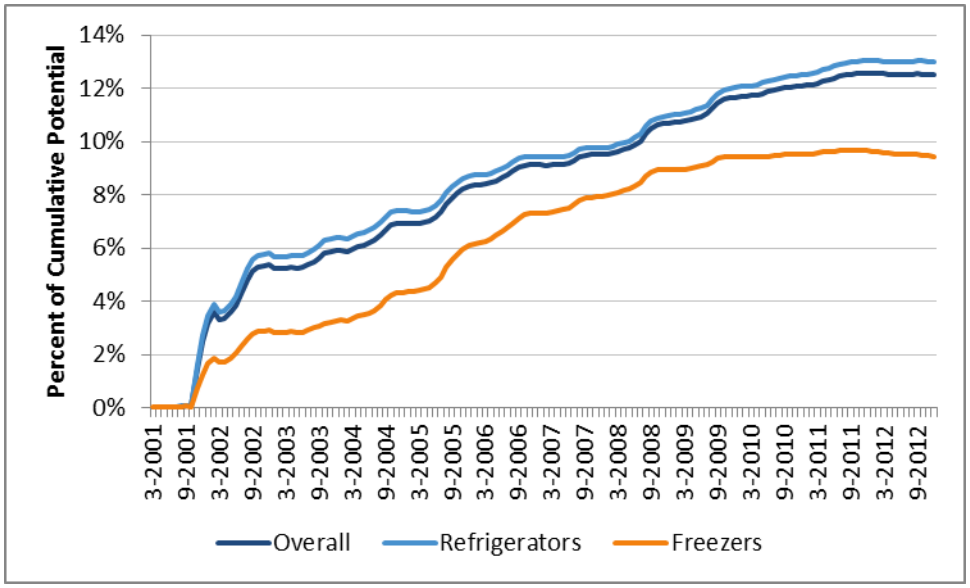


Figure 85 shows the same proportion, expressed in incremental terms. That is, the figure shows the proportion of new potential in a given period captured by the program. At its peak in the summer of 2008, the SCE program recycled 36% of refrigerators and freezers disposed of or sold into the secondary market.

Figure 85. SCE Proportion of Incremental Potential

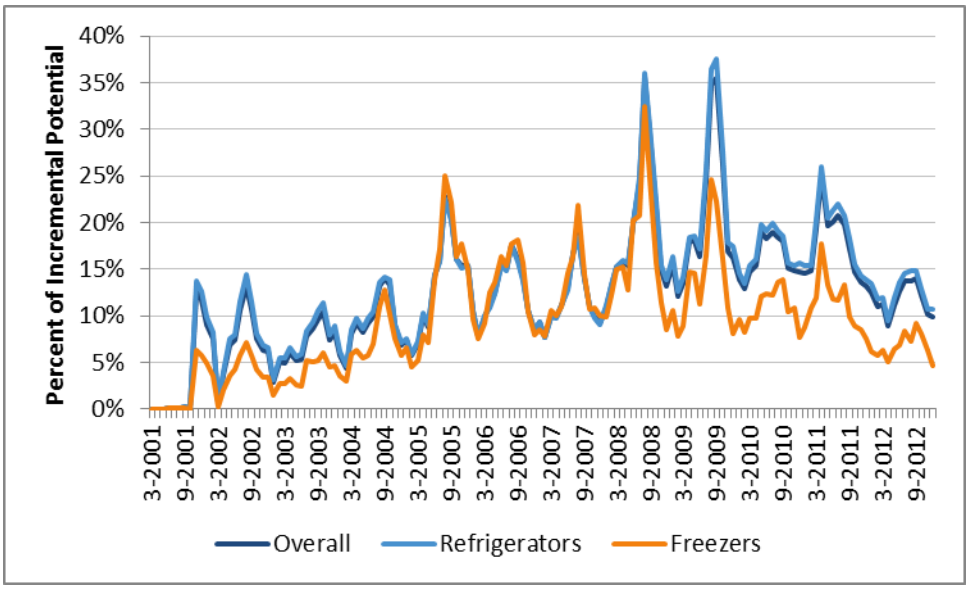
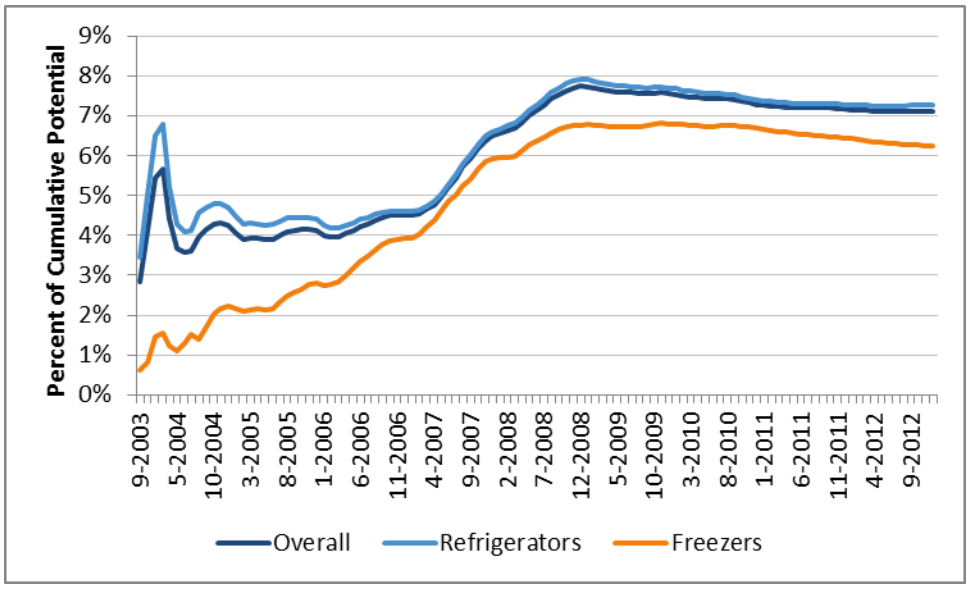


Figure 86 shows the proportion of cumulative potential achieved by the PG&E program since 2003. Driven primarily by refrigerators, the share of achieved potential accelerated rapidly in the program's first year of the program, but then tapered off, and remained relatively stagnant in subsequent years. The program steadily began to gain market share again in early 2007, and leveled off in 2009. Under its current design, it appears the program's steady-state participation rate is just above 7% of total potential.

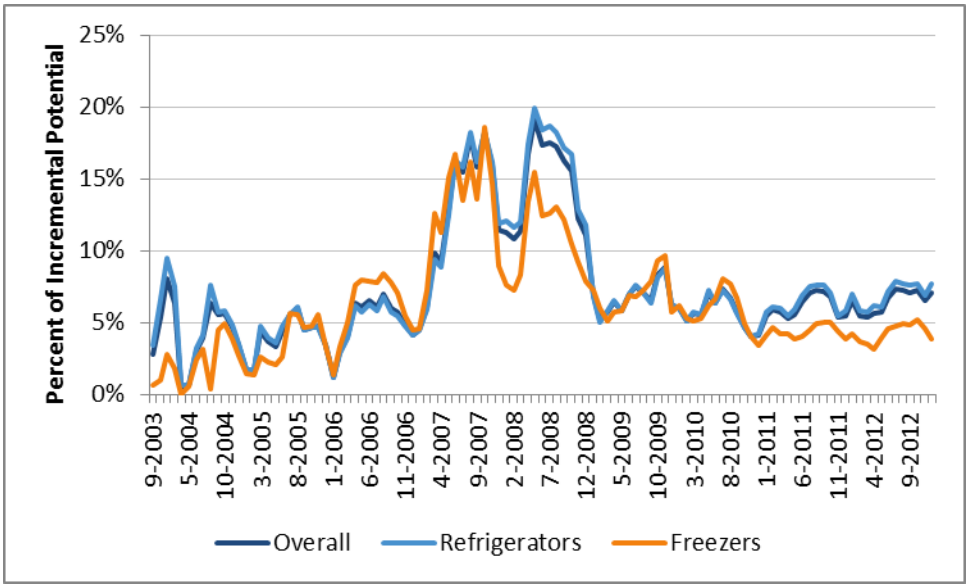
Figure 86. PG&E Proportion of Cumulative Potential



As with SCE, refrigerators primarily drove the program dynamics. Freezers achieved a slightly lower market potential share than refrigerators, at a little over 6%, compared to around 7% for refrigerators. Diffusion of freezer participation followed a much more traditional path, exhibiting a relatively smooth S-shape.

Figure 87 shows the same proportion for PG&E, expressed in incremental terms. At its peak in the summer of 2008, the SCE program recycled 19% of refrigerators and freezers disposed of or sold into the secondary market.

Figure 87. SCE Proportion of Incremental Potential



Estimated Parameters

We used the previous data to econometrically estimate diffusion parameters for each IOU, using a nonlinear least-squares regression, and recovering three parameters from the estimation:

- The *p* parameter represents the rate at which participants are recruited due to external factors, unrelated to their communications with past participants. This parameter can represent any number of factors; for the ARP, the *p* parameter represents the degree that marketing and outreach increases participation.
- The *q* parameter represents the rate at which participants are recruited due to internal influences (that is, the influence of past participants). This parameter expresses the degree that positive experiences from past participants have led to them influencing new participants. Given re-participation is possible, it encapsulates the re-participation rate as well.
- The *k* parameter indicates the maximum achievable proportion of the cumulative potential that the program could hope to capture under the current program design. This parameter could be due to any number of factors, both programmatic and otherwise. For instance, the income level

in a service area may influence the average incentive level in one service area to capture more participants than in another.

Table 53 shows estimated parameters for SCE's program. The estimated *p* and *q* parameters were very similar, indicating that the program is driven in approximately equal parts by marketing/outreach and word-of-mouth/re-participation. External influence played less of a role in the recycling of freezers, where the program was largely driven by word-of-mouth. This may have to do with the differing dynamic for the recycling of primary refrigerators, where programmatic factors may play a larger role. We found a *k* parameter estimate of approximately 24%, indicating nearly one in four potential appliances could be recycled through the program under the current design.

Table 53. SCE Diffusion Model Parameters (p and q Annualized)

Coefficient	Refrigerators		Freezers		Difference			Overall	
	Value	SE	Value	SE	Value	SE	p-value	Value	SE
p (Rate of external diffusion)	0.105	0.012	0.058	0.006	-0.047	0.013	0.000	0.100	0.011
q (Rate of internal diffusion)	0.101	0.042	0.356	0.026	0.255	0.049	0.000	0.131	0.039
k (Average proportion of potential)	0.268	0.030	0.133	0.013	-0.135	0.033	0.000	0.244	0.027

As shown in Figure 88, the model predicted participation well throughout the program's life; the model only missed the extremes of some seasonal peaks.

Figure 88. SCE Actual and Predicted Units Recycled by Month

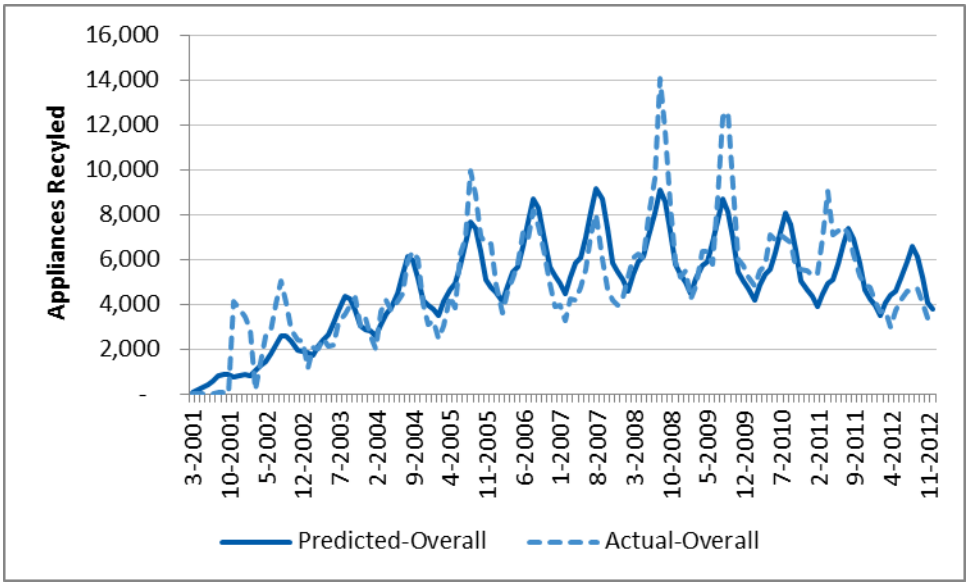


Table 54 shows estimated parameters for PG&E's ARP. Unlike for SCE's program, estimated *p* and *q* parameter values differed considerably, with internal influences playing a much larger role in the program's diffusion, but their values were similar between refrigerators and freezers (there were not significant differences in the estimated p and k parameters between appliance types, as were found for

SCE). The difference between *p* and *q* values may relate to the relatively smaller scale of the program compared to SCE (keep in mind that *p* and *q* are relative to the potential, as estimated through *k*). This also confirms findings from the participant surveys, where customers cited a lack of marketing and outreach as a suggestion for program improvement.

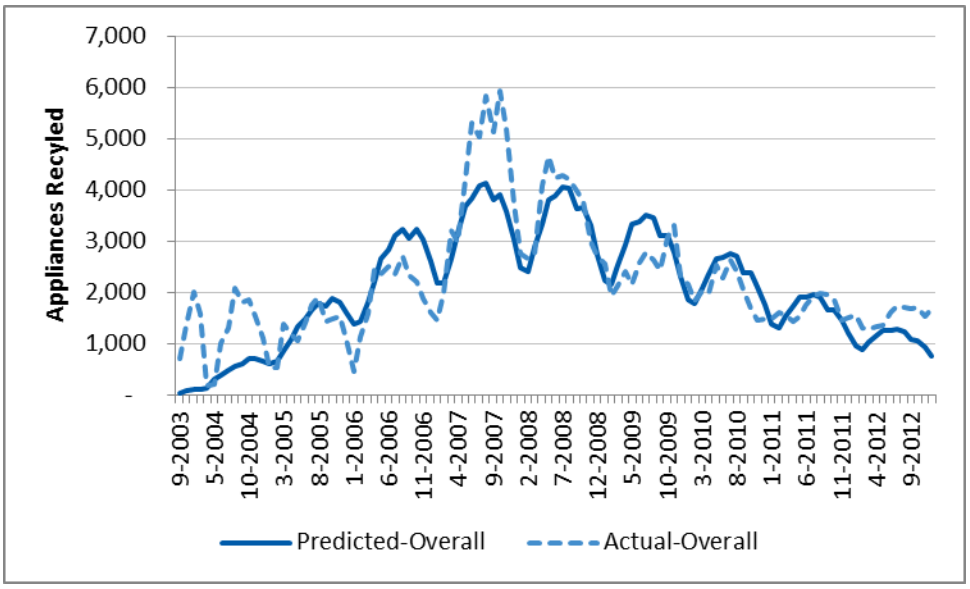
That said, the high values for the *q* parameters suggest participants had positive experiences and shared those experiences with others. We found a *k* parameter estimate of approximately 11% indicating the potential participation was about half the estimate for SCE. Further research would be required to determine how much of this lower value results from demographic differences between SCE and PG&E, and how much results from less aggressive marketing of the program.

Table 54. PG&E Diffusion Model Parameters (p and q Annualized)

Coefficient	Refrigerators		Freezers		Difference			Overall	
	Value	SE	Value	SE	Value	SE	p-value	Value	SE
p (Rate of external diffusion)	0.091	0.015	0.078	0.011	-0.013	0.019	0.247	0.091	0.014
q (Rate of internal diffusion)	0.460	0.055	0.589	0.046	0.129	0.071	0.035	0.471	0.050
k (Average proportion of potential)	0.112	0.017	0.092	0.013	-0.020	0.022	0.171	0.110	0.016

As with SCE, the estimated parameters resulted in predictions that generally tracked participation over the program's life, as shown in Figure 89.

Figure 89. PG&E Actual and Predicted Units Recycled by Month



6.3.4 Forecasted Participation

Cadmus forecasted subprogram participation by combining three elements:

- Likely proportions of units that could be recycled for low, medium, and high program design scenarios, estimated from the second appliance surveys;
- Forecasted number of freezers and second refrigerators estimated from the market characterization study; and
- Diffusion parameters (*p*, *q*, and *k*) for freezer participants estimated from historical tracking data.

We combined these data to generate three-year forecasts for low, medium, and high scenarios for each IOU. We then compared those to forecasted participation in the core program, estimated using each IOU's diffusion model.

Figure 90 shows the forecasted monthly participation for SCE's subprogram in the medium case, with the subprogram to recycle approximately 230 units per month, 59% of which would be freezers. In comparison, the core program is projected to recycle just less than 3,900 units per month, 4% of which will be freezers.

Figure 90. SCE Forecasted Monthly Subprogram Participation (Medium Case)

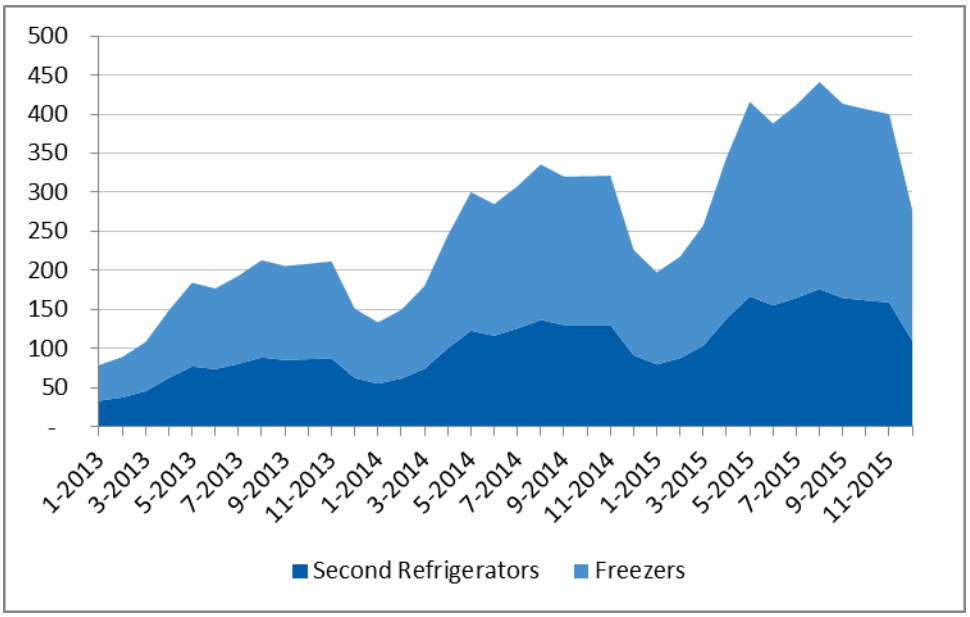


Figure 91 compares forecasted annual participation in the subprogram to that expected for the core program. The subprogram would be expected to grow over the period, while the core program would decline. Under the medium case, the subprogram would make up roughly 8% of total participation by 2015.

Figure 91. SCE Forecasted Annual Participation by Program Type (Medium Case for Subprogram, Low and High Shown in Error Bars)

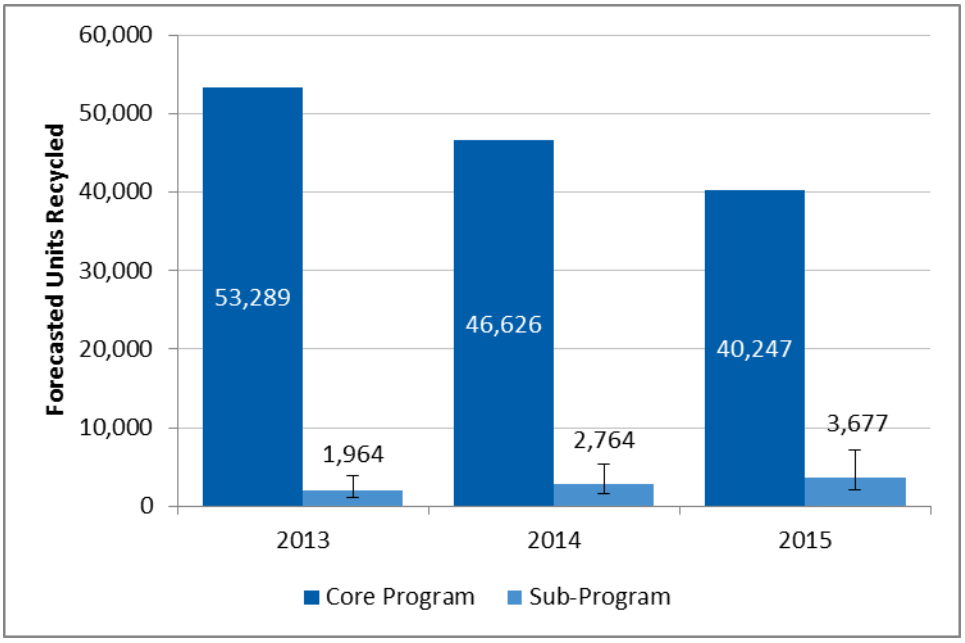


Figure 92 shows forecasted monthly participation for PG&E's subprogram in the medium case. Despite having greater technical potential than SCE, the PG&E subprogram would operate at about the same level as for SCE, largely owing to a lower estimated propensity to participate (the *a* parameter). We project the program to recycle approximately 250 units per month, 59% of which would be freezers. For comparison purposes, the core program is forecasted to recycle approximately 550 units per month, 8% of which were freezers.

Figure 92. PG&E Forecasted Monthly Subprogram Participation (Medium Case)

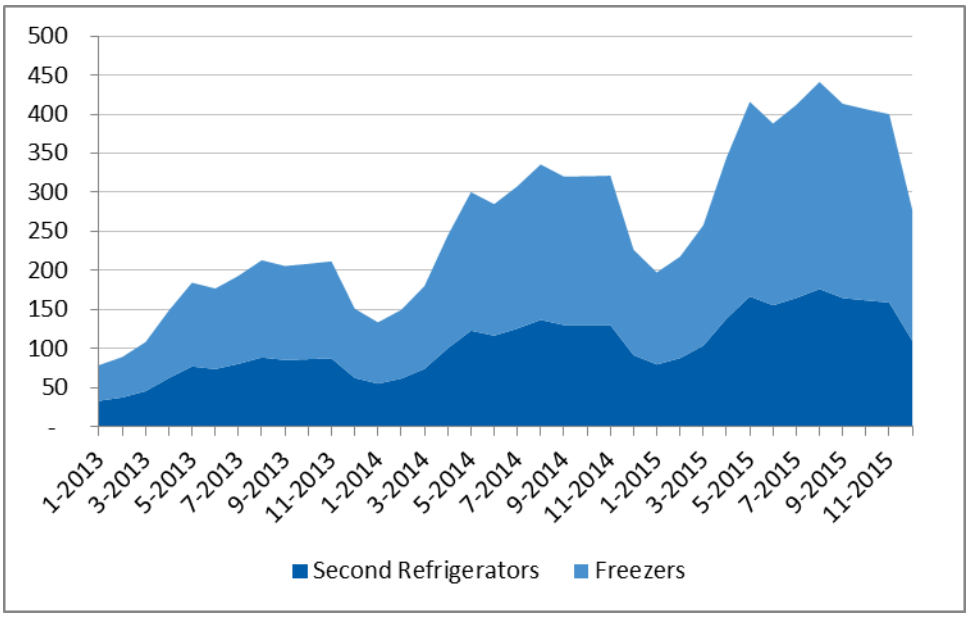
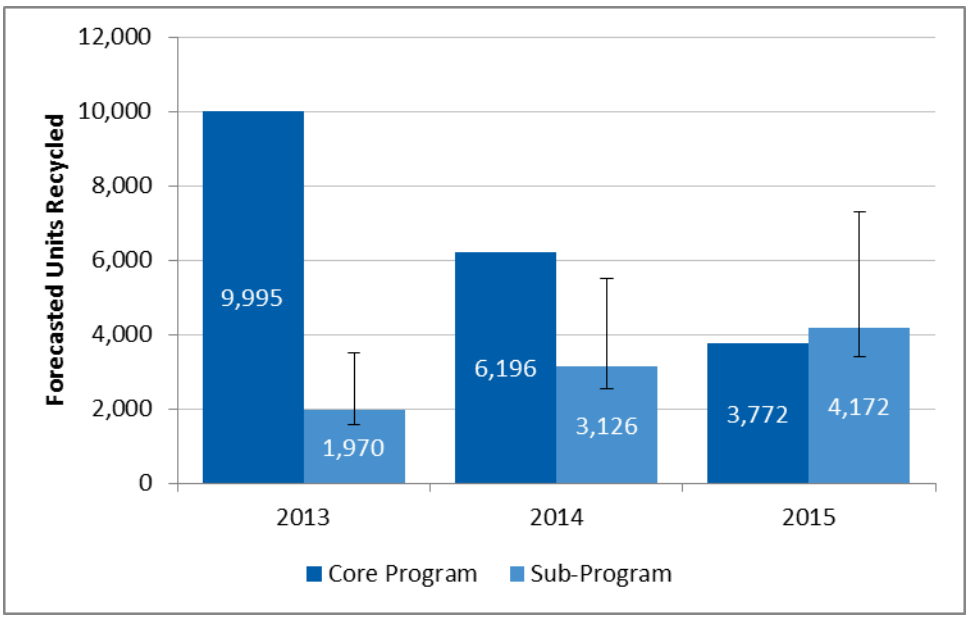


Figure 93 compares forecasted annual participation in the subprogram to that projected for the core program. The subprogram participation would be expected to grow over the period, while the core program is expected to experience a steep as the program levels off. Under the medium case, the subprogram would make up about one-half of the total participation. Under the high scenario, the subprogram actually would be the dominant participation form.

Figure 93. PG&E Forecasted Annual Participation by Program Type (Medium Case for Subprogram, Low and High Shown in Error Bars)



6.3.5 Forecast Unit Savings

Cadmus forecasted unit savings using a combination of data sources. We used DEER per-unit savings values for final per-unit gross savings estimates for each program, with expected NTG values adjustments assigned for each of the low, medium, and high cases.

Per-unit gross savings values derive from the weighted average, IOU-specific DEER 2013–2014 planning values for refrigerators and freezers. For the core program, we used DEER's appliance type-specific NTG ratios to adjust gross savings.

For the subprograms, we deemed NTG values for the low, medium, and high cases. Presumably, if the subprogram operates according to its plan, the NTG ratio should be 1 in all cases, as one recycled unit results in one less unit operating on the grid. However, a possibility exists for noncompliance or other forms of takeback. Therefore, we set the NTG at 0.8, 0.9, and 1.0 for the low, medium, and high cases, respectively.

Table 55 shows input parameters used to calculate gross and net savings.

Table 55. Gross and Net Savings Parameters

Parameter	IOU	Program	Refrigerators	Freezers
Per-Unit Gross Savings	SCE	All	629	790
	PG&E	All	672	703
NTG	Both	Core program	0.53	0.70
		Subprogram (low case)	0.80	0.80
		Subprogram (medium case)	0.90	0.90
		Subprogram (high case)	1.00	1.00

Table 56 shows unit average gross and net savings calculated for SCE for each program year and case. Using DEER values, gross savings were somewhat higher for the subprogram because of the higher proportion of freezers recycled through the subprogram (14% for the medium case). Net savings were substantially higher due to the higher NTG values, where the subprogram would likely exceed the core program by nearly 92% in 2015, for the medium case.

Table 56. SCE Expected Annual Unit Energy Savings (DEER Inputs, kWh/year)

Year	Core program		Subprogram					
			Low Case		Medium Case		High Case	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net
2013	637	345	722	578	722	650	722	722
2014	635	342	724	579	724	652	724	724
2015	634	341	725	580	725	653	725	725

Table 57 shows a similar pattern for PG&E's programs, with gross savings expected to be 2% higher than the core program by 2015 in the medium case, and net savings expected to be 70% higher.

Table 57. PG&E Expected Annual Unit Energy Savings (DEER Inputs, kWh/year)

Year	Core program		Subprogram					
			Low Case		Medium Case		High Case	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net
2013	675	368	694	556	690	621	690	690
2014	675	367	695	556	690	621	690	690
2015	674	366	695	556	691	622	691	691

6.3.6 Program Cost

We estimated program costs using expenditures from the 2012 core program as a reference point. Per-unit expenditures were calculated for four cost categories: administrative, marketing/outreach, direct implementation, and incentives. Per-unit estimates were calculated using the EEGA data on total program expenditures for 2012 and dividing by total unit recycled. These average values could then be adjusted based on program design changes specific to each component.

Table 58 shows adjustments made to costs for each scenario. We did not adjust administrative costs, as we did not consider their impact on the IOU significantly different from the core program.

Table 58. Per-Unit Cost Adjustments by Scenario

Type	Low Case	Medium Case	High Case
Administrative	$0.00	$0.00	$0.00
Marketing/Outreach	$10.00	$20.00	$30.00
Direct Implementation	$30.00	$30.00	$30.00
Incentives	$40.00	$65.00	$90.00
Total	**$80.00**	**$115.00**	**$150.00**

We did increase marketing and outreach by $10 to $30 per unit to account for increased resources dedicated to explaining the subprogram's intricacies and to distinguish it from the core program. We expect these costs would be most substantial in the program's ramp-up.

We applied an increase of $30 per unit to all scenarios for direct implementation. In the facility audit, JACO indicated this was the average cost of their staff, and we find an hour of staff time should account for follow-up visits required for all scenarios.

Incentive costs accounted for the initial incentive amount for each case, as discussed in the user profiles section ($50, $75, and $100), plus an additional $25 incentive for the follow-up visit. The sum of these, less the current incentive of $35, provides the adjustments in Table 58.

As shown in Table 59, the SCE subprogram exhibits substantially higher costs than the core program. Under the high case, program costs per unit recycled nearly double, from $164.50 under the core program to $314.50 under the subprogram.

Table 59. SCE Estimated Annual Per-Unit Implementation Costs

Year	Core program	Subprogram		
		Low Case	Medium Case	High Case
Administrative	$9.26	$9.26	$9.26	$9.26
Marketing/Outreach	$19.44	$29.44	$39.44	$49.44
Direct Implementation	$100.80	$110.80	$120.80	$130.80
Incentives	$35.00	$75.00	$100.00	$125.00
Total	**$164.50**	**$224.50**	**$269.50**	**$314.50**

Relative to their core program, impact to PG&E's costs prove less substantial, as shown in Table 60.

Table 60. PG&E Estimated Annual Per-Unit Implementation Costs

Year	Core program	Subprogram		
		Low Case	Medium Case	High Case
Administrative	$28.08	$28.08	$28.08	$28.08
Marketing/Outreach	$51.93	$61.93	$71.93	$81.93
Direct Implementation	$99.06	$109.06	$119.06	$129.06
Incentives	$35.00	$75.00	$100.00	$125.00
Total	**$214.07**	**$274.07**	**$319.07**	**$364.07**

6.3.7 Cost-Effectiveness

To assess how cost-effective the program would be, we compared changes in per-unit benefits and costs relative to the core program. Presumably, if the percent change in benefits exceeded that of costs, the program would be more cost-effective.

Table 61 shows estimates for SCE's programs over the three-year forecasting period. While the increase in program costs exceeded the change in gross benefits, the percent increase in benefits exceeded the increase in costs from the net perspective. Under the medium case, net benefits from the subprogram would be 92% higher than the core program, while only incurring 64% more in costs.

Table 61. SCE Subprogram Per-Unit Benefits and Costs Relative to Core program

Year	Low Case			Medium Case			High Case		
	Gross Benefits	Net Benefits	Cost	Gross Benefits	Net Benefits	Cost	Gross Benefits	Net Benefits	Cost
2013	113%	168%	149%	113%	189%	164%	113%	210%	191%
2014	114%	169%	149%	114%	190%	164%	114%	211%	191%
2015	114%	170%	149%	114%	192%	164%	114%	213%	191%

While the program would likely be more cost-effective, SCE's subprogram program would not provide the majority of total net savings for the combined programs.

As shown in Table 62, we forecast the subprogram to achieve 2,607 MWh of savings in 2015 in the medium case, for 16% of the expected total savings.

Table 62. SCE Forecasted Total Annual Program Savings (in MWh)

Year	Core program		Subprogram					
			Low Case		Medium Case		High Case	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net
2013	33,938	18,358	780	624	1,419	1,277	2,802	2,802
2014	29,622	15,963	1,102	882	2,001	1,801	3,932	3,932
2015	25,517	13,708	1,474	1,179	2,668	2,401	5,215	5,215

SCE's subprogram costs will steadily increase over the program's first three years, reaching just under $1 million per year by 2015 under the medium case, as shown in Table 63.

Table 63. SCE Forecasted Total Annual Program Costs

Year	Core program	Subprogram		
		Low Case	Medium Case	High Case
2013	$8,765,756	$263,961	$529,268	$1,219,714
2014	$7,669,783	$372,271	$744,779	$1,708,077
2015	$6,620,505	$496,627	$991,065	$2,260,497
Total	**$23,056,044**	**$1,132,858**	**$2,265,112**	**$5,188,288**

Table 64 shows relative changes in per-unit benefits and costs for PG&E's programs over the three-year forecasting period. Under the medium case, per unit net benefits from the subprogram would be 70% higher than the core program, while incurring only 49% more in costs.

Table 64. PG&E Subprogram Per-Unit Benefits and Costs Relative to Core program

Year	Low Case			Medium Case			High Case		
	Gross Benefits	Net Benefits	Cost	Gross Benefits	Net Benefits	Cost	Gross Benefits	Net Benefits	Cost
2013	103%	151%	137%	102%	169%	158%	102%	187%	179%
2014	103%	151%	137%	102%	169%	158%	102%	188%	179%
2015	103%	152%	137%	102%	170%	158%	102%	189%	179%

By 2015, under the medium case (and 2014 under the high case), PG&E's subprogram would make up the majority of total net savings of the combined programs. As shown in Table 65, the subprogram would achieve 2,632 MWh of savings in 2015 in the medium case, for 63% of the expected total savings.

Table 65. PG&E Forecasted Total Annual Program Savings (in MWh)

Year	Core program		Subprogram					
			Low Case		Medium Case		High Case	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net
2013	6,746	3,682	1,082	865	1,360	1,224	2,411	2,411
2014	4,180	2,274	1,752	1,401	2,158	1,942	3,806	3,806
2015	2,544	1,380	2,352	1,882	2,881	2,593	5,047	5,047

As shown in Table 66, by 2015, PG&E's subprogram costs would exceed those of the core program, even under the low case.

Table 66. PG&E Forecasted Total Annual Program Costs

Year	Core program	Subprogram		
		Low Case	Medium Case	High Case
2013	$2,139,526	$458,090	$667,917	$1,341,453
2014	$1,326,333	$741,401	$1,059,762	$2,117,044
2015	$807,420	$995,354	$1,414,481	$2,806,501
Total	**$4,273,279**	**$2,194,845**	**$3,142,161**	**$6,264,999**

7 INCLUSION OF OTHER APPLIANCES

7.1 Methodology

Any additional measure offered through SCE's and PG&E's ARPs would ideally increase the overall program's cost-effectiveness, while also increasing the total program energy savings. Cadmus observed that refrigerators, the historic focus of SCE's and PG&E's ARPs, are particularly well-suited to cost-effective recycling due to these three key characteristics:

1. **Large target market.** Since every SCE and PG&E residential customer has at least one refrigerator, and many have two or more,[30] the target market for refrigerator recycling is large. The target market includes customers replacing their still-operable refrigerators with new units, as well as those who no longer need their second (or third) unit.
2. **High energy-savings potential.** Appliance recycling saves energy by discontinuing the use of second appliances, removing old inefficient appliances from service when they are replaced (rather than keeping them in use as second units), and preventing the continued use of old inefficient appliances in another household through a direct transfer (selling or giving them away) or indirect transfer (resale on the used appliance market). Due to the high unit energy consumption (UEC) of older refrigerators, and the great improvements in refrigerator efficiency in recent decades (i.e., the much lower UEC of new refrigerators), the savings associated with refrigerator recycling can be substantial.
3. **Long estimated useful life (EUL) or remaining useful life (RUL, if available).** Discarding a still functional refrigerator before the end of its long useful life means that a less efficient unit could potentially be transferred to a new owner and remain in operation for many years.[31] Alternatively, when a still-functional unit is recycled instead of put back into service, savings accrue over the duration of the unit's remaining useful life.

Each of the appliance recycling success indicators listed above is an important direct cost-effectiveness input.[32] Since any measure added to the ARP must contribute to the overall program cost-effectiveness, we used these success indicators as high-level screens.[33] That is, Cadmus screened the saturation, unit

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30 KEMA, Inc. *2009 California Residential Appliance Saturation Study, Volume 2: Results.* October, 2010.

31 According to U.S. DOE's Refrigerator Market Profile, 2009: "*approximately 40% of refrigerators that could be retired remain on the grid: they are retained as second refrigerators, sold, or given away to other users*."

32 Saturation is an indirect (rather than direct) cost-effectiveness modeling input. The expected number of participants in an ARP, which derived from saturation, is an important cost-effectiveness input.

33 Other important inputs to program cost-effectiveness assessment, such as internal utility labor and marketing costs, could likely be equivalent (on a per-unit-recycled basis) to those of refrigerators, but are unknown at this time. Measure-specific implementation costs and NTG ratios, which also affect cost-effectiveness, would need to be established on a measure-by-measure basis. Measure-specific environmental benefits could affect the success of other appliance measures (since environmental benefits are an important part of the program's marketing message), but under the current treatment of cost-effectiveness analysis they would not affect the program cost-effectiveness.

energy-savings potential, and useful life of each other appliance measure considered for inclusion in the ARP against the saturation, unit energy-savings potential, and useful life of second refrigerators. We focused our analysis on the removal of a device before the end of its useful life, and assumed the unit was not replaced. For another appliance measure to succeed, it would likely need to compare favorably with second refrigerators on two or more of the ARP success indicators. Measures that compare unfavorably with second refrigerators across all three indicators are unlikely to prove cost-effective, and should therefore not be included in an expanded ARP.[34]

We gathered saturation and energy-savings data primarily from the 2009 California RASS,[35] and determined EUL and RUL data primarily from California's 2008 DEER database.[36] However, these data sources did not provide saturation, energy savings, and useful life information for all of the measures we examined. In these cases, the additional data sources we used are cited in the measure-specific sections below.

With these metrics in hand for each device, Cadmus applied the following formula to compute a normalized benefits indicator for each device, where the device's potential energy-savings benefits are normalized relative to the second refrigerator's benefits:

$$Normalized\ Benefits\ Indicator\ for\ Device\ = \frac{Device\ Lifetime\ Savings\ Potential}{2nd\ Refrigerator\ Lifetime\ Savings\ Potential}$$

Where:

$$Lifetime\ Savings\ Potential = Saturation * EUL * Potential\ Annual\ UES$$

While this assessment is necessarily *qualitative* in nature, its conclusions are informed by quantitative indicators from the California RASS and other data sources. SCE and PG&E could implement a pilot program, and have an accompanying impact evaluation of that pilot, to make an informed *quantitative* assessment of an ARP that includes additional measures.

In addition to measure-by-measure screening, Cadmus conducted the following research activities to learn about the programmatic issues involved with expanding the programs to include other appliances,

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[34] The logic Cadmus applied with the Benefits Indicator described here assumes the NTG of other appliances is similar to that of refrigerator recycling, since very little information is available about NTGs for other appliance recycling measures. However, if the NTG of another appliance were substantially different from the refrigerator NTG, that difference could change the likelihood the other appliance would be cost-effective as a recycling measure.

[35] See: KEMA, Inc. *2009 California Residential Appliance Saturation Study, Volume 2: Results*. Table 2-8: Electric UECs by Electric Utility. October 2010. Available online: http://www.energy.ca.gov/2010publications/CEC-200-2010-004/CEC-200-2010-004-V2.PDF.

[36] See: California Public Utility District. *2008 Database for Energy-Efficient Resources, DEER2008 for 09-11 Planning/Reporting*. Available online: http://www.deeresources.com/index.php?option=com_content&view=article&id=65&Itemid=57.

the physical processes and infrastructure needed to recycle other appliances, and the regulatory environment under which such recycling would take place:

- Interviewed SCE and PG&E ARP staff about the costs, benefits, and obstacles associated with including additional appliances;
- Interviewed program implementer staff at JACO and ARCA;
- Reviewed process and impact evaluations from other ARPs that accept other appliances to understand the eligible appliances, program operations, number of units collected relative to customer base, program restrictions and stipulations, incentives, and measured energy savings associated with each;
- Interviewed government organizations regulating the recycling and disposal of appliances to determine their policies, requirements, volumes, materials covered, and recommendations for utility programs;
- Interviewed other California utilities to gather anecdotal information on their non-refrigerator recycling program experiences.[37]

7.2 Findings

7.2.1 Other Appliances Considered for Inclusion in the ARPs

Cadmus began assembling a list of candidate appliances, starting with those suggested by SCE and PG&E program staff. We appended this list with other appliances for which we expected to have sufficient appliance-specific data to conduct an assessment (based on information in the 2009 RASS). The other appliance list includes:

1. RACs
2. Dehumidifiers
3. Clothes washers
4. Clothes dryers
5. Televisions
6. Personal computers, and
7. Set-top boxes.

We intended to supplement this list with appliances and electronics included in other utilities' ARPs. However, the only non-refrigerator/freezer appliances recycled through those programs were RACs and dehumidifiers. Table 67 documents the results of our research into other utilities' ARPs. As shown in the table, the New York State Energy Research and Development Authority (NYSERDA) began offering RAC recycling and a corresponding ENERGY STAR-qualified RAC rebate to its Keep Cool Program in 2000. SCE and PG&E later incorporated RAC recycling into their ARPs, following the best-practice model

[37] At the IOUs' request, Cadmus limited these interviews to California utilities.

established by NYSERDA and at the suggestion of the Program Advisory Group; PG&E also later incorporated dehumidifier recycling.

Table 67. Examples of Utility ARPs Including Appliances Other Than Refrigerators and Freezers

Utility/Program Administrator	State/Province	Other Appliance(s) Recycled	First Year Program Included Other Appliances
Ameren Illinois	Illinois	RACs	2010
Commonwealth Edison	Illinois	RACs	2008
Northeast Utilities	Connecticut	RACs	2004
New York State Energy Research and Development Authority (NYSERDA; Keep Cool Program)	New York	RACs	2000
Ontario Power Authority	Ontario	RACs; Dehumidifiers	2008
Pacific Gas & Electric	California	RACs	2006
		Dehumidifiers	2009
PPL Electric	Pennsylvania	RACs	2009
Silicon Valley Power	California	RACs	2007
Southern California Edison	California	RACs	2004-2005

Cadmus focused the remainder of our research and analysis on determining whether the seven appliances listed above could be included in future SCE and PG&E ARPs.

7.2.2 Cross-Measure Findings

Cost-Effectiveness

Although SCE's ARP previously recycled RACs, and PG&E's ARP recycled RACs and dehumidifiers in the most recent program cycle, staff at both IOUs expressed concern about the cost-effectiveness of including other appliances. SCE ARP staff reported that the program no longer recycles RACs because it is no longer cost-effective. SCE has considered developing a consumer electronics recycling program, and would tie electronics recycling to the purchase of high-efficiency units. A discussion of the potential energy savings (and potential cost-effectiveness) of consumer electronics recycling is provided in the Relevant Regulations section below.

While PG&E staff was not opposed to including additional appliances in the ARP, its engineering team had determined that only refrigerators and freezers would be cost-effective to recycle.

Relevant Regulations

Federal and California laws require that specific material components of appliances be properly handled. Under Section 608 of the Clean Air Act of 1990, EPA has established regulations (40 CFR Part 82, Subpart F) that require safe disposal of refrigerant and maximize the recovery and recycling of ozone-depleting substances during the disposal of refrigerant-containing appliances. Furthermore, California's requirements for proper appliance disposal include:

- Materials that Require Special Handling (MRSH) must be removed from major appliances prior to processing for scrap metal (Public Resource Code Section 42175.1; Health & Safety Code Section 25212). MRSH include:
  - Mercury, found in switches and temperature control devices;
  - Used oil from compressors and transmissions;
  - Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and other non-CFC replacement refrigerants injected in air-conditioning/refrigerant units;
  - All metal-encased capacitors;
  - Any parts that contain encapsulated polychlorinated biphenyls (PCBs) or diethylhexylphthalate; and
  - Any other material that is a regulated hazardous waste.
- A person who intends to remove these materials must obtain certification from the Department of Toxic Substance Control (Health and Safety Code Section 25211.1).
- Documentation must accompany discarded appliances to ensure that MRSH are removed by Certified Appliance Recyclers (Health and Safety Code Section 25211.3).

Although these regulations are in place at both the state and federal levels, barriers to compliance exist, including cost and access to appropriate recycling facilities.[38] Recycling programs ensure proper handling of specific material components of appliances by providing a financial incentive for recycling, as well as ensuring that utility customers have access to proper recycling facilities. Though this consideration does not affect energy savings associated with ARPs, it does represent a co-benefit of recycling refrigerant-containing appliances.

7.2.3 Measure-Specific Findings

As described above, Cadmus considered the suitability of each candidate appliance based on three criteria, comparing each other appliance to a second refrigerator. Cadmus selected second refrigerators as the base appliance for comparison because refrigerator recycling has historically been cost-effective in many jurisdictions (and refrigerators are therefore—by far—the most commonly recycled appliance in utility ARPs).

[38] See Chapter **Error! Reference source not found.** for more details.

Room Air Conditioners (RACs)

The saturation of RACs is considerably lower than that of refrigerators: 18% in SCE's territory and 11% in PG&E's territory according to the 2009 RASS. Furthermore, these saturations appear to be declining: the 2004 RASS found RAC saturation of 20% in SCE's territory and 14% in PG&E's territory.[39]

All of the ARPs we reviewed that accept RACs required RACs to be in working condition. As shown in Table 68, RAC recycling incentives ranged from $0 to $50. Some programs stipulated that RAC recycling was only offered as an add-on service for refrigerator or freezer recycling participants, while some placed limits on the number of appliances that could be recycled per year, and some required that the recycled RACs be replaced by an ENERGY STAR-qualified unit.

RACs constitute a very small portion of the total number of appliances recycled through ARPs. Of the utility programs we researched, harvest rates ranged from less than 0.01% (Ameren Illinois, 2010) to 0.44% (Northeast Utilities, 2004). In contrast, refrigerator/freezer harvest rates ranged from 0.22% (PG&E, 2004) to 3.49% (Pacific Power in Washington, 2006).[40]

Table 68. RAC Requirements and Participation

Utility / Program Administrator	Pgm Year	Condition	Restriction (annual, per customer)	Incentive ($/ appliance)	# RACs Collected	# Residential Customers*	RAC Harvest Rate**
Ameren Illinois	2010	Working or plugged in	Up to two appliances, but only if also picking up a refrigerator or freezer	$0	27	1,049,264	0.00%
Commonwealth Edison	2008	Working	Up to two appliances	$25	465	3,439,455	0.01%
	2009			$25	724	3,425,593	0.02%
	2012			$10	N/A	N/A	N/A
Northeast Utilities	2004	Working	Must replace with a new ENERGY STAR RAC	$25	5,875	1,338,596	0.44%
NYSERDA	2003	Working	Must replace with high-efficiency RAC	$35	23,729	6,875,329	<0.00%

[39] http://www.energy.ca.gov/reports/400-04-009/2004-08-17_400-04-009ES.PDF

[40] See the Literature Review chapter for more information about refrigerator/freezer harvest rates.

Utility / Program Administrator	Pgm Year	Condition	Restriction (annual, per customer)	Incentive ($/ appliance)	# RACs Collected	# Residential Customers*	RAC Harvest Rate**
Ontario Power Authority	2008	Working	One RAC, but only if also picking up a refrigerator or freezer	$0	1,610	4,500,000	0.04%
Pacific Gas & Electric	2009	Working and plugged in	One RAC, but only if also picking up a refrigerator or freezer	$25	264	4,574,196	<0.01%
	2010				329	4,565,636	<0.01%
	2011				275	4,574,094	<0.01%
PPL Electric	2011	Working	Up to four RACs	$25	1,385	766,002	0.18%
Southern California Edison	2006	Working	Must replace with a new ENERGY STAR unit at an SCE-sponsored event	$25	115	4,166,496	<0.01%
	2007				296	4,211,970	<0.01%
	2008				401	4,231,943	<0.01%

* Source: Energy Information Administration, Table 6, 2004 through 2011.

** The harvest rate is the percentage of total units recycled divided by the number of residential customers.

As shown in Table 69, a RAC's EUL of nine years is half a refrigerator's EUL of 18 years. Table 69 also depicts that both the saturation and UEC of a RAC are much lower than the saturation and UEC of a refrigerator. Since residential air conditioning load contributes to California's summer peak load,[41] the peak load reduction from recycling older RACs that would otherwise continue to operate may increase the viability of RAC recycling. However, the peak load reduction benefit may not be large enough to render the measure cost-effective.

[41] CPUC: http://www.cpuc.ca.gov/cfaqs/

Table 69. RAC and Refrigerator EULs, UECs, and Saturations

Appliance	EUL (years)	RUL (years)	SCE		PG&E		Peak Demand (kW)
			UEC (kWh/yr)	Saturation	UEC (kWh/yr)	Saturation	
RAC	9	3	238	18%	221	11%	1.465*
First Refrigerator	18	5	784	100%	774	100%	0.089**
Second Refrigerator	18	5	1,174	26%	1,226	25%	0.134**

* Cadmus calculated the RAC peak kW assuming the removal of a 10,000 Btu/hour unit, equal to 2.931 kW. Assuming a 0.5 coincidence factor, the peak demand for RACs is 1.465. (Note: it is especially challenging to determine the peak demand for RACs because their use is highly behavior dependent—e.g. unlike central air conditioners, they are not usually operated by a thermostat).

** Cadmus estimated refrigerator peak demand by dividing the annual energy usage by 8,760 hours (i.e., using the simplifying assumption that refrigerators draw a constant load during every hour of the year).

According to ENERGY STAR, new RAC standard-efficiency models consume just over 11% more energy than ENERGY STAR models, while models 10 years or older consume 20% more energy than a new ENERGY STAR model.

During Cadmus' visit to JACO's Hayward, California recycling facility, JACO staff explained that RACs are slightly less expensive to recycle than refrigerators and freezers. Since JACO's Hayward facility currently receives fewer RACs for recycling than refrigerators and freezers, warehouse staff store RACs at the facility and recycle them once they have collected 50 to 100 units. To do so, JACO staff members temporarily stop the refrigerators and freezer recycling process and switch the equipment for RAC decommissioning and recycling. The decommissioning process includes the following steps:

- All plastic removed from RAC unit, where possible, and recycled
- Compressor and coil manually removed from RAC unit
- Refrigerant removed and properly disposed
- All other RAC materials shredded and disposed
- Shredded ferrous and non-ferrous metals sold to recycler
- Other shredded materials (rubber, etc.) sent to landfill or incinerator

The normalized benefits indicators for RAC are presented in Table 70. The target market and energy-savings potential are smaller for RAC recycling than for refrigerator recycling, and RAC EUL is half that of refrigerator EUL. However, RAC recycling could potentially make a more substantial contribution to summer peak demand reduction than refrigerator recycling.

Table 70. RAC Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	7%
PG&E	4%

PG&E ARP staff reported that, although PG&E offered RAC recycling through the end of the 2010-2012 program cycle, recycling RACs was not cost-effective for PG&E. PG&E discontinued RAC recycling in program year 2013.

Based on these factors, Cadmus recommends that SCE and PG&E *not* consider RACs for inclusion in future ARPs.

Dehumidifiers

Of the utility ARPs we researched, only Ontario Power Authority's (in addition to PG&E's) recycled dehumidifiers. In 2008, the most recent year for which data are available, the Ontario Power Authority program collected 274 dehumidifiers, for a harvest rate of less than 0.01%.

The 2009 California RASS does not provide saturations for dehumidifiers, but groups dehumidifier saturations in the "miscellaneous appliances" category. Cadmus therefore referred to the Energy Information Administration's (EIA) national dehumidifier saturation survey (12%).[42] Recognizing that California's climate is drier than many other parts of the country, we assume that the saturations of dehumidifiers in SCE's and PG&E's service areas are considerably lower than the national average.

The dehumidifier UEC shown in Table 71 is also the national average for a new standard-efficiency unit, since a California-specific value was not available.[43] While this national average new dehumidifier UEC is somewhat higher than the UEC of a primary refrigerator, a California-specific UEC is likely considerably lower since humidity levels are lower in the state and the appliance would be used less often there. Energy savings from dehumidifier recycling—even if a recycled dehumidifier is removed from operation and not replaced—is therefore expected to be relatively small. Since dehumidifiers have a relatively long EUL of eight years (and possibly longer if well-maintained), they could be discarded by their first user while still functional and remain in service elsewhere for several more years.

[42] Energy Information Administration. *2005 Residential Energy Consumption Survey*. Available online: http://www.eia.gov/consumption/residential/data/2005/hc/hc9homeappliance/pdf/alltables.pdf.

[43] A new ENERGY STAR unit consumes 695 kWh annually.

Table 71. Dehumidifier and Refrigerator EULs, UECs, and Saturations

Appliance	EUL (years)	SCE		PG&E	
		UEC	Saturation	UEC	Saturation
Dehumidifier*	8	858	<12%	858	<12%
First Refrigerator	18	784	100%	774	100%
Second Refrigerator	18	1,174	26%	1,226	25%

* Cadmus determined dehumidifier EUL from http://www.nachi.org/life-expectancy.htm; UEC from the ENERGY STAR *Savings Estimate Calculator for Qualified Appliances*; and saturation from EIA's *2005 Residential Energy Consumption Survey (RECS)*.

Table 72 presents the dehumidifier normalized benefits indicators. Primarily because the target market is so small (i.e., dehumidifiers have a very low saturation in California), the benefits indicators for dehumidifiers are quite low and are very similar for the two utilities. Cadmus therefore recommends that SCE and PG&E not consider dehumidifiers for inclusion in future ARPs.

Table 72. Dehumidifier Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	15%
PG&E	16%

Clothes Washers

None of the ARPs we examined included clothes washer recycling.

According to the 2009 California RASS, clothes washers are present in 82% of SCE's residential customers' homes and 83% of PG&E's residential customers' homes (see Table 73). The 2009 RASS also estimated that the motors in clothes washers in SCE's service area consume 119 kWh/year, and in PG&E's service area consume 88 kWh/year.

In addition to consuming electricity for motor operation, clothes washing also requires energy to heat water for warm and hot water cycles. To estimate the water heating energy used for washing clothes (assuming an electric water heater), Cadmus noted that clothes washer water heating consumption is roughly 2.17 times that of motor consumption.[44] We then computed the annual water heating energy that a clothes washer uses in SCE's and PG&E's territory as:

Average of (119 kWh/yr and 88 kWh/yr) * 2.17 = 225 kWh/yr

[44] See: Korn, David and L. Mattison. "Do Savings Come Out In the Wash? A Large-Scale Study of Residential Laundry Systems." *Home Energy Magazine* (January/February, 2012).

PG&E staff opined that clothes washer recycling could be cost-effective if an additional energy-consuming component—the energy used to pump the water used in clothes washing—were taken into account when estimating the measure's energy savings. Cadmus estimated the annual electricity used for pumping water for clothes washing as follows:

(0.0015 kWh/gal pumped) * (23 gal water/load) * (0.96 loads/day) * (365 days/yr) = 12 kWh/yr[45]

Table 73 compares clothes washer and refrigerator EULs, saturations, and UECs, where SCE's and PG&E's clothes washer UECs are the sum of the electricity consumed to operate the clothes washer motor, heat water for washing clothes, and pump water to a California home for clothes washing.

Table 73. Clothes Washer and Refrigerator EULs, UECs, and Saturations

Appliance	EUL (years)	SCE		PG&E	
		UEC	Saturation	UEC	Saturation
Clothes Washer	11	356	82%	325	83%
First Refrigerator	18	784	100%	774	100%
Second Refrigerator	18	1,174	26%	1,226	25%

During our interviews, JACO and ARCA staff explained there is a secondary (used) market for clothes washers. That is, units discarded before the end of their 11 year moderately long EUL may remain in use in different locations, much like refrigerators.[46]

The success indicators for clothes washer recycling are shown in Table 74.

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[45] Cadmus obtained the average energy consumed for pumping one gallon of water in California from: http://www.resilience.org/stories/2012-10-04/energy-water-nexus.

The number of gallons of water per load came from ENERGY STAR (see: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CWhttp://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW) and Aquacraft Water Engineering and Management with Stratus Consulting & The Pacific Institute. *California Single Family Water Use Efficiency Study, Final Report.* Sponsored by The California Department of Water Resources. June 1, 2011. Available online: http://www.ebmud.com/sites/default/files/pdfs/california-single-family-water-use-efficiency-study-june2011.PDF.

The Number of loads per day is an average of values from ENERGY STAR (0.822), Aquacraft (0.96), and California Energy Commission (1.096; see: http://www.consumerenergycenter.org/home/appliances/washers.html).

[46] Although Cadmus examined potential benefits from appliance removal assuming no replacement, we note that recycling older clothes washers and ensuring they are replaced with ENERGY STAR units could also result in modest energy savings. The U.S. EPA estimates that over 60% of new clothes washers purchased in 2011 were ENERGY STAR qualified. EPA stated that market adoption of units that meet the new ENERGY STAR standard (that took effect January 1, 2011) has occurred more quickly than anticipated. Given the many older units remaining in customers' homes, tying the recycling of an old clothes washer to the purchase of a new ENERGY STAR-qualified (or better) unit could provide program energy savings.

Table 74. Clothes Washer Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	58%
PG&E	56%

While the clothes washer saturations are substantially higher than second refrigerator saturations, clothes washer EUL and UEC are lower than the EUL and UEC of second refrigerators. Combining these parameters, both SCE's and PG&E's normalized benefits indicators for clothes washers are well under 100% (i.e., potential clothes washer recycling benefits are just over half the potential benefits of second refrigerators). Nevertheless, given the variability in these parameters and the possibility that there may be approaches to minimize program costs, SCE and PG&E may want to develop program cost estimates for clothes washer recycling in combination with more refined benefits estimates before ruling out clothes washer recycling as a viable option.

Clothes Dryers

None of the ARPs we examined included clothes dryer recycling.

The electric clothes dryer UEC is roughly half the UEC of a second refrigerator (Table 75).[47,48] Furthermore, electric clothes dryer saturations are considerably lower than refrigerator saturations. This is especially true in SCE's territory where the electric clothes dryer saturation is just 19%.

Clothes dryers do have a relatively long useful life: 13 years. JACO staff, during our tour of their Hayward, CA facility, said that clothes dryers are frequently discarded prior to the end of their EUL and can be resold in the secondary market.

Table 75. Clothes Dryer and Refrigerator EULs, UECs, and Saturations

Appliance	EUL (years)	SCE		PG&E	
		UEC	Saturation	UEC	Saturation
Clothes Dryer	13*	693	19%	648	46%
First Refrigerator	18	784	100%	774	100%
Second Refrigerator	18	1,174	26%	1,226	25%

* Cadmus determined the clothes dryer EUL from http://www.nachi.org/life-expectancy.htm.

The clothes dryer normalized benefits indicators are shown in Table 76. As reflected by the 31% normalized benefits indicator for SCE, it is unlikely that electric clothes dryers could be cost-effectively

[47] Although Cadmus assumed that removed/recycled units are not replaced, we observed that newer clothes dryers generally about use the same energy as older models. While this changing with heat pump clothes dryers and other technologies, these energy-efficient options have not yet gained much market share in the U.S.

[48] EPA awarded an Emerging Technology Award to advanced clothes dryers in February, 2012, and plans to launch an ENERGY STAR specification process for clothes dryers, which does not presently exist. See: http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_dryers.

recycled in this region due to its relatively small electric clothes dryer saturation. In PG&E's service area, however, clothes dryer recycling looks more promising. PG&E may want to develop program cost estimates for clothes dryer recycling, in combination with more refined benefits estimates, to explore whether clothes washer recycling is a viable option.

Table 76. Clothes Dryer Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	31%
PG&E	73%

Consumer Electronics

Televisions (TVs), personal computers, and set-top boxes are classified as consumer electronics and rely on rapidly advancing technologies. The services provided through these devices are all subject to change, as are the capabilities of their built-in electronics. Televisions and set-top boxes are both becoming more like computers, especially smart-televisions used in combination with cloud computing. New and more advanced replacements are continuously being introduced at ever-lower prices.

As a result of the rapidly evolving electronics market, current electronics recycling efforts have focused on environmentally responsible disposal, not on the potential for energy savings. Several states, including California, have regulations and fees paid by for by device manufacturers, retailers, or consumers to cover the cost of recycling devices. These states, as well as others, have developed electronics recycling programs for televisions and monitors at no cost to the general public at the point of recycling. In addition, many online retailers offer their own electronics recycling programs: some include free pickup of old televisions when a customer receives delivery of a new television. According to CalRecycle, these programs have been successful at reducing electronic waste in landfills. [49,50]

Televisions

Liquid crystal display (LCD) televisions and monitors have fallen in price over the past few years, causing a rapid abandonment of the older and more inefficient cathode ray tube (CRT) devices. Deployment of high-definition digital video services and media have sped up the adoption of LCD and related flat-panel technology, as CRT-based screens are less capable of displaying the higher resolutions required for these services and products. The results have been a complete phasing out of CRT-based televisions and monitors from consumer retail, and a limited resale market for CRT devices. In effect, the useful life of CRT devices is limited by the development of new technologies: a unit will likely cease to be considered useful before it ceases to operate.

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[49] Oregon Department of Environmental Quality. "Oregon E-Cycles Biennial Report." March 2012. Available online: http://www.deq.state.or.us.

[50] Department of Resources Recycling and Recovery. "Update on California's Covered Electronic Waste Recycling Program Implementation of the Electronic Waste Recycling Act of 2003." June 2012. Available online: http://www.calrecycle.ca.gov.

Nielson reports that 75% of television-owning households are HD capable, and possess at least one newer LCD-based or similar television. [51] Roughly 89% of the television-owning public owns more than one device, and 41% own four or more (Nielson 2013).While Table 77 shows TV saturations from the 2009 California RASS of 100%, many (or perhaps most) households in SCE and PG&E service areas likely contain more than one television.[52]

Combining the increasing TV saturations with the continued growth of LCD sales, it is reasonable to assume that most of the CRT televisions still in use are second units. CRTs are likely used much less than the newer primary devices, resulting in lower overall energy consumption. TV UECs are compared to refrigerator UECs in Table 77.

Table 77. Television and Refrigerator EUL,s UECs, and Saturations

Appliance	EUL (years)	SCE		PG&E	
		UEC	Saturation	UEC	Saturation
TV	6*	735	100%	672	100%**
First Refrigerator	18	784	100%	774	100%**
Second Refrigerator	18	1,174	26%	1,226	25%

* Cadmus determined TV EUL from 2012 market research (DisplaySearch May 14, 2012). The Northwest Energy Efficiency Alliance uses a longer EUL of 10 years, but recent studies show that a shorter EUL is more accurate, as documented in: Northwest Energy Efficiency Alliance, *Consumer Electronics Television Initiative Market Progress Evaluation Report #2*.

** Although the 2009 California RASS shows TV saturations of 100% in both SCE and PG&E service areas, many households likely own multiple TVs. For example, in 2009 Business Week estimated an average of 2.5 TVs per home (in homes that have a TV; see: http://www.businessweek.com/the_thread/hotproperty/archives/2009/07/the_average_ame.html). In addition, in 2011 Nielsen estimated that close to 97% of all homes have at least one TV (see: http://www.nielsen.com/us/en/newswire/2011/nielsen-estimates-number-of-u-s-television-homes-to-be-114-7-million.html).

The viability of TV recycling is shown in Table 78. For the ARPs to realize energy savings from television recycling, they may need to interrupt the resale process of inefficient devices. Given the limited demand for used, inefficient, and outdated televisions, along with the availability of increasingly less expensive and technologically superior substitutes, and the availability of easy-to-access electronics recycling programs from retailers, it is unlikely that a utility-sponsored ARP for TVs would result in significant

[51] Neilsen. "State of the Media, U.S. Consumer Usage Report." January 2013. Available online: http://www.nielsen.com/content/corporate/us/en/reports/2013.html.

[52] In 2006, there was an average of 2.73 TV sets per home (see: USA Today. "Average home has more TVs than people." September 21, 2006. Available online: http://usatoday30.usatoday.com/life/television/news/2006-09-21-homes-tv_x.htm?csp=34). Although the number of TVs per home has declined in recent years, the saturation is still likely well above 100% (see: New York Times. "Ownership of TV Sets Falls in U.S." May 3, 2011. Available online: http://www.nytimes.com/2011/05/03/business/media/03television.html?_r=0.

energy savings or be cost-effective.[53] Cadmus therefore does *not* recommend that SCE and PG&E consider TVs for future inclusion in their ARPs.

Table 78. Television Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	80%
PG&E	76%

Personal Computers and Monitors

Similar to CRT TVs, desktop personal computers (PCs) have faced a decrease in popularity in recent years. Tablets, ultra-portables, and general laptops have all taken away from the desktop market share in personal computing. [54] Also, similar to TVs, the older reliance on CRT technology has been giving way to the more efficient LCD-based monitors, and CRT monitors have lost market share. Instead, inexpensive LCD monitors have become the norm, with consumer preference for LCD monitors' thinner size, lighter weight, and improved efficiency.

Along with CRT monitors, the desktop computers are continuing to lose market share. Desktop PC sales have dropped, while sales of mobile and compact options have increased. Because these more popular devices are designed with battery operation in mind, they are inherently more energy efficient than desktops. Comparisons of PC and refrigerator EULs, UECs, and saturations are shown in Table 79.

Table 79. Personal Computer and Refrigerator EULs, UECs, and Saturations

Appliance	EUL (years)	SCE		PG&E	
		UEC	Saturation	UEC	Saturation
PC*	5	618	85%	593	86%
First Refrigerator	18	784	100%	774	100%
Second Refrigerator	18	1,174	26%	1,226	25%

* Cadmus based the PC EUL on NEEA's Alliance Cost-Effectiveness model inputs, see: http://neea.org/docs/reports/80-plus-mper-4-final-06-11-12.pdf.

With consumer preference for mobile devices continuing to rise, the demand for desktops in resale is practically non-existent. Desktops that are only a few years old retain a very limited resale value; new replacements equipped with superior technology sell for extremely low prices. To prevent the older devices from ending up in landfills, many states regulate their disposal through electronic waste programs set up so that recycling facilities take old devices for free. As with TVs, many PC retailers recycle used computers without charging a fee.

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[53] Households with older CRT televisions may keep the old units as spare televisions when they replace and upgrade. A program preventing this practice could be promising if this happened commonly enough to constitute a large market. However, Cadmus was unable to find any market research on this phenomenon.

[54] Gartner. "Gartner Says Declining Worldwide PC Shipments in Fourth Quarter of 2012 Signal Structural Shift of PC Market." January 2013. Available online: http://www.gartner.com/it/page.jsp?id=2301715.

The viability assessment for PC recycling is shown in Table 80. Limited resale demand, coupled with the prevalence of electronics disposal programs, renders it unlikely that utility-sponsored recycling for PCs would bring about substantial energy savings or prove cost-effective.

Table 80. PC Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	48%
PG&E	48%

Set-Top Boxes

Set-top boxes deliver video content from a provider to consumers' TVs, and offer the potential for real-time streaming and recording. A plethora of devices exists, with varying features and service capabilities (cable, satellite, or telecommunication).

Several recent articles have examined set-top box energy consumption[55] and found a large range of energy use, typically scaling with the number of device features. The type of service can also affect the amount of energy a device uses, due to differences in the technology used to deliver content.

Table 81 presents the current set-top box EUL, UEC, and saturation, as well as comparable metrics for refrigerators.

Table 81. Set-Top Box and Refrigerator EULs, UECs, and Saturations

Appliance	EUL (years)	SCE		PG&E	
		UEC	Saturation	UEC	Saturation
Set-Top Box*	5-8	135	100%	135	100%
First Refrigerator	18	784	100%	774	100%
Second Refrigerator	18	1,174	26%	1,226	25%

* Set-top box EUL varies based on technology. Cadmus obtained set-top box UEC and saturation information from: Hardy, Gregg, A. Phillips, et al. "Pay-Television In-Home Equipment: National Energy Consumption, Savings Potential, and Policy Barriers and Opportunities." Proceedings of the 2012 American Council for an Energy-Efficient Economy Summer Study on Energy Efficiency in Buildings, Pacific Grove, California, August 12-17, 2012.

In considering an ARP targeting set-top boxes, one must acknowledge that these devices are not owned by consumers.[56] In most instances, consumers pay for access to a service, and the service provider rents or loans set-top boxes to their customers. There are many reasons for this relationship, including

[55] E.g., Natural Resources Defense Council. "Better Viewing, Lower Energy Bills, and Less Pollution: Improving the Efficiency of Television Set-Top Boxes." June 2011. Available online: http://www.nrdc.org/energy/files/settopboxes.pdf.

[56] Set-top devices that stream content over an internet connection (e.g., Apple TV, Roku) are not owned by service providers. These devices use a fraction of the energy used by traditional set-top boxes, and are usually considered a separate class of device.

content management and experience/interface unity across a service. As a result, consumers have limited control over the power consumption of these devices.

Service providers exert a lot of control over device manufacturers, often directly dictating the features, technology, and specification for set-top box devices. Service providers—rather than utility customers—are the primary stakeholders for set-top boxes. Alternatives that reach out to service providers, rather than traditional equipment labeling and utility rebate programs, are necessary to affect the set-top box market.

That said, the substantial capital the providers have invested in the current stock of deployed devices could render a replacement recycling program challenging. This is because large service providers make set-top box procurement decisions on a national scale: the incentive dollars they might receive from utility programs are unlikely to offset the billions of dollars the providers would incur if they modified their national procurement and development decisions (Hardy et al. 2012).

These challenges, coupled with the relatively low EULs and UECs of set-top boxes, led Cadmus to conclude that it is not feasible to include set-top boxes in utility-sponsored ARPs (Table 82) unless SCE and PG&E can find service providers who are willing to make substantial investments to upgrade the set-top boxes already in use.

Table 82. Set-Top Box Recycling Viability Assessment

Utility	Normalized Benefits Indicator
SCE	15%
PG&E	15%

Although the SCE and PG&E ARPs may not be the appropriate avenue to promote improved set-top box efficiency, the set-top box industry has committed to developing and deploying new energy-efficient technology. National efforts to reduce the energy consumption of set-top boxes have been underway for several years. A number of providers and manufacturers partner with ENERGY STAR and provide energy-efficiency guidance for these devices. With recent public interest, the primary research organization of the cable industry, Cable Labs, committed to new efforts in researching and developing more efficient technology.[57]

[57] National Cable and Telecommunications Association. "CableLabs-Energy Lab Tests Verify Significant Set-Top Power Savings from 'Light Sleep' Mode." March 2012. Available online: http://www.ncta.com.

8 QUANTIFICATION OF NON-ENERGY BENEFITS

8.1 Environmental Impacts Methodology

This section summarizes our analysis of the gross and net environmental benefits attributable to SCE's and PG&E's ARPs. Unless otherwise stated, all values and findings in this section apply only to the 2010–2012 program cycle. Additionally, all greenhouse gas (GHG) conversions and subsequent valuations solely inform the calculation of an Enhanced TRC, and should not be used for any other purpose, such as valuing carbon offsets in a cap-and-trade market.

Cadmus conducted the net environmental impact assessment using a spreadsheet model that accounted for and (where possible) monetized all gross and net environmental benefits associated with decommissioning an appliance. The benefits included energy reductions as well as the benefits from reclaimed materials, landfill offsets from recycled materials (such as metal and plastic), and avoided water contamination (such as from proper disposal of mercury-containing components).

The basic analytic framework consisted of the following steps (conducted separately for each utility):

Step 1: Construct a list of all materials recycled or destroyed by the program.

Step 2: Calculate the average weight or counts of each deconstructed material, per appliance.

Step 3: Inventory all quantifiable benefits for each deconstructed material, and estimate conversion values.

Step 4: Estimate the monetary value of each benefit (often expressed in low-, medium-, and high-valuation scenarios).

Step 5: Develop "discard scenarios," with each scenario representing a different combination of material-specific disposal methods.

Step 6: Estimate the likely distribution of units across the non-program scenarios (that is in the program' absence).

Step 7: Estimate gross environmental benefits as the sum of all benefits realized under the program scenario.

Step 8: Estimate net environmental benefits as the difference between the gross benefits and the average benefits realized in the program's absence.

More detailed descriptions of each of these steps are given below.

8.1.1 Step 1: Generate List of Recycled Materials

Our analysis began by taking a full inventory of all materials recycled, reclaimed, or destroyed under a typical ARP. Interviews with senior staff from JACO and ARCA, along with visits to their decommissioning facilities, and reviews of their 2010–2012 tracking databases, informed the construction of this list. We also interviewed and obtained documentation from EPA staff overseeing the RAD programs nationally;

this provided a perspective from outside of the program, regarding materials typically recycled by these programs, and materials such programs could potentially recycle in the future.

This exercise resulted in the following list of materials:

- Used oil
- Refrigerant (CFC 12 and HFC 134A)
- Ferrous metal
- Non-ferrous metal
- Plastic
- Glass
- Capacitors
- Rubber
- Foam
- Foam-blowing agent
- Fiberglass
- Compressors
- Electrical cords, wires, and other scraps
- Mercury-containing switches

This report does not include emissions reductions from reduced generation, as these benefits are already quantified by the E3 calculator. We do, however, include a review of emissions factors used in these calculations in Appendix G.

8.1.2 Step 2: Calculate Quantities of Recycled Materials

After developing our list of materials, we calculated average weights/quantities of different disposal method-material combinations (e.g., ferrous metal recycled; CFC-11 destroyed vs. recycled). This step drew heavily from JACO's and ARCA's databases, which contain information about materials remaining after appliance decommissioning and dismantling (hereafter called "deconstructed materials"). Database information includes material volumes, weights, and/or quantities.

Cadmus also obtained information from facility visits, determining disposal methods, and confirming this information through reviews of implementers' 2010 and 2011 RAD reports, filed for SCE and PG&E. We allocated a portion of the total quantity of each material (expressed as weight, volume, or emissions) to one of three disposal methods: destroyed on site; recycled; or sent to a landfill.[58]

[58] Implementers described these three disposal methods during our facility site visits.

Table 83 shows the assumed disposal method, units, and weight/count sources by program implementer.

Table 83. JACO Raw Material Disposal Methods and Data Sources

Material	Disposal Method		Units	Weight/Count Source
	Fullerton	Hayward		
Used Oil	Recycled	Recycled	lbs.	JACO unit tracking data
Refrigerant (CFC 12 and HFC 134A)	Destroyed	Destroyed	lbs.	JACO unit tracking data
Ferrous Metal	Recycled	Recycled	lbs.	Assumption (RAD report)
Non-Ferrous Metal	Recycled	Recycled	lbs.	Assumption (RAD report)
Plastic	Recycled	Recycled	lbs.	Assumption (RAD report)
Glass	Recycled	Recycled	lbs.	Assumption (RAD report)
Capacitors	Recycled (PCB capacitors destroyed)	Recycled (PCB capacitors destroyed)	Count	Assumption (RAD report)
Rubber	Landfill	Landfill	lbs.	N/A
Foam	Destroyed (waste-to-energy)	Landfill	lbs.	N/A*
Foam-Blowing Agent	Destroyed (waste-to-energy)	Destroyed	lbs.	JACO unit tracking data
Fiberglass	Landfill	Landfill	lbs.	N/A
Compressors	Recycled	Recycled	lbs.	N/A
Electrical cords, wires, and other scraps	Recycled	Recycled	lbs.	N/A
Mercury switches	Recycled	Recycled	Count	JACO unit tracking data

*RAD report claims blowing agents constitute 10% of foam, implying approximately 9 lbs. of solid waste per unit containing foam.

Table 84. ARCA Raw Material Disposal Methods and Data Sources

Material	Disposal Method	Units	Weight/Count Source
Used Oil	Recycled	lbs.	ARCA unit tracking data
Refrigerant (CFC 12 and HFC 134A)	Destroyed	lbs.	ARCA unit tracking data
Ferrous Metal	Recycled	lbs.	Assumption (RAD report)
Non-Ferrous Metal	Recycled	lbs.	Assumption (RAD report)
Plastic	Recycled	lbs.	Assumption (RAD report)
Glass	Recycled	lbs.	Assumption (RAD report)
Capacitors	Recycled	Count	Assumption (RAD report)
Rubber	Landfill	lbs.	N/A
Foam	Recycled	lbs.	N/A*
Foam-Blowing Agent	Destroyed	lbs.	ARCA unit tracking data
Fiberglass	Landfill	lbs.	N/A
Compressors	Recycled	lbs.	N/A
Electrical cords, wires, and other scraps	Recycled	lbs.	N/A
Mercury switches	Recycled	Count	ARCA unit tracking data

*RAD report claims blowing agents constitute 10% of foam, implying approximately 9 lbs. of solid waste per unit containing foam.

8.1.3 Step 3: Inventory Benefits for Deconstructed Materials

Once we calculated average materials quantities per appliance for each implementer, we mapped materials and their disposal methods to specific benefits (e.g., GHG reduction, landfill reduction). We then converted quantities of deconstructed materials to benefit amounts, using conversion factors collected through secondary research. This section provides an overview of these calculations. For more detail, see Appendix G.

Cadmus conducted a rigorous online search of recycled goods and emissions markets to determine unitized monetary values for deconstructed materials. The research included examinations of Websites for scrap metal, textiles, and recyclable goods, and a review of CalRecycle documentation, to ultimately determine monetary unit values for materials by weight and volume (i.e., hazardous and non-hazardous material values). Cadmus also researched GHG auction prices for the California GHG market and NOx prices from the Clean Air Interstate Rule market to determine the monetary values for a metric ton of emissions of each type of GHG.

The material-to-benefit conversion process involved converting original measurement units for raw materials (gases, metals, and toxic substances) into new units of measurement that could be monetarily quantified, based on various market values. Depending on the deconstructed material, we expressed new, converted units of measurement as avoided emissions, reclaimed material weights, landfill reduction weights, and/or avoided contamination. Though each deconstructed material uniquely converted to a new material metric, which could then be monetized, conversion processes were largely similar within examined deconstructed material subgroups (ozone-depleting substances [ODS], hazardous materials, and non-hazardous materials).

Ozone-Depleting Substances

EPA's RAD program primarily seeks to ensure the proper disposal of ozone-depleting substances. RAD specifically deals with refrigerants, the largest ODS source in appliances. Additionally, ARPs implemented by ARCA and JACO abate ODS present in blowing agents from older appliances, a step above and beyond the RAD program's requirements.

As the proportion of emissions differ for each GHG involved in the appliance recycling process (CFC-11, CFC-12, HFC-134a, HCFC-22, and HCFC-141b), Cadmus researched the global warming potential for each individual gas to normalize emissions as a metric-ton CO_2 equivalence ($MTCO_2E$) emissions factor. These global warming factors have been sourced from the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report (SAR). Table 85 lists these substances and their GHG equivalences.

Table 85. GHG Emissions Factors for ODSs Found in Recycled Appliances

Deconstructed Material	New Material Metric and Units	100 Yr GWP (SAR)*
CFC-11	$MTCO^2E$ of GHG Emissions	3,800
CFC-12	$MTCO^2E$ of GHG Emissions	8,100
HFC-134a	$MTCO^2E$ of GHG Emissions	1,300
HCFC-22	$MTCO^2E$ of GHG Emissions	1,500
HCFC-141b	$MTCO^2E$ of GHG Emissions	2,250

*http://www.climatechangeconnection.org/emissions/documents/GWP_AR4.pdf

Monetary values from these gases derive from their avoided GHG costs. To determine the monetary environmental benefit of GHG avoidance, one converts 1 pound of GHG (e.g., for CFC-11) to metric tons (using standard conversion factors). Multiplying the global warming potential the gas produces by its metric ton weight determines the $MTCO_2E$ for 1 pound of emitted CFC-11. The following equation offers a sample calculation, with conversions as noted:[59]

$$1\ lbs.of\ CFC-12\ Avoided\ Contamination = (0.000453592\ metric\ ton/\ 1\ lbs.) * 8100\ (100\ Year\ GWP\ SAR) = 3.674\ MTCO2\ E\ per\ lbs.of\ CFC-12\ gas$$

The emissions factor for each raw material gas converts to $MTCO^2E$; so the per-pounds emissions avoidance can be uniformly monetized.

Hazardous Materials

We calculated the monetary benefits associated with recycling or destroying hazardous materials by quantifying: the environmental benefits of avoided contamination; and the environmental benefits of emissions reductions. As avoided contamination and emissions benefits often differ by material, we individually described the valuation for each hazardous material (e.g., used oil, mercury, and PCBs).

[59] IPCC's SAR provides these global warming potential values.

Cadmus researched previous studies (e.g., EPA), examining environmental and health costs for hazardous material exposure.

Used Oil

We calculated emissions reductions for used oil, using the GHG emissions factor for #2 heating oil, which tends to have similar energy content. To calculate the GHG emissions from 1 gallon of oil, we multiplied the emissions factor by a density factor (to convert the units to pounds), and then multiplied by another metric conversion factor to determine a value in $MTCO^2E$, as shown in the following equation:

$$(1\ Gallon\ of\ \#2\ heating\ oil) * (22.38\ lb.CO2/\ 1\ Gallon) * (.000454\ mt\ /\ lb.) = 0.0101\ \mathrm{MTCO_2E}$$

Mercury

As mercury releases do not lead to significant GHG emissions, we did not calculate emissions reduction benefits, nor did we calculate its weight leading to landfill emissions, as appliances contain only trace amounts of mercury. The primary benefit of proper disposal of mercury is avoided contamination of water sources. Cadmus noted an appliance with a mercury switch contains approximately 1.5 grams of mercury.[60]

PCB-Containing Capacitors

PCB-containing capacitors do not directly emit significant amounts of GHGs into the atmosphere. However, emissions associated with the landfill of PCB-containing capacitors must be accounted for. To determine these emissions, Cadmus referred to values derived directly from the CalRecycle Landfill Avoided Emissions Analysis. CalRecycle used the California Landfill Methane Inventory Model and the 2006 IPCC landfill emissions methodology to conclude the average total avoided landfill methane emissions in California is 0.53 $MTCO^2E$ per ton of waste. To calculate emissions from landfilled PCB waste, Cadmus multiplied the weight of landfilled, PCB-containing capacitors by the $MTCO^2E$ conversion factor, and then multiplied by a pounds/ton conversion factor to determine the result in $MTCO^2E$:

$$(1\ lbs\ PCB\ Capacitors) * \left(0.53 \frac{MTCO_2eq}{ton}\right) * \left(0.0005 \frac{ton}{lb}\right) = 0.000265\ MTCO_2eq$$

Non-Hazardous Materials

Non-hazardous materials recycled of destroyed by the appliance recycling process include: ferrous metal; non-ferrous metal; rubber; plastic; glass; non PCB-containing capacitors; foam; and fiberglass

As non-hazardous materials do not have contamination costs, one primarily calculates environmental benefits by landfill emissions avoidance and material weights. Just as with PCBs, Cadmus calculated landfill emissions benefits for non-hazardous materials using the CalRecycle results for landfill avoided emissions.

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[60] http://www.newmoa.org/prevention/mercury/projects/legacy/FranklinCounty_MercuryDevicesReport.pdf (pp8)

8.1.4 Step 4: Estimate Monetary Values

Ozone-Depleting Substances

Cadmus determined monetary values for CO_2 using California's Air Resources Board (CARB) Auction 1 results, held on November 14, 2012. The auction yielded a settlement price of $10.09 per metric ton. As this price fluctuates with the market, Cadmus added a high-value case of $15.14 (50% above the current price) and a low-value case of $5.05 (50% below the current price). These carbon prices are used throughout this analysis where benefits are expressed in offset $MTCO^2E$ (such as in landfill reduction).

We multiplied the per-pounds $MTCO^2E$ value by each of the per metric ton emission GHG allowance prices listed in our above analysis. This created a monetary range of benefit values resulting from emissions avoidance of these GHGs.

Hazardous Materials

Used Oil

To determine the monetary benefit from avoided emissions due to used oil disposal, we multiplied the number of total gallons disposed of, as shown in the equation above, and converted to $MTCO_2E$. We then multiplied this value by the GHG auction price to determine a total monetary value for emissions avoided.

Cadmus referenced documentation from the U.S. Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration to determine the per-gallon response cost of an oil spill. One should note the DOT's per-gallon cost calculation included all associated economic, environmental, ecological, and human health damages. As per gallon costs were not linear with oil spill sizes (or with exposure), DOT presented a range of per gallon costs by various oil spill sizes.[61] Cadmus created three cost scenarios, based on the low ($22 per gallon, >10,000 gallon spill), medium ($244 per gallon,> 5 gallon average of all seven scenarios), and high ($723 per gallon, 5–30 gallons) estimates of per gallon costs. These estimated values (differing based on a spill's size) provided three scenarios for monetary values per unit of avoided oil contamination, achieved by multiplying the number of gallons of oil disposed of and the probability of oil contamination (e.g., a spill), to arrive at a total avoided contamination benefit.

Mercury

To determine the benefits of avoided mercury contamination, Cadmus identified the estimated costs associated with a mercury spill. As the spill costs are not linear in regard to the amount of mercury spilled, Cadmus used a range of cost values to determine the actual benefits of avoided mercury contamination. This non-linear cost curve led to great variations among the three cost scenarios. To calculate benefits of avoided contamination, Cadmus multiplied an estimate of recycled units containing

[61] http://www.epa.gov/osweroe1/docs/oil/fss/fss09/denning.pdf (Recycled oil values are determined from "Gasoline and other fuels")

mercury switches by the weight of mercury in each switch. Cadmus then multiplied this value by each of the three cost estimates for mercury spills to determine the three different scenarios for avoided contamination benefits.

PCB-Containing Capacitors

To monetize the benefits of landfill emissions avoidance, we multiplied the total $MTCO^2E$ resulting from the landfill of PCB-containing capacitors by the per-$MTCO^2E$ emissions price in California.

Cadmus did not specifically calculate environmental and health costs related to PCB contamination. Though these costs exist, credible commissioned studies have not been conducted that examine environmental and health damages arising specifically (and only) from PCB contamination. Other studies that have calculated environmental and health-induced costs from multiple chemicals (including PCB) note that commissioning a study to determine the costs associated only from PCB contamination would prove costly and time consuming.[62] Therefore, Cadmus chose not to calculate avoided contamination benefits for PCB exposure within this model.

Non-Hazardous Materials

We monetized the offset GHG emissions from landfill reductions using the CARB auction price. Market values for recycled materials were used to quantify the. We multiplied the market value (when applicable) for each raw material by its weight (with units for the market price and material weights normalized) to determine the total benefit recovered from the value of the material itself. As we assumed material weights, these overall values varied, based on the scenario used within our model.

8.1.5 Step 5: Develop Discard Scenarios

With the ultimate goal of estimating the program's net benefits in mind, Cadmus established four disposal scenarios, in addition to the program case. Each scenario represented different levels of recycling and compliance with EPA's RAD program.

To ascertain the program's net benefits, we established four disposal scenarios, in addition to the program case. The discard scenarios primarily relied on self-reported disposal methods in the program's absence, from the participant survey fielded as part of the 2010–2012 process evaluation. We supplemented these data with a review of literature addressing white goods laws and compliance in California (Environmental Protection Agency 2012).

We considered the following discard scenarios:

1. **Full Non-Compliance:** Considered the worst-case scenario, no materials would be recycled, and all toxic substances would be disposed of in an EPA-noncompliant manner. Few environmental benefits would be realized under this scenario. Examples of this scenario include dumping appliances in isolated areas.

[62] http://www.foxriverwatch.com/economic_damage_pcb.html#critically

2. **Modified Non-Compliance:** Under this scenario, the unit would still be disposed of in an environmentally non-compliant manner, but materials with retail values (namely ferrous and non-ferrous metals) would be recycled through secondary means. For this analysis, we assumed 100% of metals would be recycled. An example of Scenario 2 would be abandoning a unit in a public place, such as leaving the appliance on the curb.
3. **Likely Minimum Compliance:** In this case, the unit would be disposed of through minimum formal compliance, though this would not explicitly involve recycling. We assumed a 90% compliance rate under this scenario, meaning 90% of units would have their refrigerant and compressor oil disposed of in an EPA-compliant manner. We assumed a lower compliance rate for the proper disposal of PCBs and mercury (50%), as compliance has been found to be lower for these rare materials. We assumed 100% of metals and 25% of plastics and glass would be recycled. An example of Scenario 3 would be taking a unit to a dump.
4. **Full Compliance Recycling:** In this case, a unit would be taken to a non-program recycling facility. The scenario assumes all compliance requirements would be met, and much of the unit would be broken down and recycled. We assumed full compliance under this scenario for all toxic substances, save for the blowing agent, which, according to program implementers, non-utility programs do not extract. All metals, plastics, and glass would be assumed recycled. However, we assumed foam and fiberglass would not be recycled under this scenario.
5. **Full Compliance, Utility-Sponsored RAD Program:** This represents the program case, with benefits realized that represented the program's gross environmental benefits.

For a comprehensive list of the benefits of attributed to each scenario, see Appendix G.

8.1.6 Step 6: Estimate Distribution of Units Across Scenarios

After establishing the mix of materials recycled or disposed of under each scenario, we determined the likely distribution of units across Scenarios 1 through 4, had the program not existed. Cadmus estimated this distribution using data from the participant surveys. This survey asked respondents to report what they would have done with their appliance in the program's absence.

Table 86 shows how we assigned discard scenarios to each survey response, by IOU. We removed responses likely to result in transferring a unit to another user (indicated in the table with an "N/A") from the analysis. For some responses, the action prompted by the scenario proved unclear; in such cases, we divided the responses evenly between scenarios.

Table 86. Assignment of Survey Responses to Discard Scenarios

Response	SCE Proportion (n=188)	PG&E Proportion (n=180)	Likely Scenario
Sold it to a private individual	16%	8%	N/A
Gave it away for free to a private individual	13%	4%	N/A
Sold it to an appliance dealer	4%	6%	N/A
Given it away to a charity organization	14%	8%	N/A
Gave it away for free to an appliance dealer	3%	7%	2, 3, or 4
Picked up as part of the delivery service with the purchase	3%	4%	2, 3, or 4
Hauled it to the landfill or dump or threw it away yourself	12%	25%	1, 2, or 3
Hauled it to a waste management or recycling center yourself	7%	12%	4
Had someone else pick it up for junking or dumping	11%	12%	3
Left it on the curb for someone to take for free	10%	4%	2
Disposed of it in some other way	1%	0%	1
Kept it	8%	11%	N/A

Mapping these responses provided distributions of likely disposal scenarios for each utility in the program's absence. As shown in Table 87 the results did not differ substantially between the two IOUs.

Table 87. Likely Distributions of Discard Scenarios in Absence of ARPs

Scenario	SCE Proportion (n=86)	PG&E Proportion (n=115)
1	19%	16%
2	24%	22%
3	37%	38%
4	20%	24%

8.1.7 Steps 7 and 8: Estimate Gross and Net Environmental Benefits

Cadmus computed the gross benefits as the benefits from the program scenario, and the net benefits as the difference between the baseline (the weighted average of the likely scenarios in the program's absence) and the program scenario. In this analysis, we estimated total gross and net environmental benefits (in dollars and raw benefits) for high-, medium-, and low-valuation cases. These estimates represented possible values for incorporation in an enhanced TRC or societal benefit-cost ratio.

Though conceptually similar to traditional NTG analysis, freeridership related to energy savings differs from freeridership related to environmental benefits. For example, if a program paid an incentive for permanently removing an old, inefficient refrigerator from service and a participant was going to take it to the dump anyway, he would be considered an energy freerider, but would not be considered an environmental freerider.

8.2 Environmental Impacts Findings

Combining the parameters outlined above, Cadmus calculated per-unit and total benefits attributable to the program. Again, we calculated gross benefits as the total monetary value of benefits from the ARPs. We calculated net benefits as the difference between gross benefits and the benefits realized in the program's absence (defined as the weighted average of the discard scenarios discussed above).

Table 88 and Table 89 show gross and net benefits attributed to the SCE and PG&E programs, respectively, using the medium-case scenario. Much variance occurs in the NTG relationship between materials. For instance, our analysis shows the majority of metal would most likely be recycled in the program's absence; so the net metal recycled remained quite low relative to gross. In contrast, our research found foam recycling essentially does not occur outside of utility ARPs; therefore, net and gross savings for foam recycling are equal.

Table 88. Gross and Net Environmental Benefits: SCE, Medium Case 2010-2012

Benefit	Units	Gross Benefits		Net Benefits		Environmental "NTG"
		Amount (in units)	Monetary Value	Amount (in units)	Monetary Value	
GHG emissions	MTCO2eq	403,665	$5,651,310	308,446	$4,318,250	0.76
Reclaimed oil	lbs.	108,400	$200,811	48,164	$89,223	0.44
Avoided oil contamination	gal.	14,453	$3,526,613	6,422	$1,566,923	0.44
Reclaimed ferrous metal	lbs.	26,834,510	$3,347,284	3,867,326	$482,403	0.14
Reclaimed copper	lbs.	1,281,407	$3,363,693	195,349	$512,790	0.15
Reclaimed aluminum	lbs.	1,268,934	$982,132	182,876	$141,543	0.14
Reclaimed plastic	lbs.	2,992,320	$871,513	2,118,093	$616,895	0.71
Reclaimed glass	lbs.	688,726	$943	487,510	$667	0.71
Avoided mercury contamination	lbs.	4	$930,322	2	$572,786	0.62
Reclaimed foam	lbs.	1,487,762	$290,114	1,487,762	$290,114	1.00
Reclaimed fiberglass	lbs.	0	$0	0	$0	
Environmental Benefits Total			**$19,164,735**		**$8,591,593**	**0.45**

Table 89. Gross and Net Environmental Benefits: PG&E, Medium Case 2010-2012

Benefit	Units	Gross Benefits		Net Benefits		Environmental "NTG"
		Amount (in units)	Monetary Value	Amount (in units)	Monetary Value	
GHG emissions	MTCO2eq	137,445	$1,924,236	95,066	$1,330,927	0.69
Reclaimed oil	lbs.	35,217	$65,240	13,939	$25,822	0.40
Avoided oil contamination	gal.	4,696	$1,145,727	1,859	$453,475	0.40
Reclaimed ferrous metal	lbs.	7,083,375	$883,566	854,625	$106,604	0.12
Reclaimed copper	lbs.	286,729	$752,664	37,579	$98,645	0.13
Reclaimed aluminum	lbs.	283,335	$219,296	34,185	$26,459	0.12
Reclaimed plastic	lbs.	1,416,675	$412,607	941,370	$274,174	0.66
Reclaimed glass	lbs.	170,001	$233	112,964	$155	0.66
Avoided mercury contamination	lbs.	0.02	$5,022	0.01	$2,861	0.57
Reclaimed foam	lbs.	460,764	$89,849	460,764	$89,849	1.00
Reclaimed fiberglass	lbs.	0	$0	0	$0	
Environmental Benefits Total			**$5,498,440**		**$2,408,970**	**0.44**

Table 90 and Table 91 provide the final estimates of per-unit and total gross benefits for SCE's and PG&E's 2010–2012 ARPs, respectively, for each valuation case (high, medium, and low). SCE's net program benefits ranged from $20 to $82 per recycled unit. For comparison purposes, the SCE program experienced an average implementation cost of $165 per unit in 2012. PG&E's net program benefits ranged from $19 to $75 per unit, and its program experienced an average implementation cost of $270 per unit in 2012.

Table 90. Gross and Net Environmental Benefits: SCE

Case	Gross Benefit		Net Benefit		Environmental "NTG"
	Per-Unit	Total	Per-Unit	Total	
Low	$50	$9,894,998	$20	$3,956,874	0.40
Medium	$98	$19,164,735	$44	$8,591,593	0.45
High	$174	$34,137,424	$82	$16,100,976	0.47

Table 91. Gross and Net Environment Benefits: PG&E

Case	Gross Benefit		Net Benefit		Environmental "NTG"
	Per-Unit	Total	Per-Unit	Total	
Low	$47	$2,656,403	$19	$1,068,191	0.40
Medium	$97	$5,498,440	$43	$2,408,970	0.44
High	$169	$9,557,982	$75	$4,233,499	0.44

8.3 Economic Impacts Methodology

Cadmus performed a macroeconomic analysis of SCE's and PG&E's ARPs to estimate net statewide employment and other economic impacts resulting from the programs' operation. We used the IMPLAN (IMpact analysis for PLANning) v3.0 modeling software, an input/output (I/O) tool that characterizes spending patterns and relationships between households and industries. The model for this analysis measures the impact of each program on the statewide economy. The analysis results can be included as additional benefits for societal cost test cost-effectiveness calculations.

Changes in final demand (i.e., purchases) drive the IMPLAN model. IMPLAN utilizes matrix math[63] to capture the impacts a change in final demand in one industry can have on other industries or sectors using built-in economic multipliers. The program describes how a $1.00 change in final demand would affect given industries' output.[64] In other words, an increase or decrease in production and employment within a local area has a "multiplier" effect as changes in local spending affect other sectors of the California economy.

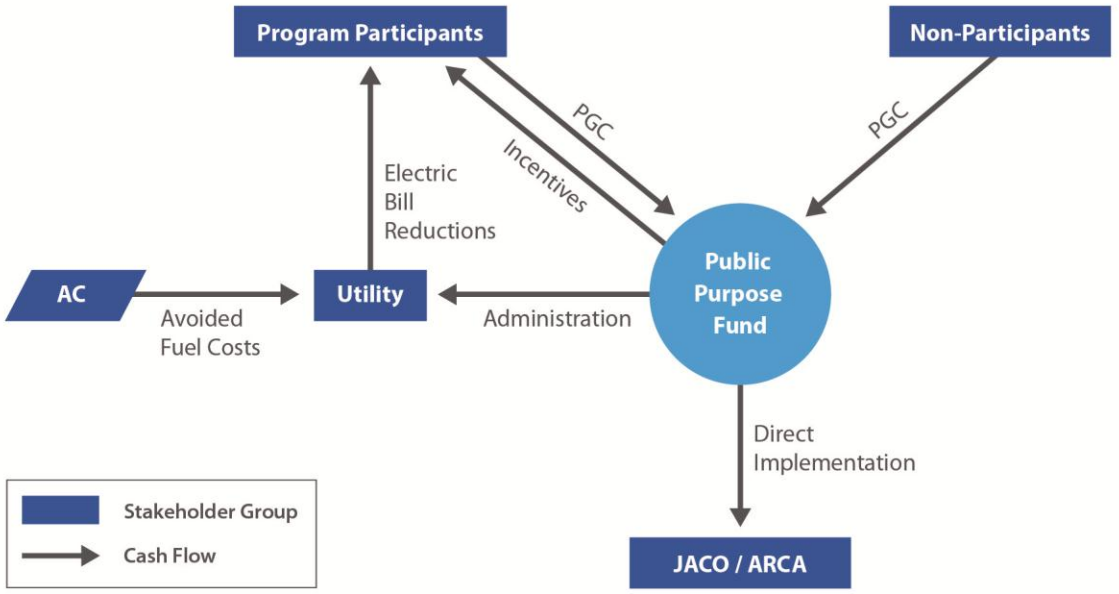
As the model's underlying assumptions have been based on historical economic data relating industries to one another, the model can effectively capture the effects of market conditions during the 2010–2012 program cycle. IMPLAN compares the effects of program-related spending on the economy to a baseline picture of the economy (in which the program would not exist). IMPLAN then outputs the net impacts of the ARP's operation on the California economy.

The IMPLAN model includes built-in assumptions about the California economy, including assumptions about industrial and household purchasing patterns. Cadmus customized IMPLAN to model the flow of ARP-related funds between ARP stakeholders, with the resulting cash flows shown in Figure 94.

63 "Matrix math" is the application of common mathematical functions (e.g., addition, subtraction, and multiplication) to rectangular arrays of numbers.

64 Lindall, S., and Olson, D. *The IMPLAN Input-Output System.* MIG Inc. Available at: ftp://199.141.121.35/Economics/NatImpact/implan_io_system_description.pdf

Figure 94. ARP Program Stakeholder Cash Flow



Cadmus organized input data into four categories for use in the IMPLAN model: program spending; costs to ratepayers; participant bill reductions; and utility revenue losses. As we used IMPLAN to model the economy as a whole, each positive model input (e.g., program spending) had a corresponding negative model input (e.g., the cost to ratepayers). Table 92 shows the relationships of modeled, ARP-related positive and negative monetary cash flows.

Table 92. ARP-Related Cash Flows Modeled

Positive Impacts Modeled	Negative Impacts Modeled
Program Spending	Cost to Ratepayers
Participant Bill Reductions	Revenue Loss (also accounts for fuel cost reductions)

Each of these data inputs affects households or industries within the region, as described below:

1. **Program Spending (Industry):** Program spending refers to monies spent on all aspects of program implementation, including: administration, marketing, and direct implementation. Cadmus allocated program administration and marketing costs to specific IMPLAN model industry codes, and direct implementation costs to "waste management and remediation services"—the IMPLAN category best matching the characteristics of the ARP implementation contractors (JACO and ARCA).

   Incentives are modeled as increases to participant income.

2. **Cost to Ratepayers (Household):** California funds its energy-efficiency programs through a PGC, collected from all applicable ratepayers (in this case, all residential customers). The ARP cost to

ratepayers therefore equals program spending. However, as industries within IMPLAN are associated with different spending multipliers, program spending and costs to ratepayers do not have the same effects on the economy (i.e., they do not cancel one another out). That is, changes in consumer spending affect the economy differently from how changes in economic demand related to the waste management and remediation industry affect the economy, since households and firms spend their incomes on different goods and services.

3. **Participant Bill Reductions (Household):** Electricity bill reductions, which result from removing appliances from use, are modeled as increases in household income that persist throughout the remaining useful life of the recycled appliances (up to five years). Cadmus computed the net present value (NPV) of bill reductions and allocated the NPV across households based on the ARP participant demographic data (collected through the ARP participant survey). Table 93 shows the income categories and distributions used in this analysis.

Table 93. Income Distribution of ARP Participants

Household Income	SCE (n=152)	PG&E (n=133)
Less than $20,000	8%	4%
20 to less than $30,000	9%	10%
30 to less than $40,000	16%	11%
40 to less than $50,000	10%	4%
50 to less than $60,000	11%	12%
60 to less than $75,000	9%	11%
75 to less than $100,000	12%	19%
100 to less than $150,000	16%	14%
150 to less than $200,000	5%	6%
More than $200,000	4%	9%

4. **Revenue Loss (Household):** Program participants purchase less electricity after recycling their old, inefficient refrigerators or freezers. Consequently, the utility experiences a loss in revenue over the remaining useful life of the recycled units. Utilities in California are allowed cost recovery from ratepayers through general rate cases, with lost revenues resulting from reduced electricity demand recovered through slight increases in residential electricity rates.

   However, utilities also spend less on fuel due to ARP participants' reduced energy usage. These avoided fuel costs help to offset revenue lost through reduced customer demand. Therefore, Cadmus calculated revenue loss as the NPV of the difference between participants' electric bill reductions and the avoided fuel costs experienced by the utility.

   As the California IOUs may recover lost revenue through rate cases, IMPLAN models revenue loss as a "household" income change.

Table 94 presents the values Cadmus used for each of the model inputs described above.[65]

[65] As the economic impact analysis covers the three-year program period, Cadmus converted all values to 2010 dollars using IMPLAN's built-in price deflator.

Table 94. Inputs for the Economic Impact Model (2010–2012 Program Cycle)

Input Category	Type of Change	Description	Value	
			SCE	PG&E
Program Spending	Industry Change	Program Administration	$1,818,563	$1,770,901
		Marketing	$3,818,661	$3,275,098
		Direct Implementation*	$19,800,108	$6,247,132
		Incentives*	$6,875,190	$2,207,345
Cost to Ratepayers**	Household Income Change	Costs to ratepayers: public goods charge	-$32,312,523	-$13,500,477
Participant Bill Reductions	Household Income Change	Present value of program participants' avoided energy costs plus incentives received	$39,664,510	$18,117,615
Revenue (Loss)	Household Income Change	Lost revenue due to DSM that is recovered through rate cases.	-$21,172,592	-$12,162,926

* The utilities' quarterly reports state incentives are included in the "Direct Implementation" expenditure category. Cadmus separated incentives from other direct implementation costs using the methodology described below.

** "Cost to Ratepayers" equals the sum of the "Program Spending" categories. We list "Cost to Ratepayers" and "Program Spending" separately here as the associated IMPLAN industries have different spending multipliers. Therefore, although the absolute values of these inputs are equal, their resulting effects on the economy may not be.

8.3.1 Data Sources

Program Spending

For the economic impact analysis, Cadmus used SCE and PG&E ARP expenditures from the utilities' most recent quarterly reports. The Energy Efficiency Groupware Application (EEGA) Website[66] provides the "Program Spending" data shown above in Table 94, above. However, program incentives are reported as a component of direct implementation in the IOUs' quarterly expenditure reports, and are not broken out as a separate line item. Therefore, Cadmus computed SCE's and PG&E's incentive totals, based on the number of participating units and the per-unit incentive values. Table 95 and Table 96 show incentive calculations for SCE's and PG&E's ARPs, respectively.

[66] The quarterly reports include cumulative expenditures since the beginning of the 2010–2012 program cycle. At the time of this writing, the most recent data available for SCE were contained in "SCE.FundShifting.2012Q3.2.xlsx," and the most recent data for available PG&E were contained in "PGE.FundShifting.2012Q3.1.xlsx." Available at: http://eega.cpuc.ca.gov/.

Table 95. SCE 2010–2012 Incentive Calculations

Program Year	A	B	C	D	E
	Refrigerator Quantity	Refrigerator Rebate (A x $35)	Freezer Quantity	Freezer Rebate (C x $35)	Total Incentive (B+D)
2010	66,952	$2,343,320	5,779	$202,265	$2,545,585
2011	70,652	$2,472,820	6,002	$210,070	$2,682,890
2012	43,433	$1,520,155	3,616	$126,560	$1,646,715
Total	**181,037**	**$6,336,295**	**15,397**	**$538,895**	**$6,875,190**

Table 96. PG&E 2010–2012 Incentive Calculations

Program Year	A	B	C	D	E
	Refrigerator Quantity	Refrigerator Rebate (A x $35)	Freezer Quantity	Freezer Rebate (C x $35)	Total Incentive (B+D)
2010	21,552	$754,320	2,983	$104,405	$858,725
2011	17,945	$628,075	2,123	$74,305	$702,380
2012	16,417	$574,595	2,047	$71,645	$646,240
Total	**55,914**	**$1,956,990**	**7,153**	**$250,355**	**$2,207,345**

Per-Unit Energy Savings, RUL, and NTG

To model participants' electric bill reductions, Cadmus monetized the energy savings resulting from program participation. We derived the NPV of energy savings using gross energy savings per unit, NTG ratios, and the RUL of the recycled units from, "DEER Database: 2011 Update Documentation" and from the report's Appendix A-1 (Itron, Inc., 2011).

Table 97 and Table 98 show savings assumptions for refrigerators and freezers, respectively. CPUC's Decision 12-05-015, Section 4.3.3.4.2,[67] states that including HVAC interactive effects proves appropriate for all DEER calculations. Therefore, when calculating energy savings, Cadmus included interactive effects resulting from appliance removal.

Table 97. Refrigerator Savings Parameters Used in Economic Benefits Estimation

Utility	Program Year	Gross Energy Savings (kWh/unit/yr)	Gross Energy Savings (therms/unit/yr)	NTG	Net Energy Savings (kWh/unit/yr)	Net Energy Savings (therms/unit/yr)	RUL
SCE	2010	737	-8.51	0.56	413	-4.51	5
	2011	737	-8.51	0.56	413	-4.51	5
	2012	737	-8.51	0.56	413	-4.51	5
PG&E	2010	848	-11.00	0.51	432	-5.83	5
	2011	848	-11.00	0.51	432	-5.83	5
	2012	848	-11.00	0.51	432	-5.83	5

[67] Available at: http://www.caleefinance.com/wp-content/uploads/2012/08/CPUC-guidance.pdf

Table 98. Freezer Savings Parameters Used in Economic Benefits Estimation

Utility	Program Year	Gross Energy Savings (kWh/unit/yr)	Gross Energy Savings (Therms/unit/yr)	NTG	Net Energy Savings (kWh/unit/yr)	Net Energy Savings (Therms/unit/yr)	RUL
SCE	2010	917	-10.10	0.56	514	-7.07	4
	2011	917	-10.10	0.56	514	-7.07	4
	2012	917	-10.10	0.56	514	-7.07	4
PG&E	2010	874	-11.00	0.51	446	-7.70	4
	2011	874	-11.00	0.51	446	-7.70	4
	2012	874	-11.00	0.51	446	-7.70	4

Discount Rate, Energy Forecasts, and Avoided Costs

Cadmus used a single discount rate—the weighted average cost of capital (WACC)—in the IMPLAN analysis to calculate the NPV of energy savings accruing to program participants and the NPV of reduced revenue accruing to the utility. We opted for this approach, rather than selecting different rates for the participant benefit and utility revenue loss computations, as it parallels the approach used in the California (E-3 calculator) cost-effectiveness tests.[68] Utility-specific discount rates derived from the avoided cost E3 calculator (with April 2010 updated avoided costs); Table 99 shows discount rates used.

Table 99. Discount Rates Used in Economic Benefits Estimation

Utility	Type of Discount Rate	Rate
SCE	Before-tax WACC	8.75%
PG&E	After-tax WACC	8.79%

Cadmus used the wholesale rate forecast for electricity and natural gas from SCE's and PG&E's *2010–2012 E3 Calculators (with Updated April 2010 Avoided Costs),*[69] and the April 2010 avoided costs from SCE's and PG&E's 2010–2012 E3 Calculators.[70] The model included these to determine utility revenue requirements resulting from lost electricity demand.

8.3.2 IMPLAN's Relationship to the TRC Test

Modeling economic impacts with IMPLAN requires many of the same inputs as required by the TRC cost-effectiveness test, though with two important differences.

First, the TRC test focuses on the benefits and costs of entities directly affected by the ARPs (the utility, program participants, and utility ratepayers). While IMPLAN economic modeling starts with these costs

[68] From the CPUC workshop proceedings "Cost-effectiveness Workshop One: The E3 Avoided Cost Model and Discount Rate," available at: http://www.cpuc.ca.gov/NR/rdonlyres/2726AF73-6BA6-49F5-8BF2-94CD6093E6F3/0/AvoidedCostWorkshop_6282012_annotated_final.pdf.

[69] From: http://www.ethree.com/public_projects/cpuc4.php. Accessed January 10, 2013.

[70] Ibid.

and benefits, it goes beyond the TRC test by quantifying the impacts of programs on all industries throughout the economy.

Second, transfer payments (i.e., incentives) are *excluded* from the TRC test, but are *included* in the economic model. The TRC does not include transfer payments as it views benefits and costs from the combined perspective of the utility and ratepayers, taken as a whole.

In contrast, the economic model takes a wider view, and analyzes impacts of transfer payments on overall demand within the broader economy; the impact of transfer payments depends on the specific multipliers involved in a given purchasing sequence. The economic model analyzes how participants spend these benefits, causing the program incentives to ripple through to other industries in the economy.

8.3.3 Economic Impacts Analysis

The IMPLAN I/O model takes the inputs described above and uses elaborate matrices to generate economic impacts outputs from the ARPs' operation. The resulting outputs include three types of economic effects:

- ***Direct effects*** represent perhaps the most intuitive type of economic impact, driven by program spending and representing production changes induced by increases in final demand. For example, ARP marketing expenditures increase the final demand for advertising services.
- ***Indirect effects*** result from changes in the demand for "factor inputs" caused by program activities. Factor inputs are the main goods and services necessary for operation of the ARPs, such as trucks to pick up the refrigerators/freezers, and saws and other equipment used to physically dismantle and recycle the units. Indirect effects account for additional materials purchased by the implementation contractors to run the ARPs. IMPLAN's I/O matrices capture these changes in demand, and model the resulting effects on all affected industries .
- ***Induced effects*** result from the ways households and workers spend newly available money, either from electric bill reductions or income increases, on general consumer goods and services. The term "induced" refers to these effects reflecting impacts on industries not directly involved with the program or its factor inputs. For example, a program participant may spend her incentive dollars on a concert ticket. In this case, program dollars (e.g., from the incentive) flow to a completely unrelated industry (the entertainment industry), but can still be attributed to the ARP.

IMPLAN generates four key indicators, showing ARP economic impacts:

- ***Employment*** is presented in units of job-years. One job-year equals 12 months of full-time employment for one person.
- ***Labor income*** includes all employees' income as well as proprietors' income (wages and benefits).

- ***Value added*** is the difference between gross output (income plus inventory change) and intermediate inputs (goods and services imported or bought from other industries). The value added includes employee compensation, tax payments, and gross operating surplus.
- ***Economic Output*** estimates production in producer prices. In manufacturing, this equals sales, plus the change in inventory. In retail and wholesale industries, this equals the gross margin, not gross sales.

8.4 Economic Impacts Findings

Running the IMPLAN model estimated the cumulative economic impacts from SCE's and PG&S's ARPs shown in Table 100 and Table 101, respectively. Each economic indicator breaks down by direct, indirect, and induced effects. All dollar figures are net present values, and represent program impacts over the remaining useful life of the appliances recycled through the program.

As shown, most of SCE's ARP impacts are more than twice those of PG&E's ARP, given that SCE operates a considerably larger program than PG&E: over the 2010–2012 program period, SCE had program costs of $32.3 million, in contrast to PG&E's program costs of $13.5 million.

Of the four examined metrics (i.e., employment, labor income, value added, and economic output), the value added metric proves most relevant to include in an "enhanced" TRC calculation. The value added metric represents the net impact of the ARPs on the IOUs' regional economies—that is, it shows the contribution of the ARPs to the overall GDP in the region.[71] Economic output results are greater than value added results as the economic outputs do not account for costs of intermediate inputs used in production.

Table 100. Summary of SCE ARP Economic Impacts (2010-2012)

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Direct Effect	130.4	$9,187,862	$14,801,228	$25,542,749
Indirect Effect	74.9	$4,361,392	$6,980,002	$11,912,793
Induced Effect	-34.5	-$1,702,837	-$3,069,376	-$5,054,498
Total Effect	**170.8**	**$11,846,418**	**$18,711,854**	**$32,401,044**

Table 101. Summary of PG&E ARP Economic Impacts (2010-12)

Impact Type	Employment (Job-Years)	Labor Income	Value Added	Output
Direct Effect	64.2	$4,627,852	$7,005,090	$11,297,065
Indirect Effect	31.4	$1,824,650	$2,919,649	$4,866,272
Induced Effect	-28.3	-$1,420,913	-$2,524,628	-$4,200,959
Total Effect	**67.4**	**$5,031,589**	**$7,400,111**	**$11,962,378**

[71] Source: Bureau of Economic Analysis. http://www.bea.gov/faq/index.cfm?faq_id=184.

To contextualize these findings and to make SCE and PG&E results more directly comparable, Cadmus divided each program's total labor income, value added, and economic output by the program's total spending. As shown in Table 102, the utilities' ARPs results are very comparable per program dollar spent, adding $0.55 (PG&E) to $0.58 (SCE) to their regional economies for every program dollar spent.

Table 102. Total Economic Impacts per Dollar Spent

Utility	Labor Income	Value Added	Output
SCE	$0.37	$0.58	$1.00
PG&E	$0.37	$0.55	$0.89

Table 103 show the 10 industries experiencing the greatest employment increases due to SCE's ARP in descending order (that is, the industry at the top of the list—waste management and remediation services—experiences the greatest employment increases, the second industry shows the next greatest employment increases, and so on). Table 104 presents a comparable list for PG&E's ARP.

Table 103. SCE's Top 10 Industries by Employment Increases

	Industry
1.	Waste management and remediation services
2.	Advertising and related services
3.	Office administrative services
4.	Employment services
5.	Food services and drinking places
6.	Accounting, tax preparation, bookkeeping, and payroll services
7.	Services to buildings and dwellings
8.	Couriers and messengers
9.	Management of companies and enterprises
10.	Management, scientific, and technical consulting services

Table 104. PG&E's Top 10 Industries by Employment Increases

	Industry
1.	Waste management and remediation services
2.	Advertising and related services
3.	Office administrative services
4.	Employment services
5.	Accounting, tax preparation, bookkeeping, and payroll services
6.	Management, scientific, and technical consulting services
7.	Couriers and messengers
8.	Services to buildings and dwellings
9.	Management of companies and enterprises
10.	Architectural, engineering, and related services

Not surprisingly, the waste management and remediation industry benefits the most from ARPs in both regions, followed by the advertising and office administrative services industries. The beneficial

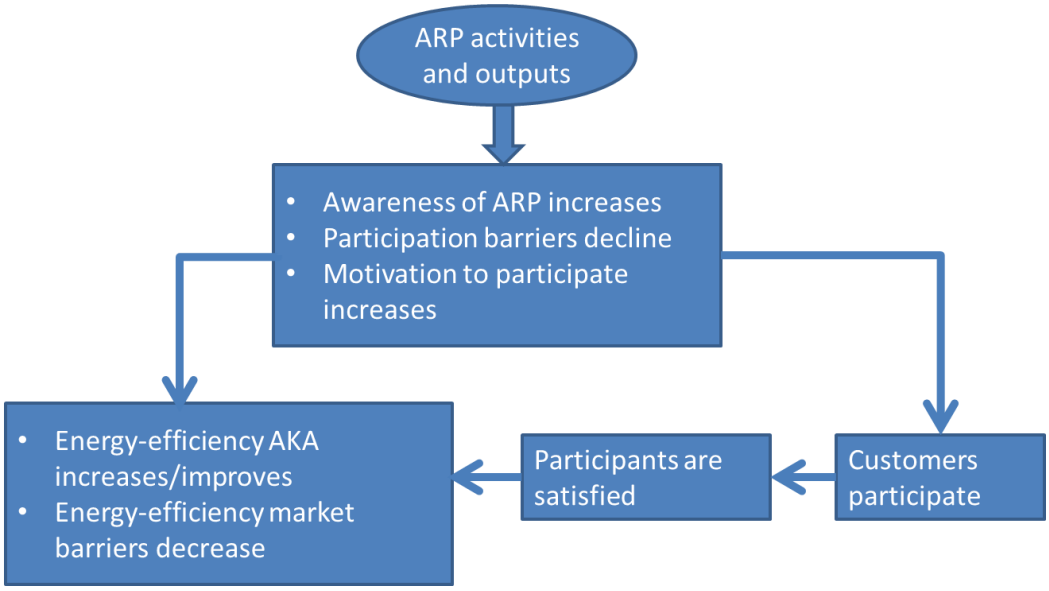
economic effects on other industries, such as employment services, food services, and accounting, result from the positive induced effect of participants' energy savings.

9 MAJOR FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes and synthesizes the results of this study to provide the major findings, research conclusions, and key recommendations. The ARPs have been implemented for several program cycles; the 2010-2012 cycle studied in this project has continued most of the same activities conducted in the past, with some modifications based on prior evaluation findings and recommendations. The market characterization for this program cycle provides insights into the characteristics and behavior of the market actors and stakeholders. The process evaluation component of the current study reports primarily on the two utilities' programs in terms of the program activities, outputs, and the status of the short-term outcomes linked to the programs' activities and outputs.

These relationships are identified in the ARP logic model and can be illustrated as shown in Figure 95:[72] Given the longevity of these programs and their evolution, it is important to compare key process evaluation metrics in this cycle to prior cycles and to assess program changes in light of prior recommendations.

Figure 95. Linkages between ARP Activities/Outputs and Short-term Outcomes



9.1 Major Findings and Conclusions

This section provides major conclusions from the market characterization and process evaluation, and from our analyses of the other topics focused on in this study.

[72] Chen, C. and K. Randazzo. December 2010. 2010-2012 *Statewide Appliance Recycling Program—Program Theory, Program Logic, Potential Indicators, and Success Criteria.* Prepared for Southern California Edison.

9.1.1 Market Characterization

Effective implementation of the ARP requires an understanding of the households and decision makers targeted by the program. The market characterization performed for this study drew largely upon RASS reports, public documents, and surveys of participants, program cancelers, nonparticipant disposers, and second appliance owners.

Since 2000, median household income in PG&E's and SCE's service areas has been relatively flat, varying between $50,000 and $60,000 (2010 dollars). During this period, the median income in SCE's area has trended downward, while it rose at first, then fell in PG&E's area. Since 2003, median income has been less in SCE's area. Over the same period, the share of households below the poverty level has steadily increased in both areas, except for a small decline in 2007. The percentage has been consistently higher in SCE's territory. Current levels are approximately 20% in SCE's area, and 18% in PG&E's area.

All categories of survey respondents (that is, participants, cancelers, nonparticipant disposers, and second appliance owners) in SCE's area are between two and four times more likely than those in PG&E's area to live in multifamily units. Seventeen percent of SCE participants live in multifamily housing, whereas on 5% of PG&E participants do. In both areas, second appliance owners are less likely to live in multifamily housing.

Average household sizes differ between the two regions. Household size for SCE customers has been fairly constant at around 3.1 persons since 2000. Over the same period, the average size of PG&E households has been about 2.8 people. Currently, average household size of SCE participants exceeds the average household size from the RASS, while the opposite is true in the PG&E area. In both areas, the household size for participants exceeds the nonparticipant household size and the household size for second appliance owners is the largest of the groups studied.

The statewide stock of residential refrigerators and freezers has increased steadily since 2000, though sales peaked around 2003 to 2005 as shown in Table 105. Used refrigerator sales have hovered around 70,000 to 100,000 per year and used freezer sales have been about 10,000 units per year since 2000.

Table 105. Statewide Refrigerator and Freezer Trends, Millions

Value	2000	2004	2008	2012
Refrigerator Sales/Yr	0.42	0.55	0.42	0.37
Freezer Sales/Yr	0.064	0.079	0.058	0.049
Refrigerator Population, Primary	4.1	4.3	4.5	4.5
Refrigerator Population, Second	0.75	0.82	1.1	1.3
Freezer Population	1.0	1.07	1.1	1.06

The total number of refrigerators disposed of in SCE's area peaked at about 610,000 in 2004 and has declined since to about 289,000 in 2012. In PG&E's area, the disposal volume has fluctuated significantly, rising from 2000 to 2002, falling, and then peaking in 2006 at about 510,000 units. It fell in

2008, increased in 2009, and fell to about 212,000 in 2012. Table 106 shows the number of units recycled through ARP in 2012 in each service area and our estimated remaining potential.

Table 106. Refrigerators Recycled through ARP and Remaining Potential in 2012

Utility Service Area	Recycled through ARP	Remaining Potential
SCE	43,433	223,783
PG&E	16,417	182,427

The total number of freezers disposed of in SCE's area peaked at about 103,000 in 2003 and has declined since to about 60,000 in 2012. In PG&E's area, like refrigerators, the disposal volume for freezers has fluctuated significantly, declining from 2000 to 2001, then peaking in 2003, and going through several more cycles to reach a level of just over 60,000 units in 2012. Table 107 shows the number of freezers recycled through ARP in 2012 in each service area and our estimated remaining potential.

Table 107. Freezers Recycled through ARP and Remaining Potential in 2012

Utility Service Area	Recycled through ARP	Remaining Potential
SCE	3,616	51,865
PG&E	2,047	54,406

The age of appliances recycled through the programs has declined over time, with the biggest decline occurring in the early program years, as shown in Table 108.

Table 108. Average Age of Program Units, Years

Service Area and Appliance	2004	2008	2012
SCE Refrigerator	27	20	20
SCE Freezer	30	21	22
PG&E Refrigerator	33	25	21
PG&E Freezer	36	30	27

The size of appliances recycled through the programs has remained relatively constant over the years, with a slight upward trend as shown in Table 109. PG&E units in the early years were considerably smaller than SCE units.

Table 109. Average Size of Program Units, Cubic Feet

Service Area and Appliance	2004	2008	2012
SCE Refrigerator	19.3	19.0	19.8
SCE Freezer	17.3	17.0	16.8
PG&E Refrigerator	15.3	19.2	20.1
PG&E Freezer	14.5	17.0	17.3

Similarities across the groups surveyed included the following:

- **Usage of recycled units:** Nearly all units recycled were used year-round. Ninety-six percent or more of SCE participant, nonparticipant, and canceler units ran year-round. The percent was slightly less for all groups in the PG&E area.
- **Disposal of primary refrigerators:** Most SCE and PG&E participants disposed of primary refrigerators rather than a second unit (77% for SCE and 76% for PG&E) as did SCE and PG&E nonparticipants (79% and 82%, respectively). For participants, this represents a marked increase from the 2006–2008 program cycle, which had a proportion of primary units of 69% and 62% for SCE and PG&E, respectively. This increase in primary unit collections could contribute to higher freeridership rates and potentially lower per-unit savings.
- **Second appliance ownership:** Second appliance ownership was essentially the same for participant and nonparticipant disposers at around 30% for SCE customers and 34% for PG&E customers. In both areas, the rate was higher than the RASS estimates by about 10%.
- **Reasons for having second appliance:** Across all groups, the most common reason for having a second appliance was "large family/need for extra space." The next two most common reasons were "buy in bulk" and "separate storage for beverages." For all groups surveyed, "large family/need for extra space" was mentioned significantly more often by SCE customers. These findings suggest it may be challenging to increase the quantity of second units recycled.
- **Main reasons for appliance disposal:** The two most common reasons respondents across all groups gave for disposing of their appliance were "purchase of a new appliance" and "the existing one did not work well." Together, these two reasons were given by about 70% to 85% of respondents across the different respondent groups.
- **Replacement of disposed units:** A large majority (from 86% to 91%) of respondents who disposed of their appliance replaced it with another unit. There were no statistically significant differences between the rates for participants and nonparticipants, or between the IOUs.

The various groups of customers differed in the following areas:

- **Type of appliance recycled:** Participants more frequently recycled freezers than nonparticipant disposers. The difference was largest for SCE customers: 9% of participants recycled a freezer, while only 3% of nonparticipants did.
- **Appliance disposal method:** If participants had not participated in the ARP, they were much more likely than nonparticipants to have sold their appliance (21% vs. 7% for SCE customers and 15% vs. 9% for PG&E customers). They were also much more likely to have hauled it away themselves than nonparticipants; nonparticipants, on the other hand, were much more likely to have had someone else pick it up. These results show that a significant proportion of disposed units outside the ARP are likely to remain in use on the grid. Responses of second appliance owners differed significantly between the two service areas: SCE customers responded more than three times more often than PG&E customers that they would have sold their second

appliance if they disposed of it, but responded only half as often that they would have given it away. This provided evidence of a viable used appliance market in SCE's area.

- **Replacement units:** Although the proportion of disposers replacing their units did not differ across groups, the proportion of used replacement units purchased was much higher for SCE participants than nonparticipants (20% vs. 10%), indicating an active used appliance market. For PG&E respondents, however, the proportion was the same (9%) for both groups of disposers.
- **Effect of energy use on decision to dispose:** Participants were significantly more likely than nonparticipants to say "it used too much energy" was the reason they disposed of their appliance. For SCE customers, 15% of participants and 10% of nonparticipants gave this reason. For PG&E customers, 18% of participants and only 5% of nonparticipants gave this reason.

Specific findings for nonparticipant disposers include the following:

- **Appliance sales:** Nonparticipants who sold their units did so to private individuals rather than dealers, and received, on average, around $135 for their units. This aligns with findings from the second appliance owner survey, and indicates a robust informal market exists for used appliances.
- **Multifamily units:** Fewer SCE nonparticipants reported living in single-family homes, compared to PG&E nonparticipants. SCE's program nonparticipants also were significantly less likely to own their homes than nonparticipants in PG&E's program (74% for SCE versus 89% for PG&E). This finding indicates there may be an opportunity to target renters and residents of multifamily housing in SCE's area.

Specific findings for second appliance owners include the following:

- **Second appliance usage:** Compared to participants, second appliance owners were more likely to use their units year-round, keep their units nearly 70% full, and have large families. These findings suggest the following conclusions:
  - Due to higher part-use, nonparticipating second appliances likely consume more energy than participating units.
  - Nonparticipating owners of second appliances may have a greater need to keep their second units, compared to participating second appliance owners.
- **Second appliance purchases:** Almost 80% of each utility's customers said they purchased their second appliance and most respondents (86% for SCE and 89% for PG&E) bought their appliances new. Those who bought used appliances most often bought them from individuals. These findings suggest the following conclusions:
  - Because they typically bought their units, and they were new, second appliance owners will likely be reluctant to dispose of their second appliances.
  - An informal market exists for used appliances.

9.1.2 Process Evaluation

Responses to Prior Recommendations

One step in the process evaluation was a review of major recommendations made in prior evaluations and a determination of whether they were implemented during this cycle. Based on our review, both IOUs have implemented two key recommendations from the 2004-2005 Statewide RARP evaluation, including:

- Prioritizing removal of second refrigerators
- Conducting market research on use of second refrigerators

In addition, SCE responded to another key recommendation:

- SCE took a substantial step to reduce pickup time by implementing the Enerpath logistics system: average pickup times were reduced from 10 days (prior to the introduction of the Enerpath system) to an average of four days during the 2010-2012 program

SCE and PG&E have implemented several recommendations consistent with the SCE 2006-2008 process evaluation including these:

- Conducting a retailer trial program
- Maintaining the incentive
- Pursuing additional research on households with two or more refrigerators

The following key recommendation from SCE's 2006-2008 process evaluation does not appear to have been implemented:

- SCE should increase the number of categories used to group appliances by, especially for those above 15 years of age. Appliances should be categorized in terms of birth year(s) to facilitate comparisons across program years.

Program Accomplishments and Program Staff Feedback

During the 2010–2012 program cycle, SCE and PG&E collectively recycled a total of 260,203 appliances distributed as shown in Table 110.

Table 110. SCE and PG&E 2010–2012 ARP Units Recycled and Orders Completed

IOU	Type	2010	2011	2012
SCE	Total Units Recycled	72,731	76,654	47,049
	Total Orders Completed	70,522	74,552	47,817
PG&E	Total Units Recycled	24,864	20,343	18,562
	Total Orders Completed	23,074	19,099	17,698

* Includes 329 room air conditioners in 2010, 275 in 2011, and 98 in 2012.

As shown in Table 111, SCE came close to meeting its recycling goal for refrigerators, but met only about 60% of its goal for freezers. PG&E met a little more than half its goal for refrigerator recycling and less than half its goal for freezers.

Table 111. SCE and PG&E 2010–2012 ARP Goals and Achievements

IOU	Appliance	Participation Goals (Totals for 2010-2012)	Achieved Participation (Totals for 2010-2012)*
SCE	Refrigerators	184,800	181,037
	Freezers	25,200	15,397
	Room ACs	N/A	N/A
PG&E	Refrigerators	104,554	55,914
	Freezers	16,269	7,153
	Room ACs	1,099	

*Achieved participation figures are included here for qualitative assessment of program performance versus goals; evaluation of participation and savings falls under the purview of the impact evaluation, which is being conducted separately.

SCE staff reported two of the program's most important achievements have been the continuation and implementation of program enhancements as well as more stringent oversight during the program's long duration. SCE and PG&E staff said their biggest challenge is keeping the ARPs cost-effective as their biggest challenge, especially as the baseline for measuring savings has increased. Although some regulators and other stakeholders believe the market has been transformed since the program's implementation, SCE and PG&E interviewees believe continued use of rebates and education is needed to remove inefficient units from the market.

Key findings and conclusions from interviews with utility program staff include:

- Program staff members are satisfied with established internal communications at their respective utilities.
- In response to the CPUC's requirement that ARPs achieve statewide alignment, the IOUs are conducting quarterly meetings to discuss program changes and future developments.
- IOU program staff members are satisfied with performance by the program implementers (JACO, ARCA, and Enerpath).
- IOU program staff regularly discuss options to include other appliances in their ARPs.
- To increase participation, Best Buy, Sears, and Home Deport joined as trade allies.
- Both utilities implemented a retailer trial with Sears in 2010, as recommended in a prior evaluation. The retailer agreed to pick up a disposed unit at delivery of a new one and then store them for bulk pick up by one of the ARP implementers. The trial was mostly successful and lowered program costs. SCE intended to expand it and PG&E intended to analyze it further before making a commitment.

- SCE will emphasize second units in its next program cycle, seeking to expand the program's retail component to capture primary units, while using marketing to target second units, especially second freezers.
- SCE and PG&E both used mass media, direct mail materials, and earned media to disseminate information about the cost of operating older appliances and to encourage ARP participation. However, PG&E staff reported the 2010–2012 ARP primarily relied on retailer marketing, rather than direct mailings, as it had in the past. PG&E also noted that just prior to this program cycle, the IOU did not advertise the program due to lack of a marketing budget.
- The IOUs report messaging to customers to clarify the meaning of recycling. Other marketing messages used include: energy savings, environmental benefits, financial incentives, and savings and benefits associated with the costs of running a second appliance. PG&E reported messaging about reducing a customer's carbon footprint have been effective.

Customer Awareness and Knowledge

Findings and conclusions regarding customer awareness of the ARPs include these:

- Awareness of the ARPs was consistent with the awareness level found in the 2004-2005 RARP study for both IOUs. Awareness among nonparticipant appliance disposers was 56% for SCE and 36% for PG&E. Compared to the 2006-2008 study for SCE, however, this represents a decrease in awareness from 70% of SCE nonparticipants who were aware of the program.
- Retailers played a significant role in informing participants about the program. One-hundred percent of SCE participants and 91% of PG&E participants stated a retail sales associate told them about SCE's ARP. On the other hand, only 17% of SCE nonparticipants and 24% of PG&E nonparticipants stated the same. This finding indicated retail staff can be instrumental in communicating to potential participants about the ARP, yet there may be room for strengthening retailer outreach to customers.
- Retailers in PG&E's area informed participants about the program more often than SCE retailers. Direct mail has been particularly effective at recruiting customers into SCE's program. Participants who purchased replacement units reported that salespeople almost always mentioned the IOUs' programs.
- Participants noted most retailers did not have their own pickup service so, given the large proportion of primary units recycled collected through the ARPs, it appears the programs chiefly fulfilled the purpose of picking up replaced appliances and, in addition, recycling them in an environmentally sound manner.

Awareness of the benefits associated with removing and recycling appliances was similar between participants and nonparticipants:

- Most participants, nonparticipants, and second appliance owners (from about two-thirds to over 80%) knew of the energy costs of appliances and environmental risk of improper disposal.

- Respondents were more likely to know that refrigerant can be harmful to the environment than they were to know the cost of continuing to operate a refrigerator.
- Participants were more likely than nonparticipants to know of the harmful effects of refrigerants.

Among participants, knowledge of program features was high:

- Across the two utilities, 95% of ARP participants correctly identified at least one of the features of the program.

Key findings and conclusions regarding knowledge of program benefits include the following:

- Participants were more likely (more than half in each utility service area) to know that the program recycled or destroyed harmful materials than they were to know it provided metal and glass recycling and sent almost no materials to the landfill.
- PG&E nonparticipants who were aware of the ARP were less likely than SCE nonparticipants to know of the program benefits.
- Although at least one-fourth of respondents knew of some of the ARP benefits, a considerable proportion of even those who participated did not know of key benefits. Knowledge of the reduced material to landfill is especially low. These findings suggest there are opportunities to increase participation through more marketing directed at the environmental benefits. Lower levels of knowledge among PG&E nonparticipants suggest the opportunity is larger in this service area.

Participation Decision

Responses from the various survey groups provided insights into the decision to participate, or not, and the role of the program features and benefits. Key findings and conclusions include the following:

- The program induced many participants to dispose of their appliance; roughly one in four participants had not considered disposing of their appliances before hearing about the program.
- The primary reasons customers chose to participate were convenience and the incentive. Convenience particularly was important to PG&E customers, where four out of five respondents cited it as a reason they participated.
- A substantial portion of nonparticipants (74% for SCE and 66% for PG&E) would have been more inclined to use ARP if they received higher incentives.
- A majority of second appliance respondents reported they would be very likely to participate when needing to dispose of their appliance. To give up their second appliance immediately, however, respondents would require a higher incentive than currently offered ($76 and $95 on average for SCE and PG&E, respectively). Consequently, a program targeting second appliance owners might need to offer a higher incentive to motivate participation.

- Nonparticipants reported various reasons for not participating in ARP, with around 30% of SCE and PG&E nonparticipants citing using a retailer pickup service as the reason for not participating in the ARP. This indicates retailer pickup services could be "competing" for units that might have been recycled through ARP.

Table 112 compares reasons for participating in the 2010-2012 cycle to prior cycles. Convenience and the incentive have been the main motivators over time. Convenience is a more important factor to PG&E customers than SCE customers. Environmental benefits have consistently been the third most important reason at around one-fourth of respondents. Utility bill savings have become a more significant factor over time.

Table 112. SCE Motivation for Participating*

Response	2004-2005	2006-2008		2010-2012	
	Statewide	SCE	PG&E	SCE	PG&E
Convenience	65%	44%	N/A	65%	80%
Cash rebate payment	46%	55%	N/A	62%	55%
Environment	22%	17%	N/A	22%	25%
Savings on bill	0%	4%	N/A	5%	7%
Recommendation of a friend/relative	1%	2%	N/A	5%	1%
Recommendation of retailer/dealer	1%	2%	N/A	4%	3%
Utility sponsorship	2%	3%	N/A	3%	5%
Never heard of any other way to dispose	3%	6%	N/A	10%	8%
Other	4%	2%	N/A	2%	3%

* Multiple responses allowed.

Satisfaction and Attitudes

Participant satisfaction with the program in both utility areas was very high and consistent with past findings:

- Overall (for both IOUs combined), 95% of 2010–2012 survey respondents reported satisfaction with their program experiences. The 2004–2005 RARP study saw similar findings, with 96% of participants reporting they were somewhat or completely satisfied. The 2006-2008 study of SCE's program also showed similar results, with 94% of participants reporting they were somewhat or completely satisfied.
- The most frequent complaints regarded the incentive (particularly the time required to receive the check). The most common suggestion to improve the SCE program was to increase the incentive amount. PG&E participants mostly commonly suggested increasing marketing and outreach.

Minor but statistically significant improvements to reported program experiences since the 2004–2005 survey included the following:

- The percentage of participants reporting having had all their questions answered by the telephone representative increased by 1%.
- The percentage of participants having to call the ARP sign-up hotline more than once decreased by 7%.
- The percentage of participants reporting their pickup representative called in advance to confirm the appointment increased by 3%.

Attitudes about ARP benefits were generally very positive:

- Two-thirds of those participants who were knowledgeable about the environmental benefits of the program said environmental benefits had "a lot" of influence on their decision to participate.
- Among nonparticipant disposers, when told about the environmentally safe disposal practices of the ARP, about two-thirds said the program practices would make them much more likely to participate in the future.
- These findings provide further evidence that an increased marketing emphasis on the environmental benefits of the ARP could enhance participation.

The responses of cancelers provided additional information about satisfaction with the programs:

- Over the course of the 2010-2012 program, an average of 16% of all SCE ARP orders were canceled: the SCE cancelation rate was 17% in 2010 and 2011, and 13% in 2012. During the same time frame, an average of 12% of all PG&E ARP orders were canceled: PG&E's cancelation rate was 13% in 2010 and 2011, and 9% in 2012. In contrast, during the 2006-2008 program, SCE's cancelation averaged 19% (the rate declined from 21% in 2006 and 2007 to 17% in 2008). The statewide ARP cancelation rate averaged approximately 20% during 2004 and 2005.
- Among SCE customers, reasons for cancelation remained similar to those reported in the 2006-2008 evaluation, with the unit not qualifying for the program being the most frequently cited reason. In the 2004-2005 RARP study, the most common reason for cancelation was difficulty with scheduling (though this finding was derived from implementer data, not from customer surveys).
- In the 2010-2012 canceler survey, more PG&E customers (36%) than SCE customers (18%) cited issues with scheduling.

9.1.3 Alternative Subprogram

Based on our analysis of the proposed subprogram that would specifically target second appliances, Cadmus presents the following findings and conclusions:

- Second appliance owners appear very aware of the cost of operating their current units—more so than participants in the current ARPs. Appealing to the benefits from reducing this cost may provide an effective strategy for marketing the subprogram.
- Based on our user profile and diffusion analysis, significant technical potential still exists for growth in the subprograms and core programs. The core programs appear to be in decline and would require design changes to realize their full potential. A targeted subprogram could potentially recruit 3% to 10% of second appliances likely recycled under a subprogram using reasonable incentive and pickup times.
- Our analysis suggests that a targeted subprogram could be cost-effective, even under an aggressive design. While this subprogram would incur higher costs, we expect them to be outweighed by substantial increases in net benefits.

9.1.4 Literature Review

The literature review provided a comparison between the IOUs' ARP and 10 other programs. Key findings and conclusions from this review include the following:

- SCE's peak harvest rate (2008, 2009) exceeded the rates of all other utilities, except two. SCE's rate has been about two to three times the rate for PG&E.
- Other utilities have implemented innovative approaches including:
  - Targeted direct mail marketing based on customer segmentation analysis
  - Bulk pickup of units from multifamily complexes in conjunction with property owners and managers
  - Inclusion of energy saving kits as an incentive
- A few utilities have conducted programs focused on second units and found the programs could be cost-effective, but challenging to implement.
- Incentives have ranged from zero to $50 per refrigerator or freezer. When programs have changed the incentive, the change has typically been an increase.
- A few utilities have included room air conditioners in their program, providing either no incentive or a smaller one than for the primary appliances.
- Assumed measure lives for the California IOU programs from DEER have declined significantly since 2005. The measure lives used in other programs that do not use DEER values have tended to be longer.
- The methodology used to calculate unit energy savings for the California ARP leads to the lowest savings estimate of all programs reviewed, except one.
- NTG values for California's ARPs are similar to those calculated for other programs.
  - The longer a program exists, the less freeridership will occur as a proportion of gross savings, so the NTG ratios will increase as programs mature.
  - Programs with higher incentives also tend to have higher NTG ratios.

  - Programs accepting primary refrigerators tend to have higher levels of freeridership (and thus lower NTG ratios). However, programs accepting only second units generally have lower levels of participation, since fewer households are eligible to participate.
- The most recent TRC for the California IOU programs is less than for any of the other programs reviewed. TRC cost-effectiveness is driven by program cost, estimated savings, the estimated NTG, and measure life, among other factors. The cause of the smaller TRC for the California ARPs is a combination of the differences in these factors applied to the California programs.

9.1.5 Inclusion of Other Appliances

There has been very little experience recycling appliances other than refrigerators and freezers through ARP-type programs—the only ones identified in our research were room air conditioners (RACs) and dehumidifiers. We assessed the potential for including seven additional appliances in the ARP:

- RACs
- Dehumidifiers
- Clothes washers
- Clothes dryers
- Televisions
- Personal computers
- Set-top boxes

These appliances could be compared to recycling a second refrigerator to establish a simple normalized potential energy savings metric with which to assess their viability for the program. Based on our research:

- Based on the simplified metric we applied, RACs, dehumidifiers, and set-top boxes do not appear to be good recycling program candidates
- Despite their better rating using the simplified metric, televisions, PCs, and monitors do not appear to be viable candidates for recycling due to logistical and technological reasons
- Clothes washers may be moderately good candidates for an ARP-type program in both service areas
- Clothes dryers appear to be a potentially viable candidate for a program in the PG&E area

9.1.6 Non-Energy Benefits

The ARPs produce a number of benefits other than energy savings. Several are associated with environmental impacts that can be monetized and others are related to direct and indirect effects on the economy. Key findings and conclusions with regard to such non-energy benefits are these:

- Applying a scenario based on medium values for inputs, the combined gross environmental benefits of the ARPs for the 2010-2012 cycle were $23.9 million.

- Under the same scenario, the net environmental benefits were $10.5 million.
- SCE's net program environmental benefits ranged from $19 to $79 per recycled unit under three different scenarios. For comparison purposes, these benefits were from 12% to 48% of the SCE program's average implementation cost per unit in 2012. If included, these benefits could have a significant effect on the program's cost-effectiveness.
- PG&E's net program environmental benefits ranged from $19 to $75 per unit under the three scenarios. These benefits were equivalent to 7% to 28% of the PG&E program's average implementation cost per unit in 2012. If included, these benefits could have a significant effect on the program's cost-effectiveness.
- The net employment effect of the ARPs was the creation of 171 job-years under the SCE program and 67 job-years under the PG&E program.
- The value added to each region's economy from the programs was $18.7 million for SCE and $5.0 million for PG&E.
- Per program dollar spent, each program contributed a net of $0.55 to $0.58 to the local economy.

9.2 Recommendations

By most measures, the utility ARPs are well-implemented and well-received. However, their survival is at risk because of concerns raised by some observers that the market for environmentally sound appliance recycling may have been nearly transformed and the apparent cost-effectiveness of the programs is marginal. Our analysis of the 2010-2012 cycle has shown that there is still substantial participation potential for recycling refrigerators and freezers. In addition, there is little evidence that the market would implement as complete, environmentally sound recycling in the absence of the program.

9.2.1 Core Program Recommendations

Our recommendations for the core program focus on ways to enhance cost-effectiveness. This can be accomplished through reducing costs and increasing participation and energy savings. Our key recommendations for enhancing the core program are the following:

- Marketing should continue to stress the convenience offered by the program.
- Messaging should also continue to focus on the cost savings from removing an inefficient appliance and the environmental benefits of recycling through the ARP.
- The utilities should design and implement a pilot that temporarily establishes a higher incentive in order to assess the effect on participation and cost-effectiveness. The pilot could emphasize convenience and the higher incentive, and it could target customers who were likely to sell their used appliance to other individuals.
- As general awareness of climate change, California's greenhouse gas programs, and concepts such as the carbon footprint increases, the utilities could use messaging about environmental benefits to educate customers and inform them of these program benefits.

- Environmental messaging also should include information about how the program reduces materials going to the landfill.
- The utilities should continue to use direct mail for marketing purposes and should explore targeting based on segmentation analysis.
- The utilities should continue to work with retailers to encourage them to inform appliance buyers about the ARP. Efforts should be made to ensure that the requirement puts minimum burdens on retailers and can be implemented efficiently and flawlessly.
- The utilities should expand the retailer pilot program to include other retailers and revise the program based on lessons learned from the initial pilot.

9.2.2 Program Modifications and Alternative Subprograms

The core program could be modified or supplemented with alternative subprograms designed to expand participation and/or decrease costs. Our key recommendations for modifying the core program or implementing subprograms include the following:

- Both SCE and PG&E should proceed with a pilot for a stand-alone second appliance subprogram. Our analysis suggests such programs should be as or more cost-effective than the current standard program offerings, despite higher implementation costs per unit.
  - The subprogram should conduct separate marketing and outreach, marketing the subprogram as a pledge by participants to give up their second appliances, not simply as a recycling service. Every effort should be made to ensure no confusion ensues for customers between the two programs. Ideally, this also will serve to reduce the rate of noncompliance in the subprogram (whether intentional or otherwise).
  - The subprogram should incorporate some form of follow-up visit to verify the participant has not purchased a replacement second unit. This could be conducted by implementation staff as part of their routine pickup routes, and would include an additional incentive. This visit could take place six months to a year after participation.
- SCE should consider designing and implementing a multifamily bulk program specifically to recycle appliances from multifamily dwellings. The utility should research other programs that have targeted multifamily buildings and the lessons learned to design its pilot.
- Both IOUs should examine ways to increase recycling of freezers: freezers are a relatively small percentage of all ARP units recycled, yet their savings potential is relatively large.
- Both IOUs should explore the logistics, costs, and benefits of including clothes washer recycling in their ARPs.
- PG&E should investigate the logistics, costs, and benefits of including clothes dryers in its program.
- The IOUs should consider discussing and entering into co-funding partnerships with other organizations that could benefit from appliance recycling. Such organizations could include, for example:

- Local and state government agencies that may be interested in partnering due to the non-energy environmental benefits attributable to appliance recycling.
- Regional water districts that could realize benefits from recycling less water-efficient clothes washers.

9.2.3 Cost-Effectiveness Calculation

Based on the calculated TRC, the current cost-effectiveness of the California IOUs' ARPs is marginal at best and very sensitive to key inputs. In addition, the non-energy benefits resulting from comprehensive recycling are not included in the calculation (though the emissions reductions from reduced electricity generation are included).

- The IOUs should refine the non-energy benefits calculated in this study and work with the CPUC on an approach for incorporating the non-energy benefits in the cost-effectiveness analysis of the ARPs.
- The IOUs should conduct research to derive improved estimates of the key inputs to the program cost-effectiveness calculation, including remaining measure life.

9.2.4 Research and Tracking Data

We offer two recommendations involving research and tracking data:

- SCE should record appliance age as a numeric value, not a category. JACO and ARCA typically record unit age as a numeric value, and SCE should capture this detail in their tracking database.
- The IOUs should continue research on the disposal of appliances outside the ARP because these units constitute the program potential.