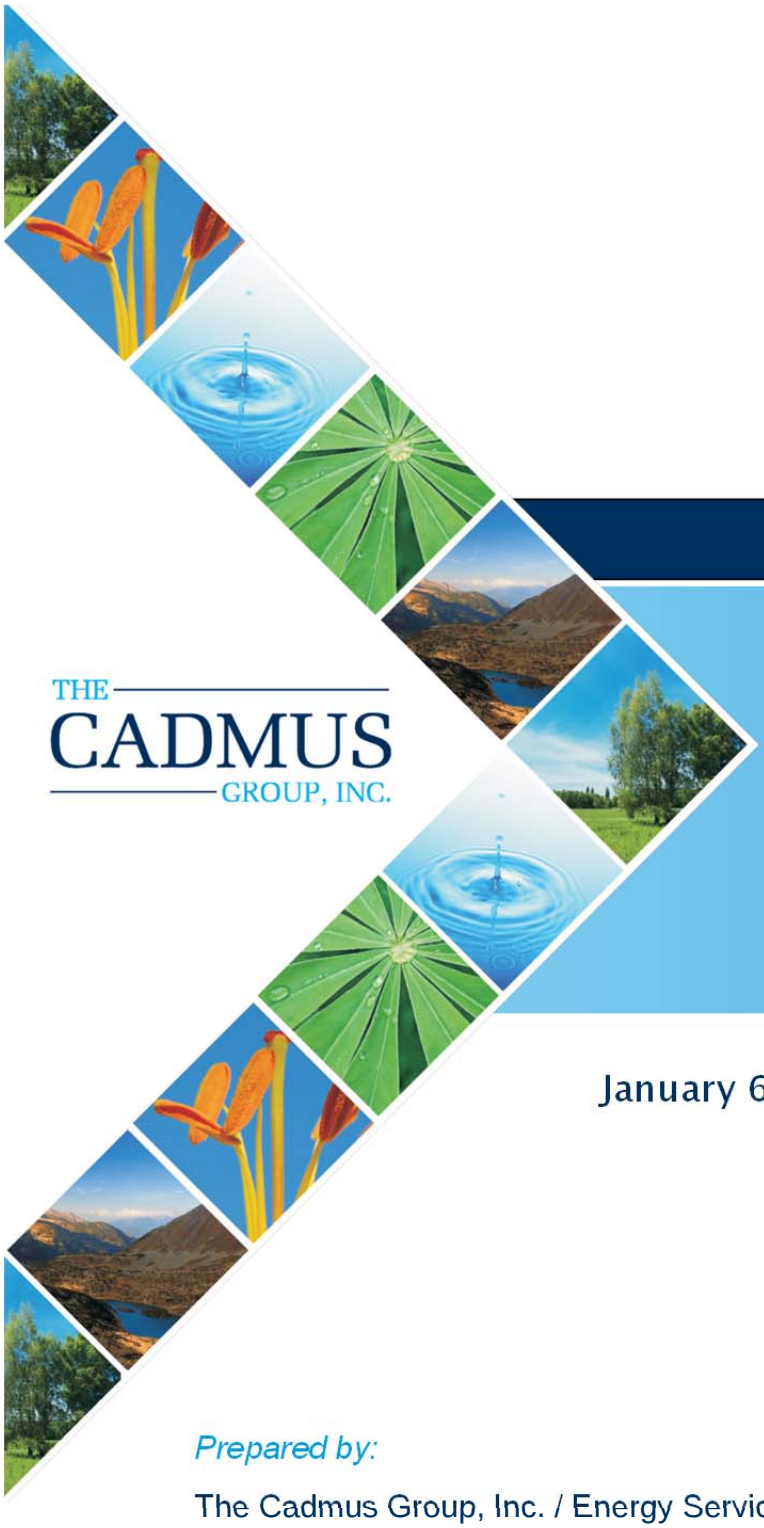

THE CADMUS GROUP, INC.

Pacific Power Washington
See ya later, refrigerator®
2009–2010 Evaluation

January 6, 2012

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Glossary of Terms

Analysis of Covariance (ANCOVA)
An ANCOVA model is an ANOVA model with a continuous variable added.

Analysis of Variance (ANOVA)
An ANOVA model explains the variation in the independent variable, based on a series of characteristics (expressed as binary variables equaling either zero or one).

Evaluated Gross Savings
Evaluated gross savings represent total savings the evaluator finds result from a program, before adjusting for freeridership or spillover. They are most often calculated for a given measure, i, as:

$$Evaluated\ Gross\ Savings_i = Verified\ Participation_i * Unit\ Consumption_i$$

Evaluated Net Savings
Evaluated net savings are the savings "net" of what would have occurred in the program's absence. These savings can be attributed to the program. Net savings are calculated as:

$$Net\ Savings = Evaluated\ Gross\ Savings * NTG$$

Freeridership
Freeridership in energy-efficiency programs is defined as participants that would have adopted the energy-efficient measure in the program's absence. This is often expressed as the freeridership rate, or the proportion of evaluated gross savings that can be classified as freeridership.

In-Service Rate (ISR)
The ISR (also called the installation rate) is the proportion of incented measures actually installed.

Net-to-Gross (NTG)
The NTG ratio is the ratio of net savings to gross savings. Analytically, NTG is defined as:

$$NTG = 1 - Freeridership\ Rate + Spillover\ Rate$$

P-Value
A p-value indicates the probability that a statistical finding might be due to chance. A p-value less than 0.10 indicates one can say, with 90 percent confidence, that the finding was due to the intervention.

Part-Use Factor
The part-use factor is the proportion of the year that equipment is operated. That is, if a given measure has a part-use factor of 0.5, it operated for six months out of the year, on average.

Net Realization Rate
The realization rate is calculated by comparing evaluated net savings to reported gross savings.

R^2

The R^2 (coefficient of determination) indicates the proportion of variance explained by a regression equation, and takes values between zero and one. An R^2 of zero indicates the independent variables have no explanatory power. An R^2 of one indicates 100% of variability in the dependent variable is explained by changes in the independent variables.

Spillover

Spillover is the adoption of an energy-efficiency measure induced by the program's presence, but not directly funded by the program. As with freeridership, this is expressed as a proportion of evaluated gross savings (or the *spillover rate*).

T-Test

In regression analysis, a t-test is applied to determine whether the estimated coefficient differs significantly from zero. A t-test with a p-value less than 0.10 indicates that there is a 90% probability that the estimated coefficient is different from zero.

Executive Summary

Pacific Power contracted with The Cadmus Group Inc. (Cadmus) to conduct impact and process evaluations for program years 2009 and 2010 of its Washington See ya later, refrigerator® (SYLR) program. The impact study sought to evaluate the program's energy savings on a gross and net savings basis. The process evaluation—utilizing structured interviews with utility program and implementation staff, and surveys with program participants and nonparticipants—sought to assess program effectiveness, marketing, and participants' experiences and satisfaction levels.

Evaluation data consisted of the following primary sources:

- Telephone surveys with 243 participating Washington customers;
- Telephone surveys with 68 nonparticipating Washington customers;
- Reviews of Washington program materials and marketing documents; and
- In-depth interviews with program management and program administrator staff;

As well as the following secondary sources:

- Cadmus' appliance metering data from 452 refrigerators and 41 freezers; and
- Cadmus' light logger metering data from 750 unique fixtures across four states.

Beginning in 2005, the SYLR program, delivered on Pacific Power's behalf by JACO Environmental, Inc. (the program administrator), has sought to decrease electricity usage (kWh) through voluntary removal and recycling of inefficient refrigerators and freezers. Participants receive a $30 incentive for each qualified refrigerator or freezer recycled through the program. Participants also receive a free energy-saving kit, which includes two 13-watt compact fluorescent lamps (CFLs), a refrigerator thermometer card, energy-saving educational materials, and information on other Pacific Power efficiency programs relevant to residential customers.

Summary of Key Findings

Key Impact Findings

The impact evaluation resulted in the following key findings:

- In 2009, the SYLR program recycled 2,310 refrigerators and freezers; in 2010, participation decreased slightly to 1,908 total units.
- Evaluated unadjusted unit energy consumption values (UECs) for refrigerators (1,240 kWh) closely matched reported savings (1,250 kWh). Evaluated unadjusted UEC for freezers (1,056 kWh) was lower than the reported value (1,853 kWh). Both reported values derived from the evaluation of Pacific Power's 2005 SYLR program, but the reported value used for freezers derived was higher than the typical range of UECs Cadmus has recently estimated for this measure.
- For both refrigerators and freezers, the part-use factor, which indicates the portion of the year the appliance operated, fell within expected ranges at 0.93 and 0.89, respectively.

- Applying adjustments for part-use and installation, gross per-unit savings were determined to be 1,153 kWh for refrigerators, 935 kWh for freezers.
- Evaluated per-unit net savings were 724 kWh for refrigerators and 542 kWh for freezers. The comparable values found in the Regional Technical Forum's (RTF) measure database are 482 kWh for refrigerators and 555 kWh for freezers.[1] Cadmus' net savings for refrigerators are substantially higher, due largely to the fact that the portion of program-induced replacement was determined through participant surveys to be much lower than RTF's assumption.
- Gross savings for energy-saving kits (80 kWh) were found to be comparable to the reported value of 72 kWh. Cadmus' evaluation method is consistent with the RTF's method, but employs different inputs specific to SYLR program participants and Pacific Power's Washington service territory.
- Participants reported installing 89 percent of CFLs provided in the energy-saving kit.
- Cadmus estimated the program's overall net-to-gross (NTG) ratio (defined as the ratio of evaluated net to evaluated gross savings) at 0.64. Spillover and induced replacement effectively offset each other in this adjustment, with the former accounting for a credit of 0.009 and the latter a debit of 0.012. The program has an overall NTG on the mid-to-high range for similar appliance recycling programs.

Table 1 summarizes program participation, gross savings (reported and evaluated), and evaluated net savings for 2009–2010.

Table 1. 2009–2010 Program Savings by Measure*

Measure	Evaluated Participation	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	Precision at 90% Confidence	Net Realization Rate
Refrigerator Recycling	3,366	4,217,500	3,879,619	2,437,138	±11.0%	58%
Freezer Recycling	852	1,599,139	796,523	462,146	±12.3%	29%
Energy-Saving Kit	3,911	281,592	313,926	313,926	±6.9%	111%
Totals	N/A	6,098,231	4,990,068	3,213,210	±8.8%	53%

*Throughout the report, table totals may not add up exactly due to rounding.
**Appendix C provides a detailed methodology for precision calculations.

[1] http://www.nwcouncil.org/energy/rtf/measures/res/FrigRecycle_FY10v2_3.xls

Table 2 and Table 3 report savings by program year.

Table 2. 2009 Program Savings by Measure

Measure	Evaluated Participation	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	Precision at 90% Confidence	Net Realization Rate
Refrigerator Recycling	1,854	2,362,500	2,136,902	1,342,381	±11.0%	57%
Freezer Recycling	456	859,792	426,308	247,346	±12.3%	29%
Energy-Saving Kit	2,168	156,096	174,020	174,020	±6.9%	111%
Totals	N/A	3,378,388	2,737,230	1,763,746	±8.8%	52%

Table 3. 2010 Program Savings by Measure

Measure	Evaluated Participation	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	Precision at 90% Confidence	Realization Rate
Refrigerator Recycling	1,512	1,855,000	1,742,716	1,094,757	±11.0%	59%
Freezer Recycling	396	739,347	370,215	214,800	±12.3%	29%
Energy-Saving Kit	1,743	125,496	139,906	139,906	±6.9%	111%
Totals	N/A	2,719,843	2,252,838	1,449,464	±8.7%	53%

Key Process Findings

The process evaluation provided the following key findings:

- Collaboration between Pacific Power and the program administrator proved effective, due to a longstanding working relationship in Washington and other states.
- In 2009 and 2010, the SYLR program did not meet its participation targets, achieving 68 percent of projected participation over the two-year period. Program staff reported a reduced incentive, economic conditions, and program maturation led to lower participation, compared to earlier years of program implementation. Cadmus has observed downward trends in participation in other similar programs.
- Participants reported high satisfaction levels with the program. Eighty-nine percent of surveyed participants reported being very satisfied with the program; less than 1 percent reported dissatisfaction. This level of satisfaction is similar to what Cadmus has found in other similar programs. An overwhelming majority of participants expressed satisfaction with the program signup process and incentive levels. The participant survey did not identify significant customer complaints.
- Participants learned of the program through various channels, the three most common being: bill inserts, print advertising, and television advertising. Both the online signup

process and the telephone signup process proved simple and easy to understand, and participants reported high satisfaction levels with both.

- A review of Pacific Power's marketing materials and online presence suggested additional marketing strategies that, if implemented, may further expand program awareness and participation. For example, Cadmus recommends increased consistency in online branding, and expanded retail partnerships.

Cost-Effectiveness Results

As shown in Table 4, the program proved cost effective across the evaluation period for four of the five primary cost-effectiveness tests: PacifiCorp total resource cost (PTRC), total resource cost (TRC); participant cost (PCT); and utility cost (UCT) perspectives.

The program was cost effective with the relatively high benefit-to-cost ratios of 5.42 and 4.93 from the PTRC and TRC perspectives and remained relatively stable over the two program years. The program did not prove cost-effective from the rate impact measure (RIM) perspective, which measures impacts of programs on customer rates. Most programs do not pass the RIM test due to the adverse impact of lost revenue. Levelized cost per kWh, presented in Table 4, represents the present value of program life cycle costs, divided by total energy savings produced by the program over the lives of the measures. This metric proves useful for comparing demand-side management (DSM) programs' energy costs with those of supply-side resources.

Table 4. 2009–2010 Evaluated Program Cost-Effectiveness Summary (NTG =1.0)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.017	$634,444	$3,440,474	$2,806,030	5.42
Total Resource No Adder (TRC)	$0.017	$634,444	$3,127,704	$2,493,259	4.93
Utility (UCT)	$0.017	$634,444	$3,127,704	$2,493,259	4.93
Ratepayer Impact (RIM)	$0.091	$3,370,041	$3,127,704	($242,338)	0.93
Participant (PCT)	NA	$122,596	$2,858,193	$2,735,597	NA

Table 5 and Table 6 show the program's cost-effectiveness for 2009 and 2010 program years, respectively.

Table 5. 2009 Evaluated Program Cost-Effectiveness Summary (NTG =1.0)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.016	$348,253	$1,888,267	$1,540,014	5.42
Total Resource No Adder (TRC)	$0.016	$348,253	$1,716,607	$1,368,354	4.93
Utility (UCT)	$0.016	$348,253	$1,716,607	$1,368,354	4.93
Ratepayer Impact (RIM)	$0.089	$1,882,990	$1,716,607	($166,383)	0.91
Participant (PCT)	N/A	$69,300	$1,604,037	$1,534,737	N/A

Table 6. 2010 Evaluated Program Cost-Effectiveness Summary (NTG =1.0)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.018	$307,370	$1,667,070	$1,359,700	5.42
Total Resource No Adder (TRC)	$0.018	$307,370	$1,515,518	$1,208,149	4.93
Utility (UCT)	$0.018	$307,370	$1,515,518	$1,208,149	4.93
Ratepayer Impact (RIM)	$0.093	$1,597,093	$1,515,518	($81,575)	0.95
Participant (PCT)	NA	$57,240	$1,346,963	$1,289,723	N/A

Summary and Recommendations

Although participation was slightly lower than expected in both 2009 and 2010, the Washington SYLR program ran smoothly with no implementation issues, and experienced high customer satisfaction.

Based on evaluation findings, Cadmus offers the following recommendations:

- Pacific Power should continue implementing the SYLR program to achieve cost-effective energy savings.
- Pacific Power should adjust its expected per-unit savings to reflect estimates calculated in this evaluation. Cadmus recommends tracking program savings using the evaluated per-unit gross savings values of 1,153 kWh for refrigerators and 935 kWh for freezers.
- Although Pacific Power did not apply a Waste Heat Factor (WHF) adjustment to CFL savings estimates, the WHF should be applied to all future planning and evaluated CFL savings values.[2] Cadmus recommends tracking program savings from energy-saving kits using the WHF-adjusted gross savings value of 70 kWh.
- Per-unit savings can be greatly affected by changes in appliance characteristics, such as configuration, age, and size. The program administrator tracks these characteristics, and Pacific Power should closely monitor changes in participating units' characteristics. This could be achieved by summarizing participation data on an annual basis, and noting changes in average participant unit characteristics.
- The program administrator and Pacific Power should continue with plans to improve reporting processes to eliminate the possibility of reporting discrepancies and increase accuracy of reported results. Cadmus identified minor discrepancies in reported number of participant units, and Pacific Power has since worked with the program administrator to prevent discrepancies between program administrator reporting and Pacific Power reporting by including additional documentation in monthly reports.

[2] Appendix B outlines Cadmus' recommended WHF approach and value.

Program Description

The Washington See ya later, refrigerator® (SYLR) residential refrigerator and freezer recycling program serves as part of Pacific Power's ongoing demand-side management (DSM) resource acquisition strategy.[3] The program's overarching objective seeks to decrease electricity usage (kWh) through removal and recycling of inefficient secondary refrigerators and freezers, and older primary refrigerators. This prevents older units from remaining in service at a participant's premise or elsewhere within Pacific Power's Washington service territory. The program encourages those shopping for replacement units to consider ENERGY STAR®-labeled models, and refers them to the Home Energy Savings (HES) program, where they may be eligible for incentives for other energy-efficiency measures and services. In addition to reducing energy consumption at the household and utility levels, the program recycles participating appliances in an environmentally sound manner.[4]

In operation since 2005, the program provides residential customers with a $30 incentive for each recycled appliance. Participants receive an incentive for up to two refrigerators or freezers. Renters owning their appliances may participate, and apartment complex owners or managers are eligible if they provide tenants with appliances. Participants also receive a free energy-saving kit, which includes: two 13-watt compact fluorescent lamps (CFLs), a refrigerator/freezer thermometer card, energy savings educational materials, and information on other company efficiency programs relevant to residential customers. Qualifying refrigerators and freezers must be: in working condition when picked up; and at least 10 cubic feet or more in size. Pacific Power contracted with JACO Environmental, Inc. (the program administrator), to deliver the program in Washington. The program administrator disables and removes the appliances, and recycles at least 95 percent of the materials, including refrigerant capture.

Program Participation

Program participation in appliance recycling programs typically follows a seasonal pattern, with the highest participation during summer, and declining into winter. As shown in Figure 1, the SYLR program for Washington saw some degree of seasonality in 2009, though participation remained reasonably consistent throughout 2010.

As refrigerator recycling programs mature, the composition of recycled appliances tends to change. In their infancy, programs recycle more secondary appliances (particularly those in use for only a portion of the year) in customer populations. Such units tend to be older, smaller, located in unconditioned spaces, such as garages or basements, and to be less efficient. Such refrigerators also are much more likely to be single-door units.

[3] See ya later, refrigerator® has been registered to PacifiCorp through the U.S. Patent and Trademark Office since April 6, 2010, under registration number 3770705.

[4] Environmentally-sound disposal of this equipment includes: proper disposal of oils, PCBs, mercury, and CFC-11 foam; and recycling of CFC-12, HFC-134a, plastic, glass, steel, and aluminum.

Figure 1. Program Participation by Month and Year

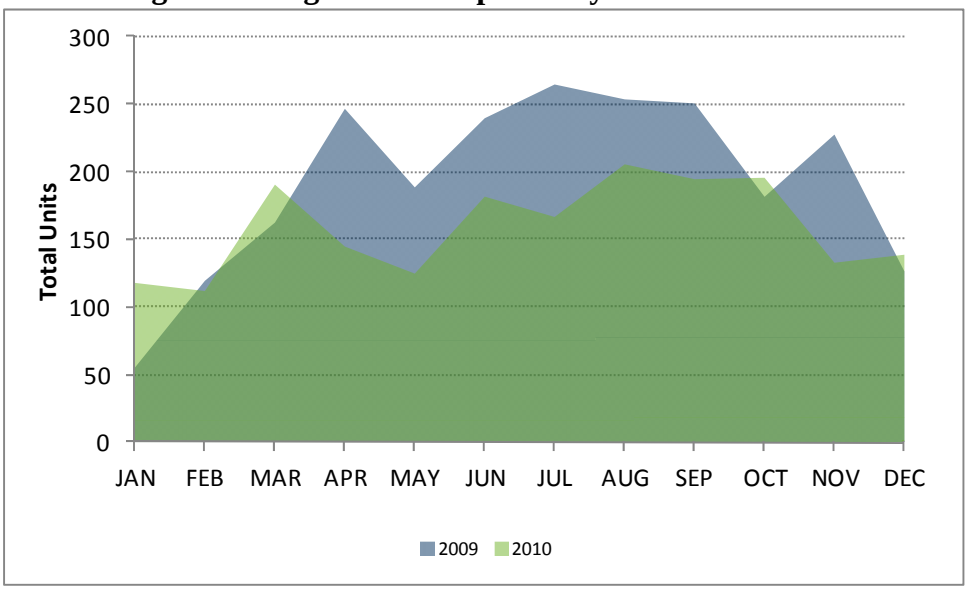
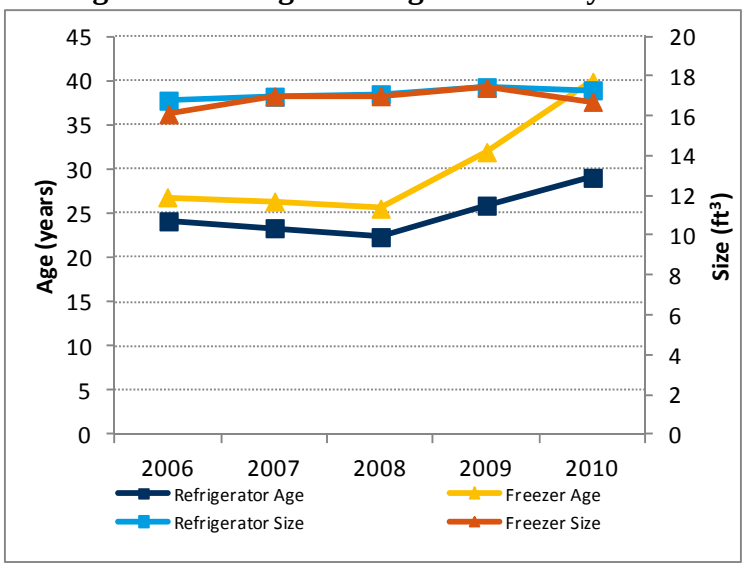


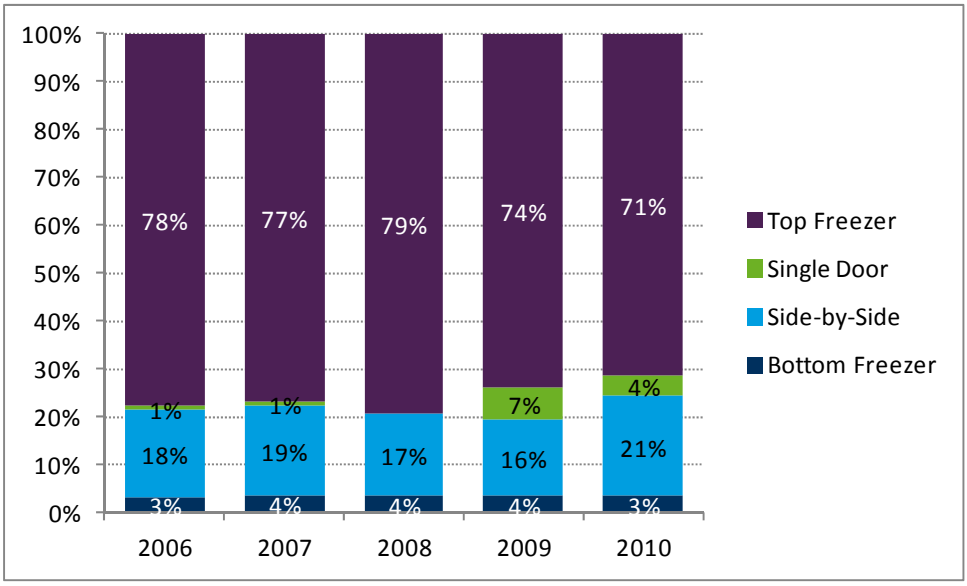
Figure 2 shows five-year trends in unit age and size. Freezers' and refrigerators' average unit sizes remained relatively constant, while average age showed an increasing trend over the past two years. Due to the unusual nature of this trend, Cadmus examined the program administrator's database in great detail to ensure this did not relate to any data quality issues. Though model numbers appeared to be entered for the vast majority of units, many older units' ages appear to have been estimated by haulers (a common practice in appliance recycling programs).

Figure 2. Average Unit Age and Size by Year



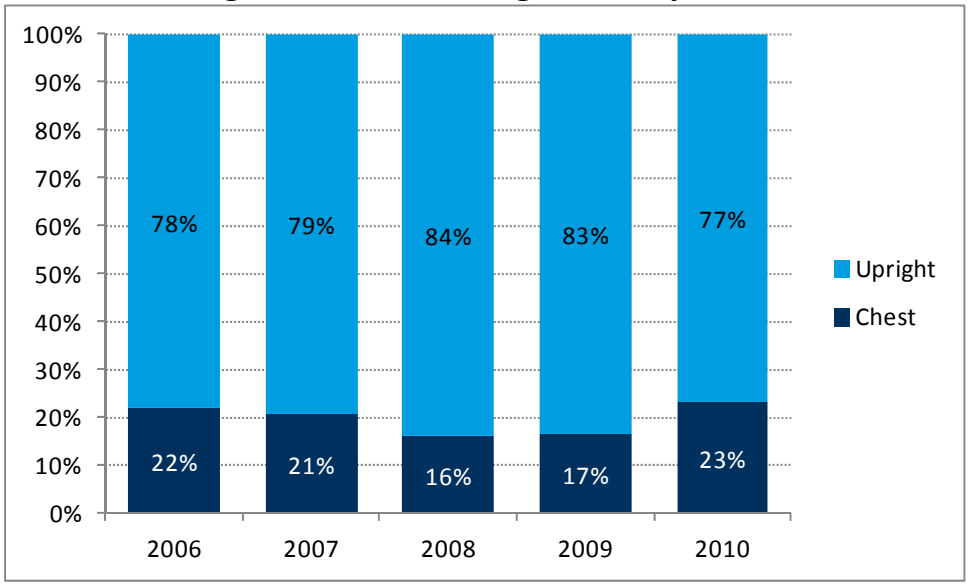
The program's refrigerator configurations also matched the expected trends. Single-door units appeared to account for an increasing share of total units; share of side-by-side units (a more modern, albeit less efficient, configuration) also increased slightly.

Figure 3. Refrigerator Configuration by Year



As shown in Figure 4, freezer configurations did not change appreciably over the past five years.

Figure 4. Freezer Configurations by Year



Impact Evaluation

Methodology

This report presents two values for evaluated savings: evaluated gross savings, and evaluated net savings. The evaluation defined reported gross savings as electricity savings (kWh) Pacific Power reported to Cadmus and contained in its 2009 and 2010 annual program reports. To determine evaluated net savings, Cadmus applied four steps to reported gross program savings, as shown in Table 7.

Table 7. Impact Steps

Saving Estimate	Step	Action
Evaluated Gross Savings	1	Verify accuracy of data in participant database
	2	Perform statistical/engineering analysis to evaluate per-unit savings
	3	Adjust evaluated gross savings with actual installation rate/part-use factor
Evaluated Net Savings	4	Apply net-to-gross adjustments

Step one (verifying accuracy of data in the participant database) included reviewing the program tracking database to ensure participants and reported savings matched the 2009 and 2010 annual reports.

Step two (performing a statistical/engineering analysis to evaluate per-unit savings) involved estimating refrigerator and freezer savings as well as CFL savings assumptions, such as delta watts, hours-of-use, and the waste heat factor.

Step three (adjusting evaluated gross savings with the actual installation rate/part-use factor) determined the mean proportion of the year in which recycled appliances were used as well as the number of CFLs program participants installed (and remaining installed). Using a telephone survey, information was collected to estimate an installation and persistence rate (referred to as the In-Service Rate or ISR), which was then used in calculating evaluated gross savings.

The first three steps resulted in evaluated gross savings. The fourth step (applying net-to-gross [NTG] adjustments) determined the net savings.[5] Through participant and nonparticipant telephone surveys, Cadmus estimated effects for freeridership, spillover, and appliance replacement induced by the program.[6]

Sampling Approach

Cadmus developed survey samples of randomly selected program participants and nonparticipants, seeking precision of ±10 percent or better at the 90 percent confidence level for individual estimates at the measure level. The evaluation determined sample sizes, assuming a 0.5 coefficient of variation. For small population sizes, Cadmus applied a finite population

[5] For some reporting purposes in Washington, the NTG adjustment is not applied. However, this evaluation examined both gross and net savings, since Pacific Power uses both sets of savings for various purposes.

[6] This report's *Net-to-Gross* section provides a detailed description of the estimation of these parameters.

adjustment to achieve precision estimates. Table 8 shows planned and achieved sample sizes by target group.

Table 8. Sample Sizes by Target Group

Data Collection Activity	Population	Sample Goal	Achieved Surveys
Participant Telephone Survey	4,218	240	243
Nonparticipant Telephone Survey	N/A	70	68

Table 9 details the screening process for eligible participants. Some 243 participants were randomly selected from 3,779 unique participants with Washington mailing addresses, valid phone numbers, and valid Pacific Power customer account numbers. 68 nonparticipants were selected through screening questions from a random sample of 3,409 Pacific Power customers residing in Washington.

Table 9. Participant Survey Sample

	Participants	Nonparticipants
Total Records	4,218	3,409
No Customer Number	0	0
Duplicate records (by customer number and phone number)	439	0
Eligible participants in call list	3,779	3,409
Completed Surveys	243	68
Response Rate*	6%	2%
Cooperation Rate**	29%	2%

* The response rate is defined as the number of customers completing a survey, divided by the number of eligible participants in the call list.

** The cooperation rate is defined as the number of customers completing a survey, divided by the number of customers reached by phone.

Regression Analysis

Cadmus developed a multivariate regression model to estimate gross unit energy consumption (UEC) for retired refrigerators and freezers. Cadmus estimated model coefficients using an aggregated *in situ* metering[7] dataset, composed of over 400 appliances, metered as part of four California and Michigan evaluations conducted between May 2009 and April 2011.[8] Collectively, these evaluations offered a wide distribution of appliance ages, sizes, configurations, usage scenarios (primary or secondary), and climate conditions. The dataset's diverse nature provided an effective secondary data source for estimating energy savings when Washington-specific metering could not be conducted.

Cadmus prefers using in-home metering data for estimating energy consumption, as opposed to Department of Energy's (DOE's) testing protocols, for two reasons.

First, metering the appliance in its original location captures impacts of critical external factors on appliance energy use (such as door openings, unit locations, and weather); these factors

[7] *In situ* metering involves metering units in the environment in which they are typically used. This contrasts with lab testing, where units are metered under controlled conditions.

[8] Southern California Edison, Pacific Gas & Electric, San Diego Gas & Electric, DTE Energy, and Consumers Energy.

cannot be accounted for when relying on DOE databases, which contain data on units metered under controlled conditions.

Second, most existing DOE databases estimate energy consumption at the time of appliance manufacture, not by unit retirement.[9] Consequently, evaluations require devising and applying additional assumptions in appliance degradation. In-home metering data reflect observed usage of appliances actually participating in appliance recycling programs at the time of retirement and as used in the homes from which they were removed.

Each observation in the aggregated dataset represents an appliance metered for a minimum of 10 days in a manner consistent with its preprogram use (i.e., in the same location, cooling food, and used by the home's occupants). Cadmus mapped weather data to participating homes' ZIP code-specific National Oceanic and Atmospheric Administration weather stations, and collected additional on-site data on relevant appliance characteristics to ensure data consistency with administrator tracking databases.

Cadmus' approach to model specification weighed the impacts of including alternative independent variables, using a variety of criteria. The model specification process sought to include variables adequately reflecting program design, while maintaining model simplicity. For each set of estimated parameters, the analysis assessed variance inflation factors (VIFs), adjusted R^2s, and measures of statistical significance.[10]

Cadmus used the following modeling considerations in the specification process:

- **Using an ordinary least squares method to estimate model parameters.** Data were approximately normally distributed, an important condition for the analysis. An examination of the final model's residual plot supported this hypothesis of normality.
- **Considering all relevant appliance characteristics for inclusion in the model.** These included: configuration, defrost type, age, size, and (in the case of refrigerators) primary or secondary designations. Age was considered as a continuous variable (capturing degradation), as dummy variables for decades of manufacture (to approximate vintages), and as a dummy variable for units manufactured before enactment of 1990s' National Appliance Energy Conservation Act (NAECA), which required new refrigerators and freezers to be more energy efficient.
- **Considering two environmental factors in the *in situ* model.** In addition to terms pertaining to appliance characteristics, the analysis considered two environmental factors in the *in situ* model: cooling degree-days (CDD) and primary or secondary appliances. Appliances in warmer climate zones were assumed to consume greater energy—as were primary appliances—due to more frequent door openings.
- **Including interaction terms only for theoretical importance to the model.** The model only included one interaction term, between units located in garages and CDDs, to

[9] The California Energy Commission maintains one such database, which can be accessed online at http://www.energy.ca.gov/appliances/database/historical_excel_files/Refrigeration/

[10] VIFs, R^2s, and statistical significance are tests of the validity of a regression model. In this case VIFs under 5 were deemed sufficient.

account for additional impacts of warmer temperatures on refrigerators in unconditioned spaces.

- **Considering transformations of explanatory variables**. These included logged and squared values, based on theoretical and empirical grounds.

Kit Savings Algorithm and Assumptions

With each pickup ordered, participants received an energy-saving kit, which contained:

- Two 13-watt CFLs;
- One refrigerator thermometer; and
- Energy-savings educational materials and other program references.

The following algorithm estimated CFL savings:

$$Evaluated\ Per\ Unit\ Savings\ (kWh\ per\ unit) = \frac{\Delta Watts * ISR * HOU * 365}{1{,}000}$$

Where:

- ΔWatts = Wattage of baseline bulb - Wattage of ENERGY STAR CFL
- ISR = In-service rate or the percentage of units installed
- HOU = Hours of use; per day
- 365 = Constant; days per year
- 1,000 = Constant; conversion of watts to kilowatts

The annual savings algorithm derived from industry-standard engineering practices, consistent with the methodology used by the Northwest Regional Technical Forum (RTF) for calculating energy use and savings for residential lighting.

The ISR captured CFLs installed, removed, and replaced by other energy-efficient light bulbs. Specifically:

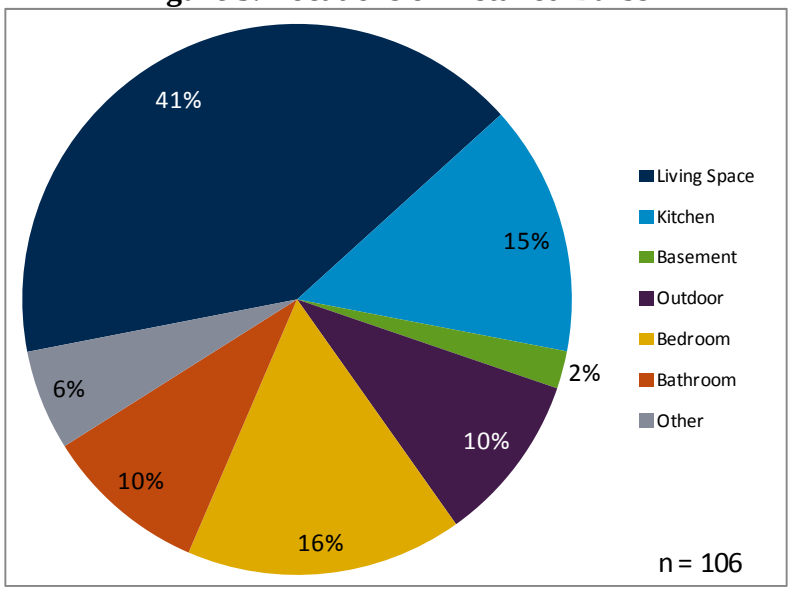
$$CFL\ In-Service\ Rate\ (ISR\ \%) = \frac{Installed - Removed}{Sent}$$

Cadmus estimated wattage changes by comparing lumen outputs of kit CFLs to their incandescent equivalents. The 13-watt kit CFLs output 900 lumens, equivalent to a 60-watt incandescent bulb. Cadmus chose to use 60 watts as the baseline because it is the incandescent bulb of equivalent lighting output (measured in lumens), and self-reported wattages can be both difficult to retrieve and unreliable. Cadmus found this represented the most reasonable, cost-effective assumption for calculating CFL savings, and provided a consistent approach across the other Cadmus Washington evaluations.

Cadmus calculated average hours of use (HOU) using ANCOVA[11] model coefficients, estimated from a combined multistate, multiyear database of light logger data, compiled by recent Cadmus CFL HOU studies. This model expressed average HOU as a function of room type, existing CFL saturations, and the presence of children in a home. Appendix B provides a more detailed exploration of the impact methodology used to estimate CFL HOU.

Figure 5 shows distributions of bulbs by room types. The values for all explanatory variables, save existing CFL saturations, were based on response data from the participant survey. For CFL saturations, Cadmus used data from Pacific Power's recent potential study for Washington.[12]

Figure 5. Locations of Installed Bulbs



Pacific Power WA SYLR Participant Survey: Question E6.

Estimating Average Gross Unit Consumption

Cadmus used regression models to estimate consumption for refrigerators (Table 10) and freezers (Table 11). Each independent variable's coefficient indicated the influence of that variable on daily consumption, holding all other variables constant. A positive coefficient indicated an upward influence on consumption; a negative coefficient indicated a downward effect.

The value of the coefficient indicates the marginal impact on the unit energy consumption (UEC) of a one-point increase in the independent variable. For instance, a 1 cubic foot increase in refrigerator size results in a 0.081 kWh increase in daily consumption. In the case of dummy variables, the value of the coefficient represents the difference in consumption if the given condition is true. For example, in the refrigerator model, the coefficient for the variable that

[11] ANCOVA, or analysis of covariance, refers to a type of statistical modeling.

[12] "Assessment of Long-Term, System-Wide Potential for Demand-Side and Other Supplemental Resources." http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/DSM_VolumeI_2011_Study.pdf

indicates a refrigerator was a primary unit is 0.633, indicating, all else being equal, a primary refrigerator consumes 0.633 kWh per day more than a secondary unit.

In the refrigerator model, there is no dummy variable for units manufactured after the 1990s. These units are considered the baseline, and, therefore, all other dummy coefficient values are relative to this baseline. For example, the coefficient for the variable that indicates a unit was manufactured before 1980 is 1.372. This coefficient implies that units manufactured in the 1970s consume 1.372 kWh per day more than units manufactured in the 2000s.

Refrigerator Regression Model

Table 10 shows the model used to estimate refrigerators' annual energy consumption and its estimated parameters.

Table 10. Refrigerator UEC Regression Model Estimates (Dependent Variable = Average Daily kWh, R^2 = 0.26)

Independent Variables	Coefficient	p-Value	VIF
Intercept	0.662	0.001	0.0
Age (years)	0.005	0.169	2.1
Dummy: Manufactured Pre-1980	1.372	<.0001	2.8
Dummy: Manufactured in 1980s	0.960	<.0001	4.7
Dummy: Manufactured in 1990s	0.199	0.042	4.8
Size ($ft.^3$)	0.081	<.0001	1.9
Dummy: Single Door	-1.172	<.0001	1.3
Dummy: Side-by-Side	0.823	<.0001	1.6
Dummy: Primary	0.633	<.0001	1.2
Interaction: Unconditioned Space x CDDs	0.031	<.0001	1.2

The results indicated:

1. Older refrigerators use more electricity, due to degradation and changes in efficiency over time. The impact of vintage on daily consumption, represented by the decade-of-manufacture coefficients, drops from 0.761 in the 1980s to 0.278 in the 1990s. This shows the effect of the 1990 enactment of the NAECA standard, which required new refrigerators to be more energy efficient.
2. Larger refrigerators consume more energy.
3. Single-door units consume less energy, as these units typically do not have full freezers.
4. Side-by-side refrigerators experience higher consumption due to greater exposure to outside air when opened and due to through-door features common in these units.
5. Primary appliances experience higher consumption due to increased usage.
6. At higher temperatures, refrigerators in unconditioned spaces consume more energy.[13]

[13] It is also likely units in unconditioned spaces, such as garages, consume less energy at extremely cold temperatures. Comprehensive in-home metering of refrigerators and freezers in winter months has not been extensive.

Freezer Regression Model

Table 11 details final model specifications used to estimate energy consumption of participating freezers and its results.

Table 11. Freezer UEC Regression Model Estimates (Dependent Variable = Average Daily kWh, R^2 = 0.36)

Independent Variables	Coefficient	p-Value	VIF
Intercept	-0.590	0.003	0.0
Age (years)	0.040	<.0001	1.9
Dummy: Unit Manufactured Pre-1990	0.566	<.0001	2.1
Size ($ft.^3$)	0.109	<.0001	1.2
Dummy: Chest Freezer	-0.265	<.0001	1.2
Interaction: Unconditioned Space x CDDs	0.059	<.0001	1.1

The results show:

1. Older freezers experienced higher consumption due to year-on-year degradation.
2. Freezers manufactured before the 1990 NAECA standard consumed more energy.
3. Larger freezers consumed more energy.
4. Chest freezers consumed less energy than upright units, due to reduced heat infiltration from door openings in these units.
5. At higher temperatures, freezers in unconditioned spaces consumed more energy.

Extrapolation

After estimating the final regression models, Cadmus analyzed the corresponding characteristics (the independent variables) for participating appliances (as captured in the program administrator program database). Table 12 summarizes program averages or proportions for each independent variable.

Table 12. 2009–2010 Participant Mean Explanatory Variables*

Appliance	Independent Variables	Participant Population Mean Value
Refrigerator	Age (years)	27.29
	Dummy: Manufactured Pre-1980	0.32
	Dummy: Manufactured in 1980s	0.35
	Dummy: Manufactured in 1990s	0.28
	Size (ft.3)	17.38
	Dummy: Single Door	0.05
	Dummy: Side-by-Side	0.18
	Dummy: Primary	0.49
	Interaction: Unconditioned Space x CDDs	0.71
Freezer	Age (years)	35.61
	Dummy: Unit Manufactured Pre-1990	0.87
	Size (ft.3)	17.09
	Dummy: Chest Freezer	0.19
	Interaction: Unconditioned Space x CDDs	1.31

*CDDs are the weighted average CDDs from TMY3 data for weather stations mapped to participating appliance zip codes. TMY3 is a typical meteorological year, using median daily values for a variety of weather data collected from 1991–2005.

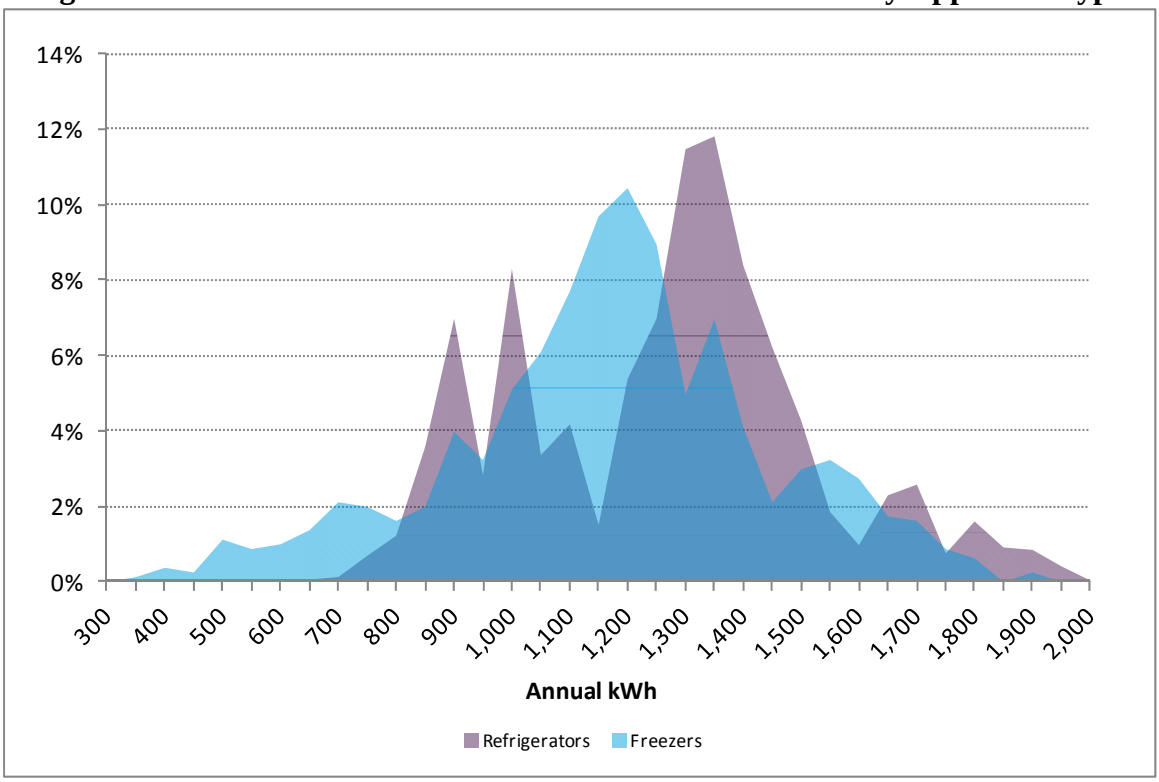
For example, using values from Table 11 and Table 12, the estimated annual UEC for freezers was calculated as:[14]

$$\begin{aligned} Freezer\ UEC = {} & 365\ days \\ & * (-0.590 + 0.040 * [35.61\ years\ old] + 0.566 \\ & * [87\%\ units\ manufactured\ pre - 1990] + 0.109 * [17.09\ ft.^3] - 0.265 \\ & * [179\%\ units\ that\ are\ chest\ freezers] + 0.059 \\ & * [1.31\ Unconditioned\ CDDs]) = \ 1{,}056\ kWh \end{aligned}$$

[14] This equation illustrates the inputs, but Cadmus' analysis took a slightly different approach to calculating average UECs. The analysis used the regression coefficients to predict an average daily UEC for each unit in the administrator tracking database. The annualized average of these predictions represented the average UEC for the participant population during the program period. This approach ensured the resulting UEC would be based on specific units recycled through Pacific Power's program. The two approaches would be mathematically identical if the tracking database was 100 percent complete. Due to rare instances of missing data, results from the two approaches differ slightly.

Figure 6 compares distributions of estimated UEC values for refrigerators and freezers.

Figure 6. 2009–2010 Distribution of Estimated Annual UECs by Appliance Type



Kit Savings

Table 13 shows final inputs and gross savings estimated for CFLs distributed in the energy-saving kits.

Table 13. CFL Savings

Incandescent Watts	CFL Watts	HOU	Gross Annual kWh (per bulb)	Gross Annual kWh (per kit)
60	13	2.63	45.0	90.1

Cadmus did not calculate savings from the refrigerator/freezer thermometer or from educational materials provided in the kits, as these savings were likely small and quite difficult to quantify accurately. However, participant survey results indicated 95 percent of participants found information provided in the kit at least somewhat helpful, and approximately 64 percent of participants reported using the refrigerator thermometer. Of those installing thermometers, however, 24 percent reported decreasing their refrigerator temperatures.

UEC Summary

Table 14 reports evaluated per-unit average annual energy consumption for refrigerators and freezers recycled by the SYLR during the 2009–2010 program period. The following section describes adjustments to these estimates used to determine gross per-unit saving estimates for participant refrigerators and freezers. The results indicated an evaluated freezer value 797 kWh lower than the reported value, with a refrigerator value approximately equal to the reported value.

Table 14. Estimates of Per-Unit Annual Energy Consumption

Appliance	Reported Annual UEC (kWh/year)	Evaluated Annual UEC (kWh/year)	Relative Precision at 90% Confidence
Refrigerators	1,250	1,240	3.4%
Freezers	1,853	1,056	4.1%
Energy-Saving Kits	72	90	4.9%

In-Service Rates

Appliance Part-Use Factor

Participants used some refrigerators and freezers recycled through the program for part of the year. Cadmus calculated a weighted average part-use factor, representing the three participant usage categories, as defined by the appliance's operational status during the year before it was recycled. For example, participants not using their appliance at all received a part-use factor of zero as no immediate savings were generated by their appliance's retirement. Table 15 shows part-use factors for the three usage categories.

Table 15. Part-Use Factors by Operational Status Description

Operational Status Description	Part-Use Factor
Not running for at least one full year	0
Running part time during the year*	0 to 1
Running throughout the year	1

*Participants using their appliances part of the year received a part-use factor derived from the proportion of total months they used using the appliance.

Table 16 shows participants using their appliances for only part of the year had average part-use factors of 0.63 for refrigerators and 0.43 for freezers. Thus, the average freezer recycler, using a freezer for part of the year, used it for approximately 5.2 months.

Using participant survey data, Cadmus assessed the percentage of participants in each three usage categories (no usage, full-year usage, and partial usage). Refrigerators and freezers had part-use factors of 0.93 and 0.89, respectively.

Table 16. Part-Use Factors and Evaluated Energy Savings by Appliance Type

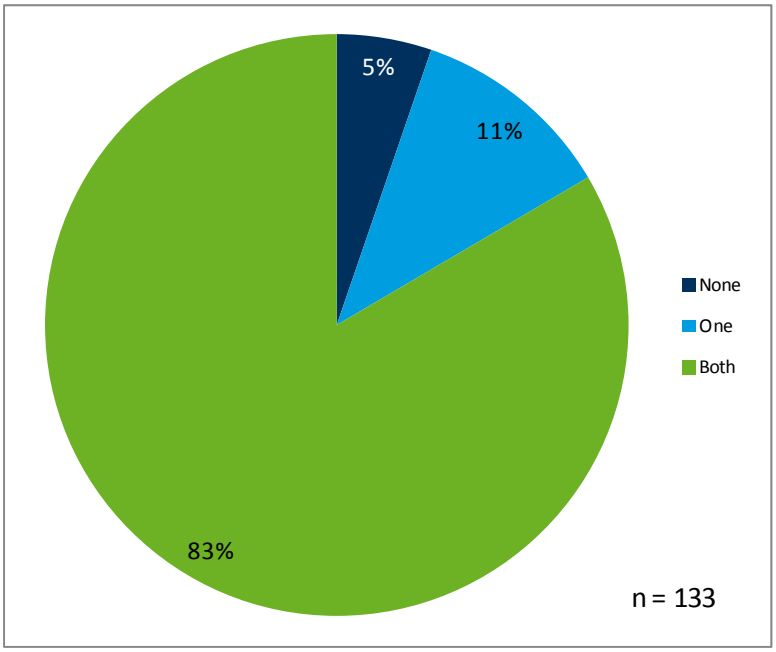
Operational Status	Refrigerators			Freezers		
	Percent of Total Recycled Refrigerator	Average Part-Use Factor	Part-Use Adjusted Energy Savings (kWh/Year)	Percent of Total Recycled Freezers	Average Part-Use Factor	Part-Use Adjusted Energy Savings (kWh/Year)
Not Running	3%	0	0	9%	0	0
Running Part Time	10%	0.63	780	5%	0.43	455
Running All Time	87%	1.00	1,240	87%	1.00	1,056
Total	100%	0.93	1,153	100%	0.89	935

*"Not in Use" refers to units that were simply not plugged in, as inoperable units were excluded from the program.

CFL Installation Rate

On average, participants initially installed 1.8 of the two bulbs received, resulting in an 89 percent installation rate. Figure 7 shows the proportion of participants installing zero, one, or two bulbs.

Figure 7. Number of Bulbs Installed



Pacific Power WA SYLR Participant Survey: Question E4.

Evaluated Gross Savings

Table 17 provides estimates of per-unit evaluated gross energy savings. Cadmus determined estimated energy consumption of units through the *in situ* metering study, adjusting it by part-use factors determined from the participant survey.

Table 17. Part-Use Adjusted Per-Unit Evaluated Gross Energy Savings by Measure

Appliance	Gross Energy Savings (kWh/Year)	Relative Precision(90% confidence)
Refrigerators	1,153	±5.3%
Freezers	935	±6.1%
Energy-Saving Kits	80	±6.9%

*For Energy-Saving Kits calculation methods, see Appendix B.

Tracking Database Review

The program administrator manager reported three types of program data tracked:

- Data on recycled appliances (stored in a "Units" database);
- Information about pickups (stored in an "Orders" database); and
- Data about customers (stored in a "Customers" database).

These integrated databases allowed the program administrator to record information collected via the call center or Website, along with on-site data collected during pickups, and post-pickup data recorded during recycling. The program administrator's client Web portal provided the Pacific Power program manager with real-time access to collection data and other program results.

Every month, the program administrator completed a monthly report using a template provided by Pacific Power, documenting the number of units recycled that month and the number of kits distributed. Pacific Power received the monthly report on the 25th of every month, and used monthly reports to compile its annual DSM reports.

During the evaluation, Cadmus learned the monthly reports documented a slightly different number of recycled units than the complete Units database, provided by the program administrator for evaluation purposes. Upon further examination of the data, the program administrator could not identify the source of this discrepancy, but confirmed the discrepancy did not affect invoicing, as invoicing occurred separately from monthly reporting. The program administrator and Pacific Power have planned changes to the reporting processes to prevent such discrepancies from occurring in the future. For the impact evaluation activities, Cadmus assumed the program administrator's Units database provided the most reliable source of the total number of units recycled. Table 18 details reporting discrepancies.

Table 18. Reporting Discrepancies

Appliance	2009		2010		Total		Difference in Totals	
	Annual Report	JACO Database	Annual Report	JACO Database	Annual Report	JACO Database	Nominal	Proportion
Refrigerator	1,890	1,854	1,484	1,512	3,374	3,366	-8	0%
Freezer	464	456	399	396	863	852	-11	-1%
Total	2,354	2,310	1,883	1,908	4,237	4,218	-19	-2%

Table 19 compares total reported and evaluated gross savings by measure.

Table 19. 2009-2010 Reported vs. Evaluated Savings by Measure

Measure	Participation (units)		Per-Unit Gross Savings (kWh/unit)		Gross Savings (kWh)		Precision at 90% Confidence
	Reported	Evaluated	Reported	Evaluated	Reported	Evaluated	
Refrigerator Recycling	3,374	3,366	1,250	1,153	4,217,500	3,879,619	5.3%
Freezer Recycling	863	852	1,853	935	1,599,139	796,523	6.1%
Energy-Saving Kit	3,911	3,911	72	80	281,592	313,926	6.9%
Total	N/A	N/A	N/A	N/A	6,098,231	4,990,068	4.3%

Net-to-Gross

Cadmus' analysis estimated net savings for recycled refrigerators using the following formula:

$$Net\ savings = Gross\ Savings * (1 - Freeridership\ Ratio + Spillover\ Ratio) - (Replacement\ kWh * Induced\ Replacment\ Proportion)$$

Where:

Gross Savings = Evaluated *in situ* UEC for the recycled unit, adjusted for part-use;

Freeridership Ratio = The proportion of program savings that would have occurred in the program's absence;

Spillover = Non-programmatic savings induced by the program, expressed as a proportion of gross savings;

Replacement kWh = Deemed UEC for the average replacement unit, adjusted for part-use; and

Induced Replacement Proportion = The proportion of participants reporting they purchased a replacement unit due to the program.

Freeridership

Assessing freeridership for appliance recycling programs can be challenging, as the programs not only seek to remove inefficient appliances from the customers' homes, but seek to remove them from the utility grid. Thus, freeridership must be estimated based on participants' reports of what would have happened to the appliance in the program's absence. This invites the risk of biased responses from participants, as participants must assess what they would have done hypothetically. Such assessments very often suffer from social desirability bias, which results from the respondents' tendency to answer questions in a manner that will be viewed favorably by others. To counteract this potential bias, Cadmus collected additional data from nonparticipants[15] about how they actually disposed of their appliances.

Table 20 presents four possible scenarios, assuming participating refrigerators or freezers had not been recycled through the program. As Scenarios 1 and 3 indicate freeridership, the report addresses those scenarios in further detail.

Table 20. Potential Freeridership Scenarios

Scenarios Independent of Program	Scenario	Indicative of Freeridership	Percent of Refrigerator Participants (n=99)	Percent of Freezer Participants (n=105)
Unit Kept But Not Used	1	Yes	4%	5%
Unit Kept And Used	2	No	16%	15%
Unit Discarded and Destroyed	3	Yes	39%	38%
Unit Discarded, Transferred, Used	4	No	40%	42%

[15] Nonparticipants were defined as Pacific Power customers disposing of a working refrigerator or freezer outside of the SYLR program during 2009 or 2010.

Scenarios 1 and 2

For participants reporting they would have kept units had they not participated in the program, the survey asked whether they would have used the unit or would have stored it unplugged. These responses provided the proportion of units that would have been kept and not used at this time (therefore, not drawing electricity from the grid—an indication of freeridership). To maintain conservative estimates, energy savings associated with these units were subtracted from the program's evaluated gross savings.

Scenarios 3 and 4

Calculating freeridership associated with Scenarios 3 and 4 (units discarded and destroyed in the program's absence, and units transferred to another owner in the program's absence) proved slightly more complex, as they included a number of different hypothetical actions.

Table 21 presents participants' Scenario 3 and 4 responses, indicating actions participants claimed they would have taken had the program not been available.

Table 21. Freeridership Scenarios 3 and 4 (Participant Responses)

Hypothetical Method of Disposal In Absence of Program	Indicative of Freeridership	Percent of Freezer Participants (n=88)	Percent of Refrigerator Participants (n=94)
Sell it to a private party, either by running an ad or to someone you know	No	15%	9%
Sell it to a used appliance dealer	Varies by appliance age*	1%	1%
Give it away to a private party, such as a friend or neighbor	No	13%	18%
Give it away to a charity organization, such as Goodwill Industries or a church	No	19%	15%
Have it removed by the dealer you got your new or replacement appliance from	Yes**	1%	5%
Haul it to the dump or recycling center yourself	Yes	47%	45%
Hire someone else to haul it away for junking or dumping	Yes	5%	7%

Pacific Power WA SYLR Participant Survey: Question F17.
*Cadmus' prior market research has indicated that used appliance dealers do not resell units over 15 years old. Thus the analysis assumed units over 15 years of age would not have remained on the grid.[16]
**Although it is possible that some dealers resell used units that are picked up, Cadmus' prior market research has shown that a majority of dealers do not resell these units. Cadmus's assumption that none of these appliances were resold is conservative, but since it affects only a small portion of participants, it has a minimal effect on overall NTG.

[16] An example of the market research that informed these assumptions can be found in the Ameren Illinois PY2 Appliance Recycling Evaluation Report, available online at http://ilsag.org/evaluation_documents.

Table 22, below, provides comparable responses for nonparticipants.

Table 22. Freeridership Scenario 3 and 4 (Nonparticipant Responses)*

Hypothetical Method of Disposal In Absence of Program	Indicative of Freeridership	Percent of Nonparticipants (n=67)
Sell it to a private party, either by running an ad or to someone you know	No	19%
Sell it to a used appliance dealer	Varies by appliance age	1%
Give it away to a private party, such as a friend or neighbor	No	27%
Give it away to a charity organization, such as Goodwill Industries or a church	No	3%
Have it removed by the dealer you got your new or replacement appliance from	Yes	21%
Haul it to the dump or recycling center yourself	Yes	12%
Hire someone else to haul it away for junking or dumping	Yes	16%

*Refrigerators and freezers pooled due to smaller sample size.
Pacific Power WA SYLR Nonparticipant Survey: Question A6.

The freeridership calculations outlined above yield the appliance-specific, freeridership ratios presented in Table 23.

Table 23. Participant and Nonparticipant Freeridership Responses

Respondent Group	Measure Stratum	Respondents Factored into Freerider Score*	Identified Number of Freeriders	Freerider Ratio	Absolute Precision (90% confidence)**
Participant	Refrigerator	99	43	43%	±8.0%
Participant	Freezer	105	45	43%	±6.8%
Nonparticipant	Refrigerator	52	14	27%	±10.3%
Nonparticipant	Freezer	15	5	33%	±21.4%

* The number of respondents factored into the Freerider Score differs from total number of participants and nonparticipants surveyed, because some respondents gave a response of "Don't know" to one or more essential questions.
**For ease of interpretation, this report uses absolute precision for proportion estimates.

Cadmus averaged the freeridership ratio estimates for participating and nonparticipating appliances to arrive at final, measure-level freeridership ratios. Calculating the average used inverse variance weights ensured placing greater weight on values with a higher degree of certainty.

Table 24. Freeridership Ratios

Participants/Nonparticipants Combined	Freerider Ratio Weighted Average	Absolute Precision (90% confidence)
Refrigerator	37%	±6.4%
Freezer	42%	±7.4%
Recycled Appliance Overall	38%	±5.5%

Spillover

Spillover refers to additional savings generated by program participants due to their program participation, but not captured by program records. Spillover occurs when participants purchase energy-efficient measures or adopt energy-efficient practices due to a program, but they choose

not to participate (or are otherwise unable to participate) in the program. As these customers are not participants, they do not appear in program records of savings generated by spillover impacts.

Spillover examples include:

- Program participants adopting additional measures without an incentive.
- Consumers acting on the programs' influence, resulting from changes in available energy-using equipment in the marketplace.
- Changes brought about by more efficient practices employed by architects and engineers, ultimately forcing consumer behaviors into desired patterns.
- Changes in nonparticipants' behaviors resulting from direct marketing or changes in stocking practices.

The energy-efficiency program's spillover effect serves as an additional impact, which can be added to the program's results, in contrast with freerider impacts (which reduce net savings attributable to the program).

Methodology

For the SYLR program, Cadmus measured spillover by asking a sample of participants purchasing and receiving an incentive for a particular measure if, due to the program, they installed another efficient measure or undertook other energy-efficiency activities. Respondents were asked to rate the relative influence of the SYLR program and incentive on their decisions to pursue additional savings.

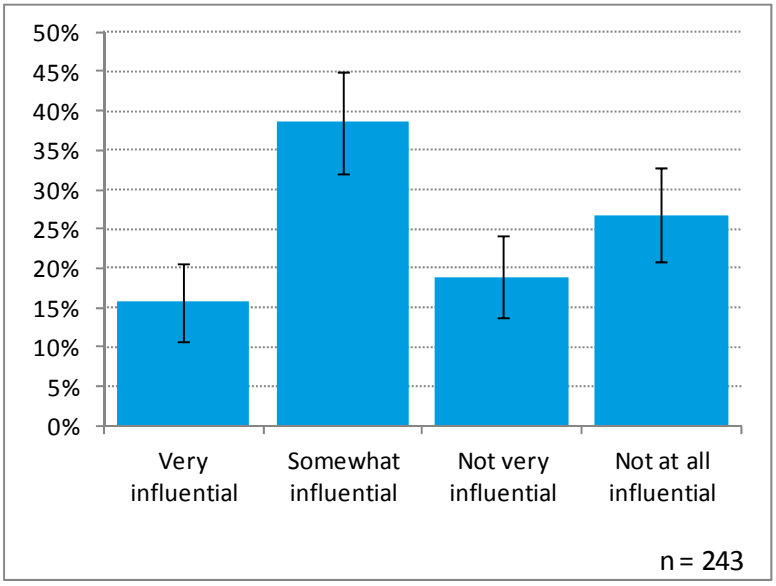
Spillover questions sought to determine whether program participants installed any other energy-saving measures since participating in the program. Savings participants received from additional measures would be considered spillover savings if the program significantly influenced their decisions to purchase additional measures, and if they did not receive additional incentives for those measures.

SYLR program participants were specifically asked whether they installed the following measures, which were associated with quantifiable spillover:

1. High-efficiency dishwashers
2. High-efficiency washers
3. High-efficiency refrigerators
4. High-efficiency water heaters
5. CFLs

If the participant installed one or more of these measures, they were asked additional questions about which year they purchased the measure, and whether they received an incentive for the measure. If applicable, participants were asked how influential the SYLR program was on their purchasing decisions (participants could answer not at all, not very, somewhat, or very influential). Participants expressed mixed responses regarding the program's influence on these actions, with data indicating 54 percent found the program "somewhat" or "very" influential.

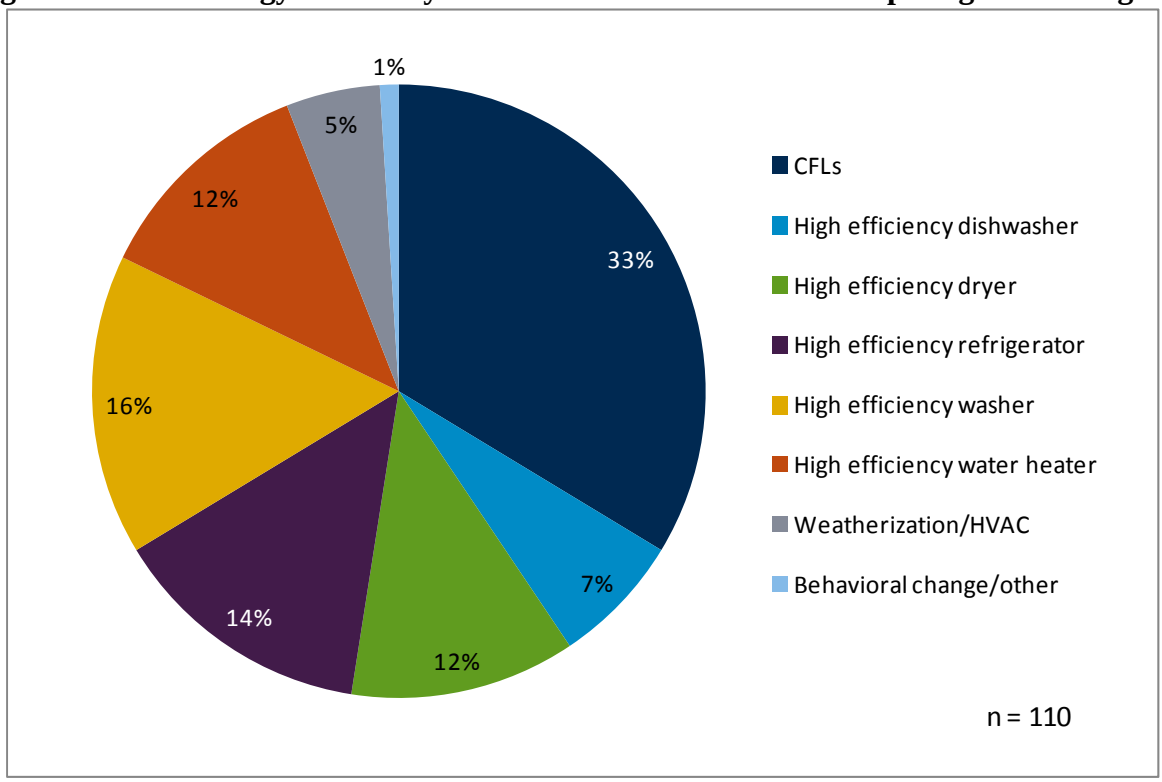
Figure 8. Program Influence on Installing Additional Measures (with 90% Confidence Intervals)



Pacific Power WA SYLR Participant Survey: Question SP7.

Sixty-five percent of participants claimed to have installed energy-efficient measures or changed their behaviors after participating in the SYLR program. However, only five such purchases represent quantifiable savings: energy-efficient refrigerators, clothes washers, dishwashers, water heaters, and CFLs. Other measures, such as weatherization and HVAC, are difficult to quantify accurately based on survey data, and thus were not included in the spillover analysis. Figure 9 shows distributions of reported actions taken, including those not associated with spillover savings

Figure 9. Other Energy-Efficiency Measures Installed Since Participating in the Program



Pacific Power WA SYLR Participant Survey: Question SP6.

Cadmus calculated participant spillover by estimating savings attributable to additional measures installed, and whether respondents credited Pacific Power with influencing their decisions. Measures were counted if they were eligible for program incentives but incentives were not requested. NTG ratios then were calculated, accounting for estimated freeridership and spillover effects.

Spillover Savings Analysis

For calculating spillover savings, Cadmus used a top-down approach. The analysis began using a subset containing only survey respondents who indicated they installed additional energy-savings measures after participating in the SYLR program, but without receiving any incentives. From this subset, Cadmus removed participants who indicated the program had little influence on their decisions to purchase additional measures.

For the remaining participants with legitimate spillover savings, Cadmus estimated energy savings from additional measures installed. Savings values, calculated by Cadmus, were matched to additional measures installed by survey participants.

Table 25, below, summarizes participant survey spillover responses. Appliance per-unit savings were derived from Cadmus' evaluation of 2009 and 2010 Home Energy Savings gross savings values. Cadmus assumed CFL savings equaled those calculated for energy-saving kits. Total spillover savings represented 0.9 percent of total program savings.

Table 25. Spillover Results

Sample Spillover kWh	Sample Program kWh	Spillover Ratio	Absolute Precision (90% confidence)
2,363	252,649	0.94%	±0.34%

Replacement

Cadmus adjusted for replacements only when the replacement's purchase resulted from the program. Table 26 illustrates an example of how this adjustment applies for a non-freerider, as seen through three possible scenarios, representing various outcomes that could have occurred in the program's absence. The likelihood of these scenarios occurring was determined using surveys with participants and nonparticipants (those disposing on units on their own). The table depicts expected loads on the grid with and without the program.

For example, in Scenario 1:

- The unit would have remained on the grid (sold to another household, donated, or kept at home);
- The removed unit would have been replaced; and
- Replacement would not have been induced by the program (i.e., would have been purchased without the program).

Under this scenario, had the program not existed, a total load would have been 1,153 kWh + 432 kWh = 1,585 kWh, because, without the program, the old unit would have stayed on the grid, and a replacement would have been purchased (keeping both units on the grid).

Due to the program, the recycled unit was taken off the grid, with the only load remaining that of the new unit (432 kWh). Thus, this scenario would indicate a program net impact of 1,153 kWh.

In Scenario 2, the unit would have remained on the grid, and the new unit would *not* have been purchased. The program's net impact for this scenario would be 720 kWh. For refrigerators, this scenario occurred only 3 percent of the time.

Finally, in Scenario 3, no adjustment is required because the unit is not replaced.

Table 26. Replacement Decision Tree

Scenario	Replaced Unit	Replacement Induced by Program	kWh Consumption Without Program	kWh Consumption With Program	kWh Reduction
1	Yes	No	1,585	432	1,153
2		Yes	1,153	432	720
3	No	N/A	1,153	-	1,153

Table 27 summarizes replacement findings, by measure.

Table 27. Replacement kWh by Measure

Scenario	Percent Induced Replacement	Replacement kWh	Induced Replacement kWh
Refrigerator	3.0%	465	14
Freezer	2.9%	443	13

Final Net-to-Gross

As summarized in Table 28, the evaluation determined final net savings (and, subsequently, the NTG ratio) as gross savings, adjusted for freeridership and spillover, less induced replacement consumption.

Table 28. Final NTG Ratios

Measure	Gross Per-Unit Energy Savings (kWh)	Freerider Ratio	Induced Additional Savings (Spillover)	Induced Replacement kWh	Net Per-Unit Energy Savings (kWh)	Relative Precision (90% confidence)	NTG
Refrigerator	1,153	36.9%	0.9%	14	724	±6.8%	62.8%
Freezer	935	41.6%	0.9%	13	542	±7.7%	58.0%

In a paper recently presented in 2011 to the International Energy Program Evaluation conference,[17] Cadmus found many factors affect appliance recycling programs' NTG. Of particular interest for the SYLR program in Washington, the paper found, as programs mature, NTG tends to increase. The study also found incentive increases can positively affect NTG. Table 29 compares NTG ratios for similar appliance recycling programs evaluated over the last decade. As shown, NTG ratios for the Washington 2009 and 2010 SYLR program fell in the mid-to-high range.

[17] Keeling, J. & Bushman, K. "A Meta-Analysis of Drivers of Freeridership in Appliance Recycling Programs." *Proceedings of the 2011 IEPEC Conference*. Boston, MA: International Energy Program Evaluation Conference. 2011.

Table 29. Comparable Appliance Recycling Programs' NTG Ratios

Study	Study Year	Refrigerator NTG Ratio	Freezer NTG Ratio
Appliance Recycling Program Evaluation – PY 2, Ameren Illinois, The Cadmus Group	2010	0.79	0.82
Results for Pacific Gas & Electric, from Residential Retrofit High Impact Measure Evaluation Report, California Public Utility Commission, The Cadmus Group	2010	0.51	N/A
PowerWise Appliance Recycling Program, Salt River Project, FY 2009 Evaluation, The Cadmus Group	2009	0.67	0.68
EM&V Study of 2004–2005 Statewide Residential Appliance Recycling Program, ADM Associates, Inc.	2008	0.61	0.71
Residential Appliance Turn-In Program in Wisconsin, PA Consulting Group,	2008	0.57	N/A
Evaluation of the Washington Refrigerator and Freezer Recycling Program, PacifiCorp, PY 2005–2006, KEMA*	2007	0.31	0.56
Measurement and Evaluation Study of 2002 Statewide Residential Appliance Recycling Program, Final Report, KEMA-Xenergy*	2004	0.35	0.54
Measurement and Verification Report for NCPA SB5X Refrigerator Recycling, Final Report, Robert Morris & Associates	2003	0.64	0.64
Measurement and Verification of SB5X Energy Efficiency Programs for the Sacramento Municipal Utility District, Final Report, Heschong Mahone Group	2003	0.55	0.68

*The methodology that KEMA applied in the 2002 California study and the 2005-2006 Washington study included part-use as one component of the NTG adjustment, resulting in lower than average NTG ratios.

As an additional point of comparison, the per-unit savings values found in the Regional Technical Forum's (RTF) measure database are 482 kWh for refrigerators and 555 kWh for freezers.[18] These can be compared to Cadmus' net savings values, as the RTF uses NTG as a proxy for a baseline adjustment. The distinction between the RTF's methods and Cadmus' methods is explained in detail in Appendix D. For refrigerators, Cadmus' estimated savings are higher, due largely to the fact that the portion of program-induced replacement was determined through participant surveys to be much lower than RTF's assumption.

[18] http://www.nwcouncil.org/energy/rtf/measures/res/FrigRecycle_FY10v2_3.xls

Summary of Impact Findings

Table 30 and Table 31 summarize impact evaluation findings.

Table 30. 2009–2010 Per-Unit Savings by Measure

Measure	Reported Gross Savings (kWh)	Evaluated Annual UEC (kWh)	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)
Refrigerator Recycling	1,250	1,240	1,153	724
Freezer Recycling	1,853	1,056	935	542
Energy-Saving Kit	72	90	80	80

Table 31. 2009–2010 Program Savings by Measure

Measure	Evaluated Participation	Reported Gross Savings (kWh)	Evaluated Gross Savings (kWh)	Evaluated Net Savings (kWh)	Precision at 90% Confidence	Net Realization Rate
Refrigerator Recycling	3,366	4,217,500	3,879,619	2,437,138	±11.0%	58%
Freezer Recycling	852	1,599,139	796,523	462,146	±12.3%	29%
Energy-Saving Kit	3,911	281,592	313,926	313,926	±6.9%	111%
Totals	N/A	6,098,231	4,990,068	3,213,210	±8.8%	53%

Process Evaluation

This section presents detailed staff interview findings as well as participant and nonparticipant survey results. Focus areas include:

- Delivery structure and effectiveness of the implementation strategy;
- Marketing approach and relative success;
- Customer satisfaction; and
- Internal and external communications.

Methodology

The research conducted to support the process evaluation followed three major steps:

1. Document review.
2. Utility staff and administrator interviews.
3. Participant and nonparticipant surveys.

Cadmus reviewed program materials, including:

- Past evaluations;
- Marketing and communication materials designed to promote participation and educate target audiences on the program;
- Logic models; and
- The program's Website.

This review sought to assess:

- The general look and feel of marketing materials;
- Brand and message consistency, program accessibility; and
- Stakeholder forms and information.

Review results helped inform the design of stakeholder interview guides and customer surveys, and development of specific recommendations regarding program marketing.

Next, Cadmus developed stakeholder interview guides to collect information about key topics from program management staff. JACO Environmental implements the SYLR program. Cadmus interviewed two main program staff: program managers at Pacific Power and at JACO, both of whom oversee the programs in all five states offering appliance recycling programs (Washington, California, Idaho, Utah, and Wyoming). Issues discussed included:

- Program history;
- Process flow;
- Program design versus program implementation;
- Changes in implementation and program marketing; and
- Strengths and areas for improvement.

Cadmus staff conducted stakeholder interviews by phone, and, for follow-up questions and clarifications, contacted stakeholders via e-mail.

Finally, Cadmus conducted telephone surveys with participant and nonparticipant customers. Cadmus designed survey instruments to collect data about the following topics:

- ***Customer information.*** Data characterizing participants and allowing extrapolation of results to the entire program population.
- ***Program process.*** Survey questions collecting information to inform the following performance indicators:
  - Is the program's design appropriate to meet its goals?
  - Is program marketing effective?
  - What are participation motivations and barriers?
  - Are program incentives set correctly?
  - Is the program process effective?
  - Are customer satisfaction goals being met?
  - What are the program's strengths or areas for improvements?

Program Implementation and Delivery

Drawing on stakeholder interviews and participant and nonparticipant survey response data, this section discusses implementation and delivery of the SYLR program.

Program Status

In 2005, the SYLR program launched in Washington. During its early implementation years, the program experienced participation levels higher than the national average. According to the program administrator, Pacific Power and the program administrator established program goals for the 2009–2010 period, based on prior program performance and on harvest rates in comparable programs elsewhere.[19] The contract between Pacific Power and the program administrator included these projected participation levels, although lower-than-expected participation did not result in a financial penalty. For the two-year period, Washington experienced lower-than-expected participation, as compared to the goals established in the contract: the 2009 program year achieved 72 percent of its participation goal; and the 2010 program year achieved 64 percent. Despite the low achievement compared to goal, program administrator staff noted that participation levels remain robust when compared to the national average.

Program staff noted several possible reasons for the declining 2009 and 2010 performance:

- The incentive amount decreased from $40 to $30 in 2008, driving a decline in participation that year. This trend of lower participation associated with a lower incentive may have continued in 2009 and 2010.

[19] Harvest rate is defined as the number of units recycled through the program in a given year divided by the total number of residential customer accounts in the service territory.

- The economic downturn, beginning shortly before the evaluation period, may have caused diminished demand for program services. During difficult economic times, customers are less likely to move to new homes or remodel, and thus less likely to dispose of appliances.
- Demand for appliance recycling may also be declining after five years of implementation. Participation declines are expected as programs mature and eliminate backlogs of older appliances.

Delivery Structure and Processes

Pacific Power and program administrator staff reported the program had been designed similarly to SYLR programs already operating in the company's other service territories. The Washington program leveraged existing infrastructure by operating through the same call center used to implement the program in other states, furnishing the Washington program with experienced customer service representatives.

During 2009 and 2010, one main subcontractor contributed to program implementation: Runyon, Saltzman & Einhorn served as the marketing subcontractor, supporting the program administrator's program marketing, advertising, and public relations activities.

The program delivery process followed four main steps:

1. Marketing.
2. Sign-up/scheduling.
3. Appliance pick-up.
4. Incentive payment.

Marketing (described in greater detail below) targeted owners of older and secondary refrigerators, although participating appliances had no minimum age requirements.

Pacific Power's Washington customers, interested in disposing of an eligible appliance, could obtain information or sign up to participate through Pacific Power's Website, or by calling the program administrator toll-free. When participants signed up, the program administrator collected data on how customers learned of the program, verified eligibility, and scheduled pick-up times. The customer received a window of time for appliance pickup on a specific day, and was required to have the appliance plugged in and running upon pickup.[20] Times between scheduling and pickup averaged 10 days. The program administrator noted pickup wait times tended to be shortest in urban areas, while customers in outlying areas experienced longer waits.

At the scheduled time, the contractor picking up the appliance verified the unit was in working condition, and collected data about the appliance's age, size, configuration, and features. During appliance pickup, participants received an energy-saving kit, containing: two 13-watt CFLs, a refrigerator thermometer, energy-savings educational materials, and information about Pacific

[20] The program administrator estimated that typically 2-3 percent of pickups are ineligible for participation because the appliance is found not to be working. Similarly, the program administrator reported that roughly 1-2 percent of units scheduled to be picked up are ineligible for participation due to their size.

Power's other energy-efficiency program offerings. Both program managers described these kits as effective program components.

During the 2009–2010 program period, the program recycling facility received picked-up appliances for decommissioning and recycling. The program administrator then assumed responsibility for mailing incentive checks to participants.

Forms and Incentives

Unlike many incentive programs, the SYLR program requires minimal paperwork for participating customers. The signup process can be completed by phone or online, and neither process requires the customer to fill out lengthy forms. Customers signing up by phone are asked for information, including their address and the location of the unit as well as a few screening questions. Customers signing up online respond to these questions through a brief, one-page online form. Customers appreciated the simplicity of the sign-up process: over 99 percent of surveyed customers reported being very or somewhat satisfied with the program sign-up process.

Participating customers reported high satisfaction levels with the incentive amount. Sixty-five percent of surveyed participants said they were very satisfied with the incentive amount, with an additional 33 percent reporting they were somewhat satisfied. Furthermore, 88 percent of participants claimed they would have participated in the program had the incentive amount been lower, and 78 percent said they would have participated even if no incentive had been offered. These results, however, may reflect social desirability bias.[21]

Marketing

Approach

The program administrator markets the SYLR program through an array of channels which include:

- Direct mail;
- Newspaper advertisements;
- Radio and television advertisements;
- Online advertising;
- A program Website;
- Customer information sheets;
- Bill inserts;
- Retailer referrals;
- Point-of-purchase advertising; and
- Social media outreach through Pacific Power.

The program administrator oversees Runyon, Saltzman & Einhorn, the marketing subcontractor, which develops marketing materials and works with the program administrator to develop an

[21] Social desirability bias is the tendency for respondents to exaggerate their inclination to "do the right thing."

overall strategy and approach. The program administrator manager described the process as collaborative, emphasizing that, as part of this process, Pacific Power must approve every piece of marketing collateral. The Pacific Power program manager confirmed this, noting that, during the evaluation period, Pacific Power provided feedback to the program administrator regarding their television advertisements, and requested development of a new advertisement, tailored to be consistent with other media created (which had performed well in Pacific Power's Washington territory).

In addition to overseeing the collaborative process of creating and disseminating marketing material, the program administrator analyzes participation data to inform marketing strategy decisions. For example, the program administrator reported that bill inserts typically provoked spikes in program activity; so the timing of bill inserts has been coordinated to periods requiring increased volume.

Materials Review

Cadmus' review of SYLR program promotional materials evaluated the messaging content, look and feel, and user accessibility of collateral materials, online promotional elements, and other user forms and educational materials. Cadmus then incorporated insights gained through interviews with program and implementation staff to apply context and develop conclusions. The high-level findings, presented below, indicate Pacific Power's ongoing marketing efforts have been effective, and new retail partnerships have helped drive participation.

Cadmus' findings include the following:

- ***The SYLR marketing plan has been well constructed:*** Pacific Power's 2010 marketing plan includes best practice tactics, and provides an appropriate range of media channels to drive participation.
- ***SYLR program marketing collateral presents a consistent look and feel:*** Program Web pages, bill inserts, and other collateral include consistently uncluttered and clear designs, bold colors, and large typefaces.
- ***SYLR program marketing collateral provides consistent messaging:*** Marketing content includes basic calls-to-action and motivating messages. This helps reinforce word-of-mouth recommendations and awareness.
- ***The Washington program next turns to trade ally support:*** The program administrator plans to support deeper market penetration via the expected launch of a retail partnership program in 2012.

Table 32 and Table 33 compare SYLR program marketing approach elements to best practice elements in energy-efficiency program marketing. Pacific Power currently appears to utilize several best practice marketing channels, but additional, remaining opportunities could increase participation.

Table 32. SYLR Program use of Best Practice Marketing Channels in 2009–2010

Best Practice Marketing Channels	SYLR Program
Direct Mail	Yes
Newspaper Ads /articles	Yes
Radio/TV Ads	Yes
Online Advertising	Yes
Website	Yes
Customer Information Sheets	Yes
Retailer Information Sheets	Yes
Telemarketing	No
Bill Inserts	Yes
Brochures	Yes
Newsletters	Yes
Presentations/Meetings	No
Events	No
Referrals/Retail Partnerships	No
Point of Purchase	No
Tests/Demonstrations	No
Social Media Outreach*	Pacific Power

*Social media (e.g. Twitter, Flickr, YouTube, Facebook) offer channels for utilities to connect with customers. Many utilities' communications efforts leverage one or more social media platform(s).

Table 33 summarizes: use of online best practices in the SYLR program's Website and rationale; and additional information regarding particular online findings. Generally, the program administrator's experience with other utilities and regions has provided practical expertise in developing effective marketing tools.

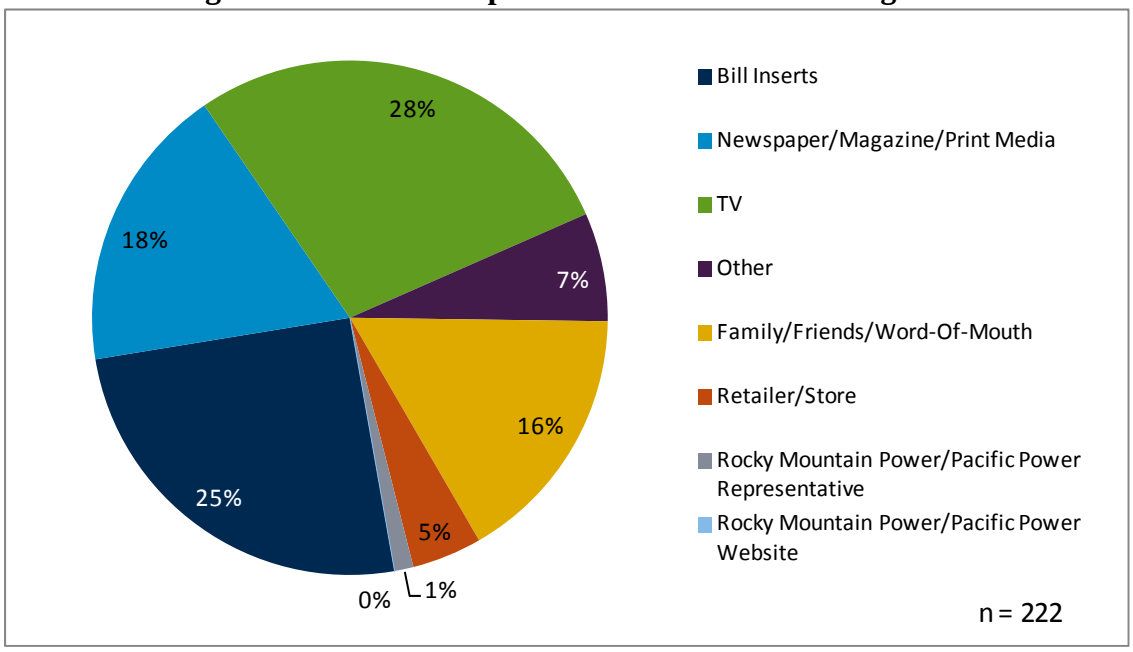
Table 33. SYLR Program use of Website Best Practices

Category	Website Best Practice Element	SYLR Program	Rationale/More Information
Navigation	Program highlighted on home page	No	Users often enter utility sites through the home page. Easy "one-click" access to a program makes participation easier, and provides greater program exposure. Other utilities have found a recycling registration button on the home page effective.
Navigation	Number of clicks from home page	Three	
Content	Description leads with benefits (i.e., What's in it for the participant?)	Home Page: WattSmart Programs and Incentives OR Save Energy (non-specific) SYLR Program Page: "Get Paid to Recycle Your Old Refrigerator or Freezer."	The SYLR program has a compelling, clear benefit statement.
Content	Clear call to action	Yes	The program's "why" has been clearly presented. Cadmus recommend including the call to action—"schedule your free pick up"—at the top and bottom of the page. Further, more consistent branding between the recycling page and the JACO ZIP code page would provide a more integrated user experience.
Marketing	Contact capture	Yes	
Content	Description of each individual program offered	Yes	
User Experience	Participant eligibility requirements	Yes	User experience refers to the online process and interactivity from the user's perspective. Easy downloads and online forms increase the likelihood that targets will participate and move forward with program activity. SYLR provides such documents online.
User Experience	Downloadable application forms	n/a	
User Experience	Online registration process	Yes	
Marketing	Downloadable program information in print format	No	Easy and simple-to-share marketing materials increase "word of mouth" activity, in-person or online. As most SYLR participants surveyed expressed satisfaction and would recommend the program, this element presents a particularly important opportunity.
Marketing	Social media "share" elements included (e.g. Facebook, Twitter, etc.)	No	

Effectiveness

According to program managers and per the marketing materials review, the SYLR program's overall marketing approach has been effective and responsive to changes in participation and market conditions. The program administrator reported tracking increased program activity in response to particular marketing pieces to evaluate the effectiveness of different marketing activities. Cadmus gathered further information about marketing effectiveness through the participant surveys. As shown in Figure 10, most participants learned of the program through three mechanisms: bill inserts, print advertising, and television advertising. These marketing methods accounted for 71 percent of all participants.

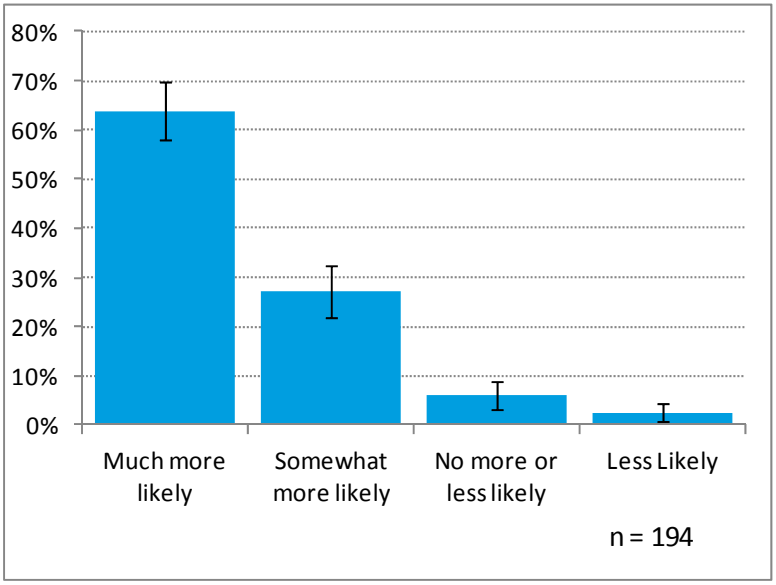
Figure 10. How Participants Learned about the Program



Pacific Power WA SYLR Participant Survey: Question B1.

The survey also asked whether SYLR program participants later participated in other Pacific Power energy-efficiency programs. Fifteen percent of participants took part in other programs after participating in the SYLR program, and, as shown in Figure 11, the vast majority of respondents stated they were more likely participate in future Pacific Power programs.

Figure 11. Likelihood of Participating in Another Pacific Power Program (with 90% Confidence Intervals)*



Pacific Power WA SYLR Participant Survey: Question SP4.
*Confidence intervals indicated by black bars in figure.

Targeting

Compared to customers in the general population, appliance recycling program participants tended to be homeowners in single-family residences, averaged roughly 55 years of age, and had children. Table 34 shows average demographics for participants surveyed.

Table 34. Participant Demographics

Characteristic	Participants
Average Head of Household Age	55.3
Homeownership	93%
Average Household Size	2.8
Proportion Earning Less than $50k	45%

The vast majority of participants (93 percent) lived in single-family residences, with less than 7 percent living in multifamily or manufactured homes. Respondents' ages reflected more than half of participant respondents were over age 50. As contact information derived from self-reported information (i.e., landlines or cell phones), the survey experienced no bias for respondents with landlines.

Comparison with Nonparticipants

A nonparticipant population differing demographically from the participant population may indicate misplaced or incomplete targeting of marketing efforts. Cadmus tested for similarities between nonparticipant and participant populations to rule out marketing not reaching some eligible demographic groups. For example, if a large portion of nonparticipants lived in mobile homes (and few participants lived in mobile homes), the mobile home market may have been overlooked.

Cadmus found few statistically significant differences between participants and nonparticipants. Table 35 shows t-tests' results for differences between the two groups[22] for a series of relevant characteristics. Where p-values exceeded 0.10, these demographics did not differ with 90 percent confidence, excepting for age, where nonparticipants were slightly younger.

Home types did not differ significantly. Cadmus' chi-square test for independence between the two groups indicated they could not be said to differ with 90 percent confidence (p-value = 0.97).[23]

Table 35. T-Tests for Demographic Differences between Participants and Nonparticipants

Characteristic	Participants	Nonparticipants	Difference	p-value
Average Head of Household Age	55.3	51.9	3.4	0.08
Homeownership	93%	96%	-2%	0.44
Average Household Size	2.8	2.6	0.2	0.29
Proportion Earning Less than $50k	45%	47%	-2%	0.80

[22] All t-tests conducted assumed unequal sample sizes and variances.

[23] A chi-square test is a statistical test used in this case to determine whether the distribution of home types for participants differed statistically from the distribution of home types for nonparticipants.

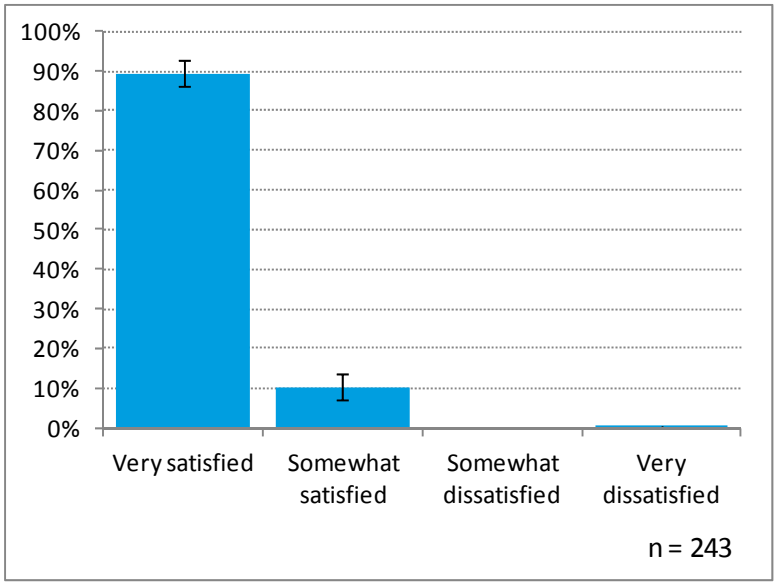
Participants' and nonparticipants' similar demographics indicate marketing has been targeted appropriately.

Customer Response

Satisfaction

The program experienced high overall satisfaction rates. Approximately 89 percent of participants reported being very satisfied with the program, with less than 1 percent reporting dissatisfaction. When asked about program specifics, such as scheduling and incentive amounts, participants expressed similar satisfaction levels (see Figure 12, below).

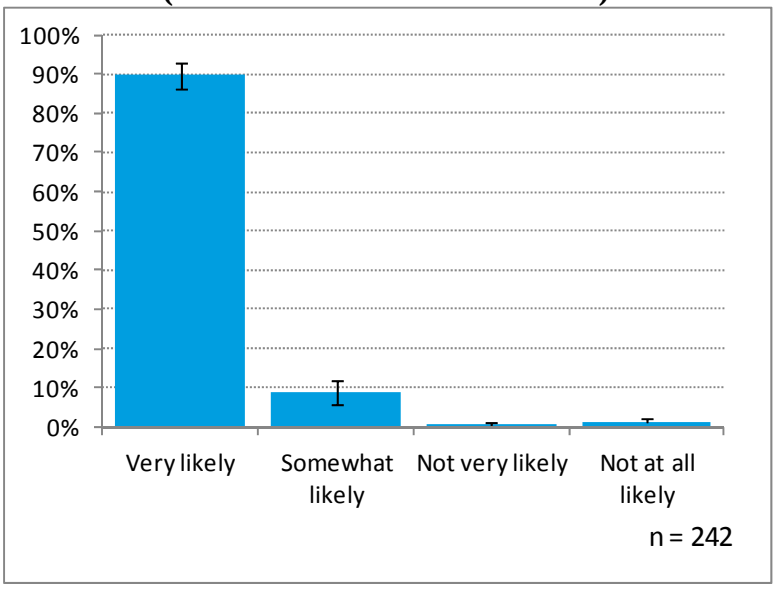
Figure 12. Overall Program Satisfaction (with 90% Confidence Intervals)



Pacific Power WA SYLR Participant Survey: Question G1.

Participants' willingness to recommend the program to others reflected their positive perceptions of the program. Figure 13 shows participants' self-reported likelihood of recommending the program ran quite high, with 98 percent saying they were somewhat or very likely to recommend the program.

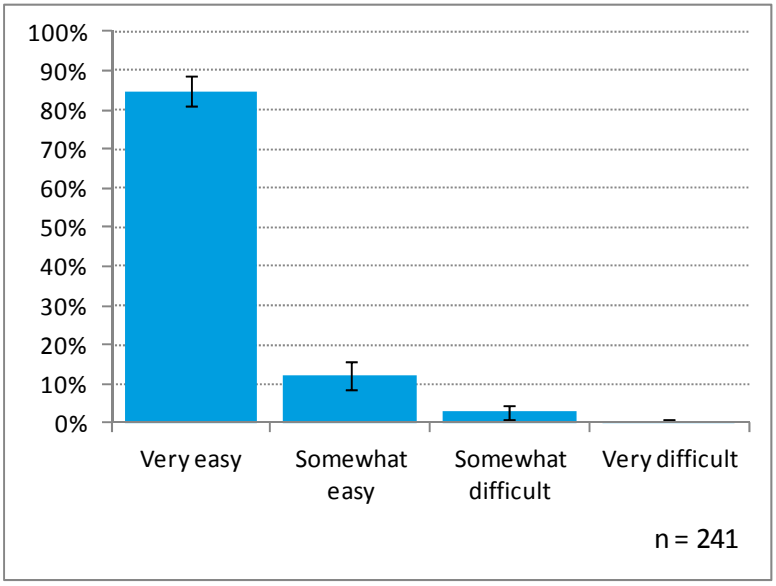
Figure 13. Likelihood of Recommending Program to Others (with 90% Confidence Intervals)



Pacific Power WA SYLR Participant Survey: Question G10.

Ninety-seven percent of customers reported having positive experiences with the program's scheduling process, with only 3 percent expressing scheduling concerns.

Figure 14. Level of Difficulty with Scheduling: Participant Survey Results (with 90% Confidence Intervals)



Pacific Power WA SYLR Participant Survey: Question G4.

Barriers

Overall, participant surveys did not reveal significant complaints or issues, and through the SYLR process evaluation, Cadmus noted no significant barriers. The program functions smoothly, likely due to its longevity in the Washington market and the program administrator's experience.

Quality Assurance

Though the program administrator manager reported data collection at numerous points throughout the participation process, Cadmus identified data entry and pickups as two areas with established quality assurance procedures for the program:

- When data, collected in the field by appliance pickup contractors, are translated into the database, opportunities arise to identify and correct errors.
- The program administrator manager reported an independent quality assurance contractor, hired by Pacific Power, follows pickup crews for a sample of pickups to observe pickup procedures and customer service. The quality assurance contractor also interviews participating customers to assess their satisfaction with the service.

Cost-Effectiveness

In assessing cost-effectiveness, Cadmus analyzed program costs and benefits from five different perspectives, using Cadmus' DSM Portfolio Pro[24] model. Benefit-to-cost ratios conducted for these tests were based on methods described in the California Standard Practice Manual (SPM) for assessing DSM programs' cost-effectiveness. Tests utilized included the following:

a. **PacifiCorp Total Resource Cost Test (PTRC):** This test examined program benefits and costs from Pacific Power's and Pacific Power customers' perspectives, combined. On the benefit side, it included avoided energy costs, capacity costs, and line losses, plus a 10 percent adder to reflect nonquantified benefits. On the cost side, it included costs incurred by both the utility and participants.

b. **Total Resource Cost Test (TRC):** This test examined program benefits and costs from Pacific Power's and Pacific Power customers' perspectives, combined. On the benefit side, it included avoided energy costs, capacity costs, and line losses. On the cost side, it included costs incurred by both the utility and participants.

c. **Utility Cost Test (UCT):** From Pacific Power's perspective, benefits included avoided energy, capacity costs, and line losses. Costs included program administration, implementation, or incentive costs associated with program funding.

d. **Ratepayer Impact (RIM):** All ratepayers (participants and nonparticipants) may experience rate increases designed to recover lost revenues. This test included all Pacific Power program costs as well as lost revenues. Benefits included avoided energy costs, capacity costs, and line losses.

e. **Participant Cost Test (PCT):** From this perspective, program benefits included bill reductions and incentives received. Costs included a measure's incremental cost (compared to the baseline measures), plus installation costs incurred by the customer.

Table 36 summarizes the five tests' components.

Table 36. Benefits and Costs Included in Various Tests

Test	Benefits	Costs
PTRC	Present value of avoided energy and capacity costs* with 10% adder for nonquantified benefits	Program administrative and marketing cost
TRC	Present value of avoided energy and capacity costs*	Program administrative and marketing cost
UCT	Present value of avoided energy and capacity costs*	Program administrative, marketing, and incentive cost
RIM	Present value of avoided energy and capacity costs*	Program administrative, marketing, and incentive costs + present value of lost revenues
PCT	Present value of bill savings and incentives received	Incremental measure cost and installation cost

* Present value of avoided energy and capacity costs includes avoided line losses occurring from reductions in customer electric use.

[24] DSM Portfolio Pro has been independently reviewed by various utilities, their consultants, and a number of regulatory bodies, including the Iowa Utility Board, the Public Service Commission of New York, the Colorado Public Utilities Commission, and the Nevada Public Utilities Commission.

Table 37 provides selected cost analysis inputs, including: evaluated energy savings for each year, discount rate, line loss, and program costs. Pacific Power provided all of these values, except energy savings. The discount rate derived from Pacific Power's 2008 Integrated Resource Plan. Pacific Power also provided the values for line loss and program costs.

Table 37. Selected Cost Analysis Inputs

Input Description	2009	2010	Total
Participation			
Refrigerator Recycling	1,854	1,512	3,366
Freezer Recycling	456	396	802
Energy-Saving Kit	2,168	1,743	3,911
Program Savings (kWh/year)*	1,960,634	1,579,887	3,540,521
Discount Rate	7.40%	7.40%	7.40%
Line Loss	11.03%	8.87%	N/A
Inflation Rate	1.90%	1.90%	1.90%
Total Program Costs	$278,953	$250,130	$529,083

* Savings reflect impacts at generation, and have been increased for line losses. Since per-unit savings and adjustments for spillover and freeridership are modeled as rounded values, the total savings shown here may differ from the total savings reported elsewhere by around 1%. However, this minor discrepancy caused by rounding in the cost-effectiveness model does not have an appreciable effect on benefit-cost ratios.

Program benefits included energy savings and their associated avoided costs. The cost-effectiveness analysis used energy savings derived from this study's evaluated kWh. Analysis used a weighted average measure life of 8.4 years, based on the measures' lifetimes, and weighted by savings and frequency of installations.[25] All analyses used avoided costs associated with Pacific Power's 2008 IRP 35 Percent Load Factor Westside Residential Whole Home Decrement.[26]

Cadmus analyzed cost-effectiveness for two scenarios. The first assumed zero percent freeridership and spillover (NTG equaling 100 percent). The second incorporated evaluated freeridership and spillover.

Table 38 presents program cost-effectiveness analysis results with NTG equaling 100 percent for all program measures for the evaluation period (2009–2010), though not accounting for non-energy benefits (except those represented by the 10 percent conservation adder included in the PTRC). For this scenario, cost-effectiveness analysis results indicated the program was cost-effective from all perspectives, except the RIM (a 1.0 or greater benefit-cost ratio would be considered cost-effective).

[25] Measure lives for recycled refrigerators, recycled freezers, and kit CFLs were derived from the most recently published workbooks available from the Regional Technical Forum: http://www.nwcouncil.org/energy/rtf/measures/res/ResCFLLighting_v2_0.xlsm, and http://www.nwcouncil.org/energy/rtf/measures/res/FrigRecycle_FY10v2_3.xls

[26] IRP decrements are detailed in Appendix G of PacifiCorp's 2008 Integrated Resource Plan, Vol. II Appendices: http://www.pacificorp.com/content/dam/pacificorp/doc/Environment/Environmental_Concerns/Integrated_Resource_Planning_6.pdf

Table 38. Program Cost-Effectiveness Summary for 2009–2010 (NTG = 100 percent)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.017	$634,444	$3,440,474	$2,806,030	5.42
Total Resource No Adder (TRC)	$0.017	$634,444	$3,127,704	$2,493,259	4.93
Utility (UCT)	$0.017	$634,444	$3,127,704	$2,493,259	4.93
Ratepayer Impact (RIM)	$0.091	$3,370,041	$3,127,704	($242,338)	0.93
Participant (PCT)	NA	$122,596	$2,858,193	$2,735,597	NA

Table 39 and Table 40 show the program's cost-effectiveness for 2009 and 2010 program years, respectively, with a 100 percent NTG.

Table 39. 2009 Evaluated Program Cost-Effectiveness Summary (NTG =100 percent)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.016	$348,253	$1,888,267	$1,540,014	5.42
Total Resource No Adder (TRC)	$0.016	$348,253	$1,716,607	$1,368,354	4.93
Utility (UCT)	$0.016	$348,253	$1,716,607	$1,368,354	4.93
Ratepayer Impact (RIM)	$0.089	$1,882,990	$1,716,607	($166,383)	0.91
Participant (PCT)	N/A	$69,300	$1,604,037	$1,534,737	N/A

Table 40. 2010 Evaluated Program Cost-Effectiveness Summary (NTG =100 percent)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.018	$307,370	$1,667,070	$1,359,700	5.42
Total Resource No Adder (TRC)	$0.018	$307,370	$1,515,518	$1,208,149	4.93
Utility (UCT)	$0.018	$307,370	$1,515,518	$1,208,149	4.93
Ratepayer Impact (RIM)	$0.093	$1,597,093	$1,515,518	($81,575)	0.95
Participant (PCT)	NA	$57,240	$1,346,963	$1,289,723	N/A

Table 41 presents program cost-effectiveness analysis results, including evaluated NTG for all program measures for the evaluation period (2009–2010), though not accounting for non-energy benefits (except those represented by the 10 percent conservation adder included in the PTRC). For this scenario, cost-effectiveness analysis results indicated the program was cost-effective from all perspectives, except the RIM (a 1.0 or greater benefit-cost ratio would be considered cost-effective).

Table 41. Program Cost-Effectiveness Summary for 2009–2010 (Evaluated NTG)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.025	$587,767	$2,194,702	$1,606,935	3.73
Total Resource No Adder (TRC)	$0.025	$587,767	$1,995,184	$1,407,417	3.39
Utility (UCT)	$0.027	$634,444	$1,995,184	$1,360,740	3.14
Ratepayer Impact (RIM)	$0.100	$2,383,552	$1,995,184	($388,368)	0.84
Participant (PCT)	NA	$122,596	$2,858,193	$2,735,597	NA

Table 42 and Table 43 show the program's cost-effectiveness in 2009 and 2010, respectively, with the evaluated NTG.

Table 42. Program Cost-Effectiveness Summary for 2009 (Evaluated NTG)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.024	$321,883	$1,204,812	$882,929	3.74
Total Resource No Adder (TRC)	$0.024	$321,883	$1,095,283	$773,400	3.40
Utility (UCT)	$0.026	$348,253	$1,095,283	$747,030	3.15
Ratepayer Impact (RIM)	$0.098	$1,330,008	$1,095,283	($234,725)	0.82
Participant (PCT)	NA	$69,300	$1,604,037	$1,534,737	N/A

Table 43. Program Cost-Effectiveness Summary for 2010 (Evaluated NTG)

Cost Effectiveness Test	Levelized $ / kWh	Costs	Benefits	Net Benefits	Benefit / Cost Ratio
Total Resource + Conservation Adder (PTRC)	$0.026	$285,559	$1,063,143	$777,583	3.72
Total Resource No Adder (TRC)	$0.026	$285,559	$966,493	$680,934	3.38
Utility (UCT)	$0.028	$307,370	$966,493	$659,124	3.14
Ratepayer Impact (RIM)	$0.103	$1,131,506	$966,493	($165,013)	0.85
Participant (PCT)	NA	$57,240	$1,346,963	$1,289,723	N/A

Appendix A: Participant Demographics

Over 95 percent of SYLR program participants lived in single-family homes or mobile homes. Roughly 96 percent of participants owned their residences. Table 44 summarizes participant home types and home ownership.

Table 44. Home Type Characteristics

Home Characteristics	Percent of Respondents	Precision at 90% Confidence
Home Type (n = 242)	–	–
Single-family home	88.4%	±3.4%
Townhouse or duplex	2.1%	±1.5%
Mobile home or trailer	8.7%	±3.0%
Apartment building with 4 or more units	0.8%	±1.0%
Own/Rent (n = 239)	–	–
Own	93.3%	±2.7%
Rent	6.7%	±2.7%

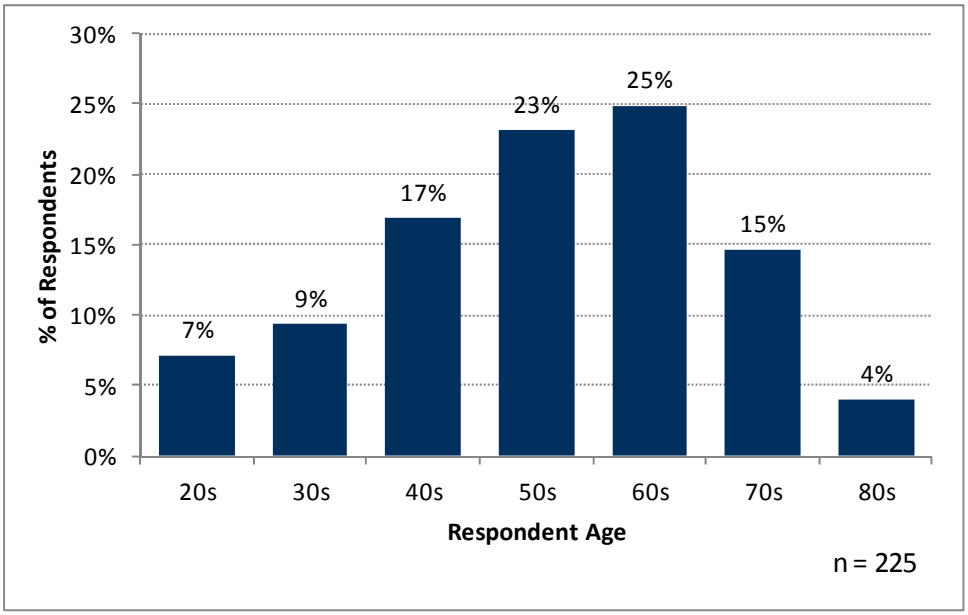
Table 45 shows average house ages, participant ages, and household sizes.

Table 45. Household Characteristics

Household Characteristics	Mean	Standard Deviation	Precision at 90% Confidence
Participant Age (n = 216)	55.3	1.7	±3.0%
Number of Residents (n =227)	2.8	0.24	±2.9%

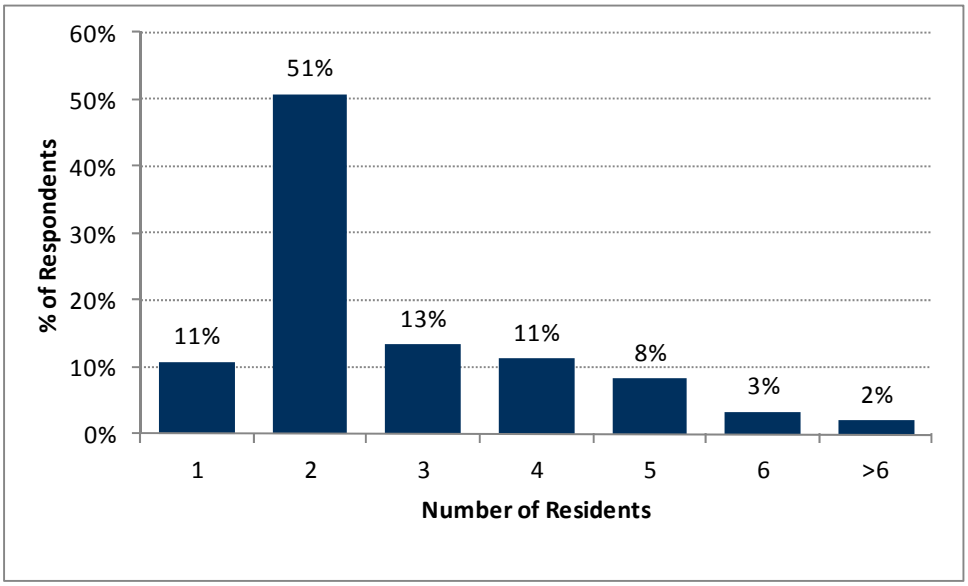
Figure 15 shows distributions of participants' ages.

Figure 15. Distributions of Participant Ages



Program participants averaged 55.3 years old, with 44 percent of participants over 60 years old. Sixteen percent of participants were in their 20s or 30s. Figure 16 shows distributions of household sizes.

Figure 16. Distributions of Household Sizes



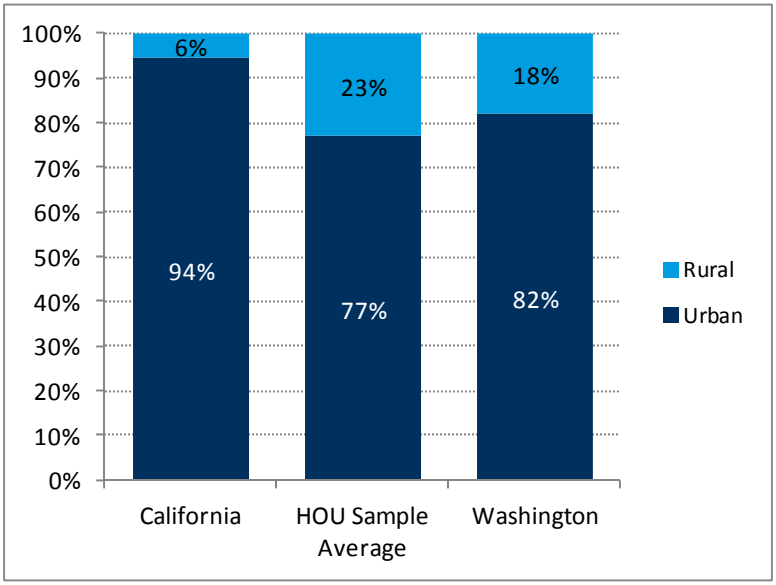
On average, two to three people lived in households participating in the program. One or two person households accounted for 62 percent of program participants.

Appendix B: CFL Engineering Calculations and Assumptions

Cadmus estimated CFL hours of use (HOU) using a multistate modeling approach, built on light logger data collected from four states: Missouri, Michigan, Ohio, and Maryland. Cadmus chose these data instead of those from the most recent California (used in the RTF's savings calculations for CFLs) evaluation for a number of reasons:

1. These states are more comparable to Washington in terms of latitude (a factor in seasonal variation in daylight hours).
2. These states all have relatively new CFL programs (unlike California, where programs have been in place for a number of years).
3. These states have a more comparable distribution of urban versus rural population (as shown in Figure 17).

Figure 17. Urban vs. Rural Comparison Between States



Source: 2000 US Census

Metering Protocol

Following whole-house lighting audits, Cadmus installed up to five loggers in each participant home. Metering periods varied by utility, ranging from three months to one year. For homes with five or fewer CFL fixture groups, Cadmus field staff installed light loggers on every CFL fixture. For homes with more than five CFL fixture groups, field staff randomly selected which five fixtures to meter. This method relied on systematic sampling, which involved installing a logger on every n^{th} CFL fixture (the n^{th} number also based on the number of total possible CFL fixtures).

During the logger removal process, field staff collected additional data for evaluating data quality and for determining if loggers had failed, had been tampered with, or had been removed.

Moreover, prior to removing each logger, field staff noted whether the logger had been correctly installed and the orientation of its sensor.

Model Specification

To estimate HOU, Cadmus determined the total "on" time for each individual light logger per day, using the following guidelines:

- If a light logger did not record any light for an entire day, the day's HOU was set to zero.
- If a light logger registered a light turned on at 8:30 p.m. on Monday, and turned off at 1:30 a.m. on Tuesday morning, 3.5 hours were added to Monday's HOU and 1.5 hours to Tuesday's HOU.

Cadmus modeled both weekday and weekend daily HOU as a function of room type, the presence of children in the home, and CFL saturations in the home. This was done using two analyses of covariance (ANCOVA) models, one for each day type.

ANCOVA models are regression models, which model a continuous variable as a function of a single, continuous explanatory variable (in this case, CFL saturation) and a set of binary variables. This way, an ANCOVA model simply serves as an analysis of variance (ANOVA) model with a continuous explanatory variable added. Cadmus chose this specification due to its simplicity, making it suitable in a wide variety of contexts. Though the model lacks the specificity of other methods, it offers estimates not nearly as sensitive to small differences in explanatory variables, compared to more complex methods. Therefore, these models can produce consistent estimates of average daily HOU for a given region, using its specific distribution of bulbs by room and household type, and by the existing CFL saturation.

Cadmus specified final models as cross-sectional, ANCOVA regressions for day-type[27] (j), and bulb (i), as:

$$Average\ Daily\ HOU_{j,i} = \beta_0 + \beta_1 CFL\ Saturation_i + \beta_2 Kids_i + \beta_3 Kitchen_i + \beta_4 Basement_i + \beta_5 Outdoor_i + \beta_6 Bedroom_i + \beta_7 Bathroom_i + \beta_8 Other_i$$

Where:

- CFL Saturation = the proportion of CFL bulbs in the home;
- Kids = a dummy variable[28] equal to one, if the household has children under 18 living in the home, and zero otherwise;
- Kitchen = a dummy variable equal to one, if the bulb is in the kitchen, and zero otherwise;

[27] The two day-types for this analysis were weekend and weekday. Cadmus defined weekends as Saturday and Sunday as well as the following federal recognized holidays: Christmas, Thanksgiving, Labor Day, Memorial Day, New Year's Day, Fourth of July, Presidents' Day, and Veterans' Day.

[28] Dummy variables are binary, taking only values of either zero or one. Coefficients for these variables can be interpreted as the difference in mean values between the two mutually exclusive groups.

- Basement = a dummy variable equal to one, if the bulb is in the basement, and zero otherwise;
- Outdoor = a dummy variable equal to one, if the bulb is outdoors, and zero otherwise;
- Bedroom = a dummy variable equal to one, if the bulb is in the bedroom, and zero otherwise;
- Bathroom = a dummy variable equal to one. if the bulb is in the bathroom. and zero otherwise; and
- Other = a dummy variable equals to one, if the bulb is in a low-use room (such as a utility room, laundry room, or closet), and zero otherwise.

Cadmus tested the potential influences of other demographic and regional variables in model specifications, such as: latitude, income, education, and home characteristics. However, these variables were not included as their estimated coefficients did not differ significantly from zero or produced signs inconsistent with expectations.

Final Estimates and Extrapolation

As shown in Table 46, not all the two models' estimated coefficients differed significantly from zero for both day types, most likely due to differences in schedules between days. Nevertheless, Cadmus included the same independent variables in each model for better cross comparability.

Table 46. HOU Model ANCOVA Estimates

Coefficient	Weekday		Weekend	
	Parameter Estimate	p-value*	Parameter Estimate	p-value
Intercept[29]	2.58	<.0001	2.90	<.0001
CFL Saturation	-1.05	0.0359	-0.32	0.6657
Kids	0.80	<.0001	0.51	0.1135
Kitchen	1.18	0.0001	0.35	0.4049
Basement	-0.25	0.5489	-1.50	0.0134
Outdoor	2.80	<.0001	-1.46	0.1347
Bedroom	-1.10	<.0001	-2.02	<.0001
Bathroom	-0.98	0.0019	-1.54	0.0025
Other	-1.30	0.0071	-2.16	0.0008

*P-values indicate the degree of confidence to which analysis asserts the given coefficient equals zero. In other words, it is the probability that the effect of a given variable on HOU is random. Therefore, a lower p-value indicates a higher degree of confidence in the estimated effect.

Cadmus used these model parameters to predict average daily use for SYLR by taking the sum of the product of each coefficient shown in Table 46, and its corresponding average independent variable. Table 47 shows independent variables used for SYLR. Except for CFL saturation, Cadmus estimated independent variables using 2009–2010 participant survey data. Due to a lack

[29] The models' intercept can be interpreted as the average HOU in the main living space (defined as the dining room, hallways, living rooms, and office/den areas), when existing CFL saturations are zero and no children live in the home.

of detailed CFL saturation data for Pacific Power's Washington service area, Cadmus used secondary data to estimate CFL saturations by room.[30]

Table 47. Weekday HOU Estimation Input Values

Variable	Value
CFL Saturation	20%
Kids	38%
Kitchen	15%
Basement	2%
Outdoor	10%
Bedroom	16%
Bathroom	10%
Other	6%

Using these values, the following equation calculated a 2.77 average weekday HOU:

$$Average\ Daily\ HOU = 2.58 + (-1.05 * 0.20 + 0.8 * 0.38 + 1.18 * 0.15 + [-0.25] * 0.02 + 2.8 * 0.10 + [-1.1] * 0.16 + [-0.98] * 0.10 + [-1.3] * 0.06) = 2.77$$

Using the same method, Cadmus calculated the weekend HOU using parameter estimates from the weekend model. The weighted average of these two values then provided the average annual HOU:

Table 48. HOU by Day Type

Day	HOU	Weight
Weekday	2.77	69.3%
Weekend	2.30	30.7%
Overall	2.63	

Precision calculations for model estimates accounted for sampling errors in model estimates and sample inputs, which largely arose from participant surveys. Precision of individual HOU estimates can be impacted by the precision of logger data model estimates and the accuracy of model inputs used for extrapolation. Cadmus estimated the final relative precision for the CFL HOU in the SYLR program at ±4.9 percent with 90 percent confidence.

Waste Heat Factor

The waste heat factor (WHF) is an adjustment representing interactive effects of lighting measures on heating and cooling equipment operation. Cadmus did not apply the WHF adjustment to lighting savings estimates as Pacific Power did not include it in their initial planning estimates. However, Cadmus recommends including this adjustment for future planning estimates and evaluations, and calculated the WHF for SYLR using the method described below.

[30] Cadmus used an average CFL saturation for service areas with relatively new programs, taken from: Albee, K., et. al. (2011). "One Analysis to Rule Them All and In the Darkness Give Them CFLs." *In proceedings of the 2011 IEPEC Conference*. Boston, MA: International Energy Program Evaluation Conference.

Cadmus calculated SYLR's WHF using ASHRAE data on heating and cooling degree days (HDD and CDD, respectively) in Pacific Power's service territory. In addition, Cadmus used the 2006 Energy Decisions Survey data[31] to determine the saturation of heating and cooling equipment types in Washington.

To determine the portion of the year that heating or cooling equipment operates, and, therefore, when lighting would affect heating or cooling energy, Cadmus used the Northwest Power and Conservation Council's workbook used to estimate the interaction for ENERGY STAR lighting savings in the 6th Regional Power Plan.[32] This calculator estimates the heating and cooling interaction based on building simulation models for a variety of HVAC equipment and cities around the region. Cadmus estimated the savings for Yakima, as representative for the Washington territory, by using a weighted average of HDD and CDD from the cities across the region to most closely match that for Yakima. This calculator determined the heating and cooling interactions for zonal heating and heat pumps. To estimate the interaction for electric forced air furnaces, a heating system efficiency of 75% (to account for duct losses) was included. The cooling interaction from heat pumps was used for all electric cooling systems. These interactions are provided in the table below:

Table M49. Interactions

HVAC System	Space Heat Interaction %	Space Cool Interaction %
Zonal	56%	NA
Electric Furnace	42%	NA
Heat Pump	39%	5.6%

These interactions are then weighted by the market share of the electric heating and cooling systems.

The heating interaction was calculated as follows:

$$Heating\ Interaction = -\sum(\%SpHtInteraction * Market\ Share)_i = -20\%$$

Where the summation is over the three electric heating types. In addition,

$$Cooling\ Interaction = \%SpCoolInteraction * Electric\ Cooling\ MarketShare = 5.0\%$$

$$Total\ electric\ WHF = 1 + Heating\ Interaction + Cooling\ Interaction$$
$$= 1 - 20\% + 5.0\% = 85.4\%$$

The combined -14.6% adjustment could be applied to electricity savings for all interior lighting measures to account for a net increase in electric heating and cooling load due to more efficient lighting. Weighting for the distribution interior/exterior distribution found in participant surveys, Cadmus found the final WHF to be 86.8% (as shown below).

[31] http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/DSM_VolumeI_2011_Study.pdf

[32] http://www.nwcouncil.org/energy/powerplan/6/supplycurves/res/EStarLighting_NewFY09v1_0.xls

$$Interior\ Total\ Electric\ WHF$$
$$= 1 + (Heating\ Interaction + Cooling\ Interaction) * \%\ Interior\ Lighting$$
$$= 1 + (-20\% + 5.0\%) * 90.0\% = 86.8\%$$

Appendix C: Precision Calculations

To determine the uncertainty level for results, Cadmus considered the effect of sampling error on all estimates presented in the report. Sampling error refers to uncertainty introduced by the use of sampled data to infer characteristics of the overall population. These data include survey results, meter data, and data from secondary sources. Cadmus used sampled data to estimate parameters for per-unit savings calculations (such as installation rates) or for the consumption of specific equipment types (such as in billing analysis).

Sampling error has been reflected in confidence intervals about estimates. Unless otherwise noted, Cadmus estimated intervals at 90 percent confidence; meaning one could be 90 percent confident the true population value fell within the given interval. Cadmus calculated confidence intervals for means, proportion, regression estimates, and any calculated values using sample estimates as an input. Cadmus calculated all confidence intervals using standard formulae to estimate uncertainty for proportions and means. For mean values, Cadmus used the following formula:

$$Confidence\ Interval_{mean} = mean \pm 1.645 * \sqrt{\frac{s^2}{n}}$$

Where s^2 equals the sample variance, and 1.645 equals the z-score for a 90 percent confidence interval.

In some cases, uncertainty of estimates derived from multiple sources. For example, for summed estimates, such as those for total program savings, the root of the sum of the squared standard errors was calculated to estimate the confidence interval:[33]

$$Confidence\ Interval_{\bar{X}+\bar{Y}} = (\bar{X} + \bar{Y}) \pm 1.645 * \sqrt{\left(\frac{s^2{}_{\bar{X}}}{n_{\bar{X}}}\right) + \left(\frac{s^2{}_{\bar{Y}}}{n_{\bar{Y}}}\right)}$$

In some cases, Cadmus multiplied estimates. For instance, net savings calculations involved combining gross estimates with an in-service rate and/or NTG ratio estimated from participant surveys. For these results, Cadmus calculated combined standard errors for the final estimates. In cases where the relationship was multiplicative, Cadmus used the following formula:[34]

$$Confidence\ Interval_{\bar{X}*\bar{Y}} = \bar{X} * \bar{Y} \pm 1.645 * \sqrt{\bar{Y}^2\left(\frac{s^2{}_{\bar{X}}}{n_{\bar{X}}}\right) + \bar{X}^2\left(\frac{s^2{}_{\bar{Y}}}{n_{\bar{Y}}}\right) + \left(\frac{s^2{}_{\bar{X}}}{n_{\bar{X}}}\right)\left(\frac{s^2{}_{\bar{Y}}}{n_{\bar{Y}}}\right)}$$

[33] This approach to aggregation errors follows methods outlined in Appendix D from Schiller, Steven et. al. "National Action Plan for Energy Efficiency". Model Energy Efficiency Program Impact Evaluation Guide. 2007. www.epa.gov/eeactionplan.

[34] Derived from Goodman, Leo, "The Variance of the Product of K Random Variables," Journal of the American Statistical Association. 1962.

In some cases, a ratio of two estimates was required. An example would be estimating the spillover ratio, expressed as the ratio of spillover savings to program savings. For this calculation, Cadmus used the following formula:[35]

$$Confidence\ Interval_{\bar{X}/\bar{Y}} = \frac{\bar{X}}{\bar{Y}} \pm 1.645 * \frac{\bar{X}}{\bar{Y}} \sqrt{\frac{\left(\frac{s^2{}_{\bar{X}}}{n_{\bar{X}}}\right)}{\bar{X}^2} + \frac{\left(\frac{s^2{}_{\bar{Y}}}{n_{\bar{Y}}}\right)}{\bar{Y}^2}}$$

To ensure transparency of the error aggregation process, Cadmus reported precision for both individual and combined estimates, where relevant.

[35] This formula assumes no covariance. Stuart, A. and Ord, J. *Kendall's Advanced Theory of Statistics (6th Edition)*. Edward Arnold. 1998.

Appendix D: Refrigerator and Freezer Savings Calculations and Comparison with RTF Calculations

Cadmus' analysis estimates kWh savings for recycled refrigerators using the following unit consumption values:[36]

$$\begin{aligned} \textbf{Gross kWh Savings} &= \textbf{Unit Energy Consumption} \times \textbf{PartUse} \\ &= \mathbf{1{,}239.7\ kWh} \times \mathbf{93.0\%} = \mathbf{1{,}152.6\ kWh}^{37,38} \end{aligned}$$

$$\textbf{Replacement kWh} = \textbf{Rated kWh} \times \textbf{PartUse} = \mathbf{500\ kWh} \times \mathbf{93.0\%} = \mathbf{464.9\ kWh}^{39}$$

$$\begin{aligned} &\textbf{Net kWh Savings} \\ &= \textbf{Gross kWh savings} \times (\mathbf{1} - \textbf{Freeridership} + \textbf{Spillover}) \\ &- \textbf{Percent Induced Replacement} \times \textbf{Replacement kWh} \\ &= \mathbf{1{,}152.6\ kWh} \times (\mathbf{1} - \mathbf{36.9\%} + \mathbf{0.9\%}) - \mathbf{3.0\%} \times \mathbf{464.9\ kWh} \\ &= \mathbf{724.0\ kWh}^{40} \end{aligned}$$

As shown, the net-to-gross (NTG) adjustment consists of three components:

- Freeridership, which is defined as the naturally occurring removal of appliances (those that would have been removed from the grid in the program's absence);
- Spillover, which accounts for additional energy-saving actions taken as a result of participating in the program; and
- Induced replacement, which accounts for the proportion of new refrigerators purchased as a result of participating in the program.

---

[36] The values listed in these equations and discussed throughout the memo are for recycled refrigerators only. The values for recycled freezers are listed in Table 51. The memo focuses on refrigerators for the sake of simplicity, as the calculations for both measures are the same, although the values used for some assumptions differ.

[37] Historically, unit energy consumption (UEC) associated with recycled appliances has been estimated using either manufacturer's claimed consumption degraded over time, DOE metering studies, or *in-situ* metering results. Using the first method, the RTF estimated UEC for refrigerators at 1,446.2 kWh. Cadmus prefers using *in-situ* metering results, and used this type of data for the SYLR evaluation to estimate a program-specific UEC of 1,239.7 kWh. Cadmus estimated this value using a statistical model using over 400 metered refrigerators in various programs. The model estimates average usage of removed units based on their age, size, configuration, and location in the house. Using the characteristics of the removed refrigerators in the SYLR program tracked by the program administrator, the Cadmus model produced the UEC value of 1,239.7 kWh.

[38] Part use refers to the portion of the year the refrigerator is used. The Regional Technical Forum (RTF) assumes this value to be 91.36%, and in this evaluation Cadmus has estimated this value to be 93.0% based on participant survey data.

[39] Rated kWh is the assumed consumption of an average new refrigerator. The RTF assumes this value to be 500 kWh, and Cadmus follows this assumption.

[40] Freeridership, spillover, and percent induced replacement were all estimated based on participant and nonparticipant survey data collected for the Washington SYLR program evaluation.

Comparison to RTF

The analysis outlined above differs from the approach taken by the RTF in two ways:

1. Some assumptions differ between the two methods, and
2. Adjustments are applied in a different order.

The RTF method applies the following equation:

$$\begin{aligned} \boldsymbol{Savings} = (&\boldsymbol{Unit\ Energy\ Consumption} - \%\ \boldsymbol{Replacement} * \boldsymbol{\ Replacement\ kWh}) \\ &* \boldsymbol{In\ Situ\ Correction\ } * \boldsymbol{PartUse} \\ &* \left(\mathbf{1} - \boldsymbol{Naturally\ Occurring\ Removal}^{41}\right) * \boldsymbol{Conservatism\ Factor} \end{aligned}$$

Compared to Cadmus' equation for Net Savings defined in this memo and used to evaluate the Washington SYLR program, the RTF equation includes two additional adjustments (*In Situ* Correction and Conservatism Factor) that are not necessary in Cadmus' analysis:

- The *In Situ* Correction is not necessary for Cadmus' calculation because UECs are calculated using *in situ* data.
- The Conservatism Factor is not necessary for Cadmus' calculation because UECs are calculated using current participation data.

Cadmus' replacement adjustment differs from that used by the RTF in that Cadmus adjusts only for replacement units purchased as a result of participating in the SYLR program, while the RTF adjustment includes all replacement units. Cadmus collected survey data to estimate the percentage of participants who replaced their unit as a result of participating in the SYLR program. The survey questions used to estimate this percentage were:

H10. Did you get a new **[INSERT APPLIANCE TYPE]** to replace the one you recycled?

1. Yes
2. No

-98. DON'T KNOW
-99. REFUSED

H12. **[ASK IF H10=1]** Would you have purchased the new **[INSERT APPLIANCE TYPE]** without the $30 incentive you received for recycling the old one?

[41] Naturally occurring removal, in the RTF analysis, is comparable to Freeridership in the Cadmus analysis. RTF used freeridership data from prior evaluations as a proxy value for this adjustment.

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H13. **[IF H10=1 AND H12=2]** Just to confirm: you would *not* have replaced your old **[INSERT APPLIANCE TYPE]** without the Pacific Power incentive for recycling, is that correct?

1. Correct
2. Incorrect
-98. DON'T KNOW
-99. REFUSED

The RTF equation applies the adjustment for Unit Replacement *prior* to applying the adjustment for Naturally Occurring Removal (which is comparable to freeridership in the Cadmus analysis). Cadmus prefers to adjust for freeridership prior to adjusting for replacement, to avoid under-representing the impact of replacement units.

Table 50 outlines all key assumptions for each method for recycled refrigerators.

Table 50. RTF and SYLR Assumptions for Recycled Refrigerator Savings Calculations

Method	Unit Energy Consumption (kWh)	Percent Replacement	Replacement kWh	*In Situ* Correction	Part-Use	Naturally Occurring Removal or Freeridership	Spillover	Conservatism Factor	Resulting kWh
RTF	1,446.2	50.0%	500.0	81.3%	91.4%	42.9%	0.0%	95.0%	481.7
SYLR	1,239.7	3.0%	464.9	100.0%	93.0%	36.9%	0.9%	100.0%	724.0

In summary, the calculation approaches followed by Cadmus and by the RTF are not drastically different mathematically. The key difference is in the definitions of the adjustments:

- Cadmus views the gross adjustments to include only the part-use adjustment. As such, Cadmus estimates *gross savings at 1,152.6 kWh*. Adjustments for replacement and naturally occurring removal from the grid (also referred to as freeridership) are included in Cadmus' net-to-gross adjustment. As such, Cadmus estimates *net savings at 724.0 kWh*.
- The RTF considers all these adjustments to be "baseline" adjustments. As such, the RTF does not distinguish between gross and net savings*, but estimates one savings value of 482 kWh.* The RTF applies this method not only to the savings estimates for the appliance recycling measure, but also to savings estimates for other measures.

Summary of SYLR Gross and Net Per-Unit Savings

Cadmus used the same method to estimate savings for recycled refrigerators and recycled freezers. Table 51 and Table 52 outline all key inputs into the calculation of per-unit gross and net savings for refrigerators and freezers.

Table 51. SYLR Unit Energy Consumption and Per-Unit Gross Savings

Measure	Evaluated Unit Energy Consumption (kWh)	Part-Use Adjustment	Evaluated Gross Per-Unit Savings (kWh)
Refrigerator	1,239.7	93.0%	1,152.6
Freezer	1,055.7	88.6%	934.9

Table 52. SYLR Net-to-Gross Adjustments and Per-Unit Net Savings

Measure	Evaluated Gross Per-Unit Savings (kWh)	Freeridership	Spillover	Percent Induced Replacement	Replacement kWh	Net Per-Unit Savings (kWh)
Refrigerator	1,152.6	36.9%	0.9%	3.0%	464.9	724.0
Freezer	934.9	41.6%	0.9%	2.9%	442.8	542.4

Appendix E: Participant Survey Instrument

Pacific Power
See Ya Later Refrigerator Program 2009-2010
Participant Survey

Introduction

[TO RESPONDENT]: Hello, my name is **[INSERT FIRST NAME]** from Discovery Research Group. I'm calling on behalf of **[UTILITY]**. I am calling to ask you some survey questions about the See ya later, Refrigerator recycling program.

[IF RESPONDENT EXPRESSES RESERVATIONS AT THIS POINT, USE THE FOLLOWING SCRIPT TO PERSUADE. IF RESPONDENT DOES NOT EXPRESS RESERVATIONS SKIP TO S1]:

I'm not selling anything, we are interested in your opinions to help improve our programs, and understand how to assist customers in saving money on their utility bills. Your responses will remain confidential.

Screening Questions

S1. According to our records, someone in your household signed up to recycle an appliance through the **[UTILITY]** "See ya Later, Refrigerator" program. Are you that person?

1. Yes
2. No
-98. DON'T KNOW **[TERMINATE]**
-99. REFUSED **[TERMINATE]**

S2. **[ASK IF S1=2]** Is that person available to speak with?

1. Yes **[CONTINUE WITH NEW RESPONDENT]**
2. No **[TERMINATE, ARRANGE CALLBACK IF POSSIBLE]**

Measure Verification

A1. **[ASK IF QUANTITY_REF>0]** Program records indicate that you received an incentive for having **[INSERT QUANTITY_REF]** refrigerator(s) recycled by the program around **[INSERT DATE OF PICKUP]**. Is this correct?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED **[TERMINATE]**

A2. **[ASK IF A1=2 OR A1=98]** How many refrigerators did you recycle through the **[INSERT UTILITY]** program?

1. **[RECORD]**
-98. REFUSED
-99. DON'T KNOW

[IF A2=0, RECODE QUANTITY_REF=0]

A3. **[ASK IF QUANTITY_FRZ>0]** Program records indicate that you received an incentive for having **[INSERT QUANTITY_FRZ]** freezer(s) recycled by the program around **[INSERT DATE OF PICKUP]**. Is this correct?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED **[TERMINATE]**

A4. **[ASK IF A3=2 OR A3=98]** How many freezers did you recycle through the **[INSERT UTILITY]** program?

1. **[RECORD]**
-98. REFUSED
-99. DON'T KNOW

[IF A4=0, RECODE QUANTITY_FRZ=0]

Awareness

B1. How did you learn about the **[INSERT UTILITY]** appliance recycling program? **[DO NOT READ LIST. RECORD UP TO 3 RESPONSES]**

1. Newspaper/Magazine/Print Media
2. Bill Inserts
3. Pacific Power/Pacific Power website
4. Other website
5. Internet Advertising/Online Ad
6. Family/friends/word-of-mouth
7. Pacific Power/Pacific Power Representative
8. Radio
9. TV
10. Billboard/outdoor ad
11. Retailer/Store
12. Sporting event
13. Home Shows/Trade Shows
14. Appliance Recycling Contractor
15. Other **[RECORD VERBATUM]**

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

B2. What are the best ways for **[INSERT UTILITY]** to inform you about energy-efficiency offerings like the appliance recycling program? **[DO NOT READ. PROMPT IF NECESSARY. RECORD UP TO THREE RESPONSES]**

1. Newspaper/Magazine/Print Media
2. Bill Inserts
3. Pacific Power/Pacific Power website
4. Other website
5. Internet Advertising/Online Ad
6. Family/friends/word-of-mouth
7. Pacific Power/Pacific Power Representative
8. Radio
9. TV
10. Billboard/outdoor ad
11. Retailer/Store
12. Sporting event
13. Home Shows/Trade Shows
14. Appliance Recycling Contractor
15. E-mail from Pacific Power/Pacific Power
16. Other **[RECORD VERBATUM]**

-98. DON'T KNOW
-99. REFUSED

B3. How would you rate your current understanding of energy-efficiency? Would you say you… **[READ LIST. RECORD FIRST RESPONSE]**

1. Have no knowledge of energy-efficiency
2. Are somewhat knowledgeable about energy-efficiency
3. Are very knowledgeable about energy-efficiency

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

Appliance Description

[IF QUANTITY_REF=0, SKIP TO H4]

H1. **[ASK IF QUANTITY_REF=1 AND QUANTITY_FRZ=0]** When you decided to get rid of the refrigerator**,** were you using it as your main refrigerator, or had it been a secondary or spare?

[IF RESPONDENT IS UNSURE: "A main refrigerator is typically in the kitchen, and a spare refrigerator is usually in the garage or basement and might not be in use all the time."]

1. Main
2. Secondary or Spare
-98. DON'T KNOW
-99. REFUSED

[ASK IF QUANTITY_REF>1, *OR* IF QUANTITY_REF>=1 AND QUANITITY_FRZ>0] The next few questions focus on just one appliance. Since you recycled more than one refrigerator through the program, please answer these questions about the first refrigerator you recycled.

H2a. Can you please tell me if this first appliance was a refrigerator or a freezer?

1. Refrigerator
2. Freezer
-98. DON'T KNOW
-99. REFUSED

H2.During the time just before you decided to get rid of this refrigerator, was it being used as your main refrigerator**,** or had it been a secondary or spare?

[IF RESPONDENT IS UNSURE: "A main refrigerator is typically in the kitchen, and a spare refrigerator is usually in the garage or basement and might not be in use all the time."]

1. Main
2. Secondary or Spare
-98. DON'T KNOW
-99. REFUSED

H3. **[ASK IF H1=2 OR H2=2]** How long were you using it as a spare before you recycled it through the program?

1. **[RECORD VALUE IN MONTHS. IF RESPONDENT ANSWERS IN YEARS, MULTIPLY BY 12 AND RECORD VALUE IN MONTHS]**
-98. DON'T KNOW
-99. REFUSED

H4. **[IF QUANTITY_REF=0, AND QUANTITY_FRZ>1, SAY: "The next few questions focus on just one appliance. Since you recycled more than one freezer through the program, please answer these questions about the first freezer you recycled."]** During the year before you recycled it, was the appliance plugged in and running… **[READ LIST]**

1. All the time
2. For special occasions only
3. During certain months of the year only
4. Never plugged in or running
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

H5. **[ASK IF H4=2 OR H4=3]** If you were to add up the total time it was running as a spare in the last year before you recycled it, how many months would that be? **[IF RESPONDENT IS UNSURE: "Your best estimate is okay."]**

1. **[RECORD MONTHS 1-12]**
-98. DON'T KNOW
-99. REFUSED

H6. Where was the **[INSERT APPLIANCE TYPE]** located during most of the year before you recycled it?

1. Kitchen
2. Garage
3. Porch/Patio
4. Basement
5. Yard/Outside
6. Other **[RECORD]**
-98. DON'T KNOW
-99. REFUSED

H7. Was the location heated?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H8. Was the location air-conditioned?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H9. Would you say the **[INSERT APPLIANCE TYPE]** you recycled… **[READ LIST. RECORD FIRST RESPONSE]**

1. Worked and was in good physical condition
2. Worked but needed minor repairs
3. Worked but had some major problems
4. Didn't work
-98. **[DO NOT READ]**DON'T KNOW
-99. **[DO NOT READ]**REFUSED

H10. Did you get a new **[INSERT APPLIANCE TYPE]** to replace the one you recycled?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H11. **[ASK IF H10=2]** Do you plan to get a replacement appliance in the near future?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H12. **[ASK IF H10=1]** Would you have purchased the new **[INSERT APPLIANCE TYPE]** without the $30 incentive you received for recycling the old one?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H13. **[IF H10=1 AND H12=2]** Just to confirm: you would *not* have replaced your old **[INSERT APPLIANCE TYPE]** without the **[INSERT UTILITY]** incentive for recycling, is that correct?

1. Correct
2. Incorrect
-98. DON'T KNOW
-99. REFUSED

H14. Is the **[INSERT APPLIANCE TYPE]** you replaced it with an ENERGY STAR or high efficiency model?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H15. Had you already considered getting rid of this **[INSERT APPLIANCE TYPE]** before hearing about **[INSERT UTILITY]**'s appliance recycling program?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

H16. Without the **[INSERT UTILITY]** refrigerator recycling program, what would you most likely have done with your old **[INSERT APPLIANCE TYPE]**? Would you have… **[READ LIST]**

1. Gotten rid of it
2. Kept it

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

H17. **[ASK H17=1]** Would you have gotten rid of it within a year of when the program took it, or more than a year later?

1. Within a year of when the program took it
2. More than a year later

-98. DON'T KNOW
-99. REFUSED

H18. **[ASK H16=2]** If you had kept it, would you have used it full time, stored it unplugged, or used it occasionally?

1. Used full time
2. Stored it unplugged
3. Used it occasionally

-98. DON'T KNOW
-99. REFUSED

Consideration of Alternatives & Freeridership

Now I have a few questions about the different options you might have considered before recycling your appliance.

F1. Did you seriously consider selling it to someone through an ad or to someone you know?

1. Yes – considered
2. No – did not consider or did not know about

-98. DON'T KNOW
-99. REFUSED

F2. Did you seriously consider selling it to a used appliance dealer?

1. Yes – considered
2. No – did not consider or did not know about

-98. DON'T KNOW
-99. REFUSED

F3. Did you seriously consider giving it away to someone for free?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F4. Did you seriously consider giving it away to a charity organization, such as Goodwill, [**IF STATE = WA , ID, SAY "**Deseret Industries"] or a church?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F5. Did you seriously consider having it removed by the dealer you got your new or replacement appliance from?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F6. Did you seriously consider hauling it to the dump yourself?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F7. Did you seriously consider hauling it to a recycling center yourself and paying the disposal fee?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F8. Did you seriously consider hiring someone else to haul it away for junking or dumping?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F9. Did you seriously consider keeping it?

1. Yes – considered
2. No – did not consider or did not know about
-98. DON'T KNOW
-99. REFUSED

F10. Did you consider any other ways of getting rid of your **[INSERT APPLIANCE TYPE]** that I haven't mentioned?

1. Yes **[RECORD VERBATIM]**
2. No
-98. DON'T KNOW
-99. REFUSED

F11. **[ASK IF F1=1 OR F2=1]** Why did you not follow through with your consideration to sell the **[INSERT APPLIANCE TYPE]**?

1. Couldn't find an interested buyer
2. Decided recycling unit was more important than selling it
3. Other **[RECORD VERBATIM]**
-98. DON'T KNOW
-99. REFUSED

F12. **[ASK IF F5=1]** If an appliance dealer were to take it away, how much, if anything, do you think you would have to pay for this service?

1. Nothing/Free Service
2. **[RECORD AMOUNT]**
-98. DON'T KNOW
-99. REFUSED

F13. **[ASK IF F8=1]** If you were to hire someone else to haul it away for junking or dumping, how much, if anything, do you think you would have to pay for this service?

1. Nothing/Free Service
2. **[RECORD AMOUNT]**
-98. DON'T KNOW
-99. REFUSED

F14. **[ASK IF F6=1 or F7=1]** You mentioned earlier that you considered hauling the **[INSERT APPLIANCE TYPE]** to the dump or recycling center yourself. Do you have the ability to do this or would you have needed assistance such as renting or borrowing a truck?

1. Yes, could do it myself
2. Would need assistance
-98. DON'T KNOW
-99. REFUSED

F15. **[ASK IF F6=1 or F7=1]** Most dumps and recycling centers charge a fee of at least $25 to dispose of a refrigerator or freezer. Were you aware that you would have to pay a fee??

1. Yes, I would have paid the fee
2. No, I wouldn't pay
-98. DON'T KNOW
-99. REFUSED

F16. **[ASK F3=1 or F4=1]** You mentioned that you considered giving the **[INSERT APPLIANCE TYPE]** away. Did you identify and contact a specific person or charity to give the **[INSERT APPLIANCE TYPE]** to?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

F17. Now that we have talked about various ways you could have gotten rid of your **[INSERT APPLIANCE TYPE]**, what do you really think you would have most likely done with it without the **[INSERT UTILITY]** program? **[READ LIST ONLY IF NEEDED]**

1. Sold it to a private party, either by running an ad or to someone you know
2. Sold it to an used appliance dealer
3. Given it away to a private party, such as a friend or neighbor
4. Given it away to a charity organization, such as Goodwill Industries or a church
5. Had it removed by the dealer you got your new or replacement appliance from
6. Hauled it to the dump yourself and pay the disposal fee
7. Hauled to a recycling center yourself and pay the disposal fee
8. Had someone else pick it up for junking or dumping
9. Kept it
10. Some other way **[RECORD VERBATIM]**
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]**REFUSED

F18. What is the main reason you chose the **[INSERT UTILITY]** program over other methods of disposing of your appliance? **[DO NOT READ. RECORD ONLY ONE RESPONSE]**

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 **[RECORD VERBATIM]**

-98. DON'T KNOW
-99. REFUSED

F19. Would you have participated in the program without the incentive check?

1. Yes
2. No

-98. DON'T KNOW
-99. REFUSED

CFL INSTALLATION

E1. Was a free kit containing CFL light bulbs and energy information given to you at the time of pickup?

1. Yes
2. No

-98. DON'T KNOW
-99. REFUSED

[IF E1<>1 SKIP TO SP1]

E2. How would you rate the information found in this kit? Would you say it was… **[READ LIST]**

1. Very helpful
2. Somewhat helpful
3. Not very helpful
4. Not at all helpful

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

E3. **[ASK IF E2<>98 Or E2<>99]** Why did you assign this rating? **[DO NOT READ LIST. RECORD MULTIPLE]**

1. Information too general
2. Already aware of information
3. Information did not apply
4. Used the suggestions provided in information
5. Written well

6. Passed information along to others
7. Other **[RECORD VERBATIM]**
-98. DON'T KNOW
-99. REFUSED

E4. How many of the CFLs that came in the kit did you install?

1. None
2. One
3. Two
3. Other **[RECORD]**
-98. DON'T KNOW
-99. REFUSED

E5. **[ASK IF E4=1 OR E4=2]** Why didn't you install **[IF E4=1, "them?" IF E4=2, "the other CFL?" [DO NOT READ LIST. RECORD MULTIPLE]**

1. Did not fit fixtures
2. Intend to install later
3. Do not like style
4. Do not like quality
5. Defective product
6. Other [RECORD VERBATIM]
-98. DON'T KNOW
-99. REFUSED

E6. **[ASK IF E4=2 OR E4=3]** Where did you install the CFL(s)? **[DO NOT READ. RECORD UP TO TWO]**

1. Living room
2. Master bedroom
3. Other bedroom
4. Kitchen
5. Bathroom
6. Garage/storage
7. Outside
8. Closet
9. Hallway
10. Other **[RECORD VERBATIM]**
-98. DON'T KNOW
-99. REFUSED

E7. Did you install the refrigerator thermometer included in your energy-saving kit?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

[IF E7=1, ASK E8. ELSE, SKIP TO E9]

E8. After installing the thermometer, did you change the temperature setting on your refrigerator?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

E9. Do you remember receiving a booklet with information about how to save energy?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

[**IF E9=1, ASK E10, ELSE SKIP TO SP1]**

E10. Have you followed any of the advice mentioned in the booklet? If so, which ones?

1. Yes, [**RECORD VERBATIM]**
2. No
-98. DON'T KNOW
-99. REFUSED

Spillover and Market Impact

SP1. Since participating in the appliance recycling program, have you participated in any other incentive programs offered by **[INSERT UTILITY]**?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

SP2. **[ASK SP1=1]** Which programs did you participate in?

1. **[RECORD VERBATIM]**
-98. DON'T KNOW
-99. REFUSED

SP3. **[ASK SP1=1]**How influential was the recycling program in your decision to participate in other **[INSERT UTILITY]** energy efficiency programs? Would you say it was… **[READ LIST]**

1. Very influential
2. Somewhat influential
3. Not very influential
4. Not at all influential

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

SP4. **[ASK IF SP1=2]** Based on your experience in recycling your appliance, how likely are you to participate in another utility energy efficiency program? Would you say you are… **[READ LIST]**

1. Much more likely
2. Somewhat more likely
3. No more or less likely
4. Less likely to participate in another program

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

SP5. Besides recycling your old **[APPLIANCE TYPE]**, have you made other energy efficiency improvements or purchases on your own without any assistance from a utility or other energy organization?

1. Yes
2. No

-98. DON'T KNOW
-99. REFUSED

SP6. **[ASK IF F5=1]** What did you install? **[DO NOT READ. RECORD MULTIPLE]**

1. High efficiency dishwasher
2. High efficiency washer
3. High efficiency dryer
4. High efficiency refrigerator
5. High efficiency water heater
6. CFLs (Compact Fluorescent Light bulbs or curly bulbs)
7. Other **[RECORD VERBATIM]**

-98. DON'T KNOW
-99. REFUSED

SP7. **[ASK IF F5=1]**How much did your experience with the See ya later, refrigerator program influence your decision to install other high efficiency equipment on your own? Would you say it was… **[READ LIST]**

1. Very influential
2. Somewhat influential
3. Not very influential
4. Not at all influential
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

Program Satisfaction

G1. How satisfied are you with the **[INSERT UTILITY]** Appliance Recycling Program overall? Would you say you are… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Somewhat dissatisfied
4. Very dissatisfied
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G2. **[ASK IF G1= 2, 3, or 4]** Why do you give it that rating? **[DO NOT READ. RECORD MULTIPLE]**

1. Incentive was too small.
2. Contractor never called me back.
3. Contractor never showed up/showed up late.
4. Contractor was unreliable/unprofessional.
5. Difficult to get an appointment time that was convenient for me.
6. Wanted to use a different [non-program] contractor.
7. Other **[RECORD VERBATIM]**
-98. DON'T KNOW
-99. REFUSED

G3. How satisfied are you with the sign-up process for the program? Would you say you are… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Somewhat dissatisfied
4. Very dissatisfied
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G4. How easy was it to schedule a convenient pickup time? Would you say it was… **[READ LIST]**

1. Very easy
2. Somewhat easy
3. Somewhat difficult
4. Very difficult
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G5. How satisfied are you with the appliance pick-up portion of the program? Would you say you are… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Somewhat dissatisfied
4. Very dissatisfied
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G6. Did the crew that picked up your appliance check to see if it was working before they took it away?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

G7. How satisfied are you with how quickly you received your incentive? Would you say you are… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Somewhat dissatisfied
4. Very dissatisfied
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G8. How satisfied are you with the amount of the incentive? Would you say you are… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Somewhat dissatisfied
4. Very dissatisfied
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G9. Would you have participated in the program if the amount of the incentive had been less?

1. Yes
2. No
-98. DON'T KNOW
-99. REFUSED

G10. How likely are you to recommend the **[INSERT UTILITY]** Appliance Recycling Program to friends and family members? Would you say you are… **[READ LIST]**

1. Very likely
2. Somewhat likely
3. Not very likely
4. Not at all likely
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

G11. Is there anything you would suggest to improve the **[INSERT UTILITY]** Appliance Recycling Program?

1. **[RECORD VERBATIM]**
-98. DON'T KNOW
-99. REFUSED

Demographics

I have just a few more questions about your household. Again, all your answers will be strictly confidential.

D1. Which of the following best describes your house? **[READ LIST]:**

1. Single-family home
2. Townhouse or duplex
3. Mobile home or trailer
4. Apartment building with 4 or more units
5. Other **[RECORD]**
-98. **[DO NOT READ]** REFUSED
-99. **[DO NOT READ]** DON'T KNOW

D2. Do you rent or own your home?

1. Own
2. Rent
3. Other **[RECORD]**
-98. REFUSED
-99. DON'T KNOW

D3. How long have you lived at that location?

1. Less than one year
2. 2-5 years
3. More than 5 years
-98. REFUSED
-99. DON'T KNOW

D4. Including yourself and any children, how many people currently live in your home?

1. **[RECORD]**
-98. REFUSED
-99. DON'T KNOW

D5. Can you please tell me in what year you were born?

1. **[RECORD]**
-98. REFUSED
-99. DON'T KNOW

D6. In 2010, was your pre-tax household income above or below $50,000?

1. Below $50,000
2. Above $50,000
3. Exactly $50,000
-98. DON'T KNOW **[SKIP TO C1]**
-99. REFUSED **[SKIP TO C1]**

D7. **[ASK IF D6=1]** Which of the following categories best represents your household income in 2010? Please stop me when I read your category:

1. Under $10,000
2. $10,000 to under $20,000
3. $20,000 to under $30,000
4. $30,000 to under $40,000
5. $40,000 to under $50,000
-98. REFUSED
-99. DON'T KNOW

D8. **[ASK IF D6=2]** Which of the following categories best represents your household income in 2010? Please stop me when I read your category:

1. $50,000 to under $60,000
2. $60,000 to under $75,000
3. $75,000 to under $100,000
4. $100,000 to under $150,000
5. $150,000 to under $200,000
6. $200,000 or more
-98. REFUSED
-99. DON'T KNOW

Conclusion

C1. How satisfied are you with the service that **[INSERT UTILITY]** provides overall? Would you say you are… **[READ LIST]**

1. Very satisfied
2. Somewhat satisfied
3. Somewhat dissatisfied
4. Very dissatisfied

-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

C2. Do you have any additional feedback or comments?

1. Yes **[RECORD VERBATUM]**
2. No

-98. REFUSED
-99. DON'T KNOW

That concludes the survey. Thank you very much for your time and feedback.

Appendix F: Nonparticipant Survey Instrument

Pacific Power
See Ya Later Refrigerator Program 2009-2010
Nonparticipant Survey

Introduction

[TO RESPONDENT]: Hello, my name is **[INSERT FIRST NAME]** from Discovery Research Group. I'm calling on behalf of **[UTILITY]**. I am calling to ask you some survey questions that will help **[UTILITY]** improve their energy-efficiency programs.

[IF RESPONDENT EXPRESSES RESERVATIONS AT THIS POINT, USE THE FOLLOWING SCRIPT TO PERSUADE. IF RESPONDENT DOES NOT EXPRESS RESERVATIONS SKIP TO S1]:

I'm not selling anything, we are interested in your opinions to help improve our programs, and understand how to assist customers in saving money on their utility bills. Your responses will remain confidential.

S. Screening Questions

S1. Did you discard a refrigerator or freezer in 2009 or 2010? By discard, we mean getting rid of it either by selling it, giving it away, having someone pick it up, or taking it to the dump or a recycling center.

1. Yes, refrigerator(s)
2. Yes, freezer(s)
3. Yes, both appliances
4. No [TERMINATE]

-98. Don't know **[TERMINATE**]
-99. Refused **[TERMINATE]**

S2. Did the appliance(s) work? [IF RESPONDENT IS UNSURE, SAY: "Even if it didn't get cold, did the appliance turn on when it was plugged in?"]

1. Yes
2. No **[TERMINATE]**

-98. Don't know **[TERMINATE]**
-99. Refused **[TERMINATE]**

S3. Did you have the appliance(s) picked up through **[INSERT UTILITY]**'s See Ya Later, Refrigerator program?

1. Yes **[TERMINATE]**
2. No

-98. Don't know **[TERMINATE]**

-99. Refused **[TERMINATE]**

S4. **[INSERT UTILITY]** offers an incentive to pick up and recycle old working refrigerators and freezers. A contractor would have picked the appliance up at your home and you would have been paid $30 later in the mail. Are you sure your appliance wasn't picked up by the utility program?

1. Yes, I'm sure it wasn't picked up by the program or I received no incentive
2. No, I did get the incentive check **[TERMINATE]**

-98. I still don't know for sure **[TERMINATE]**

-99. Refused **[TERMINATE]**

[TERMINATION SCRIPT: "Those are all the questions we have for you. Thank you very much for your time."]

N. Nonparticipant Awareness

N1. Were you aware of the **[INSERT UTILITY]** appliance recycling program prior to getting rid of your appliance?

1. Yes
2. No

-98. DON'T KNOW

-99. REFUSED

[IF N1=1, ASK N2, ELSE SKIP TO N4]

N2. How did you learn about the **[INSERT UTILITY]** appliance recycling program? **[DO NOT READ LIST. RECORD UP TO 3 RESPONSES]**

1. Newspaper/Magazine/Print Media
2. Bill Inserts
3. Pacific Power/Pacific Power website
4. Other website
5. Internet Advertising/Online Ad
6. Family/friends/word-of-mouth
7. Pacific Power/Pacific Power Representative
8. Radio
9. TV
10. Billboard/outdoor ad
11. Retailer/Store
12. Sporting event
13. Home Shows/Trade Shows
14. Appliance Recycling Contractor
15. Other **[RECORD VERBATIM]**
16. Postcard

17. Direct mail
-98. **[DO NOT READ]** DON'T KNOW
-99. **[DO NOT READ]** REFUSED

N3. What made you decide not to have your appliance picked up through the **[INSERT UTILITY]** appliance recycling program? **[DO NOT READ. RECORD UP TO THREE RESPONSES.]**

1. Unit didn't qualify
2. Did not know how to sign up
3. Was not able to schedule convenient pickup time
4. Too much hassle
5. Other **[RECORD VERBATUM]**

-98. DON'T KNOW
-99. REFUSED

N4. What are the best ways for **[INSERT UTILITY]** to inform you about energy-efficiency offerings like the appliance recycling program? **[DO NOT READ. PROMPT IF NECESSARY. RECORD UP TO THREE RESPONSES]**

1. Newspaper/Magazine/Print Media
2. Bill Inserts
3. Pacific Power/Pacific Power website
4. Other website
5. Internet Advertising/Online Ad
6. Family/friends/word-of-mouth
7. Pacific Power/Pacific Power Representative
8. Radio
9. TV
10. Billboard/outdoor ad
11. Retailer/Store
12. Sporting event
13. Home Shows/Trade Shows
14. Appliance Recycling Contractor
15. E-mail from Pacific Power/Pacific Power
16. Other **[RECORD VERBATUM]**
17. Postcard
18. Direct mail

-98. DON'T KNOW
-99. REFUSED

N5. How would you rate your current understanding of energy-efficiency? Would you say you… **[READ LIST. RECORD FIRST RESPONSE]**

1. Have no knowledge of energy-efficiency
2. Are somewhat knowledgeable about energy-efficiency
3. Are very knowledgeable about energy-efficiency

-98. **[DO NOT READ]** DON'T KNOW

-99. **[DO NOT READ]** REFUSED

A. Appliance Characteristics

[IF MORE THAN ONE APPLIANCE DISCARDED, SAY:] For the rest of the survey we would like to ask you about the appliance you discarded. If you discarded multiple appliances please answer the following questions about the appliance you got rid of MOST recently.

A1. At the time you discarded it, approximately how old was the appliance?

[RECORD AGE IN YEARS]

-98. Don't know

-99. Refused

A2. Before you made the decision to get rid of the appliance, in what room was the appliance used/located?

1. Kitchen
2. Garage
3. Porch/patio
4. Basement
5. Other **[SPECIFY]**

-98. Don't know

-99. Refused

A3. Would you say the appliance …? **[READ LIST, RECORD ONLY ONE RESPONSE]**

1. Worked and was in good physical condition
2. Worked but needed minor repairs
3. Worked but had some major problems

-98. **[DO NOT READ]** Don't know

-99. **[DO NOT READ]** Refused

A4. Did you get a new appliance to replace the one you got rid of?

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

[IF A4=1, ASK A5. ELSE SKIP TO A6]

A5. Is the appliance you replaced it with an ENERGY STAR or high efficiency model?

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

A6. How did you get rid of your old appliance? **[IF NEEDED, PROMPT: "For example, did you sell it or give it away?"]**

1. Sold it to a private party, either by running an ad or to someone you know
2. Sold it to an used appliance dealer
3. Gave it away to a private party, such as a friend or neighbor
4. Gave it away to a charity organization, such as Goodwill Industries or a church
5. Had it removed by the dealer you got your new or replacement appliance from
6. Hauled it to the dump yourself
7. Hauled to a recycling center yourself
8. Had someone else pick it up for junking or dumping
9. Kept it
10. Some other way **[RECORD VERBATIM]**
-98. Don't know
-99. Refused

Demographics

D1. Which of the following best describes your house? **[READ LIST]:**

1. Single-family home
2. Townhouse or duplex
3. Mobile home or trailer
4. Apartment building with 4 or more units
5. Other **[RECORD]**
-98. **[DO NOT READ]** REFUSED
-99. **[DO NOT READ]** DON'T KNOW

D2. Do you rent or own your home?

1. Own
2. Rent
3. Other **[RECORD]**

-98. REFUSED
-99. DON'T KNOW

D3. How long have you lived at that location?

1. Less than one year
2. 2-5 years
3. More than 5 years

-98. REFUSED
-99. DON'T KNOW

D4. Including yourself and any children, how many people currently live in your home?

1. **[RECORD]**

-98. REFUSED
-99. DON'T KNOW

D5. Can you please tell me in what year you were born?

1. **[RECORD]**

-98. REFUSED
-99. DON'T KNOW

D6. In 2010, was your pre-tax household income above or below $50,000?

1. Below $50,000
2. Above $50,000
3. Exactly $50,000

-98. DON'T KNOW **[SKIP TO C1]**
-99. REFUSED **[SKIP TO C1]**

D7. **[ASK IF D6=1]** Which of the following categories best represents your household income in 2010? Please stop me when I read your category:

1. Under $10,000
2. $10,000 to under $20,000
3. $20,000 to under $30,000
4. $30,000 to under $40,000
5. $40,000 to under $50,000

-98. REFUSED
-99. DON'T KNOW

D8. **[ASK IF D6=2]** Which of the following categories best represents your household income in 2010? Please stop me when I read your category:

1. $50,000 to under $60,000
2. $60,000 to under $75,000
3. $75,000 to under $100,000
4. $100,000 to under $150,000
5. $150,000 to under $200,000
6. $200,000 or more

-98. REFUSED
-99. DON'T KNOW

CLOSING SCRIPT: Those are all the questions we have. **[INSERT UTILITY]** appreciates your input. Thank you for your time.