

Refrigerator/Freezer Recycling Program Evaluation

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Prepared for:



Submitted by:



ADM Associates, Inc.

3239 Ramos Circle
Sacramento, CA 95827
916.363.8383

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1. Executive Summary

This report presents an evaluation of the Refrigerator/Freezer Recycling Program (Recycling Program) that the Sacramento Municipal Utility District (SMUD) offered customers in 2011, 2012, and 2013. The Recycling Program was administered by SMUD with implementation services provided by JACO Environmental (JACO). SMUD has implemented a version of the Recycling Program since 2001.

The primary objective of this evaluation is to estimate energy and peak demand impacts attributable to the Recycling Program. Additional evaluation objectives include assessment of program processes and customer feedback related to the program.

1.1 Program Overview

SMUD's Refrigerator/Freezer Recycling Program is designed to help customers reduce their energy consumption by removing old, working refrigerators and freezers from their homes to recycle them. The program provides annual electric energy savings for the remaining life of the unit by permanently removing the appliance from service. As an added environmental benefit, 95% of the materials from these units are able to be recycled (metals, plastic, glass, oil, etc.) and disposed of in an environmentally responsible manner, thus preventing the materials from reaching landfills and contaminating the environment.

The Recycling Program provides free refrigerator/freezer pick up and recycling services for SMUD customers in addition to a \$35-\$50 rebate for each unit. By offering financial incentives and free pick up services, SMUD seeks to remove unnecessary secondary units, prevent the continued use of older appliances as secondary units after new primary units are purchased, and prevent older units from being resold or transferred to other SMUD customers when no longer needed in the participant home.

Recycled refrigerators and freezers are typically quite old, are often located in unconditioned space such as a garage, and generally require more electricity for cooling compared to a newer unit. The recycling process halts their inefficient use of electric energy and safely disposes of environmentally harmful materials.

SMUD's Recycling Program is operated as a turn-key program implemented by JACO. The program is open to any SMUD residential customer. Customers may recycle up to two units per residential address, per year. The units can range in size from 10 to 27 cubic feet. Customers can request a home pick up through an online portal or over the phone with JACO representatives. Additionally, customers can sign up for the program through participating retail stores if they are purchasing new appliances. Marketing for the program consists of bill inserts, print advertisements, and more recently, television advertisements.

1.2 Evaluation Objectives

Prior to the evaluation, SMUD identified nine objectives for the study of the 2011-2013 Recycling Program:

- Verify the number of units recycled through the program.
- Verify energy and peak demand impacts due to the program.
- Assess program free-ridership and spillover (net-to-gross analysis).
- Characterize the prior use of the units recycled (primary, secondary, inactive).
- Determine the bill impacts to the customer participating in this program.
- Assess the effectiveness of program communications and avenues used to inform and educate customers and participants.
- Determine whether customer interest and knowledge in recycling is a direct result of this or other SMUD programs.
- Assess program processes and assumptions for possible future improvement.
- Assess future market potential for the program.

This study divides the objectives into impact and process evaluation components. Verification of program activity, estimation of gross energy and peak demand impacts, and estimation of program attribution (free ridership, spillover) are discussed in the impact evaluation section of this report. Assessment of program processes, assumptions, and customer feedback relating to program are discussed in the process evaluation section of this report.

1.3 Overview of Methodology

The methodology used to estimate program impacts is similar to past appliance recycling program evaluations. The key components for this process are:

- Verify the number of working units recycled through the program.
- Estimate energy consumption for recycled units had they continued to operate absent the program.
- Adjust full-year energy consumption estimates for recycled units to reflect the fact that some units would not operate year-round.
- Determine the disposition of recycled appliances in the absence of the program (keep, discard; destroy, transfer).
- Determine the program impacts on the secondary market for would-be acquirers of program units that are no longer available
- Provide final estimates of ex post energy and peak demand impacts and compare them to ex ante assumptions.

Previous evaluations of utility sponsored appliance recycling programs have typically defined gross savings as equal to the unit energy consumption (UEC) of a given program appliance, usually with a part use factor applied to account for units that are not plugged in year-around. Issues such as free-ridership (units that would have been removed from the grid even in the absence of the program) and secondary market effects have typically been accounted for in the determination of net savings. This is the approach recommended and detailed in the U.S. Department of Energy's (DOE) Uniform Methods Project (UMP) Refrigerator Recycling Evaluation Protocol.¹ The UMP is a set of protocols developed through DOE funding that provides straightforward methods for evaluating energy savings for common energy efficiency measures offered through utility sponsored programs.

However, a recent evaluation² of the 2010-2012 California Statewide Appliance Recycling Program (CA ARP) used a slightly different definition of gross savings based on the recommendation of the California Public Utilities Commission (CPUC) Energy Division in Decision D. 11-07-030, Attachment A.³ The primary difference between the UMP definition of gross savings and the CA ARP definition of gross savings is the treatment of certain effects that have typically been considered secondary market effects, and thus considered when determining net savings.

This study presents gross savings under both definitions in order to provide SMUD with estimates that are comparable to other program evaluations both nationally and within California. Net savings are unaffected by the differing gross savings definitions, as ultimately the same effects are accounted for as applied in this evaluation. It is worth noting that this evaluation does not employ the same methodology as the CA ARP study, but simply considers gross savings under a similar definition.

Net savings are estimated as the portion of gross savings that would have occurred in the absence of the program. This requires accounting for free-ridership effects (appliances that would have been removed from the grid even in the absence of the program) and secondary market effects.

Process evaluation findings are derived from survey data collected from program participants and non-participants. Program staff interviews and program tracking data were also used in developing process evaluation findings.

1.3.1 Data Sources

The key data sources used in the evaluation of the 2011-2013 Recycling Program are shown below:

¹ <http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf>

² http://www.calmac.org/publications/2010-2012_ARP_Impact_Evaluation_Final_Report.pdf

³ http://www.doe2.com/download/CPUC/ExAnteProcess/D-11-07-030_AtteachmentA-B.pdf

- Program tracking data was used to establish ex ante program savings claims and to establish the program population for extrapolating evaluation estimates.
- In situ metering was conducted for a sample of refrigerators and freezers entering the program. The metering data was used to estimate energy consumption of program units.
- A participant survey was conducted to verify program participation and determine what customers were likely to do with their appliances in the absence of the program.
- Nonparticipant survey data was used to complement participant self-reported actions in the absence of the program.
- In-depth interviews with program staff from SMUD and JACO were conducted to provide additional program insights for the process evaluation.
- Relevant secondary sources, including prior appliance recycling evaluations, were referenced to provide data for the extrapolation of short-term metering results to full-year consumption.

1.4 Summary of Findings

1.4.1 Summary of Ex Ante Impact Estimates

SMUD provided ADM with excel spreadsheets summarizing the program activity for the 2011-2013 program cycle. There was one spreadsheet provided for each year. Within each spreadsheet, there were two pertinent worksheets:

- A monthly summary report, showing the number of units collected and associated ex ante energy and demand impacts by month and in total.
- A more complete listing of refrigerators and freezers picked up by week, with an associated JACO invoice number.

In addition to this program summary data provided by SMUD, there was additional detailed tracking data provided by JACO. The JACO tracking data included information about participating customers, recycled units, and specific pick-up dates. Upon comparing the JACO tracking data and the SMUD summary data, it became apparent that there were minor differences in the claimed number of appliances recycled. Table 1-1 below shows the observed differences.

Table 1-1: Number of Units Claimed Recycled by Year

Year	SMUD Summary Data	JACO Tracking Data
2011	6,473	6,567
2012	7,531	7,531
2013	8,592	8,652
Total	22,596	22,750

Further inspection revealed that the JACO invoices worksheet within the SMUD program summary spreadsheets had a few minor summation errors. Additionally, two invoices which represented pick-up dates during the weeks where one program year ended and another began were miscategorized. After reconciling these issues, the SMUD summary data and the more detailed JACO tracking data matched almost exactly, as shown in Table 1-2 below.

Table 1-2: Corrected Number of Units Claimed Recycled by Year

Year	SMUD Summary Data	JACO Tracking Data
2011	6,568	6,567
2012	7,528	7,531
2013	8,653	8,652
Total	22,749	22,750

With the two separate tracking systems within one appliance of each other over three years, the total program population was established for this evaluation based on the more detailed JACO tracking data. Ex ante per-unit energy and demand impacts were provided by SMUD. The per-unit estimates were not differentiated by appliance type. Multiplying the ex ante per-unit impacts by the number of appliances collected in each year produces the program level ex ante impacts shown in Table 1-3. It is worth noting that the per-unit impacts assumed by SMUD have remained unchanged since program year 2009. A prior evaluation of the 2009-2010 Recycling Program suggested lower per-unit impacts, but those findings were not implemented in the determination of ex ante savings for the 2011-2013 program cycle.

Table 1-3: Summary of Reported Ex Ante Impacts

Program Year	2011	2012	2013	Total
Number of Appliances	6,567	7,531	8,652	22,750
<i>Gross Impacts</i>				
Ex Ante Gross Per Unit Annual kWh Savings	1,161			
Ex Ante Gross Per Unit Peak kW Reduction	0.153			
Ex Ante Total Gross Annual kWh Savings	7,624,287	8,743,491	10,044,972	26,412,750
Ex Ante Total Gross Peak kW Reduction	1,005	1,152	1,324	3,481
<i>Net Impacts</i>				
Assumed Net-to-Gross Ratio	0.58			
Ex Ante Net Per Unit Annual kWh Savings	675			
Ex Ante Net Per Unit Peak kW Reduction	0.089			
Ex Ante Total Net Annual kWh Savings	4,432,725	5,083,425	5,840,100	15,356,250
Ex Ante Total Net Peak kW Reduction	583	668	768	2,018

1.4.2 Verification Rate Findings

Table 1-4 summarizes the verification rate for the 2011-2013 Recycling Program. The verification rate was determined through surveys with program participants to confirm program participation and working condition of recycled appliances. Overall, the verification rates suggest that program screening measures to eliminate non-working units from the program are working well.

Table 1-4: Claimed vs. Verified Units in Working Condition

Measure	Survey Sample Size (n)	Program Claimed Units	Verification Rate (%)	Verified Units
Refrigerator	136	19,912	96.3%	19,180
Freezer	74	2,838	93.2%	2,646

1.4.3 Summary of Ex Post Impact Estimates

Table 1-5 provides the final estimates of gross and net per-unit savings. Gross savings are reported using two distinct definitions. The first definition, labeled “UMP”, is based on the gross savings definition from the DOE Uniform Methods Project Refrigerator Recycling Evaluation Protocol.⁴ This definition considers gross savings as equal to part-use adjusted unit energy consumption (UEC) for recycled refrigerators. This reflects the idea that any recycled unit represents potential energy savings in that it can no longer be used (either in the participant household or in another SMUD customer’s household after being transferred in the secondary market). The second definition, labeled “CA

⁴ <http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf>

ARP”, comes from the recent evaluation of the 2010-2012 California Statewide Appliance Recycling Program evaluation.⁵ This definition considers gross savings as equal to the difference in consumption with and without the program. This requires accounting for secondary market effects in the determination of gross savings. Gross savings under both definitions are presented in order to provide estimates comparable to program evaluations across the country (UMP) and within California (CA ARP).

Ex post gross and net per-unit annual energy savings are lower than SMUD ex ante estimates, though they are relatively similar to estimates developed in the evaluation of the 2009-2010 Recycling Program. The ex ante estimates SMUD provided for the 2011-2013 program cycle are the same as those used for the 2009-2010 cycle. Thus, the previous evaluation findings were not used to update ex ante assumptions for 2011-2013.

Table 1-5: Gross and Net Per-unit Annual Energy Savings

Appliance Type	Ex Ante Gross Per Unit Annual kWh Savings	Ex Post Gross Per Unit Annual kWh Savings (UMP)	Ex Post Gross Per Unit Annual kWh Savings (CA ARP)	Gross Realization Rate (UMP)	NTG Ratio	Ex Ante Net Per Unit Annual kWh Savings	Ex Post Net Per Unit Annual kWh Savings	Net Realization Rate
Refrigerators	1,161	1,015	684	87%	0.52	675	528	78%
Freezers	1,161	1,027	706	88%	0.56	675	573	85%

Table 1-6 provides the per-unit peak demand reduction estimates compared to ex ante values. Overall, the ex post peak demand reduction estimates are relatively similar to ex ante estimates.

Table 1-6: Gross and Net Per-unit Peak Demand Reduction

Appliance Type	Ex Ante Gross Per Unit Peak kW Reduction	Ex Post Gross Per Unit Peak kW Savings (UMP)	Ex Post Gross Per Unit Peak kW Reduction (CA ARP)	Gross Realization Rate (UMP)	NTG Ratio	Ex Ante Net Per Unit Peak kW Reduction	Ex Post Net Per Unit Peak kW Reduction	Net Realization Rate
Refrigerators	0.153	0.157	0.106	103%	0.52	0.089	0.082	92%
Freezers	0.153	0.168	0.116	110%	0.56	0.089	0.094	106%

Table 1-7 combines the verification rates and the estimated per-unit impacts to produce program level estimates of gross and net savings.

⁵ http://www.calmac.org/publications/2010-2012_ARP_Impact_Evaluation_Final_Report.pdf

Table 1-7: Program Level Gross and Net Impacts

Evaluation Result	SMUD Ex Ante	Evaluation Ex Post	Realization Rate
<i>Refrigerators</i>			
Number of Working Appliances Recycled	19,912	19,180	96%
Gross Annual Savings - UMP (kWh)	23,117,832	19,467,700	84%
Gross Peak Demand Reduction - UMP (kW)	3,047	3,011	99%
NTGR	0.58	0.52	89%
Net Annual Savings (kWh)	13,440,600	10,123,204	75%
Net Peak Demand Reduction (kW)	1,772	1,566	88%
<i>Freezers</i>			
Number of Working Appliances Recycled	2,838	2,646	93%
Gross Annual Savings (kWh)	3,294,918	2,717,442	82%
Gross Peak Demand Reduction (kW)	434	445	102%
NTGR	0.58	0.56	96%
Net Annual Savings (kWh)	1,915,650	1,516,158	79%
Net Peak Demand Reduction (kW)	253	249	99%
Total			
Number of Working Appliances Recycled	22,750	21,826	96%
Gross Annual Savings (kWh)	26,412,750	22,185,142	84%
Gross Peak Demand Reduction (kW)	3,481	3,456	99%
NTGR	0.58	0.56	96%
Net Annual Savings (kWh)	15,356,250	11,639,362	76%
Net Peak Demand Reduction (kW)	2,025	1,815	90%

Overall, ex post net energy savings were estimated at approximately 76% of ex ante claims. The realization rate reflects lower per-unit savings estimates, deductions based on the verified number of working units recycled, and a slightly lower net-to-gross ratio estimate. The overall net peak demand reduction realization rate is 90%. The approach used to estimate peak demand reductions by specifically modeling SMUD “heat wave” temperature conditions resulted in slightly higher peak demand savings than previous evaluations of the program. The peak demand realization rate is higher than the annual energy savings realization rate primarily because of this change in methodology.

1.4.4 Summary of Process Evaluation Findings

This section presents the high level findings and recommendations developed through process evaluation activities for the 2011-2013 Recycling Program.

- **Program Participation Process is Working Well:** Ninety-four percent of program participants said they were able to schedule a convenient time for the appliance pickup, all participants said the pickup crews behaved

professionally, and 99% of participants who had communications with program staff were satisfied with these communications. Additionally, 98% of the respondents indicated that the number of days it took schedule the appliance pickup was reasonable. Tracking data also suggest that appliance pickups were scheduled in nine days on average and the average number of days to process the check was 28 days.

- **Incentive Level is Appropriate:** The \$50 incentive level is consistent with the rebate offered through many other appliance recycling programs and is also consistent with the rebate offered by other California utilities. Although it is based on a small sample size, the average price paid for used appliances by non-participant survey respondents was \$53. Additionally, the \$50 incentive may have been a contributing factor to higher levels of participation in 2013.
- **Program Participants Satisfied:** Ninety-five percent of program participants said they were either satisfied or very satisfied with the Recycling Program overall. Additionally, 97% and 98% indicated satisfaction with the scheduling process and the actual pickup of the appliance. Commonly given reasons for satisfaction were that the process was smooth and that it was easy or convenient.
- **Increasing Participation and Program Awareness:** The number of units recycled increased each year of the program cycle indicating that the program has been effective in generating activity. The most frequently mentioned source of program awareness was a bill insert followed by information acquired by word of mouth. Additionally, the survey of non-participants found that 59% of respondents were aware of the program, suggesting that many SMUD customers are aware of the rebate available.

Since 2013 program marketing has been developed and managed by SMUD. The sustained level of program activity and the lower cost of providing program marketing in-house suggest that this has been an effective and efficient strategy. Additionally, the program has implemented innovative promotional campaigns to keep levels of program activity high.

- **Sustaining Cost-Effective Savings may be Challenging:** Each year the appliances recycled through the program are of more recent vintage. As result the per unit electricity savings is declining over time because newer appliances consume less electricity. This creates challenges for the program to maintaining cost-effectiveness if the operational costs remain stable.

1.4.1 Recommendations

Overall, the Recycling Program is operating well with no significant issues. However, the following recommendations are offered in the interest of further program improvement.

- **Ensure that the Website Offers Multiple Pickup Dates:** During a review of the program website, the evaluator was only presented with one date for scheduling an appliance pickup. This may have been anomalous but it would be beneficial if the website software was programmed such that more than one date was presented to the customer and that the customer would have the option of requesting additional days not displayed.
- **Make Unit Eligibility Requirements on SMUD and JACO Website Consistent:** During a review of the website, staff noted that the unit size requirements were stated as 10-27 cubic feet on the SMUD website but were stated as 10-30 cubic feet on the JACO website. These values should be changed to be consistent.
- **Consider Strategies for Ensuring Long Term Cost-Effectiveness:** As the appliances recycled through the program are of increasingly newer vintage, the potential per unit savings is declining. Over the long term this may effectively reduce cost effectiveness of the program. Strategies for ensuring long-term cost-effectiveness include incorporating non-energy benefits into the testing⁶ and focusing on older more efficient appliances by changing eligibility requirements and reducing the operational scale of the program.
- **Update Ex Ante Impact Assumptions to Reflect Evaluation Findings:** The ex ante savings assumptions used for 2011-2013 were the same values used for 2009-2010. A prior evaluation in 2011 estimated savings values that were lower than those used for 2009-2010, but those findings were not utilized for 2011-2013. Energy consumption of recycled refrigerators and freezers is highly correlated with appliance vintage. Newer appliances, especially those manufactured after 1993, use considerably less energy than older units. It is important moving forward to use regularly updated ex ante savings assumptions as the average vintage of program appliances increases.
- **Consider Leaving Cooling Unit Operational at Pickup:** As is typically found in evaluations of recycling programs, a few respondents reported that their appliance was not working at the time of pickup. Other service territories

⁶ Keeling, J., Pal, A., Chen, C. (2013). ARPs are RAD: How to Incorporate Environmental Benefits from Appliance Recycling Programs into Cost-Effectiveness Calculations.

have procedures that require the pickup crew to leave the cooling unit operational and the cord uncut so that the working condition of the appliance can be verified at the recycling center. The unit can still be disabled at the time of pick-up by damaging the appliance shell, but leaving the cord intact until after the unit arrives at the recycling center allows for one more opportunity to verify that the unit was properly screened through the scheduling and pick-up process.

- **Consider conducting studies related to the secondary market for appliances:** A critical aspect to understanding savings developed through appliance recycling programs is the operation of the market for used appliances (both peer-to-peer and through traditional used appliance dealers). Unfortunately, this market is difficult and costly to study. There are some studies within California that address the secondary market to some extent, but none are specific to the SMUD service territory.

2. Introduction

This report presents an evaluation of the Refrigerator/Freezer Recycling Program (Recycling Program) that the Sacramento Municipal Utility District (SMUD) implemented in 2011, 2012, and 2013. The Recycling Program was administered by SMUD with implementation services provided by JACO Environmental (JACO). SMUD has implemented a version of the Recycling Program since 2001.

The primary objective of this evaluation is to estimate energy and peak demand impacts attributable to the Recycling Program. Impacts are estimated at the gross and net levels. Gross impacts refer to changes in energy consumption and peak demand that result from refrigerators and freezers being permanently decommissioned by program participants, regardless of whether the program caused the desired outcome. Net impacts refer to the portion of gross impacts that is directly attributable to the program. Determining net impacts requires separating out changes in energy consumption and peak demand that would have occurred even in the absence of the program. Additional evaluation objectives include assessment of program processes and customer feedback related to the program.

2.1 Program Overview

SMUD's Refrigerator/Freezer Recycling Program is designed to help customers reduce their energy consumption by removing old, working refrigerators and freezers from their homes to recycle them. The program provides annual electric energy savings for the remaining life of the unit by permanently removing the appliance from service. As an added environmental benefit, 95% of the materials from these units are able to be recycled (metals, plastic, glass, oil, etc.) and disposed of in an environmentally responsible manner, thus preventing the materials from reaching landfills and contaminating the environment.

The Recycling Program provides free refrigerator/freezer pick up and recycling services for SMUD customers in addition to a \$35-\$50 rebate for each unit. By offering financial incentives and free pick up services, SMUD seeks to remove unnecessary secondary units, prevent the continued use of older appliances as secondary units after new primary units are purchased, and prevent older units from being resold or transferred to other SMUD customers when no longer needed in the participant home.

Recycled refrigerators and freezers are typically quite old, are often located in unconditioned space such as a garage, and generally require more electricity for cooling compared to a newer unit. The recycling process halts their inefficient use of electric energy and safely disposes of environmentally harmful materials.

SMUD's Recycling Program is operated as a turn-key program implemented by JACO. The program is open to any SMUD residential customer. Customers may recycle up to

two units per residential address, per year. The units can range in size from 10 to 27 cubic feet. Customers can request a home pick up through an online portal or over the phone with JACO representatives. Additionally, customers can sign up for the program through participating retail stores if they are purchasing new appliances. Marketing for the program consists of bill inserts, print advertisements, and more recently, television advertisements.

2.2 Reported Program Activity and Impacts

Table 2-1 shows the number of recycled appliances as well as ex ante energy and peak demand savings for the 2011-2013 Recycling Program. This data was summarized from detailed tracking data provided by JACO.

Table 2-1: 2011-2013 Recycling Program Reported Activity and Impacts

Year	Measure	Units	Net Annual Energy Savings (kWh)	Net Peak Demand Reduction (kW)
2011	Refrigerator	5,775	3,898,125	512
	Freezer	792	534,600	70
2012	Refrigerator	6,529	4,407,075	579
	Freezer	1,002	676,350	89
2013	Refrigerator	7,608	5,135,400	675
	Freezer	1,044	704,700	93
Total	All	22,750	15,356,250	2,018

2.3 Evaluation Objectives

Prior to the evaluation, SMUD identified nine objectives for the study of the 2011-2013 Recycling Program:

- Verify the number of units recycled through the program.
- Verify energy and peak demand impacts due to the program.
- Assess program free-ridership and spillover (net-to-gross program analysis).
- Characterize the prior use of the units recycled (primary, secondary, inactive).
- Determine the bill impacts to the customer participating in this program.
- Assess the effectiveness of program communications and avenues used to inform and educate customers and participants.
- Determine whether customer interest and knowledge in recycling is a direct result of this or other SMUD programs.
- Assess program processes and assumptions for possible future improvement.

- Assess future market potential for the program.

This study divides the objectives into impact and process evaluation components. Verification of program activity, estimation of gross energy and peak demand impacts, and estimation of program attribution (free ridership, spillover) are discussed in the impact evaluation section of this report. Assessment of program processes, assumptions, and customer feedback relating to program are discussed in the process evaluation section of this report.

2.4 Report Organization

The remainder of this report is organized into the following chapters:

- Chapter 3 describes the methodologies used in the study.
- Chapter 4 presents detailed impact evaluation findings, including estimates of gross and net energy and peak demand impacts.
- Chapter 5 details findings from the process evaluation.
- Chapter 6 presents the conclusions and recommendations derived from the evaluation.

The following appendices provide supplementary information including:

- Appendix A: Metering Equipment and Protocols
- Appendix B: Participant Survey Instrument
- Appendix C: Nonparticipant Survey Instrument
- Appendix D: Metering Data Annual Extrapolation Models

3. Methodology

This chapter provides a description of the methodology used by ADM in the evaluation of the 2011-2013 Refrigerator/Freezer Recycling Program. The chapter is divided into two sections: impact evaluation methodology and process evaluation methodology.

3.1 Impact Evaluation Methodology

3.1.1 Conceptual Overview

Energy savings resulting from appliance recycling is somewhat different than most energy efficiency programs. A typical energy efficiency program generates energy savings by promoting the replacement of less efficient equipment or behaviors with more efficient equipment or behaviors. Appliance recycling, however, generates energy savings from the complete removal of less efficient equipment from the grid. There are two ways in which the removal and decommissioning of refrigerators and freezers produce savings:

- In participant households, the removal of an appliance may cause the participant to reduce their overall refrigeration end-use consumption. This could reflect the participant household removing a secondary (or spare) unit that had previously been in use. It could also reflect the removal of a recently replaced primary unit that might have become a secondary unit if the program had not intervened.
- By removing working appliances from participant households, the program may also affect the level of appliance related energy consumption in non-participant households. The decommissioning of program appliances prevents their sale or transfer to other SMUD customers. With program appliances no longer available, used appliance acquirers who may have purchased a program unit in the absence of the program must now take other actions. Possible outcomes include forgoing the acquisition of a unit altogether, purchasing a new unit, or purchasing an alternative (non-program) used unit. All of these outcomes are likely to result in reduced energy use as compared to the continued use of program units.

3.1.2 Gross vs. Net Impacts

Previous evaluations of utility sponsored appliance recycling programs have typically defined gross savings as equal to the unit energy consumption (UEC) of a given program appliance, usually with a part use factor applied to account for units that are not plugged in year-around. Issues such as free-ridership (units that would have been removed from the grid even in the absence of the program) and secondary market effects have typically been accounted for in the determination of net savings. This is the approach recommended and detailed in the U.S. Department of Energy's (DOE)

Uniform Methods Project (UMP) Refrigerator Recycling Evaluation Protocol.⁷ The UMP is a set of protocols developed through DOE funding that provides straightforward methods for evaluating energy savings for common energy efficiency measures offered through utility sponsored programs.

However, a recent evaluation⁸ of the 2010-2012 California Statewide Appliance Recycling Program (CA ARP) used a slightly different definition of gross savings based on the recommendation of the California Public Utilities Commission (CPUC) Energy Division in Decision D. 11-07-030, Attachment A.⁹ The primary difference between the UMP definition of gross savings and the CA ARP definition of gross savings is the treatment of certain effects that have typically been considered secondary market effects, and thus considered when determining net savings. The UMP protocol recommends the typical approach, where all free-ridership and secondary market effects are accounted for in the determination of net savings. The CA ARP evaluation differs by defining gross savings as the difference in consumption with and without the program. This requires accounting for secondary market effects in the determination of gross savings. Ultimately, both approaches result in similar determinations of net savings, only differing substantially in defining the difference between gross and net impacts.

In order to provide estimates of gross and net impacts that are comparable both within California (compared to the CA ARP) and nationally (compared to the typical definitions outlined in the UMP protocol), ADM reports gross savings under both definitions in this evaluation report. Net savings are unaffected by the differing gross savings definitions, as ultimately the same elements of free-ridership and secondary market effects are considered, whether as part of the gross or net impact analysis. For the CA ARP definition, ADM did not replicate the exact methodology for determining gross savings used in the CA study. Instead, secondary market effects were simply moved from net savings to gross savings in order to provide comparable results.

The difference between the two gross savings definitions is described in more detail later in this Chapter.

3.1.3 Data Sources

ADM utilized both primary and secondary data sources in order to estimate the gross and net impacts of the 2011-2013 Recycling Program. Table 3-1 below provides an

⁷ <http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf>

⁸ http://www.calmac.org/publications/2010-2012_ARP_Impact_Evaluation_Final_Report.pdf

⁹ http://www.doe2.com/download/CPUC/ExAnteProcess/D-11-07-030_AtteachmentA-B.pdf

overview of all data sources used and the impact evaluation component they address. Each data source is discussed in more detail below.

Table 3-1: Data Sources Used for Impact Evaluation

Data Source	Program Activity Verification	Estimation of Program UECs	Appliance Load Shape Development	Program Unit Disposition (Free-ridership)	Secondary Market Effects
Program Tracking Data	√				
New In-Situ Metering		√	√		
Prior In-Situ Metering		√	√		
Participant Survey	√			√	
Non-participant Survey				√	√
Prior Evaluation Models		√	√		

Program Tracking Data: SMUD provided ADM with spreadsheets summarizing the program activity for 2011, 2012 and 2013. These spreadsheets provided detailed records of the number of refrigerators and freezers collected for recycling during each month of the evaluation period. Additionally, the spreadsheets contained ex ante estimates of per-unit energy and peak demand impacts.

JACO provided additional program tracking data with details including participant contact information, appliance characteristics and other information collected at the time of pick-up. The JACO tracking data was provided in the form of spreadsheet extracts from the main program tracking database (JACO Dashboard). The JACO tracking data was easily tied to the SMUD summary spreadsheets based on invoice numbers to verify that both sources represented the same number of refrigerators and freezers collected during the evaluation time period.

The program tracking data was used to establish ex ante energy savings and peak demand reduction for each program year. Additionally, the tracking data was used to extrapolate evaluation estimates to the program population of recycled units.

In-Situ Metering: ADM conducted energy consumption metering of refrigerators and freezers for a sample of units that had recently enrolled in the program in late 2014 and early 2015. ADM coordinated with JACO to identify units that were scheduled for pick-up and to conduct short term metering between the time when the participant enrolled in the program and the scheduled pick-up date. In total, 29 refrigerators and 2 freezers were newly metered in participants' homes as part of the evaluation effort. Additionally, ADM utilized metered data collected during past evaluations of the SMUD Recycling Program to provide a more robust sample for calculating UECs. Past metering of

refrigerators and freezers in the SMUD service territory was conducted by ADM in 2006 and 2011 in support of evaluations for previous program years. The final dataset used for the purpose of estimating UECs consisted of 83 refrigerators and 20 freezers that were metered in-situ in SMUD customer homes. Table 3-2 below details the number of appliances metered by cohort.

Table 3-2: Metering Sample by Cohort

Sample	Refrigerators	Freezers
2006 Metering Sample	28	13
2011 Metering Sample	26	5
2014 Metering Sample	29	2
Total	83	20

A discussion of the metering protocol used including a copy of the data collection form is provided in Appendix A.

Participant Survey: SMUD customers who participated in the program during the 2011 – 2013 program cycle were sampled from the program tracking data and randomly prioritized in a call list in order to conduct a telephone survey. The participant survey included questions relevant to both the impact and process evaluation components of this study. For the impact evaluation, the surveys were used to verify program participation, verify the working condition of recycled appliances, and determine what the participant customer would have done with the appliance in the absence of the program. The survey was completed by 210 program participants representing 136 recycled refrigerators and 74 recycled freezers.

A copy of the survey instrument used for program participants is provided in Appendix B.

Non-participant Survey: A general population survey of non-participants was conducted using randomly selected telephone numbers for residential customers in the SMUD service territory (Random Digit Dialing). The primary purpose of the survey was to collect data for the calculation of free-ridership and secondary market effects. The survey focused on identifying SMUD customers that had discarded or acquired program eligible appliances in the previous five years. These customers were asked a series of questions to assess the characteristics of the secondary market for used refrigerators and freezers. Respondents who indicated that they had recently discarded of an appliance were asked to detail the disposition of that discard. Respondents who indicated recently acquiring a used appliance were asked to detail how those units were used (primary or secondary, part time or all year, etc.). At the end of the survey, customers were asked about their awareness of the Recycling Program and their likelihood of participating in the future. In total, 194 respondents indicated that they had discarded or acquired an appliance. However, in subsequent questioning, nine of these respondents could not recall how many appliances were discarded or indicated that

they had not discarded any. These respondents were not asked any questions about the discarded appliance. In total, 157 respondents had discarded an appliance and 36 had acquired an appliance.¹⁰

A copy of the survey instrument used for non-participants is provided in Appendix C.

3.1.1 Gross Savings

As previously mentioned, gross savings are estimated in this evaluation using two separate definitions. Both definitions are estimated in recognition of the fact that SMUD may be interested in comparing program results to other programs within California and nationally. The first, more common definition reflects the idea that any working appliance recycled represents potential energy savings by avoiding continued use (in participant households or elsewhere on the grid). Free-ridership effects (units that would have been removed from the grid absent the program) and secondary market effects are parameters of net savings under this definition. This approach is detailed in the Uniform Methods Project protocol for appliance recycling and is thus referred to as the “UMP” definition in this report. The UMP protocol defines gross energy savings for an appliance recycling program as:

$$Gross_{kWh} = N \times UEC_{existing} \times Part_Use$$

Where:

- $Gross_{kWh}$ = Annual electricity savings measured in kilowatt-hours (kWh)
- N = The number of appliances recycled through the program
- $UEC_{existing}$ = The average annual energy consumption of participating refrigerators and freezers
- $Part_Use$ = The portion of the year the average refrigerator/freezer would likely have operated if not recycled through the program.

The alternate definition of gross savings comes from the recent 2010-2012 California Statewide Appliance Recycling Program evaluation. Thus, it is referred to in this report as the “CA ARP” definition. The CA ARP approach defines gross savings as the difference in energy consumption with and without the program. Because the program goal is removal of units from the grid, gross savings are defined in terms of consumption changes at the grid level. This requires some estimation of participant actions in the absence of the program (which is considered under net savings for the UMP approach). Table 3-3 shows a simplified calculation of gross savings using the CA ARP definition.

¹⁰ Some respondents acquired and discarded an appliance.

Table 3-3: CA ARP Simplified Gross Savings Calculation¹¹

Unit Disposition	Location	Consumption without Program (A)	Consumption with Program (B)	Gross Savings (A-B)
Kept in Use	Participant Household	UEC as secondary unit	No consumption	UEC as secondary unit
Kept Unused	Participant Household	No consumption	No consumption	No Savings
Transferred from Participant Household	Transferee Household	UEC as primary or secondary unit	UEC as primary or secondary unit, given removal of program units	UECa - UECb

Conceptually, this approach to estimating gross savings differs from the UMP approach as follows: Program effects on the secondary or used market are moved from the net savings calculation to the gross savings calculation. Net savings are then calculated by only netting out the effects of free-ridership (units that would have been destroyed even in the absence of the program). The secondary market effects accounted for in this evaluation are 1) whether would-be acquirers of program units would have found an alternate unit in the absence of the program and 2) whether the alternative units found would have been used (similar to program units) or new (standard efficiency).

Figure 3-1 depicts the difference between the UMP and CA ARP gross savings values provided in this report.

¹¹ This table is taken directly from the 2010-2012 CA ARP evaluation report.

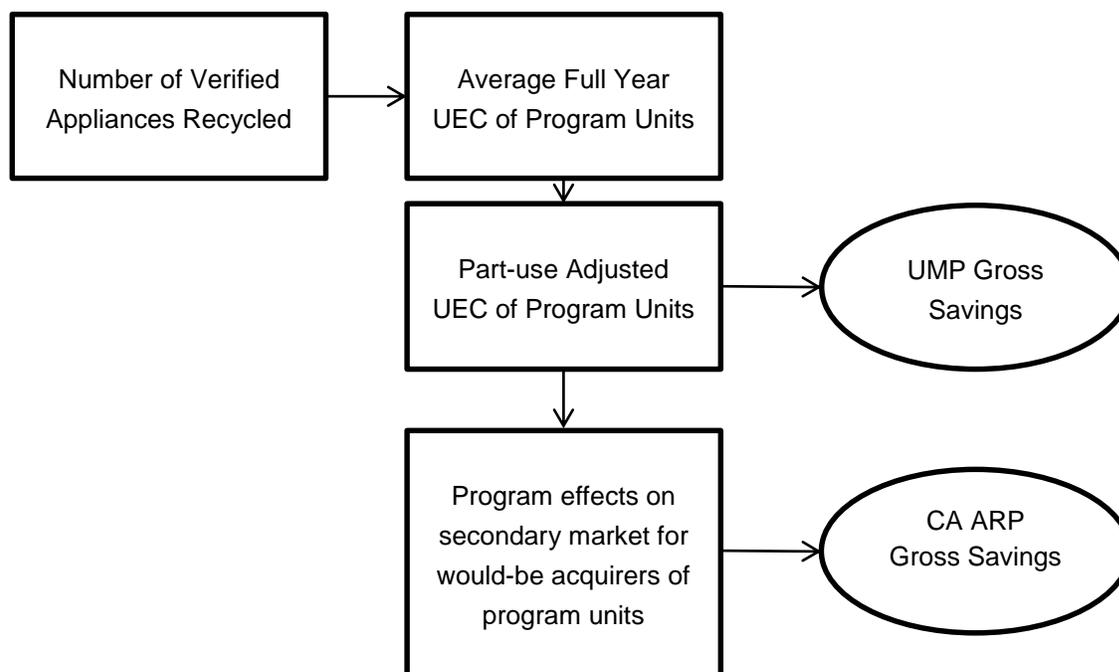


Figure 3-1: UMP vs. CA ARP Gross Savings Definitions

3.1.1.1 Verification of Units Recycled

The first aspect of conducting measurements of program activity is to verify the number of refrigerators and freezers collected and recycled through the program. When a customer schedules a pick-up, either online or over the phone, they are screened to ensure the scheduled unit(s) is operational and will be plugged in at the time of pick-up. At the time of pick-up, implementation crews are instructed to check that the unit powers on and produces air before permanently disabling the unit by cutting the power cord and damaging the appliance shell. However, it is not unreasonable to suspect that a small percentage of non-operational appliances may enter the program despite these screening efforts. If a non-operational unit is beyond reasonable repair, it offers no savings opportunity.¹²

To account for this possibility, ADM employed the following verification steps:

- Validating program tracking data provided by SMUD and JACO by checking for duplicate or erroneous entries; and,
- Conducting telephone surveys with a sample of program participants. The surveys were used to verify that customers listed in the program tracking database did

¹² Aside from the potential environmental benefits of recycling compared to alternative disposal methods.

indeed participate and that the number of appliances claimed to be recycled was accurate. Additionally, survey respondents were asked a series of questions to verify the working condition of their recycled appliances.

3.1.1.2 Short-term In Situ Metering

Past evaluations of appliance recycling programs have generally taken one of two approaches to estimating UECs. The first, and perhaps more dated, approach involves metering program refrigerators and freezers using DOE testing protocols (DOE 2008) after they are collected for recycling (or using DOE based UECs that are published at the time of manufacture). The DOE protocols specify certain test conditions that are meant to provide general UEC ratings for new appliances. However, more recent evaluations have indicated that the DOE test protocols may not reflect actual usage conditions for appliances in utility customer homes (e.g., no door openings, empty cabinets, and a 90°F test chamber).

The second approach involves utilizing metered data that is collected from utility customer homes before an appliance is collected for recycling. The UMP protocol recommends using this in-situ (meaning “in its original place”) metering data to estimate a regression model because it accounts for environmental and usage patterns within program participating homes that might not be accurately reflected through DOE testing based metering. ADM utilized short-term in situ metering for this evaluation. An existing database of appliances metered in the SMUD service territory in 2006 and 2011 was supplemented by a new sample of units metered in late 2014 and early 2015.

Table 3-4 shows the target and achieved sample sizes. ADM was unable to achieve the desired sample sizes, particularly for freezers, due to the project timeline. Much of the metering was performed around the holiday season, which resulted in a lower participation rate in the metering study than planned. Additionally, during the metering period the number of freezers recycled through the program was considerably lower than refrigerators (as it is throughout the year). ADM recommends that future evaluations of the Recycling Program allow for sufficient time to meter program units over the course of several seasons. This not only increases the likelihood of achieving the desired sample size, but also allows for longer term metering that captures seasonal effects on appliance energy use.

Table 3-4: Target and Achieved Sample for In Situ Metering

Sample	Refrigerators	Freezers
Existing	54	18
New - Target	30	10
New - Achieved	29	2

The final model used to estimate program UECs was developed using metered data from 83 refrigerators and 20 freezers. To facilitate extrapolating the model to the program population of appliances, only explanatory variables that were readily available in the program tracking database for all units were considered. Details regarding the metering effort and the process of annualizing the short-term data are provided below

Metering Equipment

The same metering equipment was used for each appliance metered as part of 2011-2013 Recycling Program evaluation effort. Metering that was conducted in past years (2006, 2011) utilized slightly different equipment, but ultimately similar data was captured for each metering sample. Energy consumption was captured using a plug-in logger developed by ADM. This plug-in logger (Figure 3-2) measures true RMS power and records actual energy use in five-minute intervals. The monitoring box is designed to be easy to use and unobtrusive. The box contains a WattNode® wathour transducer with an accuracy of $\pm 0.5\%$ and a 20 Amp precision current transducer with an accuracy of $\pm 1.0\%$. The output from the wathour transducer is recorded onto a battery powered logger inside the box. The logger has non-volatile memory which can store more than a year of data.



Figure 3-2: ADM's Plug-In Appliance Logger

At the time the metering box was installed, a portable plug-in meter (Ex-tech EM100 Energy Monitor, see Figure 3-3) was used to record measurements of power, voltage, current, and power factor as a secondary source of data for reference in the event that any short term metering data appeared unusual.



Figure 3-3: Extech EM100 Plug-In Meter with Display

All of the energy metering equipment described above has been used in numerous past projects and has proven reliable and accurate. Past refrigerator and freezer metering efforts (including the SMUD data from 2006 and 2011) have also included measurement of ambient and cabinet temperature. This metering effort did not include temperature metering, as the delta temperature between outside air and appliance cabinet is not easily extrapolated to the population of program appliances. Instead, temperature effects are developed using Typical Meteorological Year (TMY) data.

Additional data recorded at the time of equipment installation includes appliance type, configuration, location, and nameplate information. More details regarding the metering protocols used including data collection forms can be found in Appendix A.

Annualization of Short-term Metering Data

The metering data collected for this evaluation, as well as the data collected in 2006 and 2011, represents a small window of time between when a customer schedules a pick-up and when the pick-up actually occurs. The average length of time the metering equipment was installed in customer homes was 11 days. This timeframe is sufficient for capturing multiple appliances defrost cycles as well as weekend/weekday usage differences. However, the ideal metering study would record data from program appliances in customer homes for a full year to capture seasonal effects. This approach is not feasible because participating customers have usually enrolled in the program because they intend to dispose of the unit quickly.

As a result, the data collected from short-term metering requires some process of extrapolation to a full year UEC. The most straightforward approach to extrapolation is to simply multiply the average hourly kW readings from the monitoring period by 8,760 hours. However, this method of extrapolation does not take into account that energy use for an appliance varies with outdoor temperature (albeit mediated by changes in indoor temperature and indoor-internal cabinet temperatures). Figure 3-4 below illustrates the challenge presented by this simple approach to annualization. The blue line shows the typical seasonal variation in appliance energy use over one year. The dotted red line shows the energy usage during four hypothetical monitoring periods. A

simple extrapolation of average energy usage during these metering periods would misrepresent the annual usage because it does not account for this seasonality. Units metered in the summer months would extrapolate to annual UECs that are likely overestimated, while the opposite is true of units metered in the winter time.

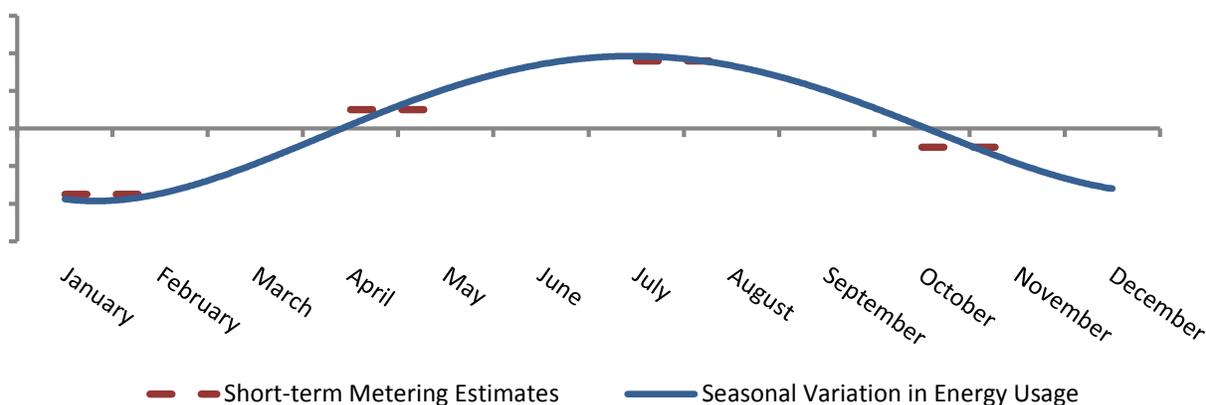


Figure 3-4: Bias of Simple Extrapolation due to Seasonality

To account for seasonality in extrapolating the short term metering data to full year UECs, ADM used a model developed in an evaluation of the 2004-2005 California Statewide Appliance Recycling Program.¹³ The 2004-2005 evaluation utilized long term appliance metering data collected in California in the 1990's to develop models of the relationship between hourly consumption and hourly outdoor temperature.¹⁴ The result of these models is equations that have been used to develop appliance and weather specific load shapes of refrigerator and freezer energy usage. Monthly expansion factors are then used to adjust short-term metering measurements to full year UEC based on the appliance type and month in which the metering occurred. ADM utilized expansion factors that were based upon Typical Meteorological Year (TMY) data for CEC Climate Zone 12, which includes the SMUD service territory. The 2004-2005 evaluation estimated separate models for freezers, secondary refrigerators, primary top-freezer refrigerators, and primary side-by-side refrigerators. Table 3-5 provides the model for primary top freezers. Appendix D provides the complete set of models used to extrapolate the short-term metering data to full-year UEC estimates.

¹³http://www.calmac.org/publications/EM&V_Study_for_2004-2005_Statewide_RARP_-_Final_Report.pdf

¹⁴ These models are based on relatively old appliance metering data that might not accurately reflect the refrigerators and freezer recycled through the 2011-2013 program. However, the models were recently tested against newly developed models based on metering data from the 2010-2012 CA ARP study and performed reasonably well.

*Table 3-5: Top Freezer Extrapolation Model from 2004-2005 ARP Evaluation
(Dependent Variable = watthour per hour)*

Variable Description	Coefficient	Standard Error
Intercept	-98.3825	1.1320
Mean Watt Hours	0.9815	0.0005
January Dummy	3.8639	0.9129
February Dummy	-0.1099	0.9076
March Dummy	5.6952	0.9017
April Dummy	12.9591	0.9349
May Dummy	7.6151	0.9584
June Dummy	9.6176	1.0150
July Dummy	16.1311	1.0329
August Dummy	6.4387	1.0690
September Dummy	6.8108	1.0193
October Dummy	15.1539	1.1215
November Dummy	4.4912	0.9349
December Dummy	Suppressed	
Ambient Temperature (F)	1.4172	0.0186
Appliance Volume (cubic feet)	3.0881	0.0578
January Dummy * App Volume	-0.5238	0.0524
February Dummy * App Volume	-0.4686	0.0559
March Dummy * App Volume	-0.8596	0.0588
April Dummy * App Volume	-1.6752	0.0583
May Dummy * App Volume	-1.7853	0.0608
June Dummy * App Volume	-1.6470	0.0610
July Dummy * App Volume	-1.7913	0.0625
August Dummy * App Volume	-1.2161	0.0643
September Dummy * App Volume	-0.9315	0.0623
October Dummy * App Volume	-2.1263	0.0768
November Dummy * App Volume	-0.8015	0.0571
December Dummy * App Volume	Suppressed	
Ambient Temperature * App Volume	-0.0488	0.0010
January Dummy * App Volume * Ambient Temperature	0.0079	0.0007
February Dummy * App Volume * Ambient Temperature	0.0096	0.0008
March Dummy * App Volume * Ambient Temperature	0.0145	0.0007
April Dummy * App Volume * Ambient Temperature	0.0228	0.0007
May Dummy * App Volume * Ambient Temperature	0.0307	0.0007
June Dummy * App Volume * Ambient Temperature	0.0309	0.0006
July Dummy * App Volume * Ambient Temperature	0.0301	0.0006
August Dummy * App Volume * Ambient Temperature	0.0279	0.0007
September Dummy * App Volume * Ambient Temperature	0.0209	0.0007
October Dummy * App Volume * Ambient Temperature	0.0264	0.0009
November Dummy * App Volume * Ambient Temperature	0.0118	0.0008
December Dummy * App Volume * Ambient Temperature	Suppressed	
	R-square	0.5189

3.1.1.3 Full-year Unit Energy Consumption (UEC) Calculation

After establishing estimates of annual in situ UEC for the sample of appliances that received short term metering, the next step is to estimate unit level annual consumption for non-metered program units recycled during 2011-2013. This is accomplished through the use multiple linear regression analysis to model end-of-life UEC of the recycled refrigerators and freezers based on characteristics recorded in the program tracking data. In analytical terms, the regression analysis involves estimating the parameters of a regression model:

$$\text{UEC} = \text{function of } (V_1, V_2, V_3, \dots, V_n)$$

Where UEC is a measure of the annual energy use of a refrigerator and the V_i are independent variables (e.g., age, size, configuration, etc.) used to explain the amount of energy consumption. This approach to estimating refrigerator and freezer energy use is fairly standard, and is the recommended method described in the UMP Protocol.

Applying the regression equations to the program tracking data for 2011-2013 provides the final full year per-unit UEC estimates.

3.1.1.4 Part-Use Factor

The full-year UEC estimates must be adjusted to account for the fact that not all appliance are in continues operation year round. The part-use factor reflects the percentage of the year that an appliance is plugged in and operational. For primary refrigerators, the part-use factor is assumed to be 100%, as it is unlikely a customer goes without any food refrigeration. For secondary refrigerators and freezers the possibility of part-use becomes more likely.

The participant survey was used to estimate part-use factors for secondary refrigerators and freezers, separately. Respondents were asked to indicate whether the appliance they recycled was in full use, part use, or disuse during the 12 months prior to collection. If a respondent indicated part use, they were asked to estimate the number of months the unit was in operation (out of the prior 12). Gross baseline consumption of recycled appliances is calculated as the full year UEC estimates multiplied by the part-use factors.

Next, the part-use factors, which are based on historical usage of the recycled appliances, are combined with participants' self-reported actions had the program not been available. Specifically, whether they would have kept or discarded the unit. This information is important because it informs what type of part-use profile the unit would have had in the absence of the program (for example, if a respondent indicates that they would have kept a primary refrigerator and continued to use it as a primary unit, a part-use factor of 1 is appropriate).

3.1.1.5 Gross Peak Demand Reduction

SMUD is particularly concerned with reducing system wide average demand during a SMUD defined condition known as a “heat storm” - three consecutive weekdays when temperatures reach Sacramento’s highest average levels. For evaluation purposes, SMUD models this condition on a normal weather year, presented in Table 3-6. During such a condition, SMUD is interested in reducing the average system-wide demand (in kilowatts, kW) of all three days, specifically between the hours of 4:00pm and 7:00pm (nine hours over the three days of a heat storm).

Table 3-6: SMUD Temperature Conditions for Peak Savings

Consecutive Weekday		Temperature
High Temperature 4-7 PM	First Day	100 °F
	Second Day	104 °F
	Third Day	106 °F
Low Temperature	Third Day	67 °F

To assess average kW reduction during a SMUD defined heat storm, ADM used the same model that is used to extrapolate short-term in situ metering data to annual UECs. Average program values for appliance size and appliance configuration were used. Mean watt hours were calculated as the estimated full-year UEC multiplied by 1000 (to convert kWh/year to Wh/year) and divided by 8,760 (to convert Wh/year to Wh/h). It is assumed that a heat wave as described by the SMUD definition has a 50% chance of occurring in July and a 50% chance of occurring in August (thus, the estimated dummy variables for July and August are multiplied by 0.5). Finally, ambient temperature was modeled based on the SMUD defined temperature conditions for peak savings. It is assumed that the daily high temperature occurs at 4PM. TMY3 weather data for the Sacramento region was analyzed to determine the average temperature drop from 4PM to 7PM. Table 3-7 shows the final temperature conditions used for the peak savings estimation.

Table 3-7: Modeled Temperature Conditions during Heat Wave

Day	Hour Starting	Modeled Temperature Conditions (°F)
1	4:00 PM	100
1	5:00 PM	96.5
1	6:00 PM	90.5
2	4:00 PM	104
2	5:00 PM	100.5
2	6:00 PM	94.5
3	4:00 PM	106
3	5:00 PM	102.5
3	6:00 PM	96.5

3.1.2 Net Savings

This section details the methodology used to determine the percentage of gross savings that is attributable to the program (net savings). Net savings from an appliance recycling program are only generated when the recycled appliance would have continued to operate absent the program. This includes continued operation in the participant household or continued operation in another SMUD household after being transferred through the secondary market. This evaluation considers two approaches to estimating gross savings (the UMP and CA ARP methods described earlier in this report). As a result, some of the adjustments that are usually made in determining net savings have already been accounted for in one of the gross savings estimations (CA ARP). This, however, does not affect the final estimation of net savings, as both methods ultimately account for the same factors as applied in this evaluation. That is, while the two methods produce different gross savings estimates, they both produce the same net savings estimates. The net-to-gross ratio estimates from this evaluation were applied to gross annual energy savings and gross peak demand reductions.

This section will explain the net savings methodology in the context of the UMP protocol estimation of gross savings. The three effects discussed in this section are free-ridership, secondary market impacts, and induced replacement. Net savings are calculated relative to UMP gross savings using the formula below.

$$\text{Net Savings} = \text{Gross Savings} - \text{Freeridership} - \text{Secondary Market Impacts} - \text{Induced Replacement}$$

Where:

Gross Savings = The evaluated in situ UEC for the average recycled unit, adjusted for part use (UMP definition of gross savings);

Free-ridership = Program savings from units that would have been destroyed even in the absence of the program;

Secondary Market Impacts = Program Savings that would have occurred in the absence of the program based on the estimated/assumed counterfactual actions of appliance acquirers.

Induced Replacement = Average additional energy savings consumed by replacement units purchased due to the program.

Note that the CA ARP definition of gross savings already includes secondary market effects. Thus, the secondary market impacts deduction implied by the formula above is not applicable to CA ARP gross savings. The following sections detail more thoroughly the free-ridership, secondary market effects, and induced replacement components of net savings. After each effect is discussed individually, a summary diagram is provided in Figure 3-6 to illustrate the complete net savings adjustment.

3.1.2.1 Free-Ridership

Free-ridership occurs when an appliance recycled through the program would have been taken off the grid even in the absence of the program. The first step of the free-ridership analysis was to ask participants if they had considered discarding the program appliance before learning about the program. If the participant indicated no previous consideration of unit disposal, they are categorized as non-free-riders and removed from the subsequent free-ridership analysis. Conceptually, this reflects the assumption that without prior consideration of disposal, the program induced the resulting decommissioning of the appliance.

Next, the remaining participants (i.e., those who had previously considered discarding the program appliance) were asked a series of questions to determine the distribution of program appliances that would have been kept within participant households versus those that would have been discarded. If one considers the counterfactual scenario where there is no program intervention, there are essentially three outcomes for participating appliances:

- The appliance would have been kept in use by the participant household.¹⁵

¹⁵ Note that units kept by participant households but *not* used are accounted for in the estimation of part-use factors and therefore discounted from gross savings.

- The appliance would have been discarded in such a way that it was transferred to another customer for continued use.
- The appliance would have been discarded in such a way that it would be taken out of service.

Of the three outcomes, one indicative of free-ridership:

- Discarded and taken out of service (destroyed)

This outcome is indicative of free-ridership because the units would have been removed from the grid even without program intervention.

The participant and non-participant surveys were used to estimate the percentage of program appliances that fall into each category. Participants were asked a series of questions about what they would have done with the appliance in the absence of the program. Because this is a hypothetical question and participants may be unaware of available options and barriers to other forms of appliance disposal, similar questions were also asked of nonparticipants who reported actually discarding of an appliance outside the program.¹⁶ The distribution of likely discard outcomes was then calculated as a weighted average of the participant and non-participant responses.¹⁷

The specific questions used in the customer surveying to assess free-ridership are provided in Appendix B (participants) and Appendix C (nonparticipants). The goal of the questions is twofold: first determine whether the unit would have been kept or discarded, and then determine whether discarded units would have been transferred or removed from the grid.

3.1.2.2 Secondary Market Impacts

Secondary market impacts refer to the effect the program has on would-be acquirers of program participating units. In the event that a program unit would have been transferred to another SMUD customer (sold, gifted, donated), the question then becomes what other appliance acquisition decisions are made by the would-be acquirer of the program unit now that it is decommissioned and unavailable. The would-be acquirer could:

- Not purchase/acquire another unit.
- Purchase/acquire a different non-program used appliance.

¹⁶ The exception to this is the case of units that would have been kept in the home. These percentages were estimated based solely on responses to the participant survey.

¹⁷ The distribution of discard scenarios was weighted equally for participant and non-participant transfer/destroy ratios for refrigerators. For freezers, only participant survey responses were considered because there was an insufficient sample of nonparticipants who reported recently discarding a freezer.

- Purchase a new appliance instead.

Absent the program, if we consider the options of would-be acquirers at the market level, there are a range of possibilities as described below:

- **None of the would-be acquirers would find another unit:** This reflects a scenario where program participation results in a one-for-one reduction in the total number of appliances on the grid. In this case, the total UEC of avoided transfers would represent energy savings achieved.
- **All of the would-be acquirers would find another unit:** This reflects a scenario where program participation has no effect on the total number of appliances operating on the grid. Without the program units available, all acquirers simply purchase non-program units (whether new or used).
- **Some of the would-be acquirers would find another unit, while others would not:** This possibility reflects the most likely possibility, where some would-be acquirers who were in the market for an appliance acquire a unit. Other would-be acquirers, who perhaps would have only taken the unit opportunistically (for example, taking a neighbors discarded unit to use as a secondary garage unit), do not acquire a new unit because of program intervention.

Ultimately, the true market level outcome in the absence of the program is difficult to assess. ADM did not conduct a top-down secondary market assessment as part of this evaluation.¹⁸ The nonparticipant surveys conducted for this evaluation do include some questions that attempt to address the issue. Specifically, non-participants who recently acquired a used refrigerator or freezer were asked to describe what they would have done if the specific unit they acquired had not been available. While this results in some useful information, it is uncertain whether the nonparticipant answers truly reflect the counterfactual market outcome. Additionally, with only 26 nonparticipant survey respondents indicating recent used appliance acquisitions, the sample size available for extrapolating to the full used appliance market is quite small.

As a result of these difficulties, this evaluation takes a midpoint approach, as recommended by the UMP protocols. That is, 50% of would-be acquirers of program avoided transfers are assumed to find an alternate unit. The next question of interest is whether the alternative units acquired would be used (similar to those recycled by the program) or new. Again, this market distribution is difficult to estimate with any certainty. This evaluation takes the UMP recommendation and assumes that 50% of the alternative units would be used and 50% would be new, standard efficiency units.

¹⁸ While it is not specific to the SMUD service territory, the 2010-2012 CA ARP evaluation includes a secondary market study. Given the proximity to the SMUD service territory, the findings of that study are likely relevant in the SMUD market. The study is available at: http://www.calmac.org/publications/2010-2012_ARP_Impact_Evaluation_Final_Report.pdf

It should be noted that these midpoint assumptions produce uncertainty in the final net savings values that is not quantified. Some recent studies have shown that the percentage of would-be acquirers who obtain alternate units is considerably higher than 50%. This would decrease the net savings attributable to the Recycling Program. Other studies have found that recycling programs not only effect whether or not would-be acquirers would find alternate units, but also the average level of efficiency for alternate used units. This would theoretically increase net savings attributable to the program. Quantifying these specific effects was prohibitive given the budget and timeline for this evaluation. Even with substantial budget and time, the estimation of these effects is likely to have a high degree of uncertainty depending on available market level data and bias introduced through surveying program participants and/or nonparticipant utility customers.

3.1.2.3 Induced Replacement

Induced replacement refers to a scenario in which the Recycling Program causes a program participant to purchase a replacement appliance. That is, the participant would not have replaced the refrigerator or freezer in the absence of the program. The purchase of a new appliance in conjunction with participating in the program does not necessarily indicate induced replacement. Older refrigerators and freezers are constantly being replaced with newer units, independent of any program effects.

However, if the program actually caused the decision to replace an older unit with a new unit (thus effectively putting another appliance on the grid) then the net program savings should account for this fact. This is the once scenario in which the energy usage of a replacement unit should be subtracted from energy savings produced by decommissioning the old unit.

The Recycling Program offers a \$35 to \$50 incentive and free pickup. This incentive is a small portion of the cost of purchasing a new appliance, and thus the likelihood of induced replacement can be reasonably assumed to be low. Indeed, past evaluations that have considered induced replacement effects have found that induced replacement is much less common than naturally occurring replacements unrelated to the program.

To account for induced replacement, the participant survey asked respondents a series of questions. First, if the respondent indicated the unit recycled was a primary refrigerator and that they would have discarded the unit even without the program, they were eliminated from consideration for induced replacement (because it is extremely unlikely a participant would choose to go without a refrigerator). All remaining respondents were asked the following questions:

- *“Did you replace the old [appliance] with a new unit?”* – Respondents who did not purchase a replacement appliance are removed from consideration.
- *“Would you have purchased a replacement [appliance] even if SMUD’s recycling program had not been offered?”* – This is the primary question for determining

whether the program induced replacement. However, because the question may cause confusion, those you indicate “yes” are then asked the following confirmation question:

- “Let me be sure I understand. Are you saying that you chose to purchase a new appliance because of SMUD’s appliance recycling program, or are you saying you would have purchased a new appliance regardless of the program?” – If a respondent again indicates the program caused the replacement, then the recycled appliance in question is considered to exhibit induced replacement.

For the small proportion of program participants that were induced to replace an appliance, it is assumed that they purchased a standard efficiency new unit. Energy consumption for a standard unit was determined by 2011 sales weighted energy consumption data for refrigerators (452 kWh) and freezers (443 kWh).¹⁹ Figure 3-5 below provides an example of how the induced replacement factor is calculated. In the example, induced replacement causes a 17 kWh per-unit decrease in net savings.

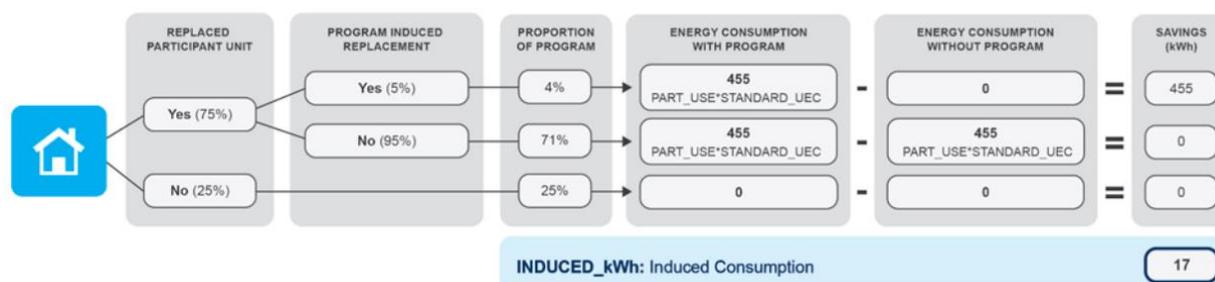


Figure 3-5: Induced Replacement Example²⁰

3.1.2.4 Spillover

Spillover was not quantified in this evaluation, per the recommendation of the UMP protocol for appliance recycling. The UMP protocol does not recommend spillover adjustments for the following reasons:

- Opportunities for “like” spillover (the most common and defensible form of spillover for downstream energy efficiency programs) are limited in a recycling program because the number of refrigerators and freezers in a typical home is limited
- Unlike certain energy efficiency programs, an appliance recycling program does not provide comprehensive energy education to participants that might result in “unlike” spillover.”

¹⁹ AHAM Energy Efficiency and Consumption Trends 2012

²⁰ Figure is taken directly from UMP protocol. Note that the values in the figure are just an example, and do not reflect the findings from this evaluation.

- Quantifying spillover accurately is challenging, and there is inherent uncertainty in attributing subsequent efficiency improvements to participation in a recycling program.

3.1.2.5 Net Savings Summary Diagram

Figure 3-6 summarizes the complete net-to-gross calculation used in this evaluation. Note that this diagram depicts net savings as calculated under the UMP gross savings definition.

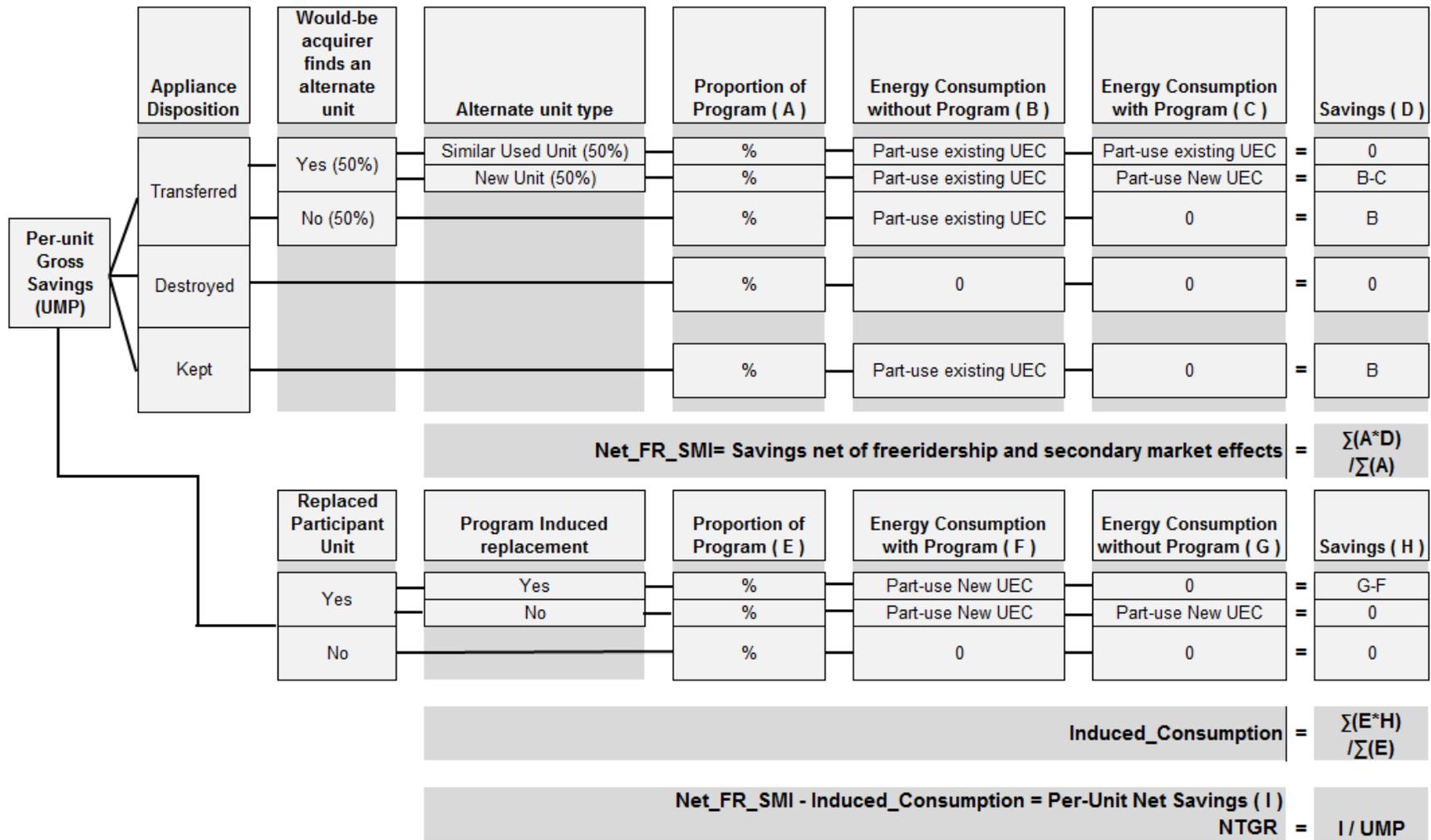


Figure 3-6: Net Savings Calculation Summary Diagram

3.2 Process Evaluation Methodology

SMUD identified three broad objectives for the 2011-2013 Recycling Program process evaluation, listed below:

- Assess the effectiveness of program communications and avenues used to inform and educate customers and participants.
- Determine whether customer interest and knowledge in recycling is a direct result of this or other SMUD programs.
- Assess program processes and assumptions for possible future improvement.

With these objectives in mind, the evaluation assessed the following specific research questions:

- How effective is program promotion and marketing for encouraging program participation?
- How well do SMUD staff and the implementation team work together?
- What are the characteristics of units recycled through the program?
- What trends are there in program activity during the three-year period? What do these trends imply for program operations?
- Are program quality control and verification processes sufficient?
- Is the appliance pickup process operating as intended?
- Are program participants satisfied with the program?

These questions were addressed through a series of research activities, including the following:

- **Program Data and Documentation Review:** ADM reviewed program documents including the program website, promotional materials, and program tracking data supplied by SMUD and JACO.
- **Program Staff Interviews:** ADM completed four in-depth interviews with program staff. These interviews were performed with the SMUD program manager, the JACO program manager, a JACO staff member responsible for retail partnerships, and the president of the firm that completes the household appliance pickups. The interviews were conducted during October and November of 2014. The objective of these interviews was to gather feedback from the Recycling Program implementation staff to determine how the program is operating and to collect suggestions for program improvements.
- **Participant Survey:** SMUD customers who participated in the program during the 2011 – 2013 program cycle completed a telephone survey. The purpose of

the participant survey was to evaluate customer perceptions of the program and gauge overall program satisfaction and to collect data for use in the calculation of gross and net savings. The survey design focused on customer decision-making and overall experience with the program, while gaining an understanding of how effectively the program is meeting customer needs.

- **Nonparticipant Survey:** A survey of non-participants was performed using randomly selected telephone numbers for residential customers in the SMUD service territory. The primary purpose of the survey was to collect data for the calculation of net savings. The survey focused on appliances that were discarded or acquired by SMUD customers in the previous five years. Additionally, customers were asked about their awareness of the recycling program and their likelihood of participating in the future.

The sample sizes for each of the primary data collection activities are summarized in Table 3-8.

Table 3-8 Summary of Primary Data Collection for the Process Evaluation

Target Group	Activity	n
SMUD Program Manager	Telephone Interview	1
JACO Program Manager for SMUD	Telephone Interview	1
JACO Staff for Retail Partnerships	Telephone Interview	1
Appliance Distribution Inc. President	Telephone Interview	1
Program Participants	Telephone Survey	210
Program Nonparticipants	Telephone Survey	194

4. Impact Evaluation Findings

This chapter presents the findings of the impact evaluation of the 2011-2013 Recycling Program. Ex post gross and net energy savings and demand reductions are presented at the measure and program levels. Topics are covered in the following order:

- Verification of units recycled
- Full year UEC calculation
- Part-use factors
- Per-unit gross impacts
- Per-unit net impacts
- Overall program savings

4.1 Verification of Units Recycled

ADM reviewed program tracking data provided by SMUD and JACO for accuracy. SMUD provided ADM with excel spreadsheets summarizing the program activity for the 2011-2013 program cycle. There was one spreadsheet provided for each year. Within each spreadsheet, there were two pertinent worksheets:

- A monthly summary report, showing the number of units collected and associated ex ante energy and demand impacts by month and in total.
- A more complete listing of refrigerators and freezers picked up by week, with an associated JACO invoice number.

In addition to this program summary data provided by SMUD, there was additional detailed tracking data provided by JACO. The JACO tracking data included information about participating customers, recycled units, and specific pick-up dates. Upon comparing the JACO tracking data and the SMUD summary data, it became apparent that there were minor differences in the claimed number of appliances recycled. Table 4-1 below shows the observed differences.

Table 4-1: Number of Units Claimed Recycled by Year

Year	SMUD Summary Data	JACO Tracking Data
2011	6,473	6,567
2012	7,531	7,531
2013	8,592	8,652
Total	22,596	22,750

Further inspection revealed that the JACO invoices worksheet within the SMUD program summary spreadsheets had a few minor summation errors. Additionally, two invoices which represented pick-up dates during the weeks where one program year ended and another began were miscategorized. After reconciling these issues, the SMUD summary data and the more detailed JACO tracking data matched almost exactly, as shown in Table 4-2 below.

Table 4-2: Corrected Number of Units Claimed Recycled by Year

Year	SMUD Summary Data	JACO Tracking Data
2011	6,568	6,567
2012	7,528	7,531
2013	8,653	8,652
Total	22,749	22,750

With the two separate tracking systems within one appliance of each other over three years, the total program population was established for this evaluation based on the more detailed JACO tracking data. The JACO data was comprehensively reviewed by order number, unit ID number, and identifiable customer information. No duplicate or erroneous entries were found.

Participants who responded to ADM's survey were asked to confirm whether or not they recycled an appliance(s) through SMUD's program. They were also asked to confirm the total number of appliances and appliance type (refrigerator/freezer). Finally, respondents were asked to verify the working condition of the appliance(s) at the time of pick-up.

All 210 respondents who completed the participant survey verified that they had in fact participated in the program during 2013. All except seven of the survey respondents also indicated that the number and type of appliance(s) recycled was identical to the claims in the program tracking database. The other seven reported that they "didn't know" the number and type of appliance. No respondents indicated that the number and type of appliance listed in the JACO tracking data was incorrect, as shown in Table 4-3.

Table 4-3: Participant Survey – Unit Verification

1. Our program records indicate that you had ___ (quantity of refrigerators and/or freezers) picked up for recycling through the Refrigerator/Freezer Recycling Program around (date of pickup). Is that correct?	Response	Percent of Respondents (n=210)
	Yes	96%
No	0%	
Don't know	3%	
Refused	0%	

In order for participating appliances to accrue energy savings by being taken out of service, the units must be in working condition at the time of pick-up. Survey respondents were questioned regarding whether the recycled appliances were in working condition at the time of pick-up. If a respondent indicated that the unit was not in working condition, they were asked a follow-up question to make sure the unit was truly inoperable, as opposed to a minor flaw. Only five respondents who recycled refrigerators and five who recycled freezers provided responses that clearly identified the units as inoperable. Table 4-4 shows the resulting verification rates by measure.

Table 4-4: Claimed vs. Verified Units in Working Condition

Measure	Survey Sample Size (n)	Program Claimed Units	Verification Rate (%)	Verified Units
Refrigerator	136	19,912	96.3%	19,180
Freezer	74	2,838	93.2%	2,646

4.2 Full Year UEC Calculation

Full year UEC estimates were derived using the regression modeling of in situ data from 103 appliances that were metered just before decommissioning. The short-term metering data was first extrapolated to full year UEC estimates as described in Chapter 3. Next, the full year UECs for metered units were used as the dependent variable in a regression relating unit characteristics to annual energy usage.

In selecting variables for this model, a number of considerations were taken. The independent variables needed to be readily available in the program tracking data to ensure successful application of the model to the program population. Based data availability and modeling recommendations from the UMP protocol, the following variables were considered:

- Appliance age/vintage at the time of metering
- Appliance size (cubic feet)
- Appliance type and configuration (refrigerator, freezer; side-by-side, top freezer, bottom freezer, single door, upright, chest)
- Primary or secondary usage
- Metering cohort (2006, 2011, 2014)
- Label Amps
- Weather variables (CDD, HDD)

The final model specification did not include weather variables, as there was limited variability in temperature data across zip codes within the SMUD service territory. Label

amps were also excluded from the final model specification as they explained little variation in the overall model after accounting for the other variables. The specification and parameter estimates of the selected model are shown in Table 4-5.

Table 4-5: UEC Regression Model Estimates
(Dependent Variable = kWh per Year, R-square = 0.35)

Independent Variable	Coefficient	t-ratio
Intercept	-190.28	-0.548
Appliance Age ***	25.11	2.854
Dummy: Manufactured Pre-1990	66.52	0.443
Appliance Size (cubic feet) *	25.41	1.662
Dummy: Freezer	6.91	0.058
Dummy: Refrigerator	<i>Suppressed – base variable</i>	
Dummy: Side-by-Side Configuration	224.84	1.634
Dummy: All Other Refrigerator Configurations	<i>Suppressed – base variable</i>	
Dummy: Primary Usage Type	61.49	0.467
Dummy: Secondary Usage Type	<i>Suppressed – base variable</i>	
Dummy: 2006 Metering Cohort **	269.64	2.217
Dummy: 2011 Metering Cohort **	309.99	2.575
Dummy: 2014 Metering Cohort	<i>Suppressed – base variable</i>	
* Significant at the 0.10 level ** Significant at the 0.05 level *** Significant at the 0.01 level		
R – Square = 0.35		

The program tracking database included information regarding appliance type, configuration, size, age,²¹ and correct pickup address for 22,597 of the 22,750 units collected in 2011-2013. These units were used to calculate average program characteristics for calculating program UECs. Table 4-6 shows the average program values by appliance type.

²¹ Model year is listed on refrigerator nameplates for many but not all units. As explained to ADM staff, when model year is not listed on the nameplate it is estimated by JACO staff based on appliance characteristics common to certain vintages.

Table 4-6: 2011 - 2013 Average Program Appliance Characteristics

Measure	Refrigerators (n =19,764)	Freezers (n = 2,830)
Average Age (Years)	18.10	24.35
Percentage of Units Manufactured before 1990	28.4%	59.4%
Average Size (Cubic Feet)	20.43	16.95
Percentage Side-by-Side	35.3%	0
Percentage Primary Usage*	61.8%	0
2011 Cohort Dummy Percentage**	0.5	0.5
<p><i>*While the tracking data did include records of primary/secondary usage, ADM relied on estimates from the participant survey in determining the percentage of primary refrigerators used to extrapolate program UECs. At the time of pick-up, the unit may have been moved and customers may be unavailable to determine primary/secondary usage. All freezers are considered secondary appliances.</i></p> <p><i>**This estimate assumes that appliances recycled during the 2011-2013 program cycle are similar to units metered in both 2011 and 2014.</i></p>		

The appliance characteristics shown in Table 4-6 were used in conjunction with the parameter estimates in Table 4-5 to calculate annual UEC estimates for program participating refrigerators and freezers. These calculations are shown below:

Refrigerator UEC (kWh)

$$q(\text{Side-by-Side}) + 35.3 * 18.3(\text{Size}) + 25.25 * 24.3(\text{Age}) + 19.98 * 4.2(\text{Interaction}) - 413.99 = 1,441 \text{ kWh}$$

Freezer UEC (kWh)

$$\text{Freezer UEC} = [-190.28 + +25.11 * 24.35 (\text{age}) + 66.52 * 0.594(\text{dummy: 1990}) + 25.41 * 16.95 (\text{size, cu. ft.}) + 309.99 * 0.5 (\text{dummy: cohort}) - 6.91 * 1 (\text{dummy: freezer})] = 1,053 \text{ kWh}$$

Table 4-7 summarizes the full year UEC estimates for refrigerators and freezers.

Table 4-7: Full Year Average UEC Estimates for 2011-2013 Program

Appliance Type	Number of Verified Units	Average Full Year UEC
Refrigerator	19,180	1,075
Freezer	2,646	1,053

The values above do not yet represent final gross consumption or energy savings. To determine gross savings under the UMP definition, they must first be adjusted for part-use. Under the CA ARP definition, they must also be adjusted for certain appliance dispositions in the absence of the program.

4.3 Part Use Factors

One final adjustment to the full year UECs was made to account for the fact that not all refrigerators and freezers are plugged in year round. This part-use adjustment assigns different part-use factors based on three categories into which recycled appliances fall:

- 1) Some units that were recycled are not likely to operate at all in the absence of the program. The part-use factor for such units therefore would be zero.
- 2) Other units are likely to have operated part-time in the absence of the program. For these units, the part-use factor is calculated by dividing the number of months in the past year that the unit had been plugged in and running by the number of months in the year (i.e., 12). Based on data collected through the survey of participants, the average number of months in use for a secondary refrigerator that was being partly used was 3.75 months, implying a use factor of 0.3125 (i.e., 3.75/12). For freezers in this category, the use factor was calculated to be 0.542, reflecting an average of 6.5 months in use for freezers being partly used.
- 3) Units used all of the time have a use factor of one (1). It is assumed that all primary refrigerators operate year round.

The overall part-use factor and the corresponding part-use adjusted UECs are calculated as a weighted average across the three categories, where the weights are determined by the percentages of units falling into the three categories. The participant survey is used to determine the percentage of refrigerators that are primary units, and the part-use estimates for secondary refrigerators and freezers. Table 4-8 shows the calculation of the part-use adjusted UECs for refrigerators and freezers when partial use is taken into account.

Table 4-8: Historical Part-Use Calculation

<i>Operating Status of Unit</i>	<i>Percentage of Recycled Units in Category</i>	<i>Use Factor</i>	<i>Calculation of UEC to Adjust for Part Use</i>
<u>Refrigerators – Secondary (n=51)</u>			
Not running	7.84%	0	0
Running part time	7.84%	0.3125	336
Running all time	84.3%	1	1,075
Weighted Average for Secondary Refrigerators		0.87	933
<u>Refrigerators – All (n=135)</u>			
Not running	2.96%	0	0
Running part time	2.96%	0.3125	336
Running all time	94.1%	1	1,075
Weighted Average for Refrigerators		0.95	1,021
<u>Freezers (n=70)</u>			
Not running	0%	0	0
Running part time	5.4%	0.542	571
Running all time	94.6%	1	1,053
Weighted Average for Freezers		0.97	1,027

Finally, the part-use factors developed from participant responses about how the appliances were used in the past is combined with responses regarding what they would have done with the unit in the absence of the program. Depending on whether the unit would have been kept or discarded and how it would have been used if it had been kept, different part-use factors are appropriate. Table 4-9 shows the final, prospective part-use factors that are used to adjust full-year UECs.

Table 4-9: Prospective Part-Use Factor Calculation

Measure	Use Prior to Recycling	Likely Disposition in Absence of Program	Part-Use Factor	Percent of Survey Respondents
Refrigerator	Primary	Kept (as primary)	1	0%
		Kept (as secondary)	0.87	7%
		Discarded	0.95	57%
	Secondary	Kept	0.87	0%
		Discarded	0.95	36%
	Overall	All	0.94	100%
Freezer	All	Kept or Discarded	0.97	100%
	Overall	All	0.97	100%

The analysis above results in final part-use factor estimates of 94% for refrigerators and 97% for freezers. Based on the full year UEC estimation and part-use estimation, the part-use adjusted UEC for refrigerators recycled through the program is estimated to be 1,015 kWh; the part-use adjusted UEC for freezers recycled through the program is estimated to be 1,027 kWh.

4.4 Per-unit Gross Impacts

4.4.1 Per-unit Gross Annual Energy Savings (kWh)

Per-unit gross energy savings for recycled refrigerators and freezers is equal to the part-use adjusted UEC when using the standard UMP definition of gross savings. Therefore, per-unit gross annual energy savings as calculated in the previous sections are:

- Refrigerators (UMP gross) – 1,015 kWh per-unit
- Freezers (UMP gross) – 1,027 kWh per-unit

For comparison purposes, gross savings under the CA ARP definition were also estimated. This requires further adjustments to the part-use UECs by accounting for secondary market effects.²² The participant survey was used to estimate the percentage of appliances that would have been kept or discarded in the absence of the program. Units that would have been discarded could have ultimately been transferred to other SMUD customers (without considering free-riders – units that would have been destroyed even in the absence of the program).

²² The estimates of gross savings under the CA ARP methodology are estimated using a similar definition of the split between gross and net savings. They are not estimated using the exact methodology used in the 2010-2012 CA study.

Because the units recycled through the program are no longer available on the secondary market, would-be acquirers of these units must now make alternative decisions. They could acquire a different, non-program unit or they could forgo an acquisition. For those who do acquire alternative units, they can choose between used (similar to program units) or new (standard efficiency) units.

As described in Section 3.1.2, a mid-point approach is taken in this evaluation by assuming that 50% of the would-be acquirers find alternative units in the absence of the program. Similarly, it is assumed that 50% of the alternate units acquired are new and 50% are used. Standard efficiency new units are assumed to use 452 kWh annually for refrigerators and 443 kWh annually for freezers.²³ Table 4-10 shows the per-unit CA ARP gross savings per unit after accounting for secondary market effects. Per-unit gross annual energy savings as calculated under the CA ARP definition are:

- Refrigerators (CA ARP gross) – 684 kWh per-unit
- Freezers (CA ARP gross) – 706 kWh per-unit

Table 4-10: Per-Unit Gross Savings – CA ARP Definition

Disposition in Absence of Program	Percentage from Participant Survey (n=114 (ref), 66 (frz))	Would be acquirers find alternative unit	Alternative Unit Type	Proportion of Program Appliances	Energy Consumption without Program	Energy Consumption with Program	Savings (kWh)
Kept	Refrigerators: 7% Freezers: 11%	N/A	N/A	Refrigerators: 7% Freezers: 11%	Part-use UEC	None	Refrigerators: 1,015 Freezers: 1,027
Discarded	Refrigerators: 93% Freezers: 89%	Yes (50%)	Used (50%)	Refrigerators: 23% Freezers: 22%	Part-use UEC	Part-use UEC	Refrigerators: 590 Freezers: 597
			New (50%)	Refrigerators: 23% Freezers: 22%	Part-use UEC	Part-use NEW UEC	Refrigerators: 0 Freezers: 0
		No (50%)	N/A	Refrigerators: 47% Freezers: 45%	Part-use UEC	None	Refrigerators: 1,015 Freezers: 1,027
Total Per-Unit Gross Savings (CA ARP Definition)							Refrigerators: 684 Freezers: 706

Table 4-11 summarizes the per-unit gross annual savings estimates under both definitions (UMP and CA ARP).

Table 4-11: Gross per-Unit Annual Energy Savings (kWh)

Measure	Gross Savings Per-Unit (Annual kWh)	
	UMP	CA ARP
Refrigerator	1,015	684
Freezer	1,027	706

²³ AHAM Energy Efficiency and Consumption Trends 2012

4.4.2 Per-unit Gross Peak Demand Reduction (kW)

Per-unit gross peak demand reduction was calculated as described in Section 3.1.1.5 using the SMUD “heat wave” definition. The average program values shown in Table 4-6 were used for the modeling. Table 4-12 summarizes the average peak demand reduction estimated during the 4:00PM-7:00PM hours during a three consecutive weekday heatwave.

Table 4-12: Per-unit Gross Peak Demand Reduction

Measure	Per-unit Gross Peak Demand Reduction (kW - UMP)	Per-unit Gross Peak Demand Reduction (kW - CA ARP)
Refrigerator	0.157	0.106
Freezer	0.168	0.116

4.5 Net-to-Gross Ratio Estimation Results

ADM used the formula shown below to estimate net savings for recycled refrigerators and freezers. Note that this definition considers gross savings under the UMP definition. Secondary market impacts are already included in the CA ARP definition of gross savings. Each component of the net savings calculation is described in Section 3.1.2 of this report.

$$\text{Net Savings} = \text{Gross Savings} - \text{Freeridership} - \text{Secondary Market Impacts} - \text{Induced Replacement}$$

Where:

Gross Savings = The evaluated in situ UEC for the average recycled unit, adjusted for part use (UMP definition of gross savings);

Free-ridership = Program savings from units that would have been destroyed even in the absence of the program;

Secondary Market Impacts = Program Savings that would have occurred in the absence of the program based on the estimated/assumed counterfactual actions of appliance acquirers.

Induced Replacement = Average additional energy savings consumed by replacement units purchased due to the program.

Net savings are essentially calculated using a decision tree. The decision tree is populated with estimated percentages of appliance disposition in the absence of the program based on responses to the participant and non-participant surveys. In other words, participants' actions concerning discarded equipment are used to estimate savings values under all possible scenarios. The weighted average of savings under these scenarios is then used to calculate the net savings attributable to the program.

4.5.1 Free-ridership

Participant survey respondents were first asked if they had considered discarding the program appliance before learning about the program. Respondent answers to this question are shown in Table 4-13.

Table 4-13: Prior Consideration of Disposal

24. Had you already considered disposing of the [Appliance] before you heard about SMUD's appliance recycling program?	Measure	Response	Percent of Respondents (n=136 (ref), 74 (frz))
	Refrigerator		Yes
		No	35.3%
		Don't know	10.3%
Freezer		Yes	58.1%
		No	36.5%
		Don't know	5.4%

Respondents who indicated they had not considered disposal before learning about the program were considered non-free-riders. That is, for these respondents it was assumed they would have kept the appliance in use absent the program, since they hadn't considered disposal before learning about the program. Respondents who indicated they had considered disposal or "didn't know" if they had considered disposal were asked additional questions to determine whether the appliances they recycled were indicative of free-ridership.

Participant responses were combined with responses from nonparticipants who indicated they had recently disposed of a refrigerator to generate an overall estimate of refrigerator disposition absent the program. The number of nonparticipants who reported recently discarding a freezer was too small to produce any meaningful estimate (n=4). Thus, disposition in the absence of the program for freezers was determined solely based on participant survey responses.

Table 4-14 shows appliance disposition based on participant and nonparticipant survey responses. Table 4-15 shows the same calculation for freezers, based solely on participant survey responses.

Table 4-14: Refrigerator Discard/Keep Distribution

Discard/Keep	Proportion of Participant Sample (n = 136)	Sample	Discard Scenario	Weight	Proportion of Discards	Overall Proportion	
Discard	62.5%	Participant (n= 71)	Transfer	50%	44%		
			Destroy		56%		
		Nonparticipant (n= 100)	Transfer	50%	38%		
			Destroy		62%		
		Weighted Average	Transfer		41%		25.5%
			Destroy		59%		37%
Keep	37.5%					37.5%	

Table 4-15: Freezer Discard/Keep Distribution

Discard/Keep	Proportion of Participant Sample (n = 74)	Discard Scenario	Proportion of Discards (n=42)	Overall Proportion
Discard	62.2%	Transfer	50.0%	31.1%
		Destroy	50.0%	31.1%
Keep	37.8%			37.8%

4.5.1 Secondary Market Impacts

Secondary market impacts account for program effects on would-be acquirers of program units (since they are no longer available to acquire program units). Only units that would have been transferred absent the program are considered in the secondary market impact analysis. As detailed in Section 3.1.2, a midpoint approach is taken in this evaluation, based on the recommended of the UMP protocols. That is, 50% of would-be acquirers of program avoided transfers are assumed to find an alternate unit. Of those who are assumed to find an alternative unit, 50% are assumed to find a similar used unit, while 50% are assumed to purchase a new unit.

4.5.1 Induced Replacement

Induced replacement refers to a scenario in which the Recycling Program causes a program participant to purchase a replacement appliance. That is, the participant would not have replaced the refrigerator or freezer in the absence of the program. Participant survey respondents were asked a series of questions to determine whether replacement was induced. The final induced replacement estimates are shown in Table 4-16.

Table 4-16: Induced Replacement Rate by Measure

Measure	Induced Replacement Rate
Refrigerator (n=135)	7.4%
Freezer (n=74)	9.5%

4.5.1 Final Net-to-Gross Ratio

ADM determined final net savings as UMP gross savings less free-ridership, secondary market impacts, and induced replacement. Figure 4-1 depicts the complete net-to-gross ratio calculation for refrigerators. Figure 4-2 shows the same calculation for freezers.

Per-unit Gross Savings (UMP)	Appliance Disposition	Would-be acquirer finds an alternate unit	Alternate unit type	Proportion of Program (A)	Energy Consumption without Program (B)	Energy Consumption with Program (C)	Savings (D)
	Per-unit Gross Savings (UMP)	Transferred (25.5%)	Yes (50%)	Similar Used Unit (50%)	6%	1,015 kWh Part-use existing UEC	1,015 kWh Part-use existing UEC
New Unit (50%)				6%	1,015 kWh Part-use existing UEC	425 kWh Part-use New UEC	= 590 kWh
No (50%)				13%	1,015 kWh Part-use existing UEC	0	= 1,015 kWh
Destroyed (37%)				37%	0	0	= 0 kWh
Kept (37.5%)				38%	1,015 kWh Part-use existing UEC	0	= 1,015 kWh
Net_FR_SMI= Savings net of freeridership and secondary market effects							= 553 kWh
	Replaced Participant Unit	Program Induced replacement	Proportion of Program (E)	Energy Consumption with Program (F)	Energy Consumption without Program (G)	Savings (H)	
	Yes (80%)	Yes (7%)	6%	425 kWh Part-use New UEC	0	= 425 kWh	
		No (93%)	74%	425 kWh Part-use New UEC	425 kWh Part-use New UEC	= 0	
		No (20%)		20%	0	0	= 0
Induced_Consumption							= 26 kWh
Net_FR_SMI - Induced_Consumption = Per-Unit Net Savings (I)							= 528 kWh
NTGR							= 0.52

Figure 4-1: NTGR Calculation – Refrigerators

Appliance Disposition	Would-be acquirer finds an alternate unit	Alternate unit type	Proportion of Program (A)	Energy Consumption without Program (B)	Energy Consumption with Program (C)	Savings (D)
Transferred (31%)	Yes (50%)	Similar Used Unit (50%)	7.75%	1,027 kWh Part-use existing UEC	1,027 kWh Part-use existing UEC	= 0 kWh
		New Unit (50%)	7.75%	1,027 kWh Part-use existing UEC	430 kWh Part-use New UEC	= 597 kWh
	No (50%)		15.5%	1,027 kWh Part-use existing UEC	0	= 1,027 kWh
Destroyed (31%)			31%	0	0	= 0 kWh
Kept (38%)			38%	1,027 kWh Part-use existing UEC	0	= 1,027 kWh
Net_FR_SMI= Savings net of freeridership and secondary market effects						= 596 kWh
Replaced Participant Unit	Program Induced replacement	Proportion of Program (E)	Energy Consumption with Program (F)	Energy Consumption without Program (G)	Savings (H)	
Yes (57%)	Yes (10%)	5%	430 kWh Part-use New UEC	0	= 430 kWh	
	No (90%)	52%	430 kWh Part-use New UEC	430 kWh Part-use New UEC	= 0	
No (43%)		43%	0	0	= 0	
Induced_Consumption					= 23 kWh	
Net_FR_SMI - Induced_Consumption = Per-Unit Net Savings (I) = 573 kWh						NTGR = 0.56

Figure 4-2: NTGR Calculation – Freezers

4.6 Per-unit Net Impacts

4.6.1 Per-unit Net Annual Energy Savings (kWh)

Table 4-17 summarizes per-unit net annual energy savings for refrigerators and freezers.

Table 4-17: Per-unit Net Annual Energy Savings (kWh)

Measure	Per-unit Gross Savings (UMP)	NTGR	Per-unit Net Savings
Refrigerators	1,015 kWh	0.52	528 kWh
Freezers	1,027 kWh	0.56	573 kWh

4.6.2 Per-unit Net Peak Demand Reduction (kW)

Per-unit net peak demand reduction is calculated by multiplying the measure specific net-to-gross ratio estimates by gross savings, as shown in Table 4-18.

Table 4-18: Per-unit Net Peak Demand Reduction (kW)

Measure	Per-unit Gross Peak Demand Reduction (kW - UMP)	NTGR	Per-unit Gross Peak Demand Reduction (kW - UMP)
Refrigerator	0.157	0.52	0.082
Freezer	0.168	0.56	0.094

4.7 Overall Program Savings

Table 4-19 combines the number of verified refrigerators and freezers recycled through the program with ex post gross impact estimates to show program level gross energy savings and peak demand reduction. Table 4-20 shows program level net impacts.

Table 4-19: Ex Post Program Level Gross Impacts

Measure	Number of Verified Units	Ex Post Gross Annual Energy Savings (kWh - UMP)	Ex Post Gross Annual Energy Savings (kWh - CA ARP)	Ex Post Gross Peak Demand Reduction (kW - UMP)	Ex Post Gross Peak Demand Reduction (kW - CA ARP)
Refrigerator	19,180	19,467,700	13,119,120	3,011	2,033
Freezer	2,646	2,717,442	1,868,076	445	307
Total	21,826	22,185,142	14,987,196	3,456	2,340

Table 4-20: Ex Post Program Level Net Impacts

Measure	NTGR	Ex Post Net Annual Energy Savings (kWh)	Ex Post Net Peak Demand Reduction (kW)
Refrigerator	0.52	10,123,204	1,566
Freezer	0.56	1,516,158	249
Total	0.525	11,639,362	1,815

5. Process Evaluation Findings

This chapter presents findings related to program processes and customer feedback regarding the program. Key research questions addressed in this Chapter include:

- How effective is program promotion and marketing for encouraging program participation?
- How well do SMUD staff and the implementation team work together?
- What are the characteristics of units recycled through the program?
- What trends are there in program activity during the three-year period? What do these trends imply for program operations?
- Are program quality control and verification processes sufficient?
- Is the appliance pickup process operating as intended?
- Are program participants satisfied with the program?

These questions were addressed through a series of research activities, including the following:

- **Program Data and Documentation Review:** ADM reviewed program documents including the program website, promotional materials, and program tracking data supplied by the implementation contractor.
- **Program Staff Interviews:** ADM completed four interviews with program staff. These interviews were performed with the SMUD program manager, the JACO program manager, a JACO staff member responsible for retail partnerships, and the president of the firm that completes the household appliance pickups.
- **Participant Survey:** SMUD customers who participated in the program during the 2011 – 2013 program cycle completed a telephone survey. The purpose of the participant survey was to evaluate customer perceptions of the program and gauge overall program satisfaction and to collect data for use in the calculation of net savings. The survey design focused on customer decision-making and overall experience with the program, while gaining an understanding of how effectively the program is meeting customer needs.
- **Nonparticipant Survey:** A survey of non-participants was performed using randomly selected telephone numbers for residential customers in the SMUD service territory. The primary purpose of the survey was to collect data for the calculation of net savings. The survey focused on appliances that were discarded or acquired by SMUD customers in the previous five years. Additionally, customers were asked about their awareness of the recycling program and their likelihood of participating in the future.

5.1 Program Description and Process

The following sections describe the program design, operations and participation process. This material was developed through review of program documentation and program staff interviews.

5.1.1 Program Design

The Recycling Program provides an incentive to customers who recycle a qualified refrigerator or freezer through the program. During the 2011-2013 period, the program incentive was \$35 per unit. During 2013, incentives varied during the year from the base \$35 level. The incentive levels and corresponding time periods are shown in Table 5-1. The program currently offers a \$50 incentive for recycling an appliance.

Table 5-1 Incentives Offered During 2013

Period	Incentive Level
1/1/13 – 3/31/13	\$35
4/1/13 – 5/31/13	\$50
6/1/13- 8/10/13	\$35
8/11/13 – to current	\$50

SMUD customers can recycle a full sized refrigerator or freezer through one of two channels: through directly contacting JACO or through signing up at a participating retailer when they purchase a new appliance. The program works with the following retailers:

- Sears
- Manual Joseph
- RC Willey
- Filco
- Best Buy

Program staff has expressed an interest in recruiting Lowes and Home Depot as additional retailer partners. However, there are concerns about those retailers being able to adhere to the program chain of custody requirements. These requirements ensure that that each recycled appliance can be tracked from customer pickup to recycling. Lowes and Home Depot use third party delivery services that are not currently set up to meet these requirements.

5.1.2 Program Marketing and Outreach

The Refrigerator/Freezer Recycling Program is promoted through a variety of channels. These include bill inserts, print advertisements, and more recently, television advertisements.

Additionally the program has run a series of promotions to encourage program participation. As previously mentioned, the program offered a promotional incentive of \$50 per unit in 2013 around Earth Day. Additionally, in 2013 the program had two promotional contests. One of these contests ran from April 1st to May 31st and was a sweepstakes for a garage remodeling that program participants were entered in. The sweepstakes was promoted through a bill mailing, radio and print advertisement, direct mail, internet advertising, and through press releases. The second promotion was a contest to win a vacation package to Half Moon Bay that program participants were entered in. This promotion ran from the end of July through September 15th and was promoted through radio and print advertisement, press releases, event marketing and internet advertising. Additional contests were held during 2014. One was a contest where a SMUD customer could win a mattress set if they recycled a freezer or refrigerator during a three-month period. Another contest that ran during the summer of 2014 included a three-day, two night stay at a hotel in Napa as the prize. Again, customers were entered if they recycled a refrigerator or freezer. These contests were promoted using radio advertisements, email blasts, search and display advertising, print ads, SMUD's E-Newsletter, and on the utility's Facebook page.

A significant change in the program's marketing strategy was that in 2013, SMUD began using internal staff to develop and execute the program marketing strategy. Prior to this change, an external marketing firm managed the program marketing. This change was made because staff realized that they could market the program at a lower cost.

Another significant channel for promoting the program is through its participating retailers. Participating retailers market the program through displaying point of purchase materials promoting the program and promotion by sales staff. JACO partners with ICF in its promotion of materials in retailers. ICF implements other SMUD programs that offer rebates on appliances in the same retail outlets. Coordinating with ICF allows for efficient program administration because site visits can serve multiple purposes. JACO and ICF staff provides training to retailer sales staff and ensure that point of sales promotional materials are stocked. Between JACO and ICF staff, retailers are visited once a month at the minimum.

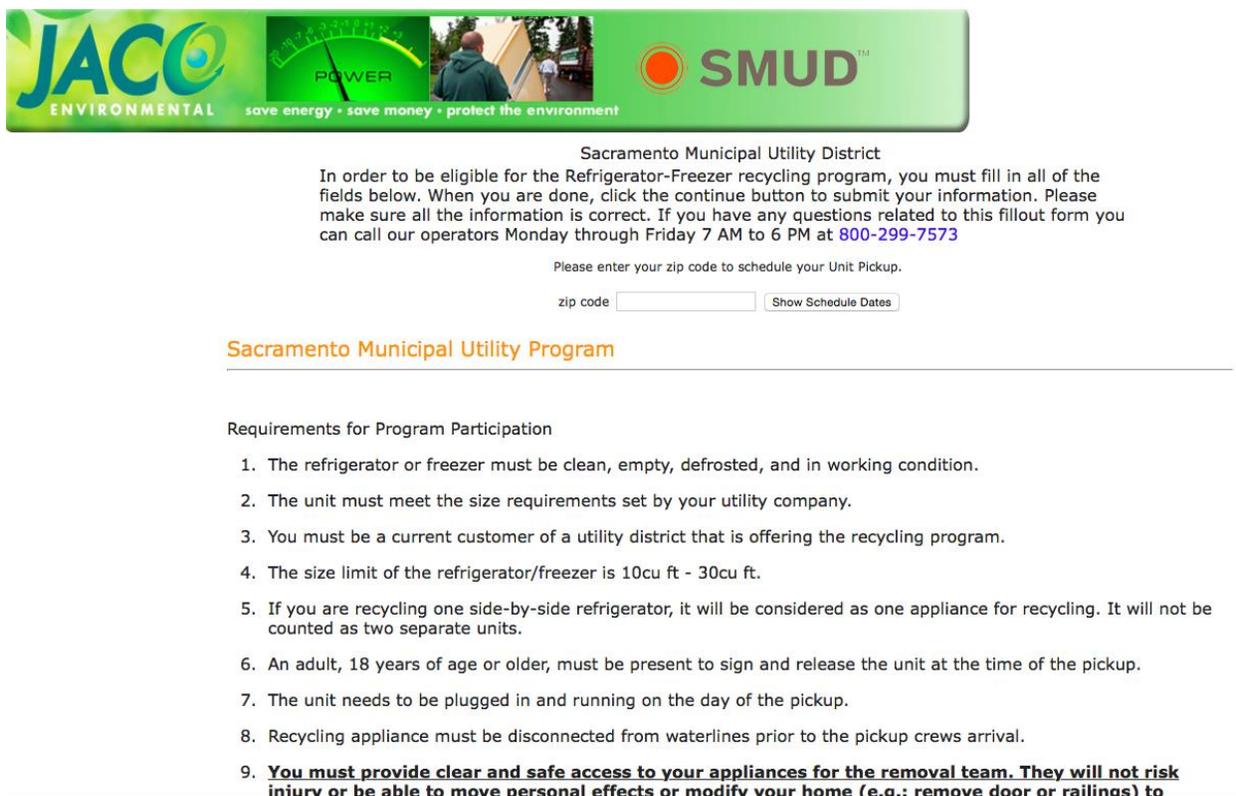
5.1.3 Program Participation Process

The program participation process differs for customers who recycle the appliance directly through JACO and those that recycle appliances through participating retailers. Each process is described below.

5.1.3.1 Pickups Scheduled through JACO

The customer participating in the program through JACO initiates participation in the program by enrolling online or by telephoning the JACO call center whose number. The program promotional materials directs customers to the program website which links to the JACO site. Customers that click on the link to recycle the unit are directed to a page that displays telephone contact information and allows scheduling of the pickup through the website. The website also displays participation qualifications. The JACO website is identified with the SMUD logo in order to maintain continuity with the program sponsor.

Figure 5-1 displays the internet portal. As shown, the portal informs the customer that they can contact the telephone number at the top or enter their the zip code information in order to begin the process of scheduling the pickup online.



Sacramento Municipal Utility District

In order to be eligible for the Refrigerator-Freezer recycling program, you must fill in all of the fields below. When you are done, click the continue button to submit your information. Please make sure all the information is correct. If you have any questions related to this fillout form you can call our operators Monday through Friday 7 AM to 6 PM at [800-299-7573](tel:800-299-7573)

Please enter your zip code to schedule your Unit Pickup.

zip code

Sacramento Municipal Utility Program

Requirements for Program Participation

1. The refrigerator or freezer must be clean, empty, defrosted, and in working condition.
2. The unit must meet the size requirements set by your utility company.
3. You must be a current customer of a utility district that is offering the recycling program.
4. The size limit of the refrigerator/freezer is 10cu ft - 30cu ft.
5. If you are recycling one side-by-side refrigerator, it will be considered as one appliance for recycling. It will not be counted as two separate units.
6. An adult, 18 years of age or older, must be present to sign and release the unit at the time of the pickup.
7. The unit needs to be plugged in and running on the day of the pickup.
8. Recycling appliance must be disconnected from waterlines prior to the pickup crews arrival.
9. **You must provide clear and safe access to your appliances for the removal team. They will not risk injury or be able to move personal effects or modify your home (e.g.: remove door or railings) to**

Figure 5-1 Program Internet Portal

Customers enrolling online are guided through a series of steps to collect information to verify that the customer and unit is qualified. If the customer contacts the call center, their eligibility to participate is reviewed through a series of screening questions. These questions include verifying that the customer is a residential customer within the appropriate service territory and confirming the size and functionality of refrigerators or freezers. Customers who sign up are verified using utility records provided to JACO. These records indicate whether or not the participant is a residential customer in the SMUD service area.

Customers are given a choice of dates to schedule a pickup, generally within a two-week window. However, it should be noted that when ADM accessed the website, only one date was provided.²⁴ Additionally, there was no mechanism to request a different date.

Appliance Distribution performs the appliance pickup. Appliance Distribution interfaces with the JACO database to acquire data for scheduling pickups and entering pickup information. An automated call is placed with customers 24-48 hours before the appliance is picked up to remind them of the appointment. On the day of the pickup, drivers call customers 30 minutes prior to the pickup time. Officially, appliances are picked up within a four-hour scheduled window. The appointment times are scheduled using zip code data and software designs schedules and routes to maximize the number of sites that can be reached during a driver's shift. On the day of the pickup, drivers call customers 30 minutes prior to the pickup time.

During the pickup, the pickup crew enters the customer's residence and verifies that the refrigerator or freezer is plugged in and in working condition. Customers must be home during the pickup time to sign over the unit and verify that no damage occurred during the pickup. If the customer is not home at the pickup time the driver photographs the house as a verification that they were at the location at a specific time of day.

The pickup crew collects information about the appliance and records information such as unit age, make, and type. The appliance is then rendered inoperable by cutting the cord, breaking the cold control unit, and cutting a hole in it. The appliances are then taken to a facility in Hayward, CA for recycling.

After the appliance is picked up, JACO processes the rebate check that is mailed to the customer. JACO then invoices SMUD monthly for the cost of the rebates paid to customers.

5.1.3.2 Retailer Partner Units

Customers participating through a retail partner enroll in the store to have the appliance recycled. Participating customers are given a sticker that they take home and place on the unit to be recycled. The appliance is picked up during the delivery of the customer's new appliance. During the pickup, the driver verifies that the unit meets program requirements. The unit is then picked up but it is left in working condition. After pickup, the unit is stored at the appliance retailer for a period of time until a batch of 10-12 units has accrued. Once a sufficient number of units have been collected, the units are then taken to the Hayward facility for recycling. Randomly sampled units at the Hayward facility are selected to verify that they are working.

²⁴ Website accessed on December 17, 2014. Only date made available was for December 29th.

5.1.4 Appliance Recycling Crew Human Resource Management

Appliance Distribution Inc. provided information on their hiring, training, and pay processes. These are described below.

In order to be hired for a pickup crew position at Appliance Distribution, applicants must pass a background check and a pre-hire drug test. Additional drug testing is performed at random, after an accident, and at based on suspicion. Additionally, driving records are reviewed during for driver applicants.

Once hired, staff receives a minimum of one week of training. The training covers pickup procedures and safety. The training includes “classroom” training as well as on the job training. Typically two to three days is spent on classroom training during which new hires learn the policies and procedures. New hires are also provided a new hire handbook. The classroom training is followed by three to six days of on the job training during which the new hire accompanies a driver.

Appliance Distribution has a national safety committee that reviews policies and removal procedures, on a monthly basis, to ensure that minimal damage occurs during pickup and that other accidents are avoids. Additionally, once a week, managers participate in webinars. Many of these webinars cover safety topics. The following day, managers have safety meeting with crews to discuss what was discussed on the webinars.

The company reports that they have minimal turnover and estimated that each member of the Sacramento crew has at least five years of experience. Appliance crews are paid based on number of units picked up.

5.1.1 Program Communications

SMUD and its contractors have regular meetings to discuss the program progress, goals, and marketing and outreach strategies. These meetings are attended by the SMUDs program manager, SMUDs program planner who works on the development of three year star, ICF field representatives, and JACO staff. Additionally, the SMUD program manager has frequent communications with JACO staff. SMUD and JACO staff indicated that communications were effective.

5.2 Analysis of Program Activity

The following sections describe the program activity during the 2011 to 2013 cycle in terms of the size, usage, and vintage of units; and level of program activity during the period.

5.2.1 Number of Units Picked up During the Program Cycle

The number of units recycled for each program year is shown in Table 5-2. The 2012 and 2013 program years each saw an increase of 15% from the prior year in the annual number of units recycled during the program year.

Table 5-2 Number of Units Recycled Each Year

Pickup Year	Total Units	Percent Increase from Prior Year
2011	6,567	-
2012	7,531	15%
2013	8,652	15%

Figure 5-2 displays the number of units picked up during each month of the three-year cycle. The shaded gray area covers the period of time during which the program offered a \$50 incentive as opposed to the standard \$35 incentive and the shaded purple area covers the periods during which the two 2013 promotional contests were held. The highest periods of monthly activity occurred during the periods when the promotional contests were held and the incentive levels were \$50.

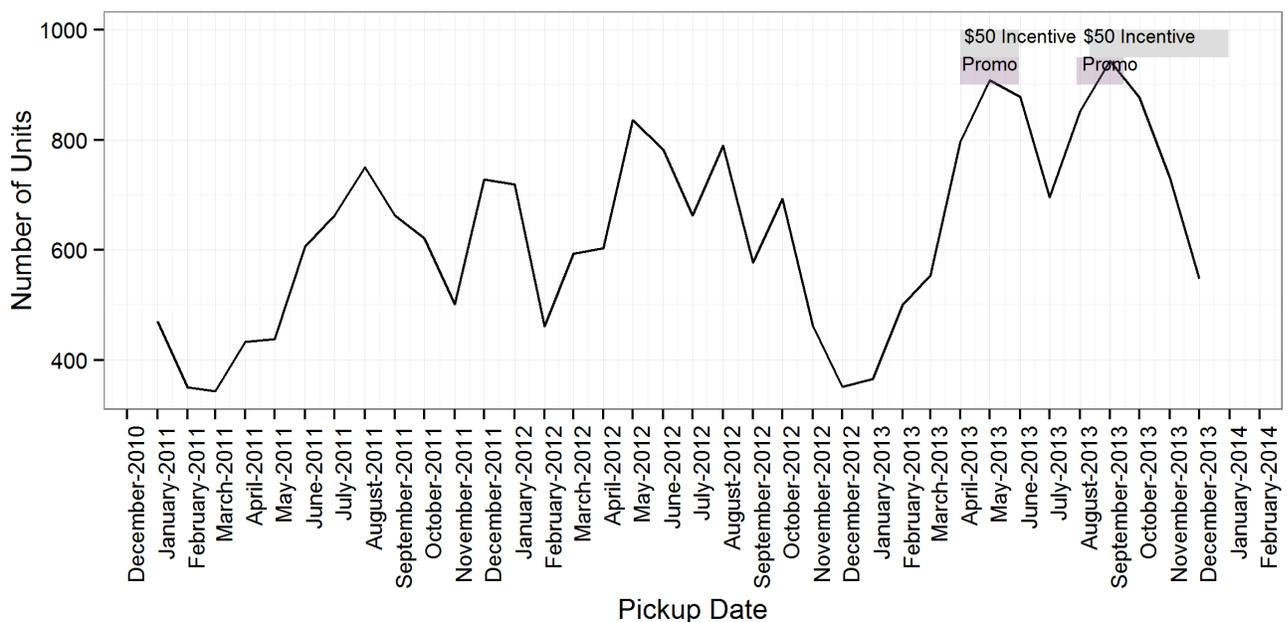


Figure 5-2 Unit Pickups by Month

Figure 5-3 displays the number of units picked up during each week of the three-year cycle. Again, the shaded gray area covers the period of time during which the program offered a \$50 incentive as opposed to the standard \$35 incentive and the shaded purple

area covers when the promotional contests were held. The red line represents a three week rolling average of program activity.

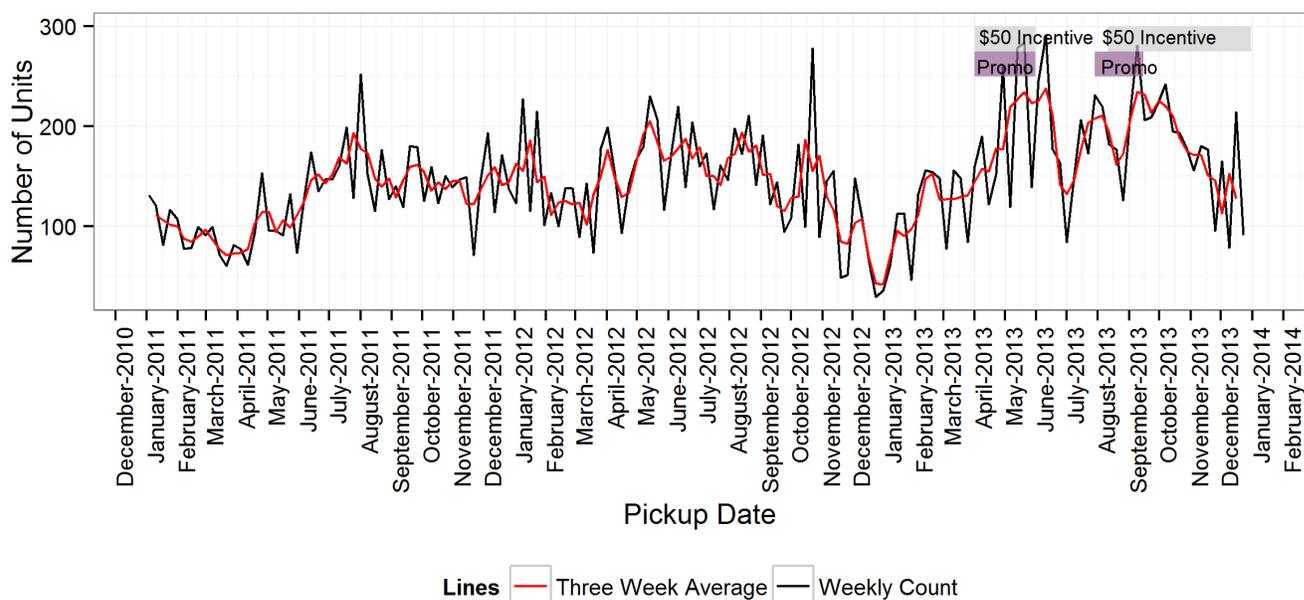


Figure 5-3 Unit Pickups by Week

5.2.2 Size of Units Recycled

Table 5-3 displays the size of unit for each year of the program cycle. During the three-year period, the size of units remained consistent. On average, freezers were approximately 17 cubic feet and refrigerators were approximately 20 cubic feet.

Table 5-3 Average Size of Freezers and Refrigerators by Program Year

Pickup Year	Freezers			Refrigerators		
	Number of Units	Percent of Units	Average Size (cubic feet)	Number of Units	Percent of Units	Average Size (cubic feet)
2011	792	12%	17.1	5,775	88%	20.3
2012	1,002	13%	16.8	6,529	87%	20.5
2013	1,044	12%	16.9	7,608	88%	20.5

5.2.1 Unit Usage

How the units were used prior to recycling is shown in Table 5-5. In a large number of cases the usage was unknown. However, the number of units for which usage was unknown was considerably higher during the 2011 program year than in 2012 and 2013,

suggesting some improvement in data collection. For the units with known usage, the share of primary units recycled decreased in 2013 from 2012.

Table 5-4 Type of Use

Pickup Year	Total Units	Primary Unit	Secondary Unit	Not in Use	Unknown
2011	6,567	38%	16%	4%	42%
2012	7,531	51%	23%	2%	24%
2013	8,652	36%	38%	0%	26%

As shown in Table 5-5 the majority of units were used during all months of the year. Very few units were known to be operating during specific months of the year and the amount of usage was unknown for a large share of units.

Table 5-5 Year Round and Seasonal Usage

Pickup Year	Total Units	All Months	Winter	Spring/ Fall	Summer	Not in Use	Unknown
2011	6,567	57%	<1%	<1%	<1%	0%	43%
2012	7,531	72%	<1%	<1%	<1%	<1%	27%
2013	8,652	69%	<1%	<1%	<1%	1%	30%

The share of units for each program year located in air-conditioned space is shown Table 5-6. These results suggest that a large share of the units recycled were located in unconditioned spaces where their summer energy use and peak demand use is likely to be higher than for units located in conditioned space.

Table 5-6 Whether or Not Units were Located in Air Conditioned Space

Pickup Year	Total Units	Yes	No	Unknown
2011	6,567	19%	81%	<1%
2012	7,531	29%	61%	11%
2013	8,652	14%	43%	42%

5.2.1 Vintage of Units Recycled

The distribution of unit vintages is shown for each of the three program years in Figure 5-4. There was substantial variability in the vintages of the units recycled through the program and overall distribution of unit vintage remained relatively consistent during each of the three program years. However, the median year of manufacture increased by about one year during each program year. This demonstrates a trend toward newer and more efficient units recycled through the program, and confirmed an observation by JACO staff. As a result, the potential per-unit savings for the program is declining and this may present long term challenges to the program remaining cost effective.

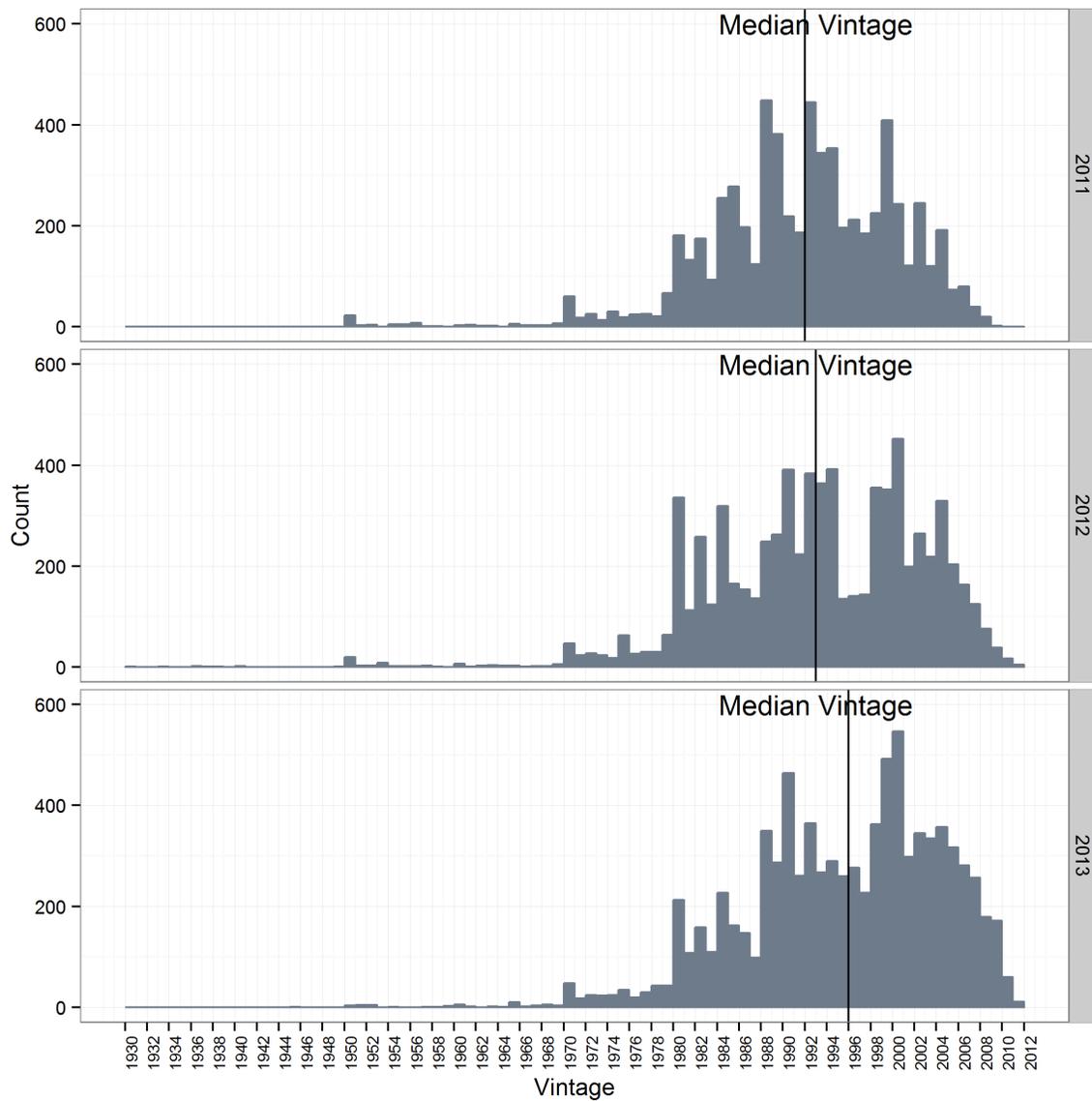


Figure 5-4 Unit Vintage

Table 5-7 displays the average of age of the recycled appliances. As shown the average age decreased in 2013, which corresponds with the change in appliance vintage shown in the figure above.

Table 5-7 Average Age of Recycled Appliances

Pickup Year	Total Units	Average Age (Years)
2011	6,567	19.6
2012	7,531	19.4
2013	8,652	18.0

5.2.1 Order Placement and Processing Time

Approximately 78% of the recycling orders were placed through the call center as shown in Table 5-8. Relatively few orders were placed through retailers, although the share increased from 1% in 2011 to 4% in 2012 and 2013. Overall, these findings demonstrate that the call center is the primary channel for receiving and scheduling orders.

Table 5-8 Method of Order Placement

Pickup Year	Total Units	Internet Orders	Retail Orders	Call Center Orders
2011	6,291	20%	1%	79%
2012	7,276	19%	4%	77%
2013	8,428	18%	4%	78%

The average number of days between order placement and pickup of the unit, and between pickup and when the check was sent, are shown for year in Table 5-9. As shown, the average number of days to have the unit(s) picked up remained fairly consistent from year-to-year, ranging from 9 days in 2013 to 8 days in 2012. This indicates that customers are readily able to find a convenient time for the unit pickup. The amount of time required to process the order and send the check was also relatively short. The median days to process the pickup and send the check ranged from 24 in 2011 to 31 in 2012.

Table 5-9 Number of Days for Pickup and Sending Check

Pickup Year	Number of Units	Average Days from Order to Pickup	Average Days from Pickup to Receive Check
2011	6,567	9	24
2012	7,531	9	27
2013	8,652	8	31

5.3 Participant Survey Findings

The following sections present findings from a sample of program participants. In total, 585 program participants were contacted by telephone. Interviews were completed with 210 of these participants. Response dispositions for the contacts are shown in Table 5-10.

Table 5-10 Survey Response Dispositions

Description	Total
Technical Difficulties	9
Soft Refusal	71
Disconnected Number	87
Business Number	14
Language Barrier	8
Refused	4
Wrong Number (Dead)	52
Fax Machine / Modem / Pager	3
Blocked call - Call screener refusal	3
Language Barrier - Spanish	10
Dropped Call	38
Respondent Terminated - Screener Break Off	1
Respondent Terminated - Qualified Break Off	46
Quota Full	4
Complete	210
Other Non-Connect	25
Total:	585

The number of survey respondents by appliance type recycled and year of participation is shown in Table 5-11.

Table 5-11 Survey Respondent Description

Appliance Type	Year of Participation			Total
	2011	2012	2013	
Refrigerators	45	44	47	136
Freezers	25	26	23	74
Total	70	70	70	210

Based on collected data, 77% of program participants live in single-family homes and 10% participants live in manufactured or mobile homes. Eight percent chose to not disclose their type of residence. The remaining participants live in two to three family attached residences, apartments, or condos.

Eighty-four percent of participants own their homes and 7% rented their homes; the remainder either did not know or would not state whether they rented or owned their home.

Fifteen percent of respondents reported that they had previously participated in a SMUD energy efficiency program in the last three years. As shown in Table 5-12, some of the

programs the participants had participated in included receiving rebates for purchasing new HVAC systems, energy efficient lighting, window replacements, tree services, solar installations, and the appliance-recycling program.

Table 5-12 Programs Survey Respondents Previously Participated In

Response	n	Percent
Appliance recycling program	11	39%
HVAC	8	29%
Lighting rebates	3	11%
Windows	3	11%
Tree program	1	4%
Solar program	1	4%
Water heater	1	4%

Seventeen percent of participants indicated that they have a kitchen appliance they plan to recycle in the next three years. The most frequently mentioned type of appliance was a refrigerator.

Table 5-13 Appliances Participants Plan to Recycle

Response	n	Percent
Refrigerator	14	50%
Stove	11	39%
Microwave	7	25%
Dishwasher	5	18%
Freezer	2	7%
Washing machine	2	7%
Toaster oven	2	7%
Clothes Dryer	1	4%

5.3.1 Program Awareness

Participants were asked how they first learned of SMUD's appliance recycling program. Twenty-two percent of participants first became aware of the program through an insert in their monthly bill. Sixteen percent heard of the program through word-of-mouth through a friend or relative. Ten percent of respondents learned of the program through a retailer and 8% learned of the program online or from SMUD's website.

Table 5-14 Initial Source of Program Awareness

	Response	Percent of Respondents (n=210)
How did you first learn about SMUD's appliance pick-up and recycling program?	Bill insert	23%
	Friend or Relative (word-of-mouth)	16%
	Retailer/store	10%
	Online/SMUD Website	8%
	Newspaper/magazine/print media	6%
	TV ad	5%
	SMUD Brochure	5%
	Radio	3%
	SMUD Representative	2%
	Billboard / Sign	1%
	Email	1%
	Other	4%
	Don't know	15%
	Refused	0%

5.3.1 Decision Making

The most frequently mentioned reason for participating in the program, mentioned by 36%, was to receive cash incentive payment. The second most common reason for participation, mentioned by 21% of respondents, was the convenience of the recycling service. The third most common reason, given by 15% of survey respondents, was because it was a free pickup service. These responses suggest that both the incentive dollars and the convenience of the service were important motivations for participating in the program.

Seventy-one percent of participants said they replaced the recycled appliance with a new one. Of the respondents who stated they replaced their recycled unit with a new appliance, 87% indicated that they would have purchased the new appliance if the recycling program had the recycling program not been available. This suggests that few participants are purchasing new appliances because of the availability of the program rebate.

Participants were asked if they had considered removing and disposing of the appliance before they heard of SMUD's appliance recycling program. Slightly more than one-half (56%) of participants said "yes", indicating that the program is motivating the disposal of appliances in addition to preventing them from being reused.

One-third of participants said that had they not participated in the program they would have taken their appliance to the dump or recycling center. This response would indicate some measure of free-ridership, or non-program induced disposals. However, the specific level is based on multiple survey responses and the single question cannot

be considered to represent program free ridership on its own. Other commonly mentioned options for what would have been done with the appliance, each mentioned by 10% of respondents, were that the participant would have given it to a charitable organization or that they would have sold it to a private party. A relatively small share of participants (3%) stated that they would have sold the appliance to an appliance detailer.

Table 5-15 What Respondents Would Have Done If They Had Not Recycled the Appliance through the Program

Response	Percent of Respondents (n=210)
Taken it to a dump or recycling center	33%
Sold it to a private party	10%
Given it away to a charity organization, such as Goodwill Industries or a church	10%
Given it away to a private party, such as a friend or a neighbor	8%
Kept it and continued to use it	7%
Put it on a curb with a "Free" sign on it	6%
Hired someone to take it to a dump or recycling center	5%
Had it removed by the dealer you got your new or replacement refrigerator from	4%
Sold it to a used appliance dealer	3%
Kept it and stored it unplugged	1%
Gotten rid of it some other way	<1%
Don't know	13%
Refused	0%

Participants were asked if they would have participated in the program if the amount of the rebate was less but the appliance pick up was still provided at no cost. Seventy-three percent said yes, 13% said maybe, and 8% said no. Of those who said they would have participated with a smaller rebate, 78% said they would have still participated if no rebate were offered at all. These responses suggest that the convenience of the service is a key motivator for participating in the program. However, the responses may also reflect response bias. Participants may be aware of the environmental benefits of appliance recycling and may have been reluctant to indicate that they were motivated by the incentive.

During 2013, there were two periods of time during which participants received a \$50 incentive of instead of the \$35 incentive. Table 5-16 displays the differences in willingness to participate without an incentive by amount of incentive received. A smaller share of participants who received the \$50 incentive would have participated if no

rebate was offered than among those who received the \$35 incentive.²⁵ This finding suggests that the higher \$50 incentive is considered to be more of a motivator or participating than the \$30 incentive.

Table 5-16 Participation without Incentive by Incentive Level

Incentive Level	Would you have participated in the program with no rebate check altogether, but appliance pick-up was still provided at no cost?	
	Yes	No
\$35 (n=128)	91%	9%
\$50 (n=33)	76%	24%
Chisq = 5.431, df = 1, p-value = 0.02		

5.3.1 Appliance Characteristics

The average age of surveyed participants' appliances was 16 years and the age of the appliances ranged from 1 to 57 years old. As shown in Table 5-17, 52% of participants said their recycled appliance was their household's primary unit.

Table 5-17 Share of Respondents who Recycled Primary and Secondary Units

Was the old [Appliance] your primary or secondary (spare, auxiliary) unit?	Response	Percent of Respondents (n=210)
		Primary
Secondary		44%
Don't know		4%
Refused		0%

Survey respondents were asked a series of questions about the operational condition and amount the recycled unit was used. As shown in Table 5-18, 94% of respondents indicated that the unit was plugged in and operating during the prior year. Relatively few survey respondents indicated that the appliance was only running during special occasions (2%) or during certain months of the year (1%). Additionally, only two percent of survey respondents indicated that the appliance was not used at all. These findings are generally consistent with data on usage collected by JACO.

²⁵ The difference in the share of participants who stated they would not have participated in the program with a smaller incentive was not statistically different for those who received the \$35 versus \$50 incentives.

Table 5-18 Operation of the Recycled Unit

	Response	Percent of Respondents (n=210)
Thinking about the year prior to recycling the [Appliance], was it plugged in and running ...	All the time	94%
	For special occasions only	2%
	During certain months of the year only, or	1%
	Never plugged in or running	2%
	Don't know	0%
	Refused	0%

Participants who indicated that their appliance was not running all of the time indicated whether or not it was still in working condition. Most (78%) said that it was. One respondent indicated that it was not working and another respondent stated that it worked but would not produce cold air. Overall, this suggests that only a handful of participants recycled appliances that were not operating.

5.3.1 Participation Process

As shown in Table 5-19, 94% of respondents indicated that they were able to schedule the pickup for at a time that was convenient to them.

Table 5-19 Convenience of Appointment Scheduling

	Response	Percent of Respondents (n=210)
Were you able to schedule the pick-up for a time that was convenient for you?	Yes	94%
	No	1%
	Don't know	4%
	Refused	0%

The average number of days it took SMUD to pick up the participant's appliance was seven days with a range of one day to 30 days. Ninety-eight percent of participants felt this was a reasonable amount of time. Only one respondent said the amount of time was not reasonable. This respondent reported that it took 14 days to have the appliance picked up and that five days would have been a reasonable amount of time.

Participants are supposed to receive two reminder calls about the appliance pickup: a confirmation call placed approximately 24-48 hours before the pickup and a reminder call placed shortly before the pickup. As shown in These findings do not suggest that the participants are not receiving the reminder calls.

Table 5-20, large shares of respondents did not recall whether or not these calls were placed. However, only 2% reporting not receiving a confirmation call and 6% reported not receiving the reminder call. These findings do not suggest that the participants are not receiving the reminder calls.

Table 5-20 Placement of Confirmation and Reminder Calls

Response	Before the pick-up date, did someone call to confirm the date and time of your scheduled pick up? (n=210)	On the pick-up date, were you called by the program to let you know someone would be arriving soon? (n=210)
Yes	58%	45%
No	2%	6%
Don't know	39%	48%
Refused	0%	0%

None of the participants stated that the technician picking up the appliance behaved unprofessionally.

Ninety percent of participants had received their rebate at the time of the survey. Only 3% had not and 7% didn't know if they had received it yet.

5.3.1 Staff Contacts

Participants were asked how often they contacted SMUD or program staff with questions in the course of participating in SMUD's program. As shown in Table 5-21, 50% of participants said they never contacted SMUD or program staff and 42% said they contacted staff at least once. Eighty-five percent of these communications were by telephone and 5% were by email. Only 1% of respondents indicated that they were dissatisfied with their communications with SMUD or program staff.

Table 5-21 Frequency of Staff Contacts during Participation

	Response	Percent of Respondents (n=210)
In the course of participating in SMUD's program, how often did you contact SMUD or program staff with questions?	Never	50%
	Once	36%
	2 or 3 times	5%
	4 times or more	1%
	Don't know	0%
	Refused	8%

5.3.1 Program Satisfaction

Survey respondents rated their satisfaction with various program elements and the program overall. As shown in Figure 5-5 Participant Satisfaction, program participants were generally satisfied with the program with few reporting dissatisfaction.

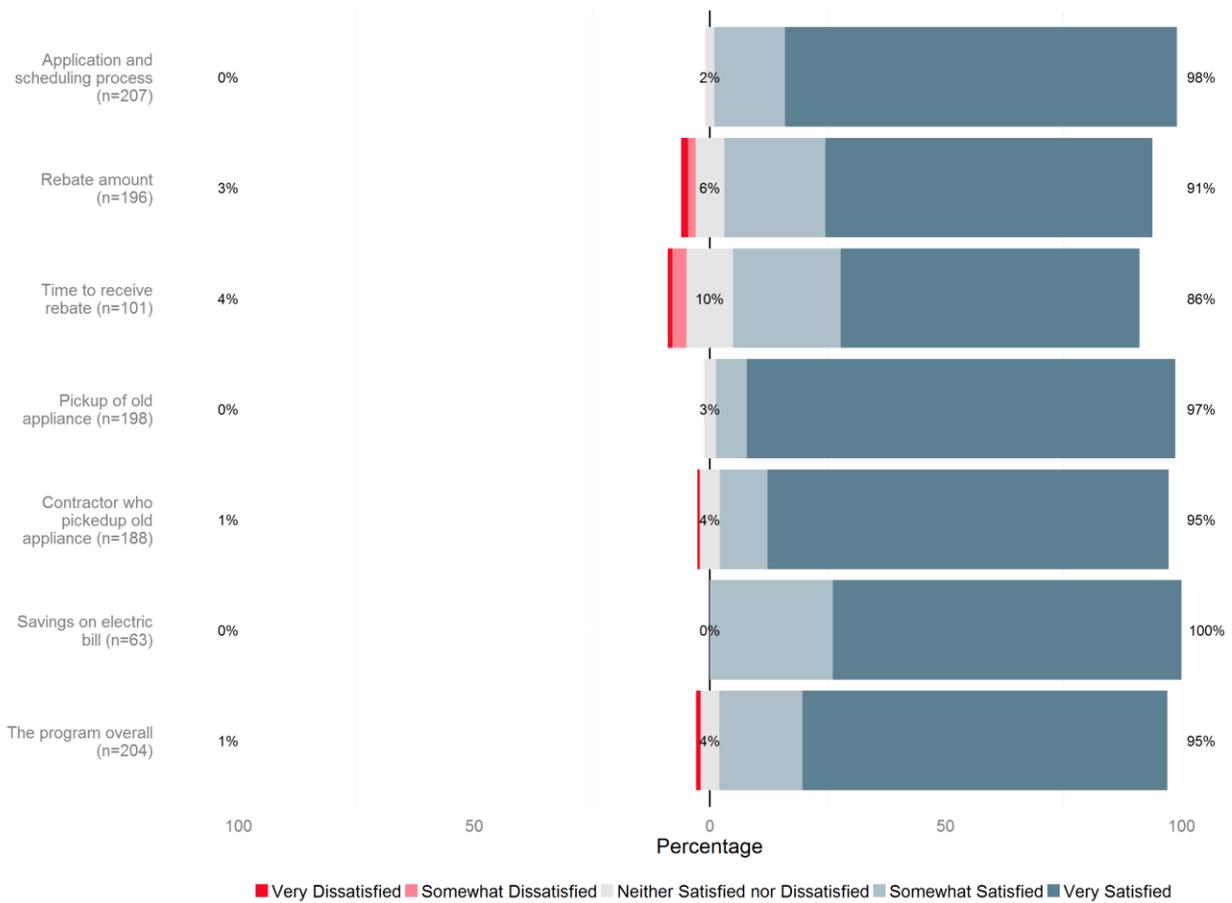


Figure 5-5 Participant Satisfaction

Respondents were asked to provide additional comments about the reason for their level of satisfaction with the program. Their responses are shown below in Table 5-22. These results highlight the value that participants place on how smooth the participation process is, the convenience of the service, and the rebate amount. As shown, the most common source of dissatisfaction was the length of time it took to receive the incentive check, although only four participants stated that this was a reason for their dissatisfaction.

Table 5-22 Categorized Reasons for Overall Satisfaction or Dissatisfaction

Reasons for Satisfaction	n	Percent*
Smooth process	77	42%
Easy/Convenient	63	34%
Rebate	35	19%
General satisfaction	12	6%
Environmental benefit	10	5%
Happy with SMUD	3	2%
Easy to find information	1	1%
Energy savings are a benefit	2	1%
Easy to find information	1	1%
Reasons for Dissatisfaction		
Took too long/Didn't receive rebate	5	3%
Rebate was small	4	2%
Electric savings smaller than expected	2	1%
Waste of money	1	1%
Difficulty with scheduling	1	1%

5.3.1 Suggestions for Improvement

A few participants provided suggestions for improving the program. Their suggestions are categorized and displayed in Table 5-23.

Table 5-23 Suggestions for Program Improvement

Response	n	Percent
Higher rebate	7	39%
More advertisements	5	28%
Quicker rebate payback	4	22%
Do survey earlier	2	11%
Better pick up times	1	6%

5.4 Non-Participant Survey Findings

A sample of 6,372 randomly selected telephone numbers in the SMUD service territory were dialed for the purpose of administering the non-participant survey to residents. Contacts were screened for whether or not they had disposed of a full-size refrigerator or a freezer in the last five years or acquired a used appliance in the same period of time. In total, 194 respondents indicated that they had discarded or acquired an appliance. However, in subsequent questioning, nine of these respondents could not recall how many appliances were discarded or indicated that they had not discarded any. These respondents were not asked any questions about the discarded appliance.

In total, 157 respondents had discarded an appliance and 36 had acquired an appliance.²⁶

Including discarders that could not report on how many appliances they had discarded, the total number of respondents were classified as having not discarded or acquired an appliance was 512. The share of respondents who discarded an appliance was 23% and the share of respondents who had acquired a used appliance was 5%.

Response dispositions for the contacts are shown in Table 5-10.

Table 5-24 Survey Response Dispositions

Description	Total
Technical Difficulties	4
Soft Refusal	219
Disconnected Number	3
Business Number	35
Language Barrier	113
Refused	159
Wrong Number (Dead)	2
Fax Machine / Modem / Pager	22
Blocked call - Call screener refusal	28
Language Barrier - Spanish	103
Dropped Call	175
Respondent Terminated - Screener Break Off	6
Respondent Terminated - Qualified Break Off	12
Did not Acquire or Discard Appliance	503
Complete	194
Other Non-Connect	4794
Total:	6,372

The following sections summarize the findings from the non-participant survey.

5.4.1 Appliance Discarder Responses

Reasons given by participants for choosing to dispose of their appliance are displayed in Table 5-25. Respondents most commonly disposed of appliances because they were not working well (31%) or because they got a new unit and the old one was unneeded (28%).

²⁶ Some respondents acquired and discarded an appliance.

Table 5-25 Reasons for Appliance Disposal

	Response	Percent of Respondents (n=157)
Why did you decide to get rid of your [Appliance]?	It wasn't working well	31%
	Got a new unit and didn't need the old one	28%
	It used too much energy	10%
	Cosmetic reason/Didn't like appearance	10%
	I didn't use it often/at all	2%
	Other	18%
	Don't know	0%
	Refused	0%

All of the respondents indicated that the appliance was in working condition, as shown in Table 5-26. However, 18% of the respondents noted that it was in need of major repair.

Table 5-26 Condition of Appliance at Disposal

	Response	Percent of Respondents (n=157)
What was the condition of the [Appliance] just before you disposed of it?	It worked and was in good condition	54%
	It worked but needed minor repair	26%
	It worked but needed major repair	18%
	Or, it didn't work	0%
	Other	0%
	Don't know	3%
	Refused	0%

Table 5-27 displays the ages of the disposed appliances. The modal age range of the disposed of appliances was between 10-14 years old.

Table 5-27 Age of Disposed Appliance

	Response	Percent of Respondents (n=157)
At the time you got rid of it, approximately how old was the [Appliance]?	Less than five years old	5%
	5-9 years old	16%
	10-14 years old	30%
	15 -19 years old	16%
	20-30 years old	12%
	More than 30 years old	5%
	Don't know	16%
	Refused	0%

As shown in Table 5-28, 31% of respondents indicated that they disposed of the appliance through an appliance dealer from whom they purchased a new appliance. It is possible that a large share of these disposals occurred through participating retailers in the SMUD program and that these customers received a rebate for the appliance. Additionally, 29% of customers indicated that they disposed of the appliance through the SMUD program. Together, these findings suggest that upwards of 60% of disposed appliances were recycled through the program. The responses also show that approximately another 30% of the appliances were disposed through other means that took them out of use, permanently.

Table 5-28 Disposal Method

	Response	Percent of Respondents (n=157)
How did you dispose of this [Appliance]?	Had it removed by the dealer I purchased a new unit from	31%
	Used the SMUD Appliance Recycling Program	29%
	Gave it away to a private party, such as a friend or a neighbor	16%
	Took it to the dump or recycling center	6%
	Sold it to a private party	5%
	Got rid of it some other way	4%
	Hired someone to take it to a dump or recycling center	3%
	Sold it to a used appliance dealer	1%
	Gave it away to a charity organization, such as Goodwill or a Church	1%
	Put it on a curb with a "free" sign on it	1%
	Kept it and stored it unplugged	0%
	Don't know	3%
	Refused	0%

Forty-seven percent of customers indicated that they had disposed of their appliance because it was the easiest option. This suggests that convenience of the disposal method is an important factor in customer decision making.

Table 5-29 Reason for Choosing Disposal Option

	Response	Percent of Respondents (n=157)
Why did you choose that option for getting rid of the unit?	Least expensive option	6%
	Easiest option	47%
	Other	39%
	Don't know	8%
	Refused	0%

When asked how much they got when they sold the appliance, the average value for the five respondents was \$53. Respondents who discarded the appliance using a method that may have potentially had a cost associated with it were asked to report how much the disposal method cost them. Ninety-four percent of respondents stated that they paid nothing to dispose of the appliance and the remainder paid an average of \$26 to dispose of it.

Table 5-30 Amount Paid for Appliance Disposal

How much money, if any, did you pay to get rid of the [Appliance]? (n=63)	Percent of Respondents Who Paid Nothing	Average Amount for those Who Paid Something
	94%	\$26

5.4.2 Appliance Acquirer Responses

Survey respondents were asked if they had acquired any used refrigerators or freezers in the last five years. Table 5-31 displays the share of used appliances acquired that were refrigerators and refrigerators. As shown most appliances (81%) were refrigerators.

Table 5-31 Type of Appliance Most Recently Acquired

Type of Appliance Most Recently Acquired	Percent of Respondents (n=36)
Refrigerator	81%
Freezer	19%
Don't know/Refused	0%

Fifty-three percent of survey respondents indicated that the acquired appliance was an additional unit while another 44% indicated that it was a replacement unit.

Table 5-32 Whether or Not the Appliance was a Replacement or an Additional Unit

	Response	Percent of Respondents (n=36)
Was the appliance a replacement or an additional unit?	Replacement	44%
	Additional units	53%
	Don't know	3%
	Refused	0%

Two-thirds of appliances that were acquired were less than 10 years old and a relatively large (22%) share were not sure of the age of the acquired appliance.

Table 5-33 Age of Purchased Appliance

	Response	Percent of Respondents (n=36)
Approximately how old was the [Appliance] when you got it?	Less than five years old	42%
	5-9 years old	25%
	10-14 years old	11%
	15 -19 years old	0%
	20-30 years old	0%
	More than 30 years old	0%
	Don't know	22%
	Refused	0%

A majority of the survey respondents (53%) indicated that they obtained the appliance for free from a family, friend, or neighbor. Twenty-eight percent of respondents stated that they purchased the appliance from an appliance dealer.

Table 5-34 Source for Appliance Purchase

	Response	Percent of Respondents (n=36)
Where did you get this [Appliance]?	Given to me for free by (family / friend / neighbor)	53%
	Purchased from a used appliance dealer	28%
	Purchased from (family / friend / neighbor)	6%
	Obtained for free through (Craigslist / newspaper ad / classified ad)	3%
	Purchased from (Craigslist / newspaper ad / classified ad)	3%
	Obtained for free through (charity / church / organization)	0%
	Purchased from (charity / church)	0%
	Other	6%
	Don't know	0%
Refused	0%	

5.4.1 Likelihood of Recycling Appliance in the Future and Program Awareness

Survey respondents were also asked questions about their likelihood of disposing of a refrigerator or freezer in the next three years. Sixteen percent stated they were somewhat or very likely to dispose of an appliance.

Table 5-35 Likelihood of Disposing of Appliance in Next Three Years

	Response	Percent of Respondents (n=194)
How likely is it that you will be disposing of a refrigerator or freezer that you currently own sometime within the next 3 years?	Not at all likely	78%
	Somewhat likely	7%
	Very likely	9%
	Don't know	6%
	Refused	1%

All survey respondents were asked how they would likely dispose of an appliance in the future. Twenty-two percent said that they would dispose of it through the SMUD program and another 19% stated that they would dispose of it through the retailer from whom they purchase a new unit, and another 12% stated that they would recycle it.

Table 5-36 Likely Method of Disposal

	Response	Percent of Respondents (n=194)
What method of disposal are you most likely to use when you get rid of your next refrigerator or freezer?	Recycle it through SMUD program	22%
	Trade it in to retailer that I purchase new unit from	19%
	Recycle it	12%
	Give it away	8%
	Junk it/have it hauled off to dump	7%
	Sell it	6%
	Unplug and store it	0%
	Other	6%
	Don't know	22%
	Refused	0%

As shown in Table 5-37, 59% of the survey respondents reported that they were aware of SMUD's recycling program. This is a relatively high level of awareness and suggests that the program has been effective in informing customers about the rebates available. Additionally, as shown in Table 5-38, a large share of respondents stated that they were somewhat or very likely to recycle their appliance through the SMUD program.

Table 5-37 Awareness of the Appliance Recycling Program

Aware of SMUD Refrigerator Recycling Program	Percent of Respondents (n=194)
Yes	59%
No	38%
Don't know	3%
Refused	1%

Table 5-38 Likelihood of Recycling through the Program

	Response	Percent of Respondents (n=194)
SMUD's program pays a \$35 to \$50 incentive for recycling and will haul away your old working refrigerators for free. How likely would you be to use this program as opposed to other methods of refrigerator or freezer disposal?	Not at all likely	5%
	Somewhat likely	20%
	Very likely	67%
	Don't know	6%
	Refused	2%

6. Conclusions and Recommendations

6.1.1 Program Impacts

Table 6-1 summarizes per-unit impacts for recycled refrigerators and freezers. Ex post gross and net per-unit annual energy savings are lower than SMUD ex ante estimates, though they are relatively similar to estimates developed in the evaluation of the 2009-2010 Recycling Program. The ex ante estimates SMUD provided for the 2011-2013 program cycle are the same as those used for the 2009-2010 cycle. Thus, the previous evaluation findings were not used to update ex ante assumptions for 2011-2013.

Table 6-1: Gross and Net Per-unit Annual Energy Savings

Appliance Type	Ex Ante Gross Per Unit Annual kWh Savings	Ex Post Gross Per Unit Annual kWh Savings (UMP)	Ex Post Gross Per Unit Annual kWh Savings (CA ARP)	Gross Realization Rate (UMP)	NTG Ratio	Ex Ante Net Per Unit Annual kWh Savings	Ex Post Net Per Unit Annual kWh Savings	Net Realization Rate
Refrigerators	1,161	1,015	684	87%	0.52	675	528	78%
Freezers	1,161	1,027	706	88%	0.56	675	573	85%

Table 6-2 provides the per-unit peak demand reduction estimates compared to ex ante values. Overall, the ex post peak demand reduction estimates are relatively similar to ex ante estimates.

Table 6-2: Gross and Net Per-unit Peak Demand Reduction

Appliance Type	Ex Ante Gross Per Unit Peak kW Reduction	Ex Post Gross Per Unit Peak kW Savings (UMP)	Ex Post Gross Per Unit Peak kW Reduction (CA ARP)	Gross Realization Rate (UMP)	NTG Ratio	Ex Ante Net Per Unit Peak kW Reduction	Ex Post Net Per Unit Peak kW Reduction	Net Realization Rate
Refrigerators	0.153	0.157	0.106	103%	0.52	0.089	0.082	92%
Freezers	0.153	0.168	0.116	110%	0.56	0.089	0.094	106%

Table 6-3 combines the verification rates and the estimated per-unit impacts to produce program level estimates of gross and net savings. Gross savings estimated using the UMP definition and CA ARP definition are included in the table along with net-to-gross ratio and net savings estimates.

Table 6-3: Program Level Gross and Net Impacts

Evaluation Result	SMUD Ex Ante	Evaluation Ex Post	Realization Rate
<i>Refrigerators</i>			
Number of Working Appliances Recycled	19,912	19,180	96%
Gross Annual Savings - UMP (kWh)	23,117,832	19,467,700	84%
Gross Peak Demand Reduction - UMP (kW)	3,047	3,011	99%
NTGR	0.58	0.52	89%
Net Annual Savings (kWh)	13,440,600	10,123,204	75%
Net Peak Demand Reduction (kW)	1,772	1,566	88%
<i>Freezers</i>			
Number of Working Appliances Recycled	2,838	2,646	93%
Gross Annual Savings (kWh)	3,294,918	2,717,442	82%
Gross Peak Demand Reduction (kW)	434	445	102%
NTGR	0.58	0.56	96%
Net Annual Savings (kWh)	1,915,650	1,516,158	79%
Net Peak Demand Reduction (kW)	253	249	99%
Total			
Number of Working Appliances Recycled	22,750	21,826	96%
Gross Annual Savings (kWh)	26,412,750	22,185,142	84%
Gross Peak Demand Reduction (kW)	3,481	3,456	99%
NTGR	0.58	0.56	96%
Net Annual Savings (kWh)	15,356,250	11,639,362	76%
Net Peak Demand Reduction (kW)	2,025	1,815	90%

Overall, ex post net energy savings were estimated at approximately 76% of ex ante claims. The realization rate reflects lower per-unit savings estimates, deductions based on the verified number of working units recycled, and a slightly lower net-to-gross ratio estimate. The ex ante per-unit savings used by SMUD have remained the same since 2009. However, while the average age of appliances recycled through the program has remained similar, the corresponding average vintage is increasing. As a more significant portion of appliances recycled through the program are manufactured after the first DOE appliance efficiency standard became effective (1993), average per-unit savings will decrease.

The overall net peak demand reduction realization rate is 90%. The approach used to estimate peak demand reductions by specifically modeling SMUD “heat wave” temperature conditions resulted in slightly higher peak demand savings than previous evaluations of the program. The peak demand realization rate is higher than the annual energy savings realization rate primarily because of this change in methodology.

6.1.1 Summary of Process Evaluation Findings

This section presents the high level findings and recommendations developed through process evaluation activities for the 2011-2013 Recycling Program.

- **Program Participation Process is Working Well:** Ninety-four percent of program participants said they were able to schedule a convenient time for the appliance pickup, all participants said the pickup crews behaved professionally, and 99% of participants who had communications with program staff were satisfied with these communications. Additionally, 98% of the respondents indicated that the number of days it took schedule the appliance pickup was reasonable. Tracking data also suggest that appliance pickups were scheduled in nine days on average and the average number of days to process the check was 28 days.
- **Incentive Level is Appropriate:** The \$50 incentive level is consistent with the rebate offered through many other appliance recycling programs and is also consistent with the rebate offered by other California utilities. Although it is based on a small sample size, the average price paid for used appliances by non-participant survey respondents was \$53. Additionally, the \$50 incentive may have been a contributing factor to higher levels of participation in 2013.
- **Program Participants Satisfied:** Ninety-five percent of program participants said they were either satisfied or very satisfied with the Recycling Program overall. Additionally, 97% and 98% indicated satisfaction with the scheduling process and the actual pickup of the appliance. Commonly given reasons for satisfaction were that the process was smooth and that it was easy or convenient.
- **Increasing Participation and Program Awareness:** The number of units recycled increased each year of the program cycle indicating that the program has been effective in generating activity. The most frequently mentioned source of program awareness was a bill insert followed by information acquired by word of mouth. Additionally, the survey of non-participants found that 59% of respondents were aware of the program, suggesting that many SMUD customers are aware of the rebate available.

Since 2013 program marketing has been developed and managed by SMUD. The sustained level of program activity and the lower cost of providing program marketing in-house suggest that this has been an effective and efficient strategy. Additionally, the program has implemented innovative promotional campaigns to keep levels of program activity high.

- **Sustaining Cost-Effective Savings may be Challenging:** Each year the appliances recycled through the program are of more recent vintage. As result the per unit electricity savings is declining over time because newer appliances consume less electricity. This creates challenges for the program to maintaining cost-effectiveness if the operational costs remain stable.

6.1.2 Recommendations

Overall, the Recycling Program is operating well with no significant issues. However, the following recommendations are offered in the interest of further program improvement.

- **Ensure that the Website Offers Multiple Pickup Dates:** During a review of the program website, the evaluator was only presented with one date for scheduling an appliance pickup. This may have been anomalous but it would be beneficial if the website software was programmed such that more than one date was presented to the customer and that the customer would have the option of requesting additional days not displayed.
- **Make Unit Eligibility Requirements on SMUD and JACO Website Consistent:** During a review of the website, staff noted that the unit size requirements were stated as 10-27 cubic feet on the SMUD website but were stated as 10-30 cubic feet on the JACO website. These values should be changed to be consistent.
- **Consider Strategies for Ensuring Long Term Cost-Effectiveness:** As the appliances recycled through the program are of increasingly newer vintage, the potential per unit savings is declining. Over the long term this may effectively reduce cost effectiveness of the program. Strategies for ensuring long-term cost-effectiveness include incorporating non-energy benefits into the testing²⁷ and focusing on older more efficient appliances by changing eligibility requirements and reducing the operational scale of the program.
- **Update Ex Ante Impact Assumptions to Reflect Evaluation Findings:** The ex ante savings assumptions used for 2011-2013 were the same values used for 2009-2010. A prior evaluation in 2011 estimated savings values that were lower than those used for 2009-2010, but those findings were not utilized for 2011-2013. Energy consumption of recycled refrigerators and freezers is highly correlated with appliance vintage. Newer appliances, especially those manufactured after 1993, use considerably less energy than older units. It is

²⁷ Keeling, J., Pal, A., Chen, C. (2013). ARPs are RAD: How to Incorporate Environmental Benefits from Appliance Recycling Programs into Cost-Effectiveness Calculations.

important moving forward to use regularly updated ex ante savings assumptions as the average vintage of program appliances increases.

- **Consider Leaving Cooling Unit Operational at Pickup:** As is typically found in evaluations of recycling programs, a few respondents reported that their appliance was not working at the time of pickup. Other service territories have procedures that require the pickup crew to leave the cooling unit operational and the cord uncut so that the working condition of the appliance can be verified at the recycling center. The unit can still be disabled at the time of pick-up by damaging the appliance shell.
- **Consider conducting studies related to the secondary market for appliances:** A critical aspect to understanding savings developed through appliance recycling programs is the operation of the market for used appliances (both peer-to-peer and through traditional used appliance dealers). Unfortunately, this market is difficult and costly to study. There are some studies within California that address the secondary market to some extent, but none are specific to the SMUD service territory.

Appendix A. Metering Equipment and Protocols

To perform the monitoring of a refrigerator/freezer at a site, ADM technicians first gained access to the electrical outlet where the appliance is normally plugged in. In the event that the appliance needed to be moved to gain access to the outlet, appliance skids were used as necessary. The skids allow for easy movement of the units while limiting the possibility of damaging surrounding flooring materials.

While the refrigerator has been moved from its usual location, a portable plug-in meter (Extech EM100 Energy Monitor, see Figure 6-1) is used to make one-time measurements of true rms power, voltage, current and power factor.



Figure 6-1: Extech EM100 Plug-In Meter with Display

Electrical monitoring of the refrigerator or freezer is conducted by the field technician using a plug-in logger developed by ADM. The ADM Appliance Logger (see Figure 6-2) measures true RMS power and records actual energy use. This monitoring box is designed to be easy to use. It has a three prong plug on a cord and one receptacle outlet on the face of the box. The box contains a WattNode watt-hour transducer with an accuracy of $\pm 0.5\%$ and a 20 Amp precision current transducer with an accuracy of $\pm 1\%$. The output from the watt-hour transducer is recorded onto a battery powered logger inside the box. The logger has non-volatile memory and can store more than a year of data.

The appliance logger is plugged into the wall outlet used by the refrigerator or freezer. The refrigerator's power cord is then plugged into the receptacle on the Appliance Logger box. This allows for quick and easy installation of the monitoring equipment and is generally unobtrusive for the customer.



Figure 6-2: ADM's Plug-In Appliance Logger

The Appliance Logger is prepared prior to installation and activated to record data in 5-minute intervals. The five-minute interval data provides high resolution of the energy use profiles and captures compressor cycling. For residential appliance recycling, this level of resolution is important for capturing an accurate depiction of the duty cycle, as the units do not operate under constant loading.

Past refrigerator and freezer metering efforts (including the SMUD data from 2006 and 2011) have also included measurement of ambient and cabinet temperature. This metering effort did not include temperature metering, as the delta temperature between outside air and appliance cabinet is not easily extrapolated to the population of program appliances.

Digital photographs are taken of the internal contents of the refrigerator or freezer, both at the time when the monitoring equipment is installed and when it is removed. Additional data is collected about each monitored unit and recorded on a field data collection form. This data includes:

- Type of unit: Refrigerator or Freezer
- Door style: Single-door, Top Freezer – Bottom Refrigerator, Top Refrigerator – Bottom Freezer, Side-by-side, Upright or Chest
- Size in cubic feet.
- Make and model
- Is it frost-free or manual defrost?
- Does it have a through-the-door ice and water dispenser?
- How old is the appliance?

- If unit is being replaced, then what type of unit will replace it?

The targeted length of monitoring for each appliance was between 10 and 14 days, though a small number of units fell below this threshold due to the short period available to meter before the appliance was collected for recycling. The length of metering for all units used in the evaluation model was 11 days. Two defrost cycles is considered to be the minimum monitoring period to adequately capture the refrigerator energy use for annual consumption extrapolation. Refrigerator-only units do not have a defrost cycle.

Before leaving a customer's home, the technician ensures that the conditions of the refrigerator and its surrounding areas remain the same as prior to the installation. The customer is given a local or toll-free phone number to call if there are any questions or problems with the monitoring equipment.

The data collection form used to record information during the metering equipment installation process is provided in Figure 6-3.

Technician Name: _____
 Order ID Number: _____

SMUD Refrigerator Recycling Program On-Site Monitoring Data Form

Customer Name: _____ Phone: _____
 Address: _____ City: _____

Appliance Information

Type (please circle one) REFRIGERATOR / FREEZER

Configuration (please circle one) UPRIGHT / CHEST / ONE DOOR / TWO DOOR / SBS / TOP FREEZER / BOTTOM FREEZER

Through the door water or ice? _____

Defrost Type _____

Household Information

of Occupants _____

Usage Information

Usage (PRI/SEC) _____ (please ask if unit is operating normally or if it is plugged in only for the test period) _____

Year-round or seasonal usage (if seasonal, please note months/year) _____

Location _____ How long at this location? _____

Conditioned space? _____

Food storage amount? _____

Estimated door openings/week _____

Nameplate Information

Manufacturer _____

Model No. _____

Voltage _____ Amps _____

Mfg. Date _____

Unit Size (ft³) _____

One-Time Measurements

Volts: _____

Amps: _____

kW: _____

pf: _____

Logger Information

Plug-In Logger SN: _____

Lighting Logger SN: _____

Temperature Logger SN: _____

Date Installed: _____

Time: _____

Date Removed: _____

Time: _____

Notes:

Figure 6-3: On-Site Metering Data Collection Form

Appendix B. Participant Survey

Sacramento Municipal Utility District (SMUD) Refrigerator/Freezer Recycling Program Participant Telephone Survey

Interviewer: _____ Date of Interview:
_____/_____/_____

Respondent: _____ Address: _____
May I please speak with [CONTACT NAME]: _____)?

*Hello. My name is _____ and I am calling on behalf of **Sacramento Municipal Utility District (SMUD)** about the Refrigerator/Freezer Recycling Program that your household participated in back in ____ **[Month/Year of Participation]**. Are you the person who is most familiar with having a refrigerator, freezer, and/or room air conditioner picked up for recycling through **SMUD's** program?*

(IF NOT RIGHT PERSON) May I please speak to the person who would know the most about the appliance that was picked up for recycling?

REPEAT INTRODUCTION AND CONTINUE

*(IF RIGHT PERSON) We are conducting a study to evaluate **SMUD's** Refrigerator/Freezer Recycling Program. **SMUD** will use the results of this evaluation to determine the effectiveness of the program and to make improvements. We would like to include your feedback about the program in our evaluation. The interview will take approximately 15 minutes. May I ask you a few questions?*

IF REFUSAL: THANK AND TERMINATE

VERIFICATION

1. Our program records indicate that you had ____ (**quantity of refrigerators and/or freezers**) picked up for recycling through the Refrigerator/Freezer Recycling Program around (**date of pickup**). Is that correct?
 1. Yes
 2. No
 98. Don't know
 99. Refused

2. **[IF Q1=2]** How many refrigerators and/or freezers did you have recycled through the Refrigerator/Freezer Recycling program?
 1. _____ **[Record Quantity of Each Appliance]**

- 98. Don't know
- 99. Refused

AWARENESS

3. How did you first learn about **SMUD's** appliance pick-up and recycling program? **[Do not read, prompt if necessary. Choose One.]**
- 1. Newspaper/magazine/print media
 - 2. Bill insert
 - 3. Friend or Relative (word-of-mouth)
 - 4. TV ad
 - 5. SMUD Representative
 - 6. SMUD Brochure
 - 7. Retailer/store
 - 8. Other **[Specify]**_____.
 - 98. Don't know
 - 99. Refused
4. Did you hear about the program from any other sources? If so, which sources? **[Check all that apply.]**
- 1. No other sources
 - 2. Newspaper/magazine/print media
 - 3. Bill insert
 - 4. Friend or Relative (word-of-mouth)
 - 5. TV ad
 - 6. SMUD Representative
 - 7. SMUD Brochure
 - 8. Retailer/store
 - 9. Other **[Specify]**_____.
 - 98. Don't know
 - 99. Refused

PICK-UP PROCESS

5. Starting with the first time you contacted the program about recycling your **[IF TOT_QTY = 1: appliance; if TOT_QTY > 1: appliances]** about how many days passed before the program picked up your **[IF TOT_QTY = 1: appliance; if TOT_QTY > 1: appliances]**?
- ___ Number of Days
- 98 Don't know
 - 99 Refused

6. **[Skip if Q5= 98 or 99]** Do you feel that this was a reasonable amount of time?
(Select one)

- 1. Yes **[SKIP TO Q8]**
- 2. No
- 98. Don't know **[SKIP TO Q8]**
- 99. Refused **[SKIP TO Q8]**

7. **[IF Q6=2]** What do you feel would have been a reasonable number of days?

- ___ Number of Days
- 98. Don't know
 - 99. Refused

8. Were you able to schedule the pick-up for a time that was convenient for you?
(Select one)

- 1 Yes
- 2 No
- 98. Don't know
- 99. Refused

9. Before the pick-up date, did someone call to confirm the date and time of your scheduled pick up? **(Select one)**

- 1 Yes
- 2 No
- 98. Don't know
- 99. Refused

10. On the pick-up date, were you called by the program to let you know someone would be arriving soon? **(Select one)**

- 1 Yes
- 2 No
- 98. Don't know
- 99. Refused

11. Did the technician who removed your **[IF TOT_QTY = 1: appliance; if TOT_QTY > 1: appliances]** behave professionally? **(Select one)**

- 1 Yes
- 2 No
- 98 Don't know
- 99 Refused

12. **[IF Q11=2]** Why do you say that?

[RECORD VERBATIM]

APPLIANCE DESCRIPTION AND RECYCLING DECISION

13. **IF [TOT_QTY] = 1:** Now I'm going to ask you some specific questions about the **[refrigerator, freezer]** that was picked up and recycled by **SMUD**.

IF [TOT_QTY] > 1: I'd like to focus on just one of the appliances you recycled through **SMUD**'s program. It does not matter which appliance you choose, just that you respond with only that appliance in mind. Can you tell me which appliance you've selected to tell me about?

1. ____ Refrigerator
2. ____ Freezer

14. How old was your **[refrigerator, freezer]**? **[Record response in years, enter "00" if less than one year]**?

1. _____ **[Record years]**
98. Don't know
99. Refused

15. Was the old **[refrigerator, freezer]** your primary or secondary (spare, auxiliary) unit?

1. Primary
2. Secondary
98. Don't know
99. Refused

16. For the majority of the year prior to recycling, where within your home was the **[refrigerator, freezer]** located?

1. Kitchen
2. Garage
3. Porch/patio
4. Basement
5. Living room
6. Family room
7. Bedroom
8. Hallway
9. Other **[Specify]** _____
98. Don't know
99. Refused

17. Thinking about the year prior to recycling the [refrigerator, freezer], was it plugged in and running ... **[Read all]**
1. . All the time **[Skip to Q19]**
 2. . For special occasions only
 3. . During certain months of the year only, or
 4. . Never plugged in or running **[Skip to Q19]**
 98. Don't know
 99. Refused
18. If you were to add up the total amount of time it was running in the year prior to being picked up, how many months would that be? Your best estimate is okay. **[Get nearest month]**
1. . _____ **[Record number of months 1-11]**
 2. . All the time
 98. Don't know
 99. Refused
19. Was the [refrigerator, freezer] still in working condition when it was picked up? By working condition I mean did the unit turn on and produce cold air?
1. . Yes **[Skip to Q21]**
 2. . No
 3. . It worked but had some problems
 98. Don't know **[Skip to Q21]**
 99. Refused **[Skip to Q21]**
20. What was wrong with the unit? **(If respondent is unsure, ask "would it turn on and produce cold air?")**
1. Wouldn't turn on
 2. Wouldn't keep food/room cold ENOUGH
 3. Wouldn't keep food/room cold at all
 4. Too loud
 5. Don't know, but would produce cold air
 6. Don't know, but would NOT produce cold air
 7. Other **[Specify]** _____
 98. Don't know
 99. Refused
21. Did you replace the old [refrigerator, freezer] with a new unit?
1. Yes
 2. No
 98. Don't know
 99. Refused

22. **[IF Q21=1]** Would you have purchased a replacement **[refrigerator, freezer]** even if **SMUD's** recycling program had not been offered?
1. Yes
 2. No
 98. Don't know
 99. Refused
23. **[IF Q22=1]** Let me be sure I understand. Are you saying that you chose to purchase a new appliance because of SMUD's appliance recycling program, or are you saying you would have purchased a new appliance regardless of the program?
1. Purchased new because of program
 2. Would have purchased a new appliance regardless
 98. Don't know
 99. Refused
24. Had you already considered disposing of the **[refrigerator, freezer]** before you heard about **SMUD's** appliance recycling program? By dispose of, I mean getting the appliance out of your home by any means including selling it, giving it away, having someone pick it up, or taking it to the dump or a recycling center yourself.
1. Yes
 2. No
 98. Don't know
 99. Refused
25. What would you have most likely done with the **[refrigerator, freezer]** had you not disposed of it through **SMUD's** program?
- [Read list unless respondent indicates choice without reading the list]**
1. Sold it to a private party
 2. Sold it to a used appliance dealer
 3. Kept it and continued to use it
 4. Kept it and stored it unplugged
 5. Given it away to a private party, such as a friend or a neighbor
 6. Given it away to a charity organization, such as Goodwill Industries or a church
 7. Put it on a curb with a "Free" sign on it
 8. Had it removed by the dealer you got your new or replacement refrigerator from
 9. Taken it to a dump or recycling center
 10. Hired someone to take it to a dump or recycling center
 11. Gotten rid of it some other way **[Specify]** _____
 98. Don't know

99. Refused

26. What is the MAIN reason you chose to get rid of your [refrigerator, freezer,] through SMUD's program over other methods of disposing of your appliance?

**[If multiple are mentioned, ask: "Of those, which is the main reason?"
Do not read, accept one answer only.]**

[If respondent says: "I didn't need or want the refrigerator/freezer," respond "Yes, but why did you choose to discard it through SMUD's program rather than through another method?"]

1. . Cash/incentive payment
2. . Free pick-up service/others don't pick up/don't have to take it myself
3. . Environmentally safe disposal/recycled/good for environment
4. . Recommendation of a friend/relative
5. . Recommendation of retailer/dealer
6. . Utility sponsorship of the program
7. . Easy way/convenient
8. . Never heard of any others/only one I know of
9. . Other **[Specify]**
98. Don't know
99. Refused

27. Did you receive your rebate for recycling your appliance through SMUD's program?

1. Yes
2. No
98. Don't know
99. Refused

28. Would you have participated in the program if the amount of the rebate had been less, but appliance pick-up was still provided at no cost?

1. Yes
2. No **[Skip to Q30]**
3. Maybe
98. Don't know
99. Refused

29. **[If Q28=2]** Would you have participated in the program with no rebate check altogether, but appliance pick-up was still provided at no cost?

1. Yes
2. No
98. Don't know
99. Refused

PROGRAM SATISFACTION

“Now I have some questions about your satisfaction with your participation in the program.”

30. How satisfied were you with the application and scheduling process? Would you say you were: Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied or Very Dissatisfied??
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know
 99. Refused
31. How satisfied were you with the rebate amount? Would you say you were: Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied or Very Dissatisfied??
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know
 99. Refused
32. From the time you had the appliance(s) picked up, about how many weeks did it take to receive your rebate?
1. Record # of weeks _____
 98. Don't know [**Skip to Q34**]
 99. Refused [**Skip to Q34**]
33. How satisfied were you with how long it took to receive the rebate? Would you say you were Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied or Very Dissatisfied?
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know
 99. Refused

34. How satisfied were you with the actual pick up of your old appliance(s)?
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know
 99. Refused
35. How satisfied were you with the contractor who picked up your old appliance(s)?
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 - 98 Don't know
 - 99 Refused
36. **[IF UNSATISFIED (somewhat or very) FOR Q30, Q31, Q33, Q34 or Q35]**
Why were you dissatisfied with the specific areas you mentioned?
1. Record Verbatim _____
 98. Don't know
 99. Refused
37. In the course of participating in **SMUD's** program, how often did you contact **SMUD** or program staff with questions?
1. Never **[Skip to Q41]**
 2. Once
 3. 2 or 3 times
 4. 4 times or more
 98. Don't know
 99. Refused
38. How did you contact them? **[CHECK ALL THAT APPLY]**
1. Phone
 2. Email or fax
 3. Letter
 4. In person
 98. Don't know
 99. Refused

39. And how satisfied were you with your communications with **SMUD** and program staff? Would you say you were Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied or Very Dissatisfied?
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know
 99. Refused
40. **[IF Q39 = 4 or 5]** Why were you dissatisfied?
1. Record Verbatim_____
 98. Don't know
 99. Refused
41. Have you noticed any savings on your electric bill since removing your old appliance(s)?
1. Yes
 2. No **[Skip to Q43]**
 3. Not sure **[Skip to Q43]**
 98. Don't know **[Skip to Q43]**
 99. Refused **[Skip to Q43]**
42. **[IF NOTICED SAVINGS]**. How satisfied are you with any savings you noticed on your electric bill since removing your old appliance(s)? Would you say you were: Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied or Very Dissatisfied??
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know
 99. Refused
43. Finally, if you were rating your overall satisfaction with the **SMUD** Appliance Recycling Program, would you say you were Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied or Very Dissatisfied?
1. Very satisfied
 2. Somewhat satisfied
 3. Neither satisfied nor dissatisfied
 4. Somewhat dissatisfied
 5. Very dissatisfied
 98. Don't know

99. Refused
44. Why do you give it that rating?
1. Record Verbatim_____
98. Don't know
99. Refused
45. Do you have any suggestions to improve **SMUD's** Refrigerator/Freezer Recycling Program?
1. Yes, Record Verbatim_____
 2. No
98. Don't know
99. Refused

DEMOGRAPHICS / OTHER PROGRAMS / FUTURE DISCARDS

“Now I have just a few final questions about your home and energy use.”

46. Which of the following best describes your home/residence?
01. Single-family home, detached construction [**NOT A DUPLEX, TOWNHOME, OR APARTMENT; ATTACHED GARAGE IS OK**]
 02. Single family home, factory manufactured/modular
 03. Single family, mobile home
 04. Row House
 05. Two or Three family attached residence—traditional structure
 06. Apartment (4 + families)---traditional structure
 07. Condominium---traditional structure
 08. Other: [**Specify**]_____
 98. Don't know
 99. Refused
47. Do you own or rent this residence?
1. Own
 2. Rent
98. Don't know
99. Refused
48. Approximately when was your home constructed? [**DO NOT READ**]
1. Before 1960
 2. 1960-1969
 3. 1970-1979
 4. 1980-1989
 5. 1990-1999
 6. 2000-2005

7. 2006 or later
 98. Don't know
 99. Refused
49. How many square feet is the above-ground living space of your home **(IF NECESSARY, THIS EXCLUDES BASEMENTS and GARAGES)?**
1. Numerical open end [Range 0-99,999]_____
 98. Don't know
 99. Refused
50. **[IF Q49=98,99]** Would you estimate the above-ground living space is about: **(read options)**
1. Less than 1,000 sqft
 2. 1,001-2,000 sqft
 3. 2,001-3,000 sqft
 4. 3,001-4,000 sqft
 5. 4,001-5,000 sqft
 6. Greater than 5,000 sqft
 98. Don't know
 99. Refused
51. How many people, including yourself, reside in your household?
1. Record Number:_____
 98. Don't know
 99. Refused
52. In the past three years, have you participated in any other SMUD energy efficiency programs for which you received rebates or incentives?
1. Yes
 2. No
 98. Don't know
 99. Refused
53. **[IF Q52 = 1]** Can you briefly describe the SMUD program you participated in or the rebate type you received?
1. RECORD VERBATIM
 98. Don't know
 99. Refused

54. Do you currently have any old kitchen appliances you plan to discard or replace in the next three years?

1. Yes
2. No
98. Don't know
99. Refused

55. **[IF Q54 = 1]** Can you briefly describe the kitchen appliances you plan to discard?

1. RECORD VERBATIM
98. Don't know
99. Refused

This completes the survey. SMUD appreciates your participation. Thanks for your time. Have a good day/evening.

Appendix C. Non-Participant Survey

Sacramento Municipal Utility District (SMUD) Refrigerator/Freezer Recycling Program Non-Participant Telephone Survey

Interviewer: _____ Date of Interview: ____/____/____
Respondent: _____ Address: _____
May I please speak with **[CONTACT NAME]**: _____)?

Hello. My name is _____, and I am calling on behalf of SMUD. We are conducting a survey about refrigerators and freezers. Could I speak to someone who could answer a few questions about your household's kitchen appliances?

IF NEEDED: The survey takes about 10 minutes.

IF NEEDED: I'm calling from ADM Associates, an independent research firm hired by SMUD.

IF NEEDED: I am not selling anything.

IF NEEDED: We're conducting this survey to help SMUD understand their customer's refrigerator and freezer energy use and help make improvements to energy efficiency program offerings.

IF REFUSAL: THANK AND TERMINATE

SCREENING

1. Does your household currently own any full-size refrigerators or stand-alone freezers in your home, not counting any bar-sized or mini-refrigerators or wine coolers? **[Interviewer note: we want to confirm appliance ownership as opposed to landlord ownership]**

3. Yes

4. No

100..... Don't know

101..... Refused

IF YES, CONTINUE

IF NO OR REFUSED, THANK AND TERMINATE

2. How many working full-size refrigerators do you currently have at your home?

2. _____ **[Record Quantity]**

100..... Don't know

101..... Refused

3. How many working stand-alone freezers do you currently have at your home?
1. _____ **[Record Quantity]**
 98. Don't know
 99. Refused
4. Has your household disposed of a full sized refrigerator or stand-alone freezer in the last five years? **[If necessary: By disposed of I mean sell, give away, or have it hauled off]**
1. Yes
 2. No
 98. Don't know
 99. Refused
5. Has your household acquired a "new-to-you" refrigerator or stand-alone freezer in the last five years? **[If necessary: By acquired I mean any way of getting a "new to you" appliance, whether purchased or free. "new-to-you" means it could be a used appliance or brand new.]**
1. Yes
 2. No
 98. Don't know
 99. Refused
6. **[If Q5=1, show Q6]** Were any of the appliances used when you acquired them or were they all brand new appliances?
1. Yes, one or more was used when I acquired it
 2. No, all were brand new appliances
 98. Don't know
 99. Refused

[Programming Notes: If Q4=1, then discarder = 1; else if Q4=2, 98, 99, then discarder = 0; If Q5=1 and Q6=1, then acquirer = 1; else if Q5=2, 98, 99 or Q6 = 2, 98, 99 then discarder = 0;]

[If discarder = 0 and acquirer =0, thank respondent and terminate interview]

[If discarder = 1, ask Discarder Section Q7-Q22]

Discarder Section

"I'd like to ask you a few questions about the refrigerators and/or freezers you have disposed of in the past five years"

7. How many refrigerators or freezers have you disposed of in the last five years?
1. None **[End Discarder Section]**
 2. One

3. More than one (record number, 2-10)
 98. Don't know [**End Discarder Section**]
 99. Refused [**End Discarder Section**]
8. How many were refrigerators that *worked* at the time of disposal?
1. None
 2. One
 3. More than one (record number, 2-10)
 98. Don't know
 99. Refused
9. How many were freezers that *worked* at the time of disposal?
1. None
 2. One
 3. More than one (record number, 2-10)
 98. Don't know
 99. Refused

[Programming Note: If Q7=2, then do

If Q8=2, then discardapp = refrigerator

Else if Q9=2, then discardapp = freezer

Skip to Q11

Else if Q7=3, show Q10]

10. [**If Q7=3, show Q10**] I'd like to ask a few questions about the appliance you disposed of most recently. Was that appliance a refrigerator or a freezer?
1. Refrigerator [**set discardapp = refrigerator**]
 2. Freezer [**set discardapp = freezer**]
 98. Don't know [**End Discarder Section**]
 99. Refused [**End Discarder Section**]
11. Do you recall the year when you disposed of [**discardapp**]?
1. Record year (2010-2015)
 98. Don't know
 99. Refused
12. Why did you decide to get rid of your [**discardapp**]?
1. Got a new unit and didn't need the old one
 2. It wasn't working well
 3. I didn't use it often/at all
 4. It used too much energy
 5. Cosmetic reason/Didn't like appearance
 6. Other [**Specify**]
 98. Don't know
 99. Refused

13. What was the condition of the **[discardapp]** just before you disposed of it?
Would you say...**[Read list]**
1. It worked and was in good condition
 2. It worked but needed minor repair
 3. It worked but needed major repair
 4. Or, it didn't work
 5. Other **[Specify]**
 98. Don't know
 99. Refused
14. At the time you got rid of it, approximately how old was the **[discardapp]**?
1. Less than five years old
 2. 5-9 years old
 3. 10-14 years old
 4. 15 -19 years old
 5. 20-30 years old
 6. More than 30 years old
 98. Don't know
 99. Refused
15. **[If discardapp= refrigerator, show Q15]** When it was in use before being disposed of, did you use this refrigerator as your main refrigeration or as a secondary or spare refrigerator?
1. Primary, Main
 2. Secondary, Spare, Extra
 98. Don't know
 99. Refused
16. **[If discardapp = freezer or Q15=2, show Q16]** In the year before you disposed of it, how often was your **[discardapp]** plugged in and running?
1. All the time
 2. For special occasions only
 3. During certain months of the year only
 4. Never plugged in or running
 98. Don't know
 99. Refused
17. **[Q16= 2 or 3, show Q17]** If you were to add up the total amount of time the **[discardapp]** was running in the year prior to being disposed of, how many months would that be? Your best estimate is okay. **[Get nearest month]**
1. ___ Record number of months (1-11)
 2. All the time
 98. Don't know
 99. Refused

18. How did you dispose of this **[discardapp]**? **[Read if needed, clarify to fit list below. E.g., Did you give it away or sell it?]**
1. Sold it to a private party
 2. Sold it to a used appliance dealer
 3. Kept it and stored it unplugged
 4. Used the SMUD Appliance Recycling Program **(do not read)**
 5. Gave it away to a private party, such as a friend or a neighbor
 6. Gave it away to a charity organization, such as Goodwill or a Church
 7. Put it on a curb with a “free” sign on it
 8. Had it removed by the dealer you purchased a new unit from
 9. Took it to the dump or recycling center
 10. Hired someone to take it to a dump or recycling center
 11. Got rid of it some other way **[Specify]**
 98. Don't know
 99. Refused
19. Why did you choose that option for getting rid of the unit?
1. Least expensive option
 2. Easiest option
 3. Other **[Specify]**
 98. Don't know
 99. Refused
20. **[IF Q18 = 1 or 2, show Q20]** How much money did you get when you sold the **[discardapp]**?
1. Record dollars (\$0-\$9999)
 98. Don't know
 99. Refused
21. **[IF Q18 = 7, 8, 9, 10, or 11 show Q21]** How much money, if any, did you pay to get rid of the **[discardapp]**? **[Record as 0 if did not pay]**
1. Record dollars (\$0-\$9999)
 98. Don't know
 99. Refused
22. Did you replace the discarded **[discardapp]** with a new one?
1. Yes
 2. No
 98. Don't know
 99. Refused

[If acquirer = 1, ask Acquirer Section Q23-32]

Acquirer Section

23. The next few questions will focus on the *used* appliance you most recently acquired. Was that appliance a refrigerator or a freezer? **[If Needed: by acquired I mean any way of getting a “new to you” use appliance, whether purchased or free]**
1. Refrigerator **[set acquireapp = refrigerator]**
 2. Freezer **[set acquireapp = freezer]**
 98. Don't know
 99. Refused
24. **[If acquireapp = discardapp, show Q24, else skip to Q25]** Is this **[acquireapp]** the replacement **[acquireapp]** for the appliance we already discussed, or another **[acquireapp]**?
1. Same one (replacement for disposed unit)
 2. Different one
 98. Don't know
 99. Refused
25. **[If Q24=1, 2, 98, 99, skip Q25]** Was this **[acquireapp]** replacing another **[acquireapp]** or was it adding to the total number of **[acquireapp]**s in your home?
1. Replacement
 2. Added another to home
 98. Don't know
 99. Refused
26. **[If acquireapp = refrigerator, show Q26, else skip to Q27]** Is the refrigerator currently being used as your main refrigerator or as a secondary or spare unit?
1. Main, Primary
 2. Secondary, Spare, Extra
 98. Don't know
 99. Refused
27. Approximately how old is was the **[acquireapp]** when you got it?
1. Less than five years old
 2. 5-9 years old
 3. 10-14 years old
 4. 15 -19 years old
 5. 20-30 years old
 6. More than 30 years old
 98. Don't know
 99. Refused
28. Where did you get this **[acquireapp]**?

1. Given to me for free by (family / friend / neighbor)
 2. Obtained for free through (charity / church / organization)
 3. Obtained for free through (Craigslist / newspaper ad / classified ad)
 4. Purchased from (family / friend / neighbor)
 5. Purchased from (charity / church)
 6. Purchased from (Craigslist / newspaper ad / classified ad)
 7. Purchased from a used appliance dealer
 8. Other **[Specify]**
 98. Don't know
 99. Refused
29. **[If Q28 = 4, 5, 6, 7, show Q29]** How much did you pay for this used **[acquireapp]**?
1. Record dollars (\$0-\$999)
 98. Don't know
 99. Refused
30. **[If Q28 = 4, 5, 6, 7, show Q30]** If you had not been able to purchase this particular used **[acquireapp]**, what would you have done? Would you say that you would have...
- [Programming Note: Randomize response options 1-3]*
1. Purchased a similar used unit elsewhere
 2. Purchased a *new* unit from a retailer
 3. Not purchased a **[acquireapp]** / stuck with what you already had
 4. Done something else **[Specify]**
 98. Don't know
 99. Refused
31. **[If Q28 = 1, 2, 3, show Q31]** If this particular free **[acquireapp]** had not been available to you, what would you have done? Would you say that you would have...
- [Programming Note: Randomize response options 1-4]*
1. Looked for a similar *free* unit elsewhere
 2. Purchased a similar *used* unit elsewhere
 3. Purchased a *new* unit from a retailer
 4. Stuck with the **[acquireapp]** you already had
 5. Other **[Specify]**
 98. Don't know
 99. Refused
32. If you had not been able to find a used **[acquireapp]** with the price or features you needed, what would you have done?
1. Purchased a *new* unit from a retailer
 2. Not purchased a **[acquireapp]** / stuck with what you already had

- 3. Other **[Specify]**
- 98. Don't know
- 99. Refused

LIKELYHOOD OF RECYCLING IN THE FUTURE

33. How likely is it that you will be disposing of a refrigerator or freezer that you currently own sometime within the next 4 years? **[If necessary: By disposed of I mean sell, give away, or have it hauled off]**

- 4. . Not at all likely
- 5. . Somewhat likely
- 6. . Very likely
- 100. Don't know
- 101. Refused

34. **[If Q33 = 2, 3, show Q34]** Which of the following are you likely to discard in the next 4 years? **[Check all that apply]**

- 8. Main or Primary Refrigerator
- 9. Spare or Secondary Refrigerator
- 10. Freezer
- 100. Don't know
- 101. Refused

35. What method of disposal are you most likely to use when you get rid of your next refrigerator or freezer? **[Read if needed, clarify to fit list below. E.g., Will you give it away or sell it?]**

- 3. . Sell it
- 4. . Unplug and store it
- 5. . Junk it/have it hauled off to dump
- 6. . Give it away
- 7. . Recycle it
- 8. . Recycle it through SMUD program **(do not read)**
- 9. . Trade it in to retailer that I purchase new unit from
- 10. Other **[Specify]** _____
- 100. Don't know
- 101. Refused

36. **[If Q35 does NOT EQUAL 6]** SMUD provides a refrigerator and freezer removal service called the Refrigerator/Freezer Recycling Program. This program helps save energy by removing and recycling unwanted or inefficient refrigerators. Do you recall hearing about this program?

- 12. Yes
- 13. No
- 100. Don't know
- 101. Refused

37. SMUD's program pays a \$35 to \$50 incentive for recycling and will haul away your old working refrigerators for free. How likely would you be to use this program as opposed to other methods of refrigerator or freezer disposal?

- 10. Not at all likely
- 11. Somewhat likely
- 12. Very likely
- 100. Don't know
- 101. Refused

DEMOGRAPHICS / OTHER PROGRAMS

"Now I have just a few final questions about your home and energy use."

38. Which of the following best describes your home/residence?

- 09. Single-family home, detached construction **[NOT A DUPLEX, TOWNHOME, OR APARTMENT; ATTACHED GARAGE IS OK]**
- 10. Single family home, factory manufactured/modular
- 11. Single family, mobile home
- 12. Row House
- 13. Two or Three family attached residence—traditional structure
- 14. Apartment (4 + families)---traditional structure
- 15. Condominium---traditional structure
- 16. Other: **[Specify]** _____
- 100. Don't know
- 101. Refused

39. Do you own or rent this residence?

- 3. Own
- 4. Rent
- 100. Don't know
- 101. Refused

40. Approximately when was your home constructed? **[DO NOT READ]**

- 8. Before 1960
- 9. 1960-1969
- 10. 1970-1979
- 11. 1980-1989
- 12. 1990-1999
- 13. 2000-2005
- 14. 2006 or later
- 100. Don't know
- 101. Refused

41. How many square feet is the above-ground living space of your home **(IF NECESSARY, THIS EXCLUDES BASEMENTS and GARAGES)?**
1. Numerical open end [Range 0-99,999]_____
 98. Don't know
 99. Refused
42. **[IF Q41=98,99, show Q42]** Would you estimate the above-ground living space is about: **(read options)**
7. Less than 1,000 sqft
 8. 1,001-2,000 sqft
 9. 2,001-3,000 sqft
 10. 3,001-4,000 sqft
 11. 4,001-5,000 sqft
 12. Greater than 5,000 sqft
 - 100..... Don't know
 - 101..... Refused
43. How many people, including yourself, reside in your household?
2. Record Number:_____
 - 100..... Don't know
 - 101..... Refused
44. In the past three years, have you participated in any other SMUD energy efficiency programs for which you received rebates or incentives?
3. Yes
 4. No
 - 100..... Don't know
 - 101..... Refused
45. **[IF Q44 = 1]** Can you briefly describe the SMUD program you participated in or the rebate type you received?
2. RECORD VERBATIM
 - 100..... Don't know
 - 101..... Refused

This completes the survey. SMUD appreciates your participation. Thanks for your time. Have a good day/evening.

Appendix D. Metering Data Extrapolation Models

Table 6-4: Primary Top-Freezer Refrigerators

Variable Description	Coefficient	Standard Error
Intercept	-98.3825	1.1320
Mean Watt Hours	0.9815	0.0005
January Dummy	3.8639	0.9129
February Dummy	-0.1099	0.9076
March Dummy	5.6952	0.9017
April Dummy	12.9591	0.9349
May Dummy	7.6151	0.9584
June Dummy	9.6176	1.0150
July Dummy	16.1311	1.0329
August Dummy	6.4387	1.0690
September Dummy	6.8108	1.0193
October Dummy	15.1539	1.1215
November Dummy	4.4912	0.9349
December Dummy	Suppressed	
Ambient Temperature (F)	1.4172	0.0186
Appliance Volume (cubic feet)	3.0881	0.0578
January Dummy * App Volume	-0.5238	0.0524
February Dummy * App Volume	-0.4686	0.0559
March Dummy * App Volume	-0.8596	0.0588
April Dummy * App Volume	-1.6752	0.0583
May Dummy * App Volume	-1.7853	0.0608
June Dummy * App Volume	-1.6470	0.0610
July Dummy * App Volume	-1.7913	0.0625
August Dummy * App Volume	-1.2161	0.0643
September Dummy * App Volume	-0.9315	0.0623
October Dummy * App Volume	-2.1263	0.0768
November Dummy * App Volume	-0.8015	0.0571
December Dummy * App Volume	Suppressed	
Ambient Temperature * App Volume	-0.0488	0.0010
January Dummy * App Volume * Ambient Temperature	0.0079	0.0007
February Dummy * App Volume * Ambient Temperature	0.0096	0.0008
March Dummy * App Volume * Ambient Temperature	0.0145	0.0007
April Dummy * App Volume * Ambient Temperature	0.0228	0.0007
May Dummy * App Volume * Ambient Temperature	0.0307	0.0007
June Dummy * App Volume * Ambient Temperature	0.0309	0.0006
July Dummy * App Volume * Ambient Temperature	0.0301	0.0006
August Dummy * App Volume * Ambient Temperature	0.0279	0.0007
September Dummy * App Volume * Ambient Temperature	0.0209	0.0007
October Dummy * App Volume * Ambient Temperature	0.0264	0.0009
November Dummy * App Volume * Ambient Temperature	0.0118	0.0008
December Dummy * App Volume * Ambient Temperature	Suppressed	
	R-square	0.5189

Table 6-5: Primary Side-by-Side Refrigerators

Variable Description	Coefficient	Standard Error
Intercept	-60.836926	3.13516983
Mean Watt Hours	0.9910134	0.00096084
January Dummy	42.3418249	2.42211709
February Dummy	62.8310354	2.44869184
March Dummy	41.8495433	2.41649957
April Dummy	58.3417937	2.51267304
May Dummy	73.2672747	2.55048377
June Dummy	79.7802447	2.69408587
July Dummy	117.7533536	2.75501407
August Dummy	106.9141381	2.81719751
September Dummy	47.3686927	2.83032519
October Dummy	-0.0081397	2.62090611
November Dummy	-29.4737659	2.55918227
December Dummy	Suppressed	
Ambient Temperature (F)	0.1416014	0.05007385
Appliance Volume (cubic feet)	0.6011845	0.14650758
January Dummy * App Volume	-2.2335172	0.12879069
February Dummy * App Volume	-3.6174671	0.13049878
March Dummy * App Volume	-2.9902837	0.12959983
April Dummy * App Volume	-3.7538833	0.12916003
May Dummy * App Volume	-4.5718452	0.13059738
June Dummy * App Volume	-4.2321832	0.13538012
July Dummy * App Volume	-4.5745224	0.13661274
August Dummy * App Volume	-4.5591112	0.13975266
September Dummy * App Volume	-2.3785578	0.14313159
October Dummy * App Volume	-0.7015866	0.13549306
November Dummy * App Volume	0.9592702	0.13373732
December Dummy * App Volume	Suppressed	
Ambient Temperature * App Volume	0.018306	0.00235531
January Dummy * App Volume * Ambient Temperature	0.007466	0.00126355
February Dummy * App Volume * Ambient Temperature	0.0188268	0.00130278
March Dummy * App Volume * Ambient Temperature	0.0223909	0.00131731
April Dummy * App Volume * Ambient Temperature	0.0243394	0.00121428
May Dummy * App Volume * Ambient Temperature	0.0293407	0.00123524
June Dummy * App Volume * Ambient Temperature	0.0255776	0.00117126
July Dummy * App Volume * Ambient Temperature	0.0136646	0.00115748
August Dummy * App Volume * Ambient Temperature	0.0192796	0.00116550
September Dummy * App Volume * Ambient Temperature	0.0194732	0.00123921
October Dummy * App Volume * Ambient Temperature	0.0190032	0.00123861
November Dummy * App Volume * Ambient Temperature	0.0072091	0.00126622
December Dummy * App Volume * Ambient Temperature	Suppressed	
	R-square	0.5373

Table 6-6: Secondary Refrigerators

Variable Description	Coefficient	Standard Error
Intercept	-8.63433454	3.84504931
Mean Watt Hours	1.00133675	0.00243205
January Dummy	3.71997977	2.49413759
February Dummy	18.56938692	2.52496809
March Dummy	21.37394518	2.52139460
April Dummy	8.64715038	2.56449441
May Dummy	6.29601491	2.54864036
June Dummy	9.99666097	2.72685263
July Dummy	15.11129573	2.68840244
August Dummy	23.89796412	2.77566132
September Dummy	10.76193151	2.66194595
October Dummy	19.55585928	2.54261481
November Dummy	7.72783243	2.49915110
December Dummy	Suppressed	
Ambient Temperature (F)	-0.03439937	0.06194624
Appliance Volume (cubic feet)	-0.56123413	0.22895982
January Dummy * App Volume	-1.25521282	0.23280911
February Dummy * App Volume	-3.35512948	0.24122852
March Dummy * App Volume	-3.58751347	0.25358323
April Dummy * App Volume	-2.27590605	0.22404025
May Dummy * App Volume	-1.89495106	0.24706731
June Dummy * App Volume	0.11221609	0.23727096
July Dummy * App Volume	2.90587876	0.23900445
August Dummy * App Volume	1.2582153	0.23450946
September Dummy * App Volume	-0.37329715	0.24791826
October Dummy * App Volume	-2.33758426	0.24150065
November Dummy * App Volume	-2.16399912	0.22949521
December Dummy * App Volume	Suppressed	
Ambient Temperature * App Volume	0.0039585	0.00390604
January Dummy * App Volume * Ambient Temperature	0.01707046	0.00364014
February Dummy * App Volume * Ambient Temperature	0.04187236	0.00361216
March Dummy * App Volume * Ambient Temperature	0.04785965	0.00386312
April Dummy * App Volume * Ambient Temperature	0.04275837	0.00318882
May Dummy * App Volume * Ambient Temperature	0.03785715	0.00368079
June Dummy * App Volume * Ambient Temperature	0.01300765	0.00327248
July Dummy * App Volume * Ambient Temperature	-0.02883471	0.00322026
August Dummy * App Volume * Ambient Temperature	-0.0042737	0.00307634
September Dummy * App Volume * Ambient Temperature	0.02084085	0.00340602
October Dummy * App Volume * Ambient Temperature	0.03698408	0.00348508
November Dummy * App Volume * Ambient Temperature	0.03556025	0.00349245
December Dummy * App Volume * Ambient Temperature	Suppressed	
	R-square	0.4416

Table 6-7: Freezers

Variable Description	Coefficient	Standard Error
Intercept	-42.3862	1.0060
Mean Watt Hours	0.9934	0.0010
January Dummy	-12.9791	1.4779
February Dummy	-24.8175	1.5302
March Dummy	-28.6411	1.5660
April Dummy	-12.9082	1.4555
May Dummy	-34.3092	1.6244
June Dummy	-12.9023	1.5227
July Dummy	-10.1287	1.5627
August Dummy	-17.2383	1.5998
September Dummy	-30.1932	1.7140
October Dummy	-41.3058	1.5603
November Dummy	-18.2666	1.4614
December Dummy	Suppressed	
Ambient Temperature (F)	0.4189	0.0188
January Dummy * Ambient Temperature	0.3137	0.0273
February Dummy * Ambient Temperature	0.5586	0.0280
March Dummy * Ambient Temperature	0.6505	0.0278
April Dummy * Ambient Temperature	0.4401	0.0254
May Dummy * Ambient Temperature	0.8165	0.0274
June Dummy * Ambient Temperature	0.5692	0.0248
July Dummy * Ambient Temperature	0.5827	0.0247
August Dummy * Ambient Temperature	0.6958	0.0248
September Dummy * Ambient Temperature	0.8577	0.0269
October Dummy * Ambient Temperature	0.9200	0.0263
November Dummy * Ambient Temperature	0.4046	0.0264
December Dummy * Ambient Temperature	Suppressed	
	R-square	0.5246