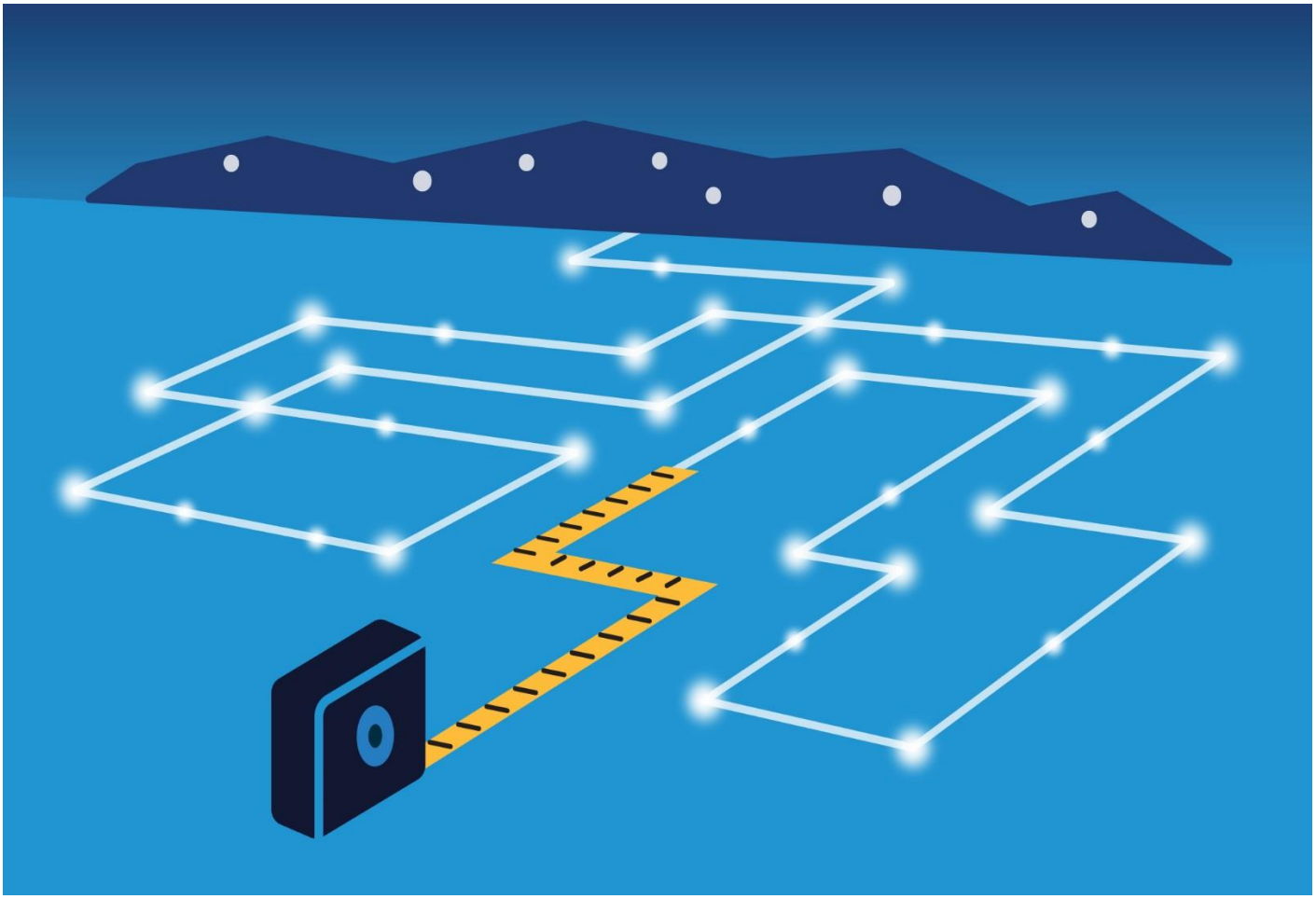
Opinion Dynamics

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451



Impact and Process Evaluation of 2013 (PY6) Ameren Illinois Company Appliance Recycling Program

Final

March 12, 2015

CADMUS

NAVIGANT

MichaelsEnergy

Opinion Dynamics

Contributors

Jane Colby
Principal, The Cadmus Group

Jason Christensen
Senior Analyst, The Cadmus Group

Opinion Dynamics

Table of Contents

Opinion Dynamics

Table of Tables

Table of Figures

1. Executive Summary

The Ameren Illinois Company (AIC) Appliance Recycling Program (ARP) offers free recycling of refrigerators, freezers, and room air conditioners for residential and small commercial customers. The program is in its sixth year of operation. AIC expected ARP to achieve approximately 7% of the electric savings of AIC's overall portfolio. Conservation Services Group (CSG) manages the program and its advertising. Appliance Recycling Centers of America (ARCA) implements the program, including picking up and recycling appliances, as well as providing scheduling and customer service.

To verify program participation and to estimate Program Year 6 (PY6) savings, the evaluation team reviewed and analyzed the tracking database. The evaluation team calculated savings estimates using the regression equation specified in the Illinois Statewide Technical Reference Manual (TRM) for Energy Efficiency Version 2.0 (June 7, 2013). The evaluation team applied net-to-gross ratio (NTGR) adjustments prospectively based on PY4 evaluation activities and estimated a new NTGR using a PY6 participant survey to inform future year evaluations.

For the process review, the evaluation team interviewed program managers from AIC, CSG, and ARCA, and gathered results from recent evaluations to benchmark several program metrics.

Impact Results

As shown in Table 1, the team verified participation by conducting surveys with a sample of 140 participants who recycled refrigerators and freezers in PY6. Because there were only 17 air conditioners recycled through the program in PY6 (accounting for only 0.2% of the total number of appliances), the evaluation team applied the PY4 verification rate of 100% for air conditioners.

Table 1. Summary of Participant Verification Results

Recycling Measure	Participants	Sample	Verified Sample	Verified Participants	Verification Rate
Refrigerator	7,079	70	70	7,079	100%
Freezer	2,181	70	70	2,181	100%
Air Conditioner	17	N/A*	N/A	17	100%
Total	**9,277**	**140**	**140**	**9,277**	**100%**

* Applying PY4 verification rate for air conditioners.

In 2012, the Statewide TRM Version 2.0 introduced a change in the methodology for estimating annual consumption of recycled refrigerators and freezers, based on an *in situ* metering study conducted for a similar Commonwealth Edison (ComEd) program. The Statewide TRM Version 2.0's algorithm relied on inputs from a program-tracking database and from a participant survey. Though gross per-unit savings decreased between PY4 and PY5 due to the changed algorithm, gross per-unit savings increased between PY5 and PY6, rising 15% for refrigerators and 18% for freezers. This is likely due to changing appliance characteristics (such as an increase in primary units from 34% in PY4 to 67% in PY6). Primary units have more utilization, which results in higher use than secondary units.

The evaluation team also used the participant survey input to calculate an updated part-use factor (the percentage of time a product remains plugged in), which will be applied in future evaluations. For PY6 impact calculations, the evaluation team applied the part-use factor specified in the Statewide TRM Version 2.0.

Table 2 shows total gross and net impacts for PY6 and the net realization rates.

Table 2. PY6 ARP Impacts

Recycling Measure	PY6 Ex Ante* Gross Savings		PY6 Ex Post** Gross Savings		PY6 Ex Ante* Net Savings		PY6 Ex Post** Net Savings		Net Realization Rate***
	MWh	MW	MWh	MW	MWh	MW	MWh	MW	
Refrigerator	5,720	0.71	6,424	0.68	3,146	0.39	4,041	0.43	128%
Freezer	1,972	0.23	2,038	0.23	1,124	0.13	1,282	0.14	114%
Air Conditioner	4	–	3	0.00	4	–	3	0.00	75%
Total	**7,696**	**0.94**	**8,466**	**0.91**	**4,274**	**0.52**	**5,326**	**0.57**	**125%**

* Ex ante estimates were provided in the tracking database, which were based on the PY4 results included in the Statewide TRM Version 2.0. Air conditioner ex ante savings are based on PY5 results, as there were no reported savings included in the tracking database.

** Ex post determined by applying NTGR and verified participation.

*** Net realization rate = ex post net savings ÷ ex ante net savings.

****Values in the table may differ from totals due to rounding.

To estimate PY6 net savings, the evaluation team applied the PY4 NTGR of 0.63 for refrigerators and freezers and 1.0 for air conditioners. It is likely that ex ante per-unit gross savings estimates were lower than ex post gross savings because of a difference in the mix of units recycled compared to that assumed for tracking purposes.[1] The evaluation team found ex post net per-unit savings to be greater than the ex ante net per-unit savings. Together, these resulted in an overall net realization rate of 125%.

Process Results

While AIC exceeded its internal program savings goal of 4,405 MWh of net savings for the year, participation decreased by 21% from PY5, falling from 11,679 to 9,277 appliances. The trend in decreasing participation continued from the program's peak year of PY4. This is not uncommon: Appliance recycling programs typically experience declining participation as they remove the pool of unused or unnecessary secondary refrigerators and freezers from the market. Additionally, AIC's service territory experienced a particularly severe winter, which likely also affected participation due to difficult road conditions for the drivers picking up the appliances.

Also, CSG transferred some marketing responsibilities to ARCA and that caused some delays getting bill inserts out during the first half of PY6, which is a typically busy time for the program. The issues were resolved early in 2014, and the unspent portion of the marketing budget was used to boost marketing efforts in the second half of the program year. However, the lack of bill inserts in 2013 likely contributed to lower participation as well.

Much of the same types of program marketing took place in PY6 as in prior years. AIC continued its retail partnership with Sears; its nonprofit referral bonus of $10, whereby a nonprofit, named by a participant as a referral entity, received payment in addition to incentives paid to the customer; and its use of the Energy Hog as the program's mascot. AIC also repeated a spring sweepstakes for a $2,000 ENERGY STAR® appliance shopping spree, with anyone recycling an appliance during January through March entered for the prize. These marketing efforts took place in addition to more customary marketing, such as bill inserts, e-mail blasts, print ads, and online ads.

[1] The implementation applied the default value in the Statewide TRM Version 2.0 to an assumed mix of units recycled based on PY4 data.

Through a benchmarking task, the evaluation team found that AIC's program is comparable to others in its participation trends and NTGR results.

Conclusions and Recommendations

- **Conclusion 1:** Given historical trends, it appears unlikely that AIC will be able to significantly increase participation in the ARP without significant effort. This is because once the really old units are removed from the grid, only a small percentage of appliances turn over each year. If the program implemented a more aggressive marketing effort, the marginal acquisition cost of additional units would likely be substantially higher than that of historical participants. AIC has already introduced the changes most likely to significantly increase participation: changing eligibility to include primary appliances and increasing the incentive. The percentage of participants hearing about the program through word of mouth is significant.
  - **Recommendation 1:** AIC could consider targeted marketing to maintain current participation levels. Marketing targeted to households with long-term active accounts could potentially identify homes with units older, on average, than other program units. Older units produce higher-than-average savings, especially if manufactured prior to the appliance efficiency standards of the early 1990s. Other programs implementing this approach saw an increase in the average appliance age and associated savings.
- **Conclusion 2:** In most program metrics, AIC greatly resembles other appliance recycling programs operating nationally, including NTGR, eligibility, incentive levels, and participation. AIC operates slightly below average in per-unit energy savings for appliances recycled through the program. AIC's per-unit savings, however, remain close to Consumers Energy in Michigan, the program most readily comparable by geography and tenure.
  - **Recommendation 2:** To increase per-home savings, AIC could consider novel program designs to possibly increase per-unit savings for each participant. Energy-saver tips and a low-cost measure (such as a couple of CFLs or an LED) could be left behind with customers, thus adding relatively cheap incremental savings to the program.
- **Conclusion 3:** The percentage of customers hearing about the ARP through word of mouth is significant (23%) likely due to AIC's combined marketing efforts.
  - **Recommendation 3:** Consider building and expanding this component by offering a referral incentive or simply requesting participants to refer others to the program.

2. Introduction

Program Description

Ameren Illinois Company's (AIC) Appliance Recycling Program (ARP) offers free recycling of refrigerators and freezers to residential and small commercial customers. Participants receive a $50 incentive payment, and the program implementer picks up and hauls the appliance to its recycling facility in Springfield, Illinois. The program not only removes older, inefficient appliances from use within AIC's service territory, but disposes of them in an environmentally responsible manner.[2] Conservation Services Group (CSG) serves as the primary implementer for all AIC residential programs, and Appliance Recycling Centers of America (ARCA) serves as a subcontractor with the primary responsibility for implementing the ARP.

AIC electric customers qualify for the program if they are served under Residential Delivery Service (Rate DS-1) or Small General Delivery Service (Rate DS-2). Further, equipment must meet all of the following requirements to qualify for the program:

- Located on account premises and operational at the time of pick-up
- Full-sized units between 10 and 27 cubic feet
- Household-type models (commercial refrigerators and freezers do not qualify)

Additionally, the program picks up and recycles working room air conditioners when removing refrigerators or freezers, although air conditioners do not qualify for incentives.

Program marketing utilizes several channels, including traditional bill inserts, direct mail, and printed materials featuring the easily recognizable Energy Hog character. The Energy Hog also makes live appearances at community events and is featured on a prominent banner at a local mall.

The program also provides a referral bonus of $10 paid to a nonprofit organization named as having referred a participant to the program.

Research Objectives

For PY6, the evaluation team sought to estimate gross and net energy savings attributable to the program. In particular, the study focused on the following research questions:

1. What are the estimated gross energy and demand impacts from this program?
2. What are the estimated net energy and demand impacts from this program?
3. What is the estimated NTGR and spillover for future planning estimates?

In addition, the evaluation team explored process-related research questions as part of the PY6 evaluation. These questions were focused on the impact of changes made between PY5 and PY6, and ways to increase program participation. Specifically, they included:

[2] This includes disposal of oils, PCBs, mercury, and CFC-11 foam, and recycling of CFC-12, HFC-134a, plastic, glass, steel, and aluminum.

1. Did the program meet its energy goals? If not, why not?
2. Is marketing effective? If not, are there ways to improve how marketing dollars are being allocated?
3. Has program participation reached its maximum participation rate within AIC's territory? That is, are cost-effective marketing options still available to increase participation, or should the marketing transition to increasing savings rather than participation?

3. Evaluation Methods

Table 3 summarizes the evaluation tasks conducted for PY6.

Table 3. Summary of Appliance Recycling Program Evaluation Activities for PY6

Activity	PY6 Impact	PY6 Process	Forward Looking	Details
Program Staff In-Depth Interviews		✓		Program staff interviews provided insights into program design and delivery, as well as potential refinements or improvements to the current program. Stakeholders included staff from AIC and CSG.
Participant Telephone Surveys	✓	✓	✓	Telephone surveys of 140 participants (70 refrigerator recyclers and 70 freezer recyclers) were conducted to assess program implementation, verify participation, calculate part-use, and calculate net-to-gross ratio (NTGR) for PY8. The evaluation team worked with the Commonwealth Edison (ComEd) EM&V contractors to ensure consistent methods for determining free-ridership and NTGR.
Review of Program Materials and Database	✓	✓		The evaluation team reviewed all data in the tracking database to ensure collection of appropriate data to inform the evaluation.
Benchmarking		✓		Comparison of evaluation results with 13 other appliance recycling programs.
Gross Savings Calculation	✓		✓	Referencing the Illinois Statewide Technical Reference Manual (TRM) Version 2.0 (June 7, 2013), the evaluation team calculated estimates of annual unit energy consumption (UEC), using inputs from the PY6 program-tracking database, with adjusted per-unit savings for part-use (also specified in the Statewide TRM Version 2.0) to determine gross savings. The evaluation team also estimated part-use to be applied in PY8.
NTGR Calculation			✓	Using PY6 participant data, the evaluation team updated the NTGR to be applied in PY8.

3.1 Data Collection

The following activities informed the ARP's PY6 evaluation.

3.1.1 Program Staff Interviews

Interviews with program staff sought to gain information about the program's design, implementation, and processes. The evaluation team also asked about data tracking and customer outreach related to the program. Part of this task included interviewing one member of ARCA's implementation team, CSG's program manager, and the AIC program manager.

3.1.2 Participant Surveys

Sample Design

The evaluation team stratified the participant population by measure for refrigerators and freezers, then drew a random sample of participants within each stratum from the tracking database. The sample design sought to achieve 90% confidence and 10% absolute precision. Table 4 presents the targeted sample sizes and achieved completes.

Table 4. Survey Sample Size and Completes

Measure	Population	Quota	Completed Telephone Surveys
Refrigerator	7,079	70	70
Freezer	2,181	70	70
Total	**9,260**	**140**	**140**

Survey Disposition and Response Rate

The response rate equals the number of completed surveys divided by the total number of potentially eligible respondents in the sample. The evaluation team calculated the response rate using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR).[3]

For various reasons, we could not determine the eligibility of all sample units through the survey process, choosing rather to use AAPOR Response Rate 3 (RR3). This includes an estimate of eligibility for these unknown sample units. The formulas used to calculate RR3 follow, while Table 5 below provides definitions of letters used in the formulas.

$$e = \frac{I + P + R}{(I + P + R) + NE}$$

$$RR3 = \frac{I}{(I + P) + (R + NC + O) + e(U)}$$

We also calculated a cooperation rate (the number of completed surveys divided by the total number of eligible sample units contacted). In essence, the cooperation rate is the percentage of participants completing a telephone survey out of all participants speaking with the evaluation team. We used AAPOR Cooperation Rate 3 (COOP3), calculated as:

$$COOP3 = \frac{I}{(I + P) + R}$$

The evaluation team conducted telephone surveys with ARP participants from August 20 to September 5, 2014. Table 5 below shows the final survey dispositions.

[3] AAPOR. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys.* 2011. http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156.

Table 5. ARP Survey Dispositions

Disposition	n
Completed interviews (I)	140
Partial (P)	4
Eligible non-interviews	545
Refusals (R)	163
Mid-interview terminate (R)	12
Respondent never available (NC)	19
Telephone answering service (NC)	206
Language problem	145
Not eligible (NE)	66
Duplicate number	3
Non-working number	26
Wrong number	21
Business/government	10
Fax/data line	4
No eligible respondent	2
Unknown eligibility non-interview (U)	105
No answer	91
Not worked	11
Busy	2
Call blocking	1
Total Participants in Sample	**860**

Table 6 provides the response and cooperation rates.

Table 6. ARP Survey Response and Cooperation Rates

AAPOR Rate	Percentage
Response Rate	18%
Cooperation Rate	44%

3.1.3 Review of Program Materials and Database

The evaluation team reviewed program data, including marketing materials and the program-tracking database.

3.1.4 Benchmarking

The evaluation team conducted benchmarking research to compare AIC's ARP components with those of appliance recycling programs offered across North America. The review included:

- An examination of the evaluation team's recent internal program evaluations
- Publicly available program evaluations conducted by other professional organizations

- Appliance recycling program-related papers from industry conference proceedings (Appendix—References section, Appendix D, includes full citations of these reports and papers)

In total, the evaluation team collected and compared information from 11 utilities' appliance recycling program designs over multiple program years, as shown in Table 7. We compared participation levels, eligibility, incentives, NTGRs, and cost-effectiveness among these programs. To supplement the historic program information found in our literature review, the evaluation team conducted web-based research to obtain information about the utilities' current program offerings. Currently, all but one program remain in operation (Northeast Utilities discontinued its program).[4]

Table 7. Appliance Recycling Programs Reviewed

Utility	State/Province	Program Years Reviewed	First Program Year
AIC	Illinois	2009, 2010, 2012, 2013	2009
ComEd	Illinois	2008, 2009, 2012	2007
Consumers Energy	Michigan	2010, 2012	2009
Massachusetts (National Grid, NSTAR Electric, Cape Light Compact, Western Massachusetts Electric Company)	Massachusetts	2009–2010	2009
Northeast Utilities (Connecticut Light & Power and United Illuminating)	Connecticut	2004*	2004
Ontario Power Authority (OPA)	Ontario	2007, 2008–2009, 2010, 2012	2007
Pacific Gas & Electric (PG&E)	California	2004–2005, 2006–2008, 2010-2012	2002**
Pacific Power	Washington	2006, 2007, 2008, 2012	2005
PNM	New Mexico	2008, 2012	2006
Rocky Mountain Power	Idaho	2006, 2007, 2008, 2012	2006
	Utah	2006, 2007, 2008, 2012	2004
	Wyoming	2009–2010, 2012	2009
Snohomish Public Utility District	Washington	2006, 2012	2004
Southern California Edison (SCE)	California	2004–2005, 2006–2008, 2010–2012	1994

* The Northeast Utilities program was discontinued, but both Connecticut Light & Power and United Illuminating continued implementing separate programs. Comprehensive information for those programs was not available.

** PG&E also operated an appliance recycling program in the 1980s.

3.2 Analytical Methods

3.2.1 Gross Impacts

The evaluation team determined gross ex post impacts by thoroughly reviewing the program database, the Statewide TRM Version 2.0 algorithms, and assumptions. We then performed individual savings calculations

[4] If data were available, the evaluation team included information from older and more recent ARPs to examine program metric trends over time.

for each measure type using data provided in the program database and collected through the participant interviews.

3.2.2 Net Impacts

To estimate net savings, the evaluation team applied the NTGR from AIC's program filing to the ex post gross savings (0.63 for refrigerators and freezers). All NTGR research conducted during PY6 will be applied prospectively beginning in PY8, should the program offering continue.

3.2.3 Net-to-Gross Ratio

To conduct a NTGR analysis for future planning inputs, the evaluation team used the methods outlined in the Uniform Methods Project (UMP) protocol for appliance recycling programs. The evaluation team also coordinated with the ComEd evaluation team to ensure use of consistent methodology. This evaluation calculated net savings using the following formula:

$$net\ savings = gross\ savings \times (1 - free\text{-}ridership\ and\ secondary\ market\ impacts\% - induced\ replacement\% + spillover\%)$$

Sources and Mitigation of Error

Table 8 provides a summary of possible sources of error associated with data collection conducted for the ARP. We discuss each item in detail below.

Table 8. Possible Sources of Error

Research Task	Survey Errors		Non-Survey Errors
	Sampling Errors	Non-Sampling Errors	
Participant Survey	• Yes	• Measurement errors • Non-response and self-selection bias • Data processing errors • External validity	• N/A
Gross Savings Calculations	• Same as participant survey	• Same as participant survey	• Data processing errors
Net Savings Calculations	• Same as participant survey	• Same as participant survey	• Data processing errors

The evaluation team took a number of steps to mitigate against potential sources of error throughout the planning and implementation of the PY6 evaluation.

Survey Errors

- Sampling Errors
  - The evaluation team designed the telephone survey sample to achieve 90% confidence and ±10% relative precision. We surveyed 140 customers out of a population of 8,780. At the 90% confidence level, we achieved a precision of ±10% assuming a coefficient of variation of 0.50. The actual precision of each survey question will differ depending on the variance of the responses to each question.

- Non-Sampling Errors

  - **Measurement Errors:** We addressed both the validity and reliability of quantitative data through multiple strategies. First, we relied on the experience of the evaluation team to create questions that, at face value, appear to measure the idea or construct that they were intended to measure. We reviewed the questions to ensure that we did not ask double-barreled questions (i.e., questions that ask about two subjects, but that have only one response) or loaded questions (i.e., questions that are slanted one way or another). We also checked the overall logical flow of the questions so as not to confuse respondents, which would decrease reliability.

    Key members of the evaluation team, as well as AIC and Illinois Commerce Commission (ICC) staff, reviewed all survey instruments. In addition, to determine if the wording of the questions was clear, we pretested each survey instrument and monitored the telephone interviews as they were being conducted, and we reviewed the pretest survey data. We also used the pretests to assess whether the length of the survey was reasonable and reduced survey length as needed.

  - **Non-Response Bias:** Given that the response rate for the participant survey was 18%, there is the potential for non-response bias. However, we attempted to mitigate possible bias by calling each potential respondent at least eight times or unless a hard refusal was received, and by calling at different times of the day as appropriate.

    We also compared the appliance characteristics that were available between those who completed the survey and the PY6 database to ensure we reached a representative sample. Overall the population and sample are pretty similar in most respects. The sample appliances are slightly older than the population for both appliance types. The configuration distributions are pretty similar as well as the sizes, though the sample refrigerators are slightly larger. Physical characteristics have not been shown to be strongly correlated with the usage characteristics (part use) and free ridership, PY6's primary research questions, however. So while the appliances in the survey sample are representative of those in the general population there is no way to estimate the potential non-response bias in regard to part use or the NTGR.

  - **Data Processing Errors:** The team addressed processing errors through interviewer training, as well as quality checks of completed survey data. Opinion Dynamics interviewers went through a rigorous training before they began interviewing. Interviewers received a general overview of the research goals and the intent of each survey instrument. Through survey monitoring, members of the evaluation team also provided guidance on proper coding of survey responses. In addition, we carried out continuous, random monitoring of all telephone interviews and validation of at least 10% of every interviewer's work.

  - **External Validity:** We addressed external validity (the ability to generalize any findings to the population of interest) through development of an appropriate research design. We drew a simple random sample for both refrigerator records and freezer records. We cross-checked the samples to ensure that no participant would be called twice, once for each appliance type.

Non-Survey Errors

- Data Processing Errors

  - **Gross Impact Calculations:** We applied the Statewide TRM Version 2.0 calculations to the participant data in the tracking database to calculate gross impacts. To minimize data processing

errors, the evaluation team had all calculations reviewed by a separate team member to verify that calculations were performed accurately.

- **Net Impact Calculations:** We applied the prospective deemed NTGR to estimate the program's net impacts. To minimize data processing errors, the evaluation team had all calculations reviewed by a separate team member to verify that calculations were performed accurately.

4. Evaluation Findings

4.1 Program Description and Participation

During PY6, AIC's ARP offered a $50 incentive to customers who signed up to have a refrigerator or freezer recycled through the program. The program sought to achieve 4,405 MWh of net energy savings and recycle 9,540 appliances. The program very nearly achieved its goals, despite severe weather in the beginning of 2014. The ARP fell slightly short of the participation goal, with 9,277 appliances recycled (97% of goal), but surpassed the net energy savings goal, with 5,326 MWh (121% of the energy savings goal).

Because of lower-than-expected participation and the continued declining participation, program staff raised concerns about whether the marketing strategy proved sufficient to meet the program goals.

Table 9. AIC ARP Historical Participation

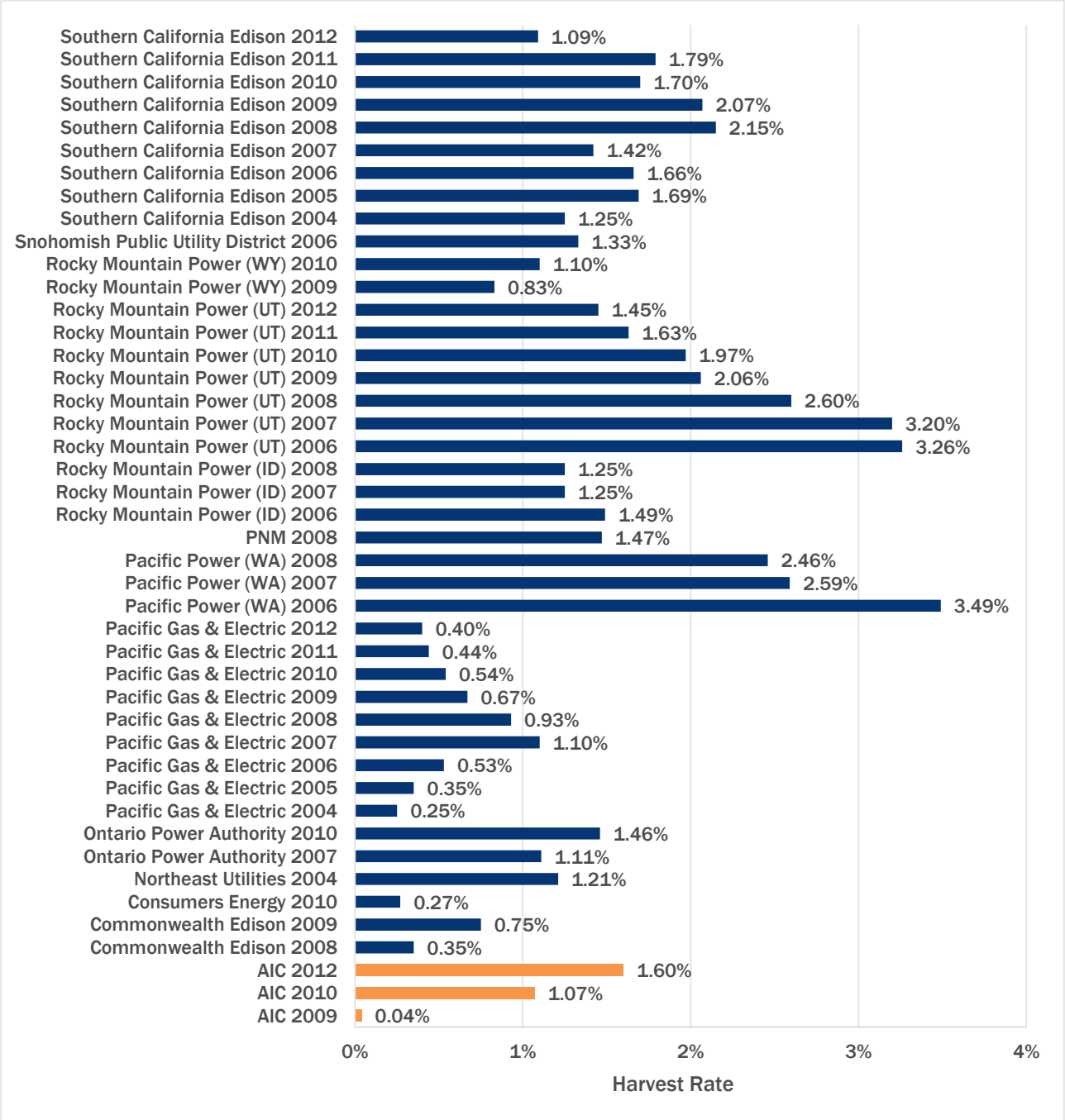
Year	Refrigerators	Freezers	Room A/Cs	Total
PY1	2,752	1,096	N/A	**3,848**
PY2	7,762	3,422	27	**11,211**
PY3	7,202	2,131	13	**9,346**
PY4	10,696	3,536	10	**14,242**
PY5	8,780	2,899	4	**11,683**
PY6	7,079	2,181	17	**9,277**

While Table 9 shows that participation has decreased since PY4, appliance recycling programs commonly experience declines as they mature. The evaluation team compared AIC's participation to programs offered through PG&E, SCE, and Rocky Mountain Power (Utah). All of these programs, which have been running longer than AIC's, have experienced drops in participation.

Figure 1 shows participation for all long-running programs declines over time. Program participation depends on multiple factors, including the size of the utility's residential customer base, program marketing efforts, and incentive amounts. Harvest rates through 2012 are calculated and shown in Figure 1, the last year for which Energy Information Administration data regarding the number of residential accounts are available. SCE peaked in 2008, upon raising program incentives. The participation increase lasted for 2 years; in 2012 (the most recent year examined), participation dropped to nearly one-half of the 2008 peak. PG&E's program did not change incentives for refrigerators and peaked in 2007, its fourth program year. In 2012 (also the most recent program year), participation fell to less than one-half of the peak. Rocky Mountain Power (Utah) decreased its incentive after 2007, its second program year. Participation dropped by 17%[5] during the following year, with 2012 participation approximately one-half the 2006 peak. A table of the data informing Figure 1 (Table 25) is included in Appendix D.

[5] Participation counts are shown in Appendix D Table 25. Benchmarked ARP Participation

Figure 1. Benchmarked Appliance Recycling Program Participation



4.2 Process Assessment

4.2.1 Program Changes

For the process assessment, the evaluation team interviewed program staff from AIC, CSG, and ARCA to understand how the program operated, to identify any changes in PY6, and to identify any areas of concern or challenges the program is facing.

The key change that program staff mentioned for PY6 was that marketing responsibilities shifted from CSG to ARCA. This transition led to some challenges, and no bill inserts were sent to customers for most of the first half of PY6. Since bill inserts are a key method for reaching potential participants, program staff reported that this challenge may have had an impact on participation. However, ARCA was able to resolve the issues surrounding the marketing transition in early 2014, and marketing resumed in the second half of the year.

Program staff indicated there are significant changes in program management planned for PY7. CSG will no longer be managing the program for AIC. Instead, Leidos will be taking over management.

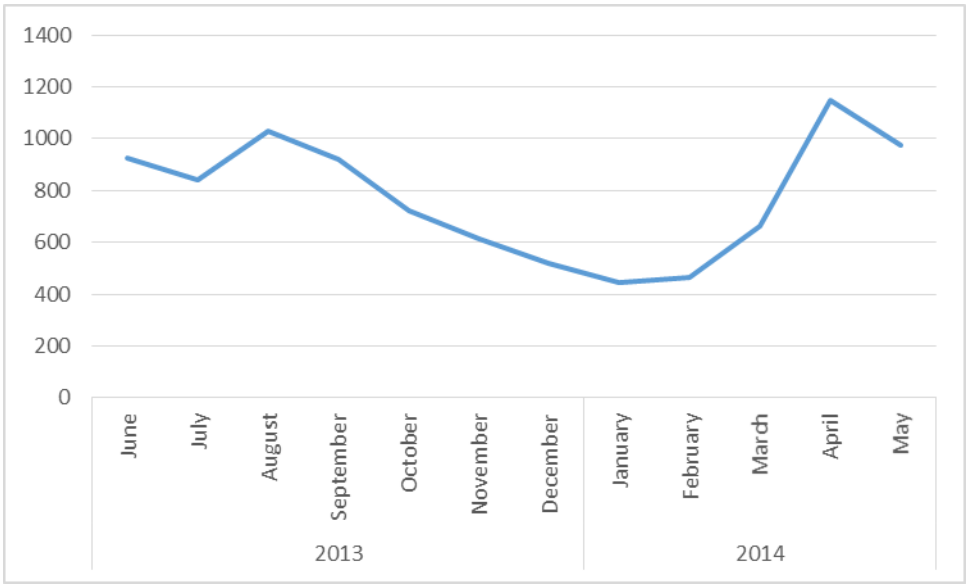
4.2.2 Marketing

Despite the change in marketing responsibilities mentioned above, much of the same program marketing took place in PY6 as in prior years. AIC continued its retail partnership with Sears; its nonprofit referral bonus of $10, whereby a nonprofit, named by a participant as a referral entity, received payment in addition to incentives paid to the customer; and its use of the Energy Hog as the program's mascot. AIC also repeated a spring sweepstakes for a $2,000 ENERGY STAR appliance shopping spree, with anyone recycling an appliance during January through March entered for the prize.

These marketing efforts took place in addition to more customary marketing, such as bill inserts, e-mail blasts, print ads, and online ads.

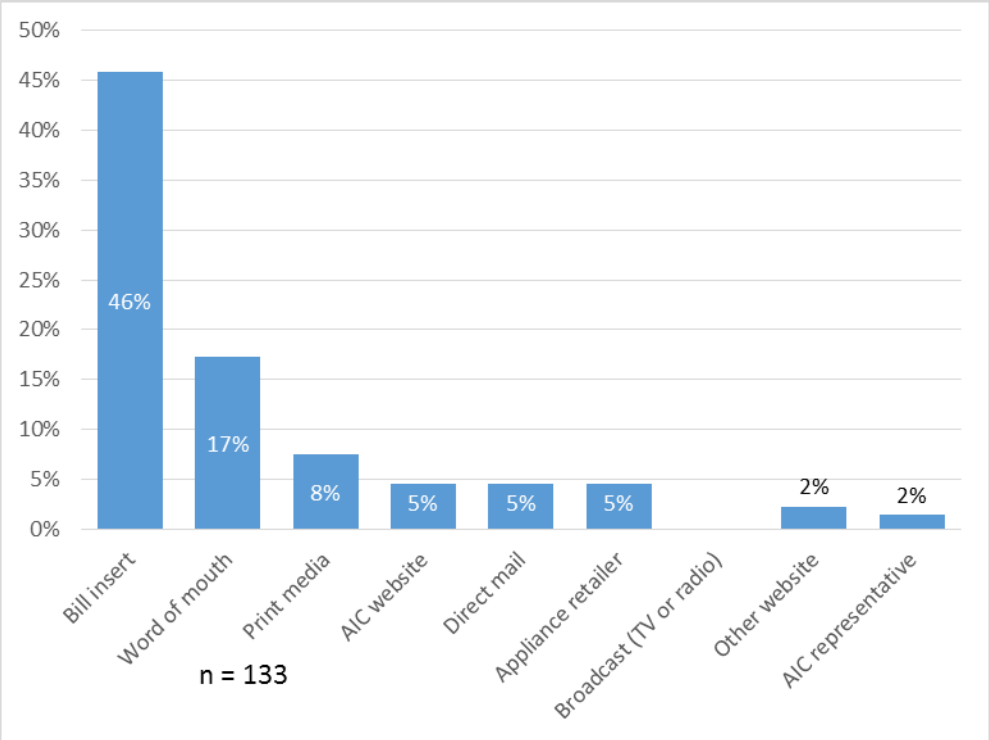
Figure 2 shows participation by month in PY6, and we see the peak in participation in April of 2014. This coincided with spring bill inserts and came just at the end of the promotional period for the $2,000 ENERGY STAR shopping spree contest. As previously mentioned, the bill inserts did not go out in much of 2013, which may explain why the peak month was April rather than late summer as is usually observed.

Figure 2. PY6 ARP Participation by Month



The program also doubled the nonprofit referral bonus between October 1 and December 31, 2013, although that change does not appear to have had much of an effect on participation. Additionally, program staff indicated that there were some issues tracking the nonprofit referrals, through which participants who signed up for the program could choose a nonprofit for the referral bonus even if it was not referred. Program staff indicated that the tracking issue has been resolved, but the number of participants referred by nonprofits is likely overstated in PY6. According to survey results, only 7% of respondents recalled participating when the nonprofit bonus was available, and fewer than half of those respondents indicated the nonprofit bonus was "very influential" in their decision to participate, though only one said it was "not influential at all."

Figure 3. How Participants Learned of the Program



According to survey responses, the two most commonly cited methods for participants learning about the program were bill inserts (46%) and word of mouth (23%). AIC's website, direct mail, appliance retailers, and broadcast media all appear to be similarly effective in reaching customers, though all taken together were still reported less often than word of mouth.

Overall, the program came very close to the participation goal, despite the issues with the bill inserts and severe weather in early 2014. This suggests that the marketing plan is sufficient to meet the targets for the program.

Other appliance recycling programs across the country have implemented the following innovative program design approaches:

1. **Targeted marketing campaigns:** ComEd used a direct-mail campaign that involved sending personalized letters and coupons to customers targeted as likely having an appliance to recycle. ComEd identified these individuals using PRIZM software, which is capable of profiling past appliance recycling program participants from ComEd's database. ComEd found past participants had somewhat higher education and income levels, and fit the profile of empty-nesters in specific communities. ComEd's appliance recycling program direct mailings targeted customers fitting this profile. According to ComEd's PY2 evaluation report, its direct mail campaign achieved a 1.2% response rate and resulted in a substantial improvement in ComEd's year-over-year harvest rate.

2. **Inclusion of multifamily appliance pickups:** Rocky Mountain Power and Pacific Power extended eligibility for their appliance recycling programs to apartment complex owners and managers providing tenants with appliances. Renters could also participate if they owned the recycled appliance. Although bulk pickups can increase participation, program staff found that they can also require additional

outreach and logistical efforts from program and implementation staff. (PG&E also performed bulk pickups from multifamily and business customers.)

3. **Inclusion of free energy-saving kits:** To increase savings from their appliance recycling programs, Pacific Power and Rocky Mountain Power offered program participants in Idaho, Utah, Washington, and Wyoming a free energy-saving kit at the time of appliance pickup. The kits included two 13W CFLs, a refrigerator thermometer card, energy-savings educational materials, and information on other residential efficiency programs. The companies provided these energy-saving kits in addition to financial incentives offered for participants' appliances. Any cost-effectiveness assessment associated with adding energy-savings kits should consider that not all products provided are installed. Installation rates can vary depending on specific products included, how they are distributed, and the level of encouragement to install.

4. A recent study[6], not listed above, found **marketing targeted specifically toward older homes**, with accounts active for 15 years or more, yielded participants with older appliances. This increased the average appliance age by approximately 27% for the program and savings per unit by approximately 19%.

Again, each of the utilities with more than 3 program years listed in Figure 1 has seen a marked decrease in participation over time.

4.2.3 Eligible Measures

The appliance recycling programs considered residential refrigerators and stand-alone freezers as key eligible appliances. Select utilities—AIC, SCE (2006–2008), PG&E, ComEd, Ontario Power Authority (OPA), and the Northeast Utilities (2004)—included room air conditioners in their programs. In addition, OPA included dehumidifiers.

Room air conditioners have historically been a convenience service for AIC's program with no incentive. Hence, they have never made up a large proportion of appliances recycled through the program (less than 0.2% in PY6). However, AIC staff mentioned in our interviews that air conditioners will no longer be picked up at all by the program after PY6, though one program manager expressed disappointment that the units would no longer be eligible. Because room air conditioners have made up only a small fraction of appliances recycled through the program, this change will not have a substantial impact.

Table 10 lists eligibility requirements for refrigerators and freezers recycled through the appliance recycling programs. Program eligibility primarily depended on appliance condition and size; some programs also used appliance age as an eligibility factor. AIC's program eligibility is similar to other programs we reviewed.

[6] Navigant Consulting Inc. *2012 EM&V Report for the Appliance Recycling Program*. October 2013. Accessed December 12, 2014. http://dms.psc.sc.gov/pdf/matters/EF1A5FFD-155D-141F-239A7CB4C326E7B7.pdf

Table 10. Refrigerator and Freezer Eligibility Requirements

Utility	PY	Condition	Minimum Refrigerator/ Freezer Age	Primary/ Secondary Restrictions	Size Restrictions (internal volume)
AIC	2009–2010	Working/plugged in	Prior to 1993	Secondary only	10–27 cubic feet
	2012–2013	Working	None	None	10–27 cubic feet
ComEd	2008–2011	Working	None	None	N/A
	2012	Working	None	Secondary only	10–30 cubic feet
Consumers Energy	2010	Working	None	Secondary only	Residential unit
	2012	Working	None	None	10–30 cubic feet
Massachusetts	2009–2010	Working	None	Secondary only*	N/A
Northeast Utilities	2004	Working	At least 10 years	Secondary only	At least 7 cubic feet
OPA	2012	Working	At least 15 years for refrigerators; at least 10 years for room air conditioners and dehumidifiers	None	10–27 cubic feet
PG&E	2004–2005	Working	Prior to 1991	Secondary only	14–27 cubic feet
	2006–2008	Working/plugged in	None	None	10–27 cubic feet
	2010–2012	Working	None	None	10–32 cubic feet
Pacific Power (WA)	2006–2008	Working/plugged in	None	None	At least 10 cubic feet
	2012	Working/plugged in	None	None	At least 10 cubic feet
PNM	2012	Working	None	None	10–27 cubic feet
Rocky Mountain Power (ID)	2006–2008	Working/plugged in	None	None	At least 10 cubic feet
	2012	Working/plugged in	None	None	At least 10 cubic feet
Rocky Mountain Power (UT)	2006–2008	Working/plugged in	None	None	At least 10 cubic feet
	2012	Working/plugged in	None	None	At least 10 cubic feet
Rocky Mountain Power (WY)	2009–2010	Working/plugged in	None	None	At least 10 cubic feet
	2012	Working/plugged in	None	None	At least 10 cubic feet
Snohomish Public Utility District	2006	Working	N/A	None	10–27 cubic feet
	2012	Working	None	None	10–32 cubic feet
SCE	2004–2005	Working	Prior to 1991	Secondary only	14–27 cubic feet
	2006–2008	Working/plugged in	None	None	10–27 cubic feet
	2010–2012	Working	None	None	10–32 cubic feet

* Although this program seeks early retirement of second appliances, the evaluation found 19% of refrigerators recycled through the program had most recently been used as primary units in the homes.

Appliance Condition

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

Appliance Age

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

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

Although SCE's and PG&E's 2004–2005 and Northeast Utilities' 2004 appliance recycling programs stipulated a minimum age requirement, neither program currently imposes a minimum age requirement. Of utility programs reviewed, only OPA still sets a minimum age eligibility requirement. Utilities with robustly cost-effective programs typically avoid restricting eligibility—units just need to be operational—to maximize total program savings and customer satisfaction.

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

DOE estimated, nationally, that 31% of second units are inefficient, pre-1993 models. In contrast, they estimated that 16% of primary refrigerators are pre-1993 models (US DOE 2009).

Thus, several utilities limited program participation to second units. AIC and Consumers Energy initially limited program participation to second appliances, but have since eased those restrictions. In 2012, only ComEd limited its program to second appliances. During Cadmus' interviews, appliance recycling program implementers commented on the difficulty of enforcing secondary-only restrictions. Such restrictions may encourage customers' dishonesty about their appliances' use, placing appliance haulers in an uncomfortable position at the time of pickup.

Appliance Size

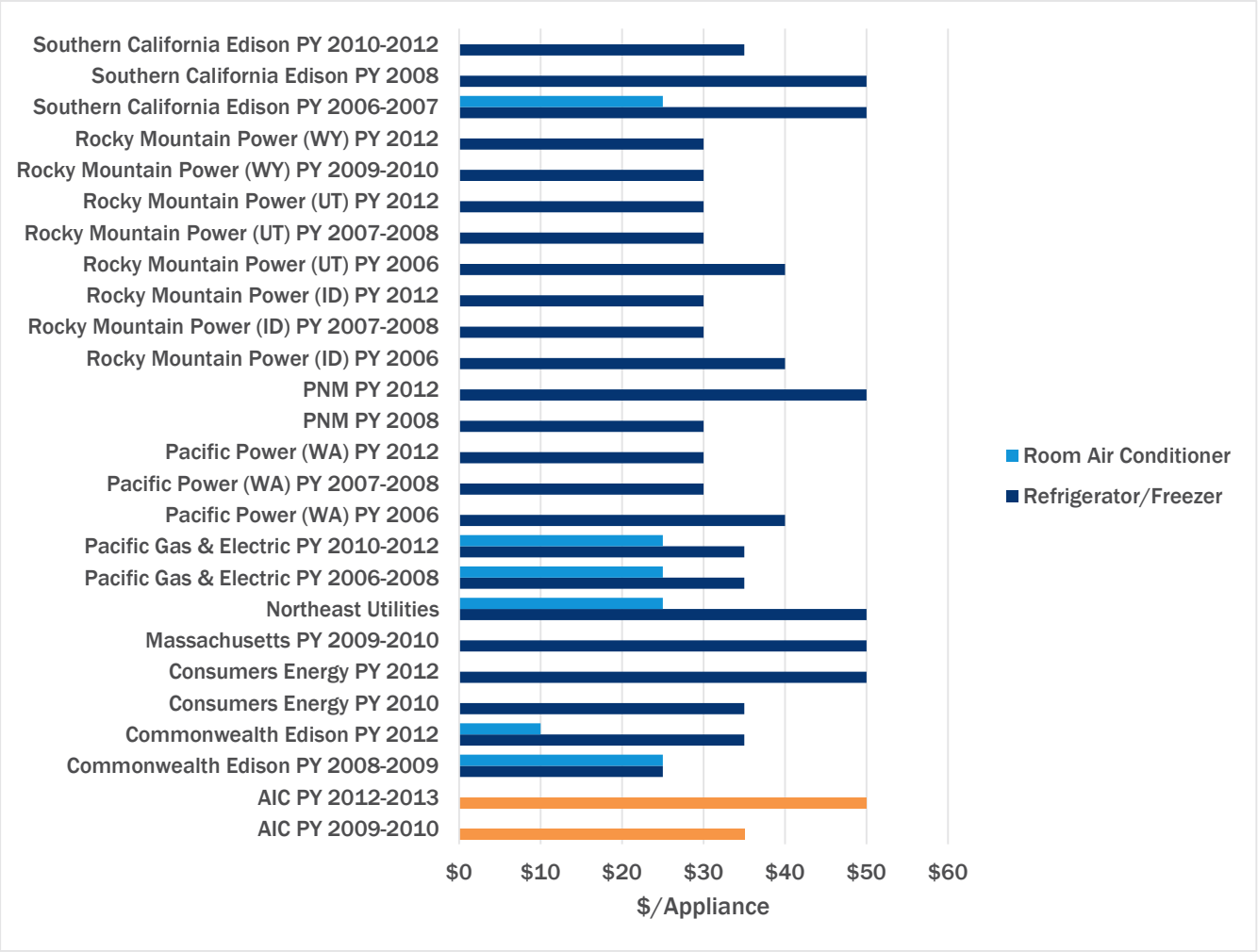
The majority of utilities' historic appliance recycling programs required appliances to be at least 10 cubic feet. In recent years, more utilities have specified maximum as well as minimum appliance sizes. Most utilities with an upper limit require units of no more than 32 cubic feet (presumably to prohibit inclusion of commercial units).

4.2.4 Incentive Levels

Figure 4 compares utility appliance recycling programs' per-unit refrigerator/freezer and room air conditioner incentives. Recent recycling program refrigerator/freezer incentives ranged from $0 for OPA's program to $50

offered by AIC, Consumers Energy, and PNM. The other programs offered $30 or $35 per appliance. The data informing Figure 4 are provided in Appendix D, Table 26.

Figure 4. Program Incentives for Recycled Appliances (in $/Appliance)



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

As shown in Figure 4, several utilities varied their incentives over time. For example, Pacific Power and Rocky Mountain Power (in Idaho and Utah) reduced their program incentives from $40 to $30 in 2007 to improve program cost-effectiveness. Several other utilities, such as AIC and Consumers Energy, increased their incentives to increase program participation. Consumers Energy saw a marked increase in participation after its July 1, 2012, incentive increase. Customers recycled 6,000 appliances in the first half of the year, when the incentive was still $35; by the end of 2012, they had recycled an additional 16,000 appliances.

Similarly, in PY4, when AIC increased incentives, participation increased by around 40%, to more than 14,000 appliances from a previous annual average of around 10,000. Participation, however, did not remain higher after the incentive change.

After peaking in PY4 (the year the incentive increased), participation decreased to levels similar to those from years when the incentive was $35. This same pattern occurs for SCE's program. In 2008, SCE increased its incentives from $35 to $50 for refrigerators. Initially participation peaked, but then declined in 2010 and 2011.

During the interviews with program staff, there was a concern expressed that AIC's PY6 incentive level might not be sufficient to hit participation targets. However, as shown in Figure 4, AIC's current incentive amount of $50 is at the high end of incentives offered by other programs and so far no programs have offered an incentive greater than $50 per appliance.

Quantity Restrictions

Almost all programs the evaluation team reviewed limited the number of refrigerators and freezers each customer could recycle through the program (two annually).

Incentives for Additional Appliances

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

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

4.2.5 Evaluated Energy Savings

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

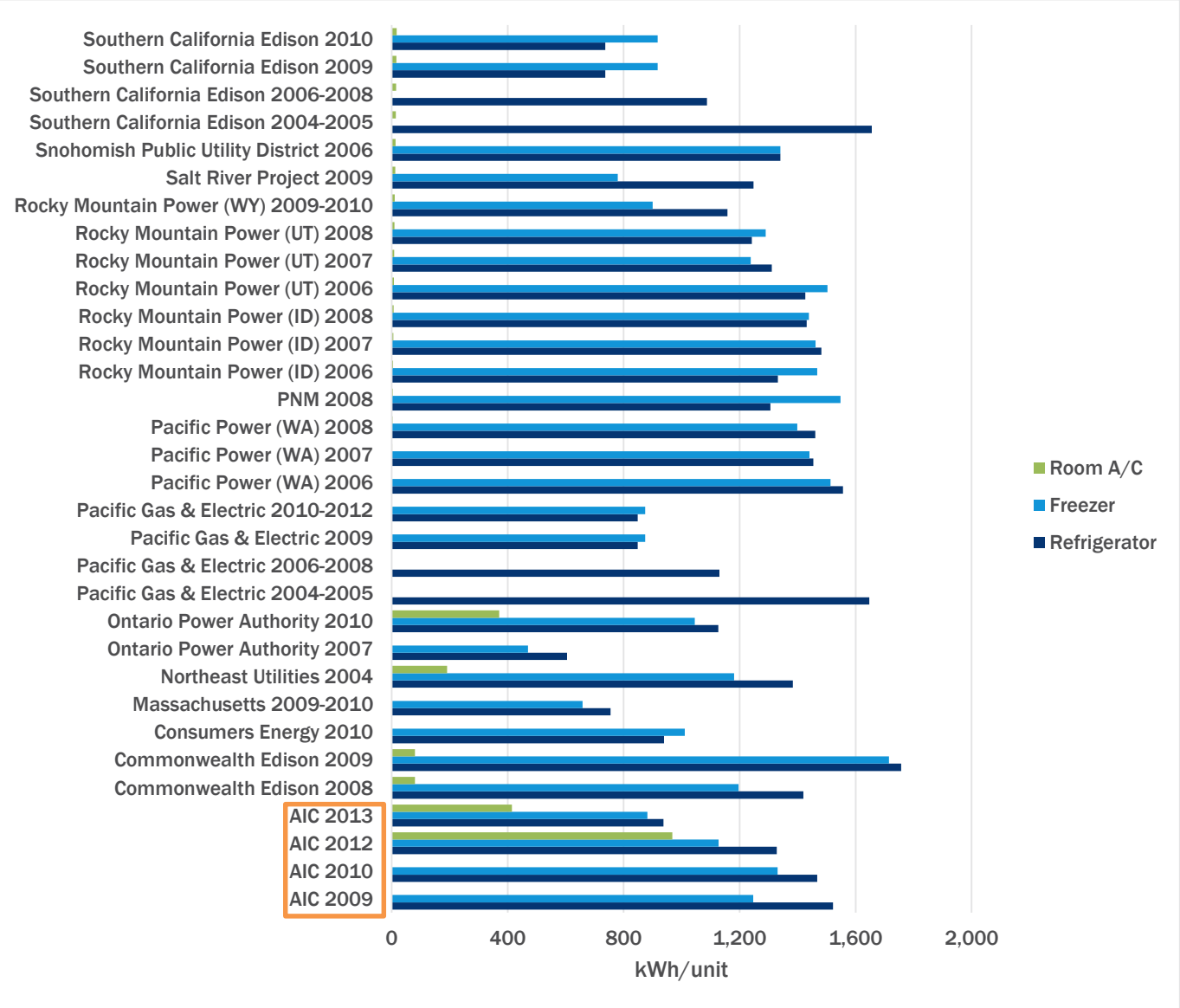
1. Unit-Level Annual Energy Consumption: Determined from one or more of the following data sources: a sample of appliances monitored within homes (in situ metering), lab-tested appliances (metering based on DOE appliance testing procedures), and/or engineering estimates using characteristics (e.g., appliance size, configuration, and model year) of appliances collected through the program. Energy-savings estimates may incorporate degradation factors to account for older equipment that no longer operates as efficiently as when new, along with interactive effects.

2. Measure Verification: Participants typically are surveyed to verify participation in the program and key details about their recycled appliances (e.g., unit type, pickup date).

3. Part-Use Factor: Most methodologies apply a part-use factor (typically based on survey response data) that converts annual energy consumption into gross savings by estimating how many years appliances would have operated had the recycling program not existed.

The evaluation team compared gross unit average energy savings used by appliance recycling programs across North America, as shown in Figure 5. All values in the figure have been adjusted for part-use. Savings reported by AIC matched other trends regarding declining savings per unit as the program matures. A table showing the data informing Figure 5 (Table 27) is shown in Appendix D.

Figure 5. Gross Unit Average Energy Savings

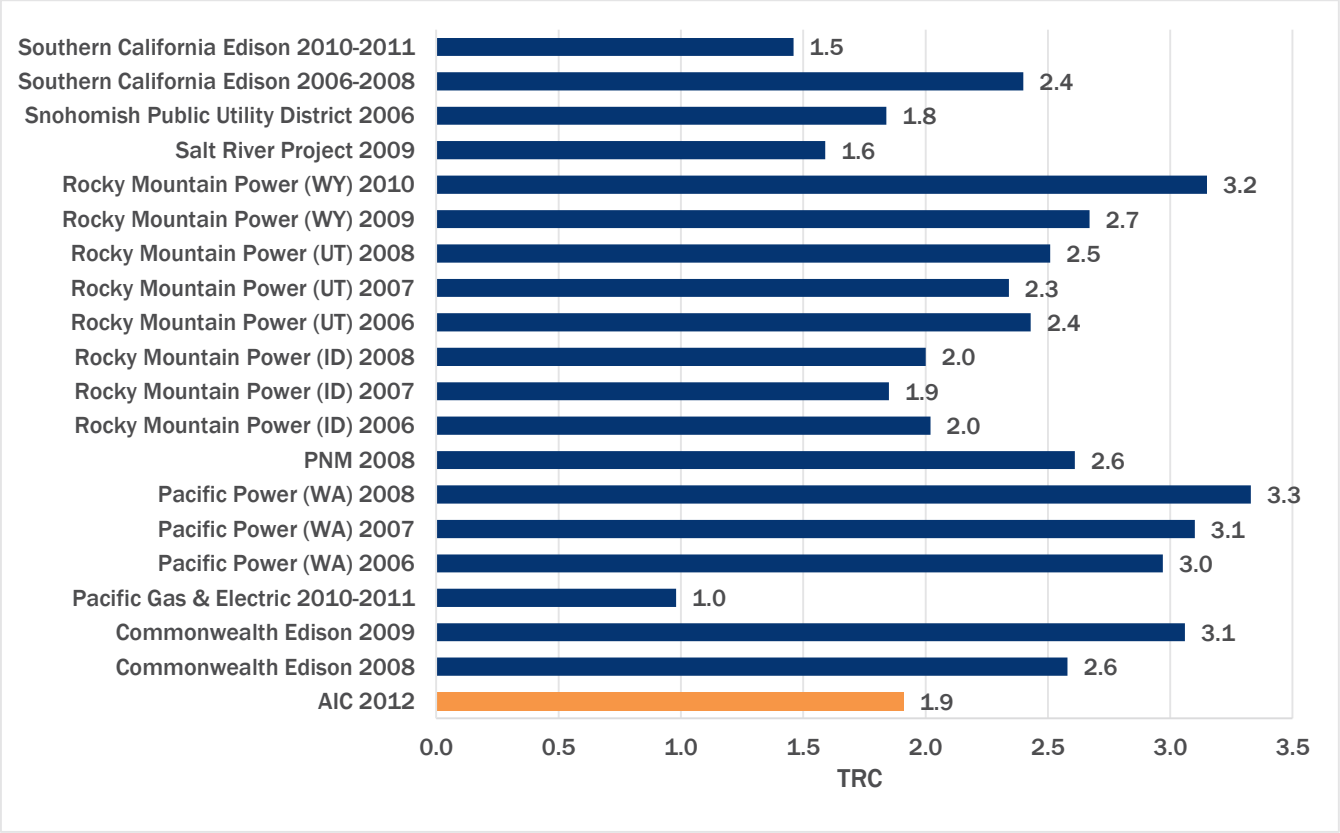


4.2.6 Cost-Effectiveness Results

Most North American utility-sponsored appliance recycling programs have operated cost-effectively in recent years, with most program cost-effectiveness ratios remaining above 1.0. Figure 6 lists TRC test results of several compared programs. These results show all programs the evaluation team compared proved cost-effective, per the analytical requirements of their respective jurisdictions. The evaluation team's comparisons

of cost-effectiveness input parameters in the previous sections shed some light on differing cost-effectiveness levels. Fully understanding the reasons for the TRC differences presented in Figure 6 would, however, require a careful review of all inputs. A table showing the data informing Figure 6 (Table 28) is provided in Appendix D.

Figure 6. Cost-Effectiveness Ratios of Comparison Programs



As noted, Pacific Power and Rocky Mountain Power (in Idaho and Utah) reduced their program incentives from $40 to $30 in the mid-2007 to improve the programs' cost-effectiveness—a successful effort (as shown in Table 28). Additionally, Pacific Power cut back on advertising for the 2007 and 2008 program years, which decreased program spending and increased overall program cost-effectiveness.

4.3 Impact Assessment

Gross Impacts

Using PY6 tracking data, participant survey data, and algorithms specified in the Statewide TRM Version 2.0, the evaluation team calculated ex post gross savings. The team verified participation by comparing the number and types of units in the tracking database to the number and types of appliances provided by survey respondents, and verified that pickup dates fell within the PY6 program period.

Verification

The evaluation team included questions in the participant survey to verify the number of refrigerators and freezers recorded in the program tracking data provided. There were no discrepancies between the quantities recorded in the tracking data and the responses given by participants. All measures were verified 100%.

Estimated Annual Consumption

The Statewide TRM Version 2.0 algorithm, basing its coefficients on a collaborative metering study conducted for ComEd, Consumers Energy, and DTE Energy in Michigan in PY4, generated savings estimates for refrigerators and freezers. The algorithm resembled that used in PY5, but specifies regressions separately for refrigerators and freezers.

Holding all other variables constant, the coefficient of each independent variable indicated the influence of that variable on annual consumption:

- A positive coefficient indicated an upward influence on consumption.
- A negative coefficient indicated a downward influence on consumption.

The coefficient value indicated the marginal impact of a 1-point increase in the independent variable on the UEC. (For instance, a 1-cubic-foot increase in refrigerator size resulted in a 19.42 kWh increase in average annual consumption.)

For dummy variables, the coefficient value represented the difference in consumption if a given condition held true. For example, the coefficient for the variable indicating a refrigerator used a primary unit was 170.98; all else being equal, this meant that a primary refrigerator consumed 170.98 kWh more annually than a secondary unit.

Table 11 lists the Statewide TRM Version 2.0 coefficients for refrigerators.

Table 11. UEC Refrigerator Regression Algorithm

Independent Variables	Estimate Coefficient
Intercept	116.84
Age (years)	10.90
Pre-1990 (= 1 if manufactured pre-1990)	431.79
Size (cubic feet)	19.42
Dummy: Single Door (= 1 if single door)	−795.37
Dummy: Side-by-Side (= 1 if side-by-side)	426.41
Dummy: Primary Usage Type (in absence of the program) (= 1 if primary unit)	170.98
Interaction: Located in Unconditioned Space x CDD/365.25	17.34
Interaction: Located in Unconditioned Space x HDD/365.25	−11.78

Table 12 lists the regression coefficients for freezers.

Table 12. UEC Freezer Regression Algorithm

Independent Variables	Estimate Coefficient
Intercept	132.12
Age (years)	12.13
Pre-1990 (= 1 if manufactured pre-1990)	156.18
Size (cubic feet)	31.84
Chest Freezer Configuration (= 1 if chest freezer)	−19.71
Interaction: Located in Unconditioned Space x CDD/365.25	−12.76
Interaction: Located in Unconditioned Space x HDD/365.25	9.78

Extrapolation

Using the PY6 tracking database, the evaluation team calculated the corresponding characteristics (the independent variables) for participating appliances to feed into the Statewide TRM Version 2.0 algorithm. Table 13 summarizes program averages or proportions for each independent variable.

Table 13. PY6 Mean Explanatory Variables

Appliance	Independent Variables	Participant Population Mean Value
Refrigerator	Age (years)	22.60
	Pre-1990 (= 1 if manufactured pre-1990)	0.42
	Size (cubic feet)	18.70
	Dummy: Single Door (= 1 if single door)	0.06
	Dummy: Side-by-Side (= 1 if side-by-side)	0.22
	Dummy: Primary Usage Type (in absence of the program) (= 1 if primary unit)	0.67
	Interaction: Located in Unconditioned Space x CDD/365.25	0.79
	Interaction: Located in Unconditioned Space x HDD/365.25	3.91
Freezer	Age (years)	28.00
	Pre-1990 (= 1 if manufactured pre-1990)	0.65
	Size (cubic feet)	15.78
	Chest Freezer Configuration (= 1 if chest freezer)	0.45
	Interaction: Located in Unconditioned Space x CDD/365.25	1.84
	Interaction: Located in Unconditioned Space x HDD/365.25	9.14

To determine annual and average daily per-unit energy consumption using the TRM algorithm and PY6 AIC tracking data, the evaluation team applied average participant refrigerator and freezer characteristics to regression model coefficients. This approach ensured that the resulting UEC was based on specific units recycled through AIC's program in PY6, rather than the UEC being a point estimate based on a secondary data source.

Table 14 provides the annual UEC for refrigerators and freezers recycled by AIC in PY6. Additionally, Table 14 shows the demand calculated by applying the following formula included in the Statewide TRM Version 2.0:

$$\text{Unit Demand Savings} = \Delta\text{kW} = \frac{\text{kWh}}{8{,}760} * Coincidence\ Factor$$

where coincidence factors are 1.081 for refrigerators and 1.028 for freezers.

Table 14. PY6 ARP Unit Energy Savings (without part-use)

Recycling Measure	Unit Energy Savings (kWh)	Unit Demand Savings (kW)
Refrigerator	1,036	0.11
Freezer	1,133	0.13
Air Conditioner	188	0.07

Part-Use

The part-use factor accounted for appliances not plugged in year-round prior to participation. For PY6, the team applied a part-use factor of 0.877 for refrigerators and 0.825 for freezers, as specified in the Statewide TRM Version 2.0. The evaluation team also conducted primary research and calculated an updated part-use factor to apply to future evaluations. Appendix B summarizes this analysis.

Applying the part-use factors to the modeled annual consumption from Table 14 yielded AIC's average per-unit gross energy savings for PY6. As shown in Table 15, the verified per-unit values for refrigerators and freezers were determined to be 907 kWh and 935 kWh, respectively.

Table 15. PY6 Evaluated Gross Energy Savings (Per-Unit)

Recycling Measure	Ex Ante Unit Energy Savings (kWh)	Ex Post Unit Energy Savings (kWh)	Percent Increase
Refrigerator	808	907	12%
Freezer	904	935	3%

Table 15 also compares the ex ante and ex post gross savings. Refrigerator savings increased by 12% due to the increase in the percentage of primary units recycled in PY6 from PY4, from 34% to 67%. Ex ante savings are based on the PY4 mix of units. As mentioned when introducing Table 11, a primary refrigerator consumes approximately 171 kWh more annually than a secondary refrigerator. This is likely due to greater usage and more frequent door openings.

The increase in savings for freezers was more modest, at 3%, with no major changes in freezer characteristics between PY4 and PY6.

Net Impacts

The program's NTGR, as calculated in PY4, drew on the self-report approach methodology, established in the 2004–2005 California Residential Appliance Recycling Program evaluation and continued in more recent

evaluations, both in California and elsewhere in the United States.[7] The PY4 NTGR offered the most recent analysis performed that met the Illinois NTGR framework.

The NTGR adjustment negated energy savings from participants whose appliances would have been removed from service independently of the program (free-riders), but it credits the program for destroying units that would have remained in use within participating homes or would have been transferred to other users for continued use if the program did not exist.

If the participating appliance had not been recycled through the ARP, it would have followed one of four scenarios:

1. The unit would have been kept by the household, but not used.
2. The unit would have been kept by the household and used.
3. The unit would have been discarded by the household through a method resulting in the unit's destruction.
4. The unit would have been transferred by the household to another entity for continued use elsewhere.

Scenarios 1 and 3 indicated free-ridership, with free-ridership occurring as the units would have been removed from the grid, even though not recycled through the program. As a result, the ARP could claim energy savings generated by recycling these appliances.

To ensure the highest quality of responses possible and to mitigate a socially desirable response bias, the evaluation team used an iterative approach in the survey free-ridership battery, bringing to attention several pertinent facts. These facts—such as the cost of disposing of a refrigerator at a local waste station, whether local charities accepted used refrigerators, and the findings of market research regarding resale viability—offer important context when asking participants about their hypothetical actions in the program's absence.

The evaluation team adjusted gross savings for free-ridership and spillover using PY4 evaluation results to determine net savings, where net savings equals:

$$net\ savings = gross\ savings \times (1 - free\text{-}rider\% + spillover\%)$$

The team applied net per-unit savings from PY4, as shown in Table 16.

Table 16. Ex Post Per-Unit Net Savings

Recycling Measure	Ex Post Gross Per-Unit Savings (kWh)	Free-Ridership	Ex Post Net Per-Unit Savings (kWh)	NTGR
Refrigerator	907	37%	571	63%
Freezer	935	37%	588	63%
Room Air Conditioner	188	0%	188	100%

4.4 Conclusions and Recommendations

- **Conclusion 1:** Given historical trends, it appears unlikely that AIC will be able to significantly increase participation in the ARP without significant effort. This is because once the really old units are removed from the grid, only a small percentage of appliances turn over each year. If the program implemented

[7] ADM Associates, Inc. "Evaluation Study of the 2004–05 Statewide Residential Appliance Recycling Program." April 2008. Available online at: http://www.calmac.org/publications/EM&V_Study_for_2004-2005_Statewide_RARP_-_Final_Report.pdf

a more aggressive marketing effort, the marginal acquisition cost of additional units would likely be substantially higher than that of historical participants. AIC has already introduced the changes most likely to significantly increase participation: changing eligibility to include primary appliances and increasing the incentive. The percentage of participants hearing about the program through word of mouth is significant.

- **Recommendation 1:** AIC could consider targeted marketing to maintain current participation levels. Marketing targeted to households with long-term active accounts could potentially identify homes with units older, on average, than other program units. Older units produce higher-than-average savings, especially if manufactured prior to the appliance efficiency standards of the early 1990s. Other programs implementing this approach saw an increase in the average appliance age and associated savings.

- **Conclusion 2:** In most program metrics, AIC greatly resembles other appliance recycling programs operating nationally, including NTGR, eligibility, incentive levels, and participation. AIC operates slightly below average in per-unit energy savings for appliances recycled through the program. AIC's per-unit savings, however, remain close to Consumers Energy in Michigan, the program most readily comparable by geography and tenure.

  - **Recommendation 2:** To increase per-home savings, AIC could consider novel program designs to possibly increase per-unit savings for each participant. Energy-saver tips and a low-cost measure (such as a couple of CFLs or an LED) could be left behind with customers, thus adding relatively cheap incremental savings to the program.

- **Conclusion 3:** The percentage of customers hearing about the ARP through word of mouth is significant (23%) likely due to AIC's combined marketing efforts.

  - **Recommendation 3:** Consider building and expanding this component by offering a referral incentive or simply requesting participants to refer others to the program.

4.5 Future Inputs

For future planning (to apply to PY8), the evaluation team estimated new NTGRs based on the participant survey conducted with PY6 participants. The updates consider the following factors:

- Part-use
- Free-ridership

Full details for the part-use calculations are included in Appendix B, and the NTGR analysis is presented in detail in Appendix C.

The part-use factors calculated based on PY6 survey respondents increased, each by three points, from 0.88 and 0.83 for refrigerators and freezers, respectively.

Table 17. PY6 Part-Use Factor by Appliance Type

Recycling Measure	Part-Use Factor
Refrigerator	0.91
Freezer	0.86

The final NTGR is calculated in Table 18 below, where net savings are equal to:

$$net\ savings = gross\ per\text{-}unit\ savings - free\text{-}ridership\% - induced\ replacement\% + spillover\%$$

Net savings adjustments are calculated on an average per-unit basis. Overall, the NTGR decreased from the results applied in PY4, 0.63 for both refrigerators and freezers.

Table 18. Verified Net Per-Unit Savings and NTGRs

Recycling Measure	Gross Per-Unit Savings (kWh)	Free-Ridership and Secondary Market Impact	Induced Replacement	Spillover	Net Per-Unit Savings (kWh)	Final NTGR
Refrigerator	907	417 (46%)	17 (2%)	0%	473	52%
Freezer	935	341 (36%)	12 (1%)	0%	581	62%

A. Appendix—Data Collection Instruments

Ameren Illinois - PY6 ARP Survey_TO C

B. Appendix—PY6 Part-Use Research

For future planning purposes, the evaluation team estimated an updated "part-use" factor according to the methods outlined in the Uniform Methods Project (UMP). Part-use is an adjustment factor specific to appliance recycling that is used to convert the UEC into an average per-unit gross savings value. The UEC itself is not equal to the gross savings value, because:

- The UEC model yields an estimate of annual consumption
- Not all recycled refrigerators would have operated year-round had they not been decommissioned through the program

In prior years, the part-use methodology relied on information from surveyed customers regarding historical pre-program usage patterns. The final estimate of part-use reflects how appliances were likely to operate had they not been recycled (rather than how they previously operated). For example, it is possible that a primary refrigerator that operated year-round would have become a secondary appliance and been operated part-time.

The updated methodology accounts for these potential shifts in usage types. Specifically, part-use is calculated using a weighted average of the following prospective part-use categories and factors:

- Appliances that would have run full-time (part-use = 1.0)
- Appliances that would not have run at all (part-use = 0.0)
- Appliances that would have operated a portion of the year (part-use is between 0.0 and 1.0)

Using information gathered through the participant survey, the team followed this multistep process to determine part-use.

1. Determine whether a recycled refrigerator was a primary unit or a secondary unit. (All stand-alone freezers were considered secondary units.)
2. Regarding participants who said that they had recycled a secondary refrigerator, ask whether the refrigerator was unplugged, operated year-round, or operated for a portion of the preceding year. (Assume all primary units were operated year-round.) The same question was asked of all participants who recycled a freezer.
3. Regarding participants who said that their secondary refrigerator or freezer was operated for only a portion of the preceding year, estimate the total number of months during which the appliance was plugged in. The responses from this subset of participants resulted in an average of 5 months that secondary refrigerators were operated and 6.8 months for secondary freezers.
4. Divide each of the values by 12 to calculate the annual part-use factor for all secondary refrigerators and freezers operated for only a portion of the year. For PY6, the average secondary refrigerator had a part-use factor of 0.42, and the average freezer had a part-use factor of 0.56.

These four steps resulted in the following information about how refrigerators and freezers were operated before they were recycled (Table 19).

Table 19. Part-Use Factors and Adjusted Energy Savings by Appliance and Usage Type

Usage Type and Part-Use Category	Refrigerators			Freezers		
	Recycled Units (%)	Part-Use Factor	Per-Unit Energy Savings (kWh/yr)	Recycled Units (%)	Part-Use Factor	Per-Unit Energy Savings (kWh/yr)
Secondary Units Only	n = 23			N/A		
Not in Use	9%	0.00	–			
Used Part-Time	13%	0.42	432			
Used Full-Time	78%	1.00	1036			
Weighted Average	**100%**	**0.84**	**867**			
All Units (Primary and Secondary)	n = 70			n = 69		
Not in Use	3%	0.00	–	9%	0.00	–
Used Part-Time	4%	0.42	432	13%	0.56	640
Used Full-Time	93%	1.00	1036	78%	1.00	1133
Weighted Average	**100%**	**0.95**	**980**	**100%**	**0.86**	**970**

Participants who said that they would have kept their unit were then asked if they would have moved the unit to a new location or would have kept the unit in the same location within their home. For participants who indicated that they would have kept their refrigerators in the kitchen, the team assumed that they would have continued to use the refrigerator as a primary appliance, so these participants were given a part-use factor of 1. For all other responses, the evaluation team assumed the appliance would have been used as a secondary appliance and, thus, used the part-use factor for secondary appliances (0.84 for refrigerators and 0.86 for freezers) in calculating the overall part-use.

Participants who said that they would have discarded their appliance independent of ARP were not asked about the future usage of that appliance, as that would be determined by another customer. Since the future use type of discarded refrigerators is unknown, the team applied the weighted part-use average of all units (0.95) for all refrigerators that would have been discarded independent of the program. By using this approach, the team acknowledges that the discarded appliances might be used as either primary or secondary units in the would-be recipient's home.

We combined the historically based part-use factors in Table 19 with participants' self-reported likely actions in the absence of the program to estimate the distribution of future usage scenarios and corresponding part-use estimates. As shown in Table 20, the weighted average of these future scenarios produces ARP's future planning estimate for refrigerators part-use factor (0.91). Freezers are not included in Table 20 since all freezers are considered secondary appliances and therefore the usage would not change.

Table 20. PY6 Overall Part Use Factor by Likely Use

Use Prior to Recycling	Likely Use Independent of Recycling	Refrigerator	
		Part-Use Factor	Participants (%)
Primary	Kept (as primary unit)	1.00	4%
	Kept (as secondary unit)	0.84	17%
	Discarded	0.95	46%
Secondary	Kept	0.84	16%
	Discarded	0.95	16%
Overall		**0.91**	**100%**

C. Appendix—PY6 NTGR Research

For future planning purposes, based on participant data collected in PY6, the evaluation team estimated the ARP NTGR based on the approach outlined in the UMP, which included approaches for estimating free-ridership, secondary market impact (SMI), and induced replacement. As the program only recycled 17 room air conditioners in PY6, and the company offered picking up room air conditioners as a free service, the evaluation did not include separate research for air conditioners. Steps for the NTGR calculation to be applied to future programs follow in the subsections below.

Estimate Free-Ridership

Free-ridership can be estimated in the same manner as results from PY4, which were applied to evaluated savings in PY6. Without the program's intervention, participating refrigerators would have been subjected to one of the following scenarios:

1. The refrigerator would have been kept by the household.
2. The refrigerator would have been discarded by a method transferring it to another customer for continued use.
3. The refrigerator would have been discarded using a method leading to its removal from service.

These scenarios encompass a definition of free-ridership: the proportion of units taken off the grid, absent the program's influence.

Free-ridership would occur under Scenario 3 because the units would have been removed from the grid and destroyed, although not recycled through the program. As a result, the program could not claim energy savings generated by recycling these appliances.

To determine the percentage of participants in each of the scenarios—and, therefore, assess the program's free-ridership—the evaluation team asked each surveyed participant what would likely have occurred to the appliance had it not been recycled by AIC.

The participants gave these responses:

- Kept it and continued to operate the appliance.
- Kept it but stored it unplugged indefinitely.
- Sold it to a private party, either by running an ad or to someone they knew.
- Sold it to a used appliance dealer.
- Gave it to a private party, such as a friend or neighbor.
- Gave it to a charity organization, such as Goodwill Industries or a church.
- Had it removed by the dealer from whom the new or replacement appliance was purchased.
- Hauled it to the dump or recycling center.
- Hired someone to haul it away for junking or dumping.

To ensure the highest quality of responses possible—and in an effort to mitigate a socially responsible response bias—the team asked some participants follow-up questions to test the reliability of their initial response. For example, through interviews with local market actors conducted for other recent evaluations, the team determined that used appliance dealers are unlikely to purchase appliances more than 10 years old. We then asked participants who had an appliance more than 10 years old ***and*** who indicated they "would have sold their unit to a used appliance dealer" what they would have likely done *had they been unable to sell the unit to a dealer*. The responses to this subsequent question facilitated the assessment of free-ridership. (In the team's experience, this dynamic, market research-based approach to surveying improves the reliability of the hypothetical self-reported actions of participants.)

Upon validating the participant's hypothetical action to the extent possible through an iterative approach, the evaluation team assessed whether each participant's response indicated free-ridership. Some responses clearly did: "I would have taken it to the dump or recycling center myself." Other responses clearly did not indicate free-ridership, as the appliance would have remained active within the participating home ("I would have kept it") or elsewhere within service territory ("I would have given it to a family member, neighbor, or friend").

However, some responses, such as "I would have sold it to a used appliance dealer," proved less clear regarding free-ridership. To determine if responses were indicative of free-ridership, the evaluation team had to determine whether a used appliance dealer would be interested in purchasing the appliance. As used appliance dealers could not be asked their interest in a specific appliance, the evaluation team relied on responses given in interviews conducted as part of other evaluations with market actors. From these interviews, the team established the general characteristics (e.g., age, condition) of older appliances viable for resale on the secondary market within AIC's service territory. The consensus was that used appliance dealers rarely purchase units that are more than 10 years old to resell. This information enabled the team to validate or invalidate a participant's response, based on specific characteristics of appliances they recycled.

Another response requiring follow-up questions was this: "I would have it removed by the dealer who sold me my new appliance." To categorize such responses, the evaluation team had to determine what new and used retailers did with the appliances they collected when delivering a new or replacement appliance. Again, the market actor interviews provided insights into whether appliances collected independently of the ARP were resold (directly or indirectly) or destroyed.

For the NTGR analysis, the team used the market actor interview findings to categorize free-rider scores based on the unit's age (specifically, for units that were more than 10 years old, which were determined to be unviable on the secondary market). Table 21 lists the results related to assessing free-ridership, for each participant response requiring validation through market information,

We also considered the retailers who the respondents bought their appliance from and considered the retailer-specific free-ridership rates reported by the ComEd evaluation team in PY5. However, only one respondent had his appliance picked up by a retailer that participated in the ComEd research. The others mentioned local retailers. This is not entirely unexpected since AIC covers a more rural territory than ComEd. Table 21 lists the results related to assessing NTGR.

Table 21. Summary of Free Ridership-Related Market Actor Interviews Findings

Hypothetical Action Absent Program	Free-Ridership Assessment	Detail
I would have sold it to a used appliance dealer.	Varies by appliance age	If the responding participant's appliance is less than 10 years old, the appliance will not be categorized as a free-rider (as the appliance potentially has resale value). If the appliance is more than 10 years old, the team's free-ridership analysis weighed the other methods of disposal that the respondent considered.
I would have had it removed by the dealer, who sold me my new appliance.	Varies by retailer type and appliance age	Regarding appliances more than 10 years old that would have been collected by used appliance dealers, the team's free-ridership analysis weighed the other methods of disposal that the respondent considered.

Based on information provided from surveyed participants and interviewed market actors, the evaluation team determined the discard scenario absent the program.

Once the team determined the final assessments of participants' actions independent of ARP, it calculated the percentage of refrigerators and freezers that would have been kept (Table 22).

Table 22. Distribution of Kept and Discarded Appliances

Stated Action Absent Program	Indicative of Free-Ridership	Refrigerators (n=65)	Freezers (n=64)
Kept	No	40%	48%
Discarded	Varies by discard method	60%	52%
Total		**100%**	**100%**

Secondary Market Impacts

If a unit transfers to another household, determining the program's impact shifts to the purchasing decisions made by would-be acquirers of participating units, once units become unavailable, representing the program's SMI.

If the participant would have directly or indirectly (through a market actor) transferred the unit to another customer on the grid (had they not participated), the next question addresses possible actions a potential acquirer might take, given the unit proved unavailable (i.e., was recycled through ARP). Three possibilities exist:

1. **None of the would-be acquirers would find another unit.** Program participation would result in a one-for-one reduction in the total number of refrigerators operating on AIC's electrical grid. In this case, total energy consumption for all avoided transfers (participating appliances that otherwise would have been used by another customer) would be credited as savings to the program.

2. **All of the would-be acquirers would find another unit.** Program participation would not affect the total number of refrigerators operating on the grid.

3. **Some of the would-be acquirers would find another unit, while others would not.** This reflects an awareness that some acquirers might be in the market for a refrigerator and would acquire another unit, while others might not be (and would have taken the unit only opportunistically).

This question proves difficult to answer with certainty, absent AIC-specific information regarding changes in the number of total refrigerators and freezers (overall and used appliances) active before and after ARP's implementation. Without this information (which rarely, if ever, becomes available), the evaluation team followed the UMP recommendation of adopting possibility #3, that is, that some of the would-be acquirers would find another unit, while others would not.

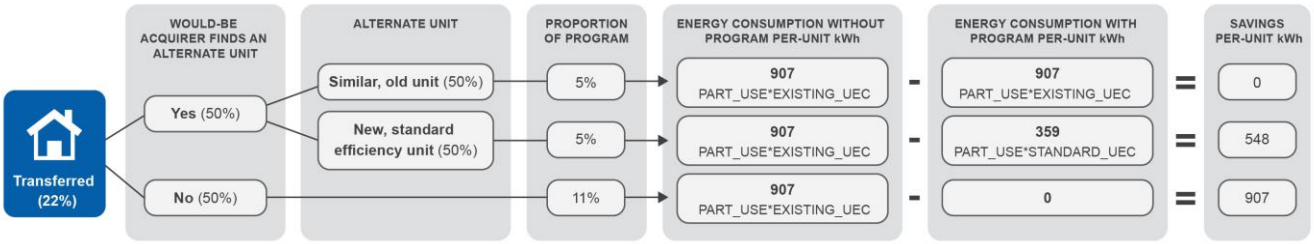
Specifically, UMP recommends that evaluators assume one-half (0.5, the midpoint of possibilities 1 and 2) of the would-be acquirers of avoided transfers found an alternate unit.

Once the team established the proportion of would-be acquirers who were assumed to find alternate units, the next issue addressed was whether the alternate unit was likely to be another used appliance (similar to those recycled through the program) or—with fewer used appliances presumably available in the market due to program activity—would the customer acquire a new standard-efficiency unit. While it is also possible that the would-be acquirer would select a new ENERGY STAR unit, the team assumed it is most likely that a customer in the market for a used appliance would upgrade to the new lowest price point. Since the nonparticipant survey consisted only of respondents who had recently disposed of a used unit, their responses could not inform the split between older, used units and new, standard units. For this reason, the evaluation team again assumed a midpoint approach: half (0.5) of the would-be acquirers of program units would find a similar used appliance and half (0.5) would acquire a new standard-efficiency unit.

As evident in Figure 7, accounting for market effects results in three savings scenarios:

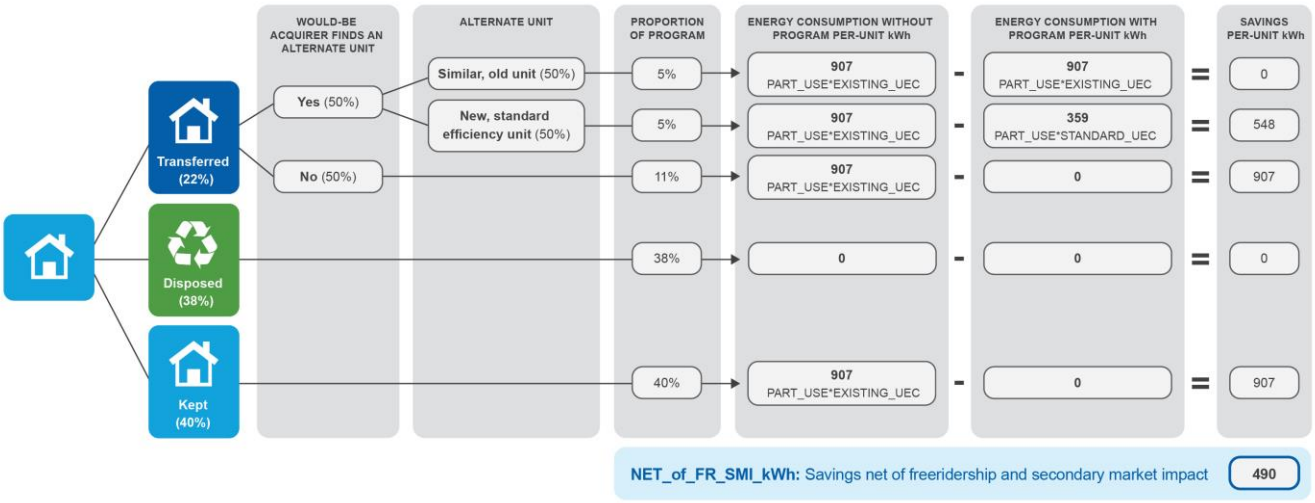
- Full savings (i.e., per-unit gross savings)
- No savings
- Partial savings (i.e., the difference between the energy consumption of the program unit and the new standard-efficiency appliance that replaced it)

Figure 7. Secondary Market Impacts



After estimating the parameters of the free-ridership impacts and the SMI, the evaluation team used the decision tree to calculate the average per-unit program savings net of their combined effect. Figure 8 shows how these values are integrated into a combined estimate of savings net of free-ridership and SMI.

Figure 8. Free-Ridership and Secondary Market Impact Decision Tree



Induced Replacement

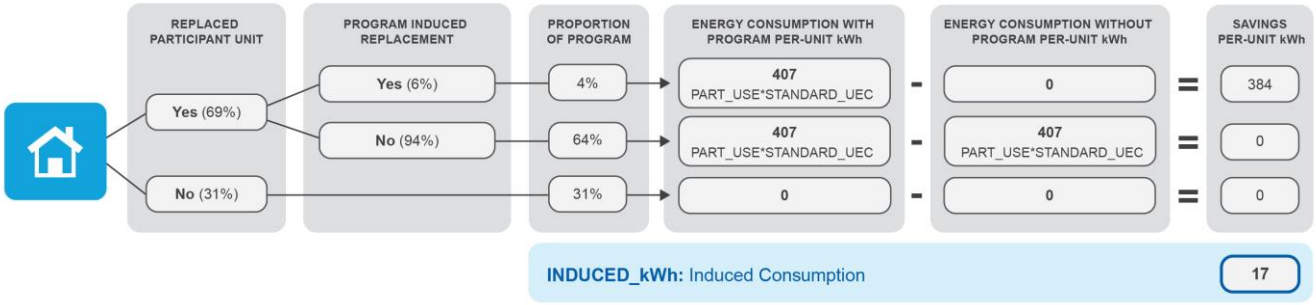
As required by the Statewide TRM Version 2.0 and recommended in the UMP, the evaluation team accounted for cases in which the recycling program induced replacement (i.e., the participant would not have purchased the replacement refrigerator in the recycling program's absence). This may occur due to the incentive, which combined with a convenient pickup, serves as the catalyst for the participant's purchase of a new refrigerator. In most cases, however, the decision to purchase a new refrigerator may have happened first, independent of the program.

When assessing participant survey responses to calculate induced replacement, the evaluation team did not count responses inconsistent with the participant's free-ridership response. For example, when customers indicated that they would have discarded their primary refrigerator independent of the program, we assumed that the replacement was not induced (as a participant would be extremely unlikely to do without a primary refrigerator operating).

Additionally, we asked participants offering responses consistent with an induced replacement: "Which program aspect proved influential in your decision to replace your appliance." If, after considering the program elements, the participant indicated none of the elements influenced his or her decision, that replacement was considered not induced by the program.

Upon determining the number of induced replacements, the information could be combined with the energy consumption of the replacement appliance to determine total energy consumption induced by the program (the change in consumption between the recycled unit and the new replacement) on a per-unit basis.

Figure 9. Refrigerator Induced Consumption



Spillover

For the following reasons, the UMP protocol does not recommend quantifying and applying traditional participant spillover to adjust net savings:

- Unlike CFL programs, recycling programs face reduced opportunities for "like" spillover (the most common and defensible form of spillover for most downstream demand-side management programs) due to the limited number of refrigerators available for recycling in a typical home.
- Unlike a whole-house audit program, recycling programs typically do not provide a comprehensive energy education to identify other efficiency opportunities within the home and generate "unlike" spillover.
- Quantifying spillover accurately proves challenging, and, despite well-designed surveys, uncertainty often exists regarding the attribution of subsequent efficiency improvements to participation in a recycling program.

Nevertheless, for the PY6 program, the evaluation team sought to quantify spillover associated with the purchase of new ENERGY STAR refrigerator and freezer replacements. As the program offers marketing and education related to operating costs of refrigerators and freezers, the ARP could directly affect the customer's decision to replace with an ENERGY STAR unit rather than a standard-efficiency unit. This is "like" spillover because it is associated with the same measure as that featured in ARP.

The evaluation team compared the replacement appliance market share of ENERGY STAR appliances to the general population using current saturation estimates from ENERGY STAR new unit shipment data, which tracks market shares of all new ENERGY STAR-rated appliance shipments.

The evaluation did not find a significant difference in the ENERGY STAR market share. In fact, participants proved less likely to have replaced an ENERGY STAR appliance than the national ENERGY STAR saturation. This estimate is highly uncertain because of the lack of local recent data; regardless, we anticipate spillover impacts to be minimal.[8] This evaluation did not make any spillover adjustments to net savings.

[8] The most recent state-level saturation data from 2009 are too old for comparison, yet national data may vary from local data.

Calculate NTGR

The evaluation team's final estimate of program-influenced savings utilized the following formula:

$$net\ savings = gross\ per\text{-}unit\ savings * (100 - (free\text{-}ridership\ and\ SMI\% + spillover\%) - induced\ replacement\%)$$

Figure 10 illustrates the integration of all net impacts and the final NTGR for refrigerators, and Figure 11 shows the net impacts for freezers.

Figure 10. NTGR Summary – Refrigerators

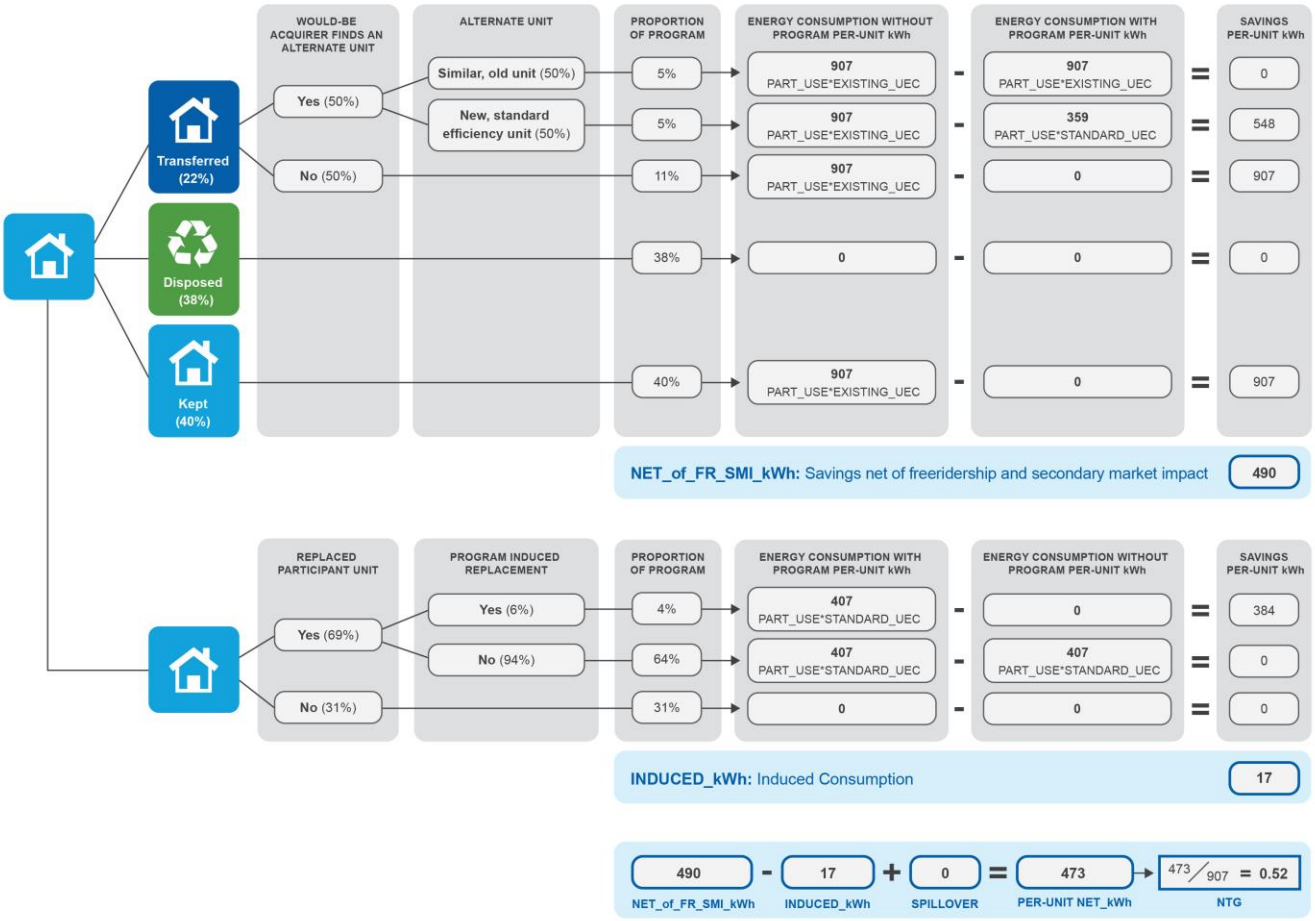


Figure 11. NTGR Summary – Freezers

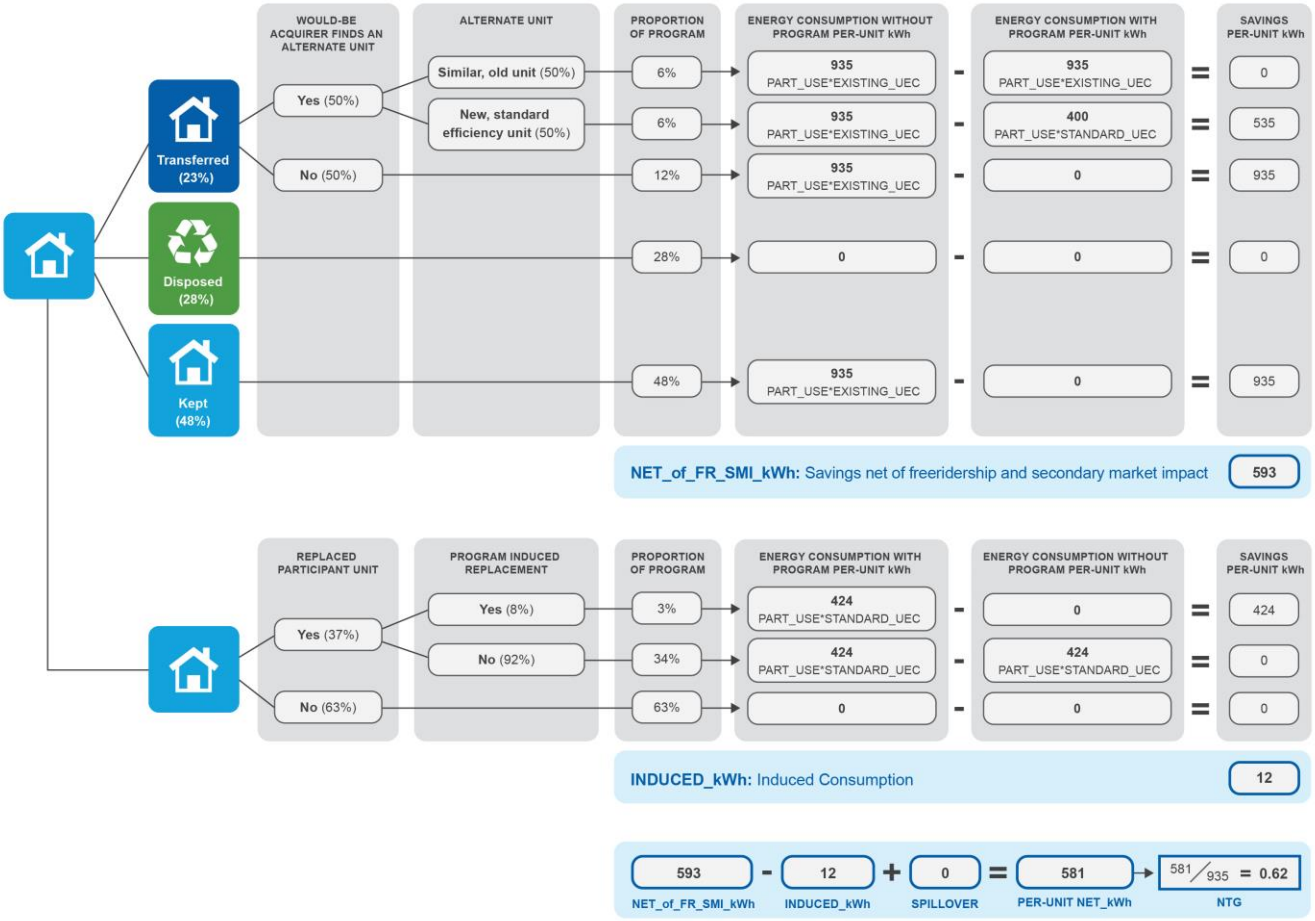


Table 23. Net Per Unit Savings and NTGR by Appliance Type

Recycling Measure	Gross Per-Unit Savings (kWh)	Free-Ridership and SMI	Induced Replacement	Spillover	Net Per-Unit Savings (kWh)	Final NTGR
Refrigerator	907	417 (46%)	17 (2%)	0	473	52%
Freezer	935	341 (36%)	12 (1%)	0	581	62%

While the NTGR has declined from PY4, which was applied to this year, the final results from this year's research are well within the range observed in other programs (see Table 18) and conform to current industry standards as outlined in the UMP.

Benchmarked NTGR

Many factors can contribute to variations in NTGR over time or between programs, making direct comparisons across programs and jurisdictions difficult. Nevertheless, the evaluation team compiled detailed NTGR data from a variety of studies, summarizing findings of a meta-analysis identifying trends in NTGRs among ARPs.

Figure 12 and Table 24 show evaluated NTGRs used by appliance recycling programs across North America, drawn from publicly available studies conducted by the evaluation team and other evaluators.

Figure 12. Historical Evaluated NTGRs

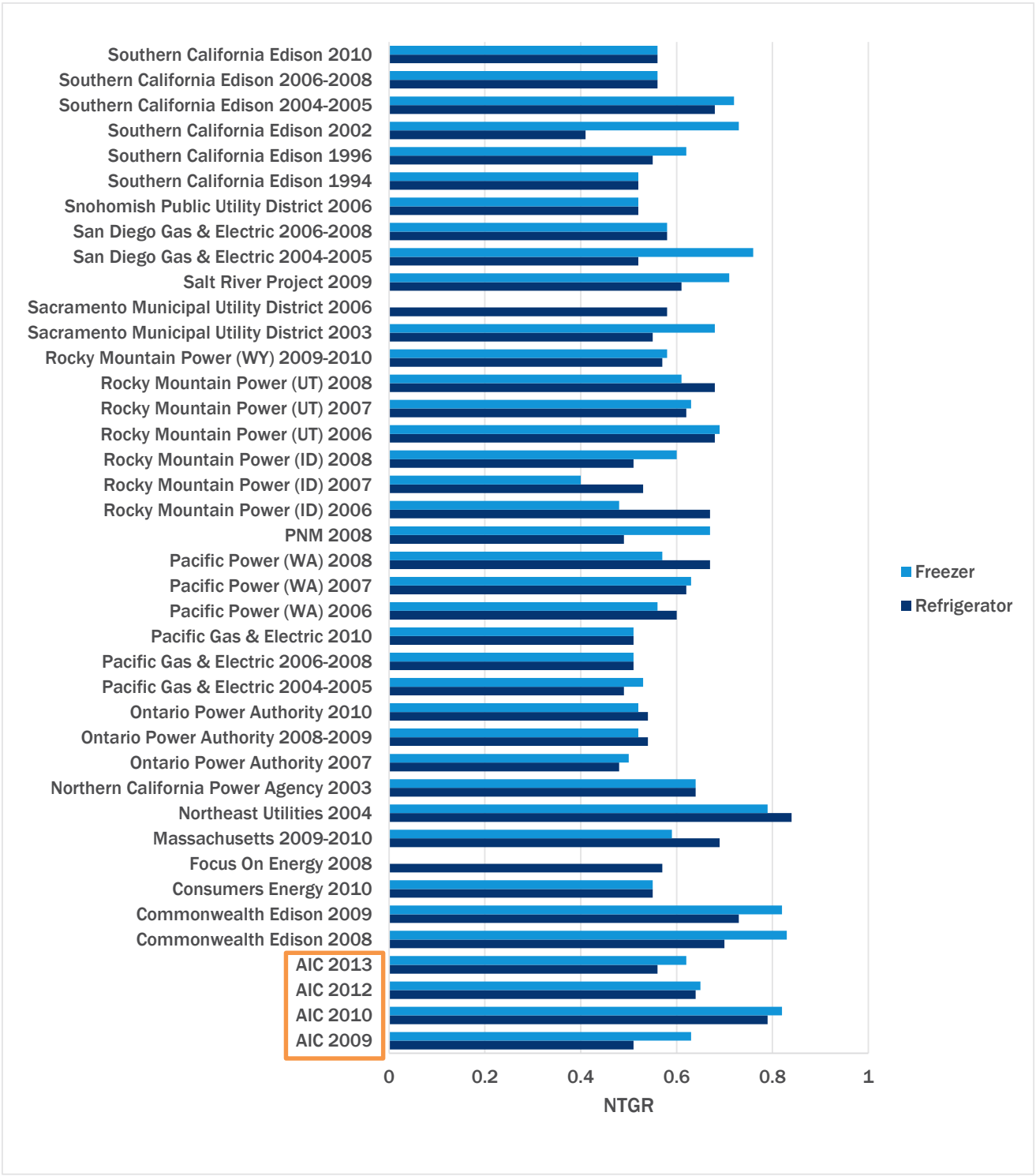


Table 24. Historical Evaluated NTGRs

Utility	PY	NTGR Refrigerator	NTGR Freezer	Evaluator
AIC	2009	0.51	0.63	Cadmus
	2010	0.79	0.82	Cadmus
	2012	0.64	0.65	Cadmus
	2013	0.56	0.62	Cadmus
ComEd	2008	0.70	0.83	Summit Blue
	2009	0.73	0.82	Navigant
Consumers Energy	2010	0.55*	0.55*	Cadmus
Focus On Energy	2008	0.57	N/A	PA Consulting
Massachusetts	2009–2010	0.69	0.59	NMR Group
Northeast Utilities	2004	0.84	0.79	NMR, RLW
Northern California Power Agency	2003	0.64	0.64	Robert Mowris & Associates
OPA	2007	0.48	0.50	Cadmus
	2008–2009	0.54	0.52	Cadmus
	2010	0.54	0.52	Cadmus
PG&E	2004–2005	0.49	0.53	ADM Associates, Inc.
	2006–2008	0.51*	0.51*	(source: DEER 2011 Update)
	2010	0.51*	0.51*	
Pacific Power (WA)	2006	0.60	0.56	Cadmus
	2007	0.62	0.63	Cadmus
	2008	0.67	0.57	Cadmus
PNM	2008	0.49	0.67	KEMA
Rocky Mountain Power (ID)	2006	0.67	0.48	Cadmus
	2007	0.53	0.40	Cadmus
	2008	0.51	0.60	Cadmus
Rocky Mountain Power (UT)	2006	0.68	0.69	Cadmus
	2007	0.62	0.63	Cadmus
	2008	0.68	0.61	Cadmus
Rocky Mountain Power (WY)	2009–2010	0.57	0.58	Cadmus
Sacramento Municipal Utility District	2003	0.55	0.68	Heschong Mahone Group
	2006	0.58	N/A	ADM Associates, Inc.
Salt River Project	2009	0.61	0.71	Cadmus
San Diego Gas & Electric	2004–2005	0.52	0.76	ADM Associates, Inc.
	2006–2008	0.58	0.58	Cadmus
Snohomish Public Utility District	2006	0.52	0.52	Kevin L. Smit
SCE	1994	0.52	0.52	Xenergy
	1996	0.55	0.62	Xenergy
	2002	0.41	0.73	KEMA (Xenergy)
	2004–2005	0.68	0.72	ADM Associates, Inc.
	2006–2008	0.56*	0.56*	(source: DEER 2011 Update)
	2010	0.56*	0.56*	

* A combined or weighted average NTGR across all types of appliances recycled.

Several observations can be drawn from the findings presented in Table 24:

- NTGRs vary greatly by utility, from a minimum of 0.40 (Rocky Mountain Power Idaho, 2007) to a maximum of 0.84 (Northeast Utilities, 2004).
- Considerable variation can occur from year to year within a given utility program.
- While some variation may result from different evaluator's favored approaches (contingent on the direction provided by the utility or regulator), the variation in NTGRs does not suggest a pattern related to the firm conducting the evaluation.
- On average among these studies, AIC's NTGRs do not substantially differ from those in other parts of the country.

The evaluation team originally presented a meta-analysis of NTGR results in a paper at the 2011 International Energy Program Evaluators Conference (IEPEC). The analysis drew on a subset of evaluation findings shown in Table 24, containing reasonably complete and detailed data. This program subset shared evaluation methods that, although different in regard to specific wording and ordering of questions, used similar logic and proved appropriate for comparison. For the IEPEC study, the evaluation team used past NTGR estimates to specify a regression model predicting estimated NTGR, subject to explanatory variables related to the program and its participants.

This regression allowed the evaluation team to infer the most influential free-ridership drivers for appliance recycling programs, with two key findings from this meta-analysis of particular interest:

- Program maturity exerted a negative effect on free-ridership. In other words, the longer a program operated, the lower the free-ridership ratio. (Otherwise stated, more mature programs tend to have higher NTGRs.)
- Incentive levels exerted a negative effect on free-ridership. Programs with higher incentives also tended to have higher NTGRs.

D. Appendix—Tables of Benchmarking Results

Table 25. Benchmarked ARP Participation

Utility	PY	Refrigerators	Freezers	Room A/Cs	Total	Residential Customers	Harvest Rate
AIC	2009	2,752	1,096	N/A	3,848	1,063,646	0.04%
	2010	7,762	3,422	27	11,211	1,049,264	1.07%
	2012	10,696	3,536	10	14,242	889,100	1.60%
ComEd	2008	8,438	3,076	465	11,979	3,439,455	0.35%
	2009	20,065	4,946	724	25,735	3,425,593	0.75%
Consumers Energy	2010	3,138	1,094	N/A	4,232	1,569,183	0.27%
Massachusetts	2009–2010	10,040	3,341	N/A	13,381	N/A	N/A
Northeast Utilities	2004	7,467	2,895	5,875	16,237	1,338,596	1.21%
OPA****	2007	36,172***	12,050	1,610	49,832	4,500,000	1.11%
	2010	48,887	16,584	2,351	67,822	4,636,355	1.46%
PG&E	2004	9,833	1,254	N/A	11,087	4,356,242	0.25%
	2005	13,216	2,076	N/A	15,292	4,388,140	0.35%
	2006	19,525	4,051	N/A	23,576	4,486,162	0.53%
	2007	42,655	7,288	N/A	49,943	4,544,498	1.10%
	2008	37,208	5,855	N/A	43,063	4,621,878	0.93%
	2009	26,473	3,818	265	30,556	4,574,196	0.67%
	2010	21,552	2,983	329	24,864	4,565,636	0.54%
	2011	17,945	2,123	275	20,343	4,574,094	0.44%
	2012	16,417	2,047	98	18,562	4,599,078	0.40%
Pacific Power (WA)	2006	2,801	696	N/A	3,497	100,158	3.49%
	2007	2,160	460	N/A	2,620	101,245	2.59%
	2008	1,999	515	N/A	2,514	102,310	2.46%
PNM	2008	5,869	612	N/A	6,481	440,935	1.47%
Rocky Mountain Power (ID)	2006	615	179	N/A	794	53,148	1.49%
	2007	565	120	N/A	685	54,655	1.25%
	2008	515	184	N/A	699	55,818	1.25%

Utility	PY	Refrigerators	Freezers	Room A/Cs	Total	Residential Customers	Harvest Rate
Rocky Mountain Power (UT)	2006	17,315	4,340	N/A	21,655	664,384	3.26%
	2007	17,689	4,141	N/A	21,830	681,587	3.20%
	2008	14,694	3,275	N/A	17,969	690,820	2.60%
	2009	12,963	3,278	N/A	16,241	787,551	2.06%
	2010	12,604	3,061	N/A	15,665	796,908	1.97%
	2011	10,571	2,493	N/A	13,064	803,538	1.63%
	2012	9,505	2,286	N/A	11,791	811,549	1.45%
Rocky Mountain Power (WY)	2009	738	158	N/A	896	107,777	0.83%
	2010	956	233	N/A	1,189	108,584	1.10%
Snohomish Public Utility District	2006	2,532	1,207	N/A	3,739	281,749	1.33%
SCE	2004	44,740	5,537	N/A	50,277	4,034,569	1.25%
	2005	60,182	9,210	N/A	69,392	4,098,559	1.69%
	2006	59,590	9,578	N/A	69,168	4,166,496	1.66%
	2007	52,029	7,901	N/A	59,930	4,211,970	1.42%
	2008	80,215	10,606	N/A	90,821	4,231,943	2.15%
	2009	79,833	7,881	N/A	87,714	4,246,361	2.07%
	2010	66,952	5,779	N/A	72,731	4,269,757	1.70%
	2011	70,652	6,002	N/A	76,654	4,287,994	1.79%
	2012	43,433	3,616	N/A	47,049	4,305,586	1.09%

* Source: Energy Information Administration.

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

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

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

Table 26. Program Incentives for Recycled Refrigerators and Freezers

Utility	PY	Refrigerator/Freezer Incentive ($/appliance)	Room A/C Incentive ($/appliance)	Restrictions (annual)
AIC	2009–2010	$35	$0	Up to two appliances
	2012–2013	$50	N/A	None
ComEd	2008–2009	$25	$25	Up to two appliances
	2012	$35	$10	Up to two appliances
Consumers Energy	2010	$35	N/A	Up to two appliances
	2012	$50	N/A	Up to two appliances
Massachusetts	2009–2010	$50	N/A	Up to two appliances
Northeast Utilities	2004	$50	$25	None
OPA	2012	$0	$0	One room air conditioner or dehumidifier, but only if also picking up a refrigerator or freezer
PG&E	2006–2008	$35	$25	Up to two appliances
	2010–2012	$35	$25	Up to two refrigerators and/or freezers; one room air conditioner, but only if also picking up a refrigerator or freezer
Pacific Power (WA)	2006	$40	N/A	Up to two appliances
	2007–2008	$30*	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
PNM	2008	$30	N/A	None
	2012	$50	N/A	Up to two appliances
Rocky Mountain Power (ID)	2006	$40	N/A	Up to two appliances
	2007–2008	$30*	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
Rocky Mountain Power (UT)	2006	$40	N/A	Up to two appliances
	2007–2008	$30*	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
Rocky Mountain Power (WY)	2009–2010	$30	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
Snohomish Public Utility District	2006	$35	N/A	Up to two appliances
	2012	$30	N/A	Up to two appliances
SCE	2006-2007	$35 for refrigerators; $50 for freezers	$25**	Up to two appliances
	2008	$50	N/A	Up to two appliances
	2010-2012	$35	N/A	Up to two appliances

* These incentives were reduced in mid-year 2007.

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

Table 27. Gross Unit Average Energy Savings

Utility	PY	Refrigerator (kWh/unit)	Freezer (kWh/unit)	Room Air Conditioner (kWh/unit)
AIC	2009	1,522	1,247	N/A
	2010	1,467	1,331	N/A
	2012	1,328	1,127	968
	2013	937	882	415
ComEd	2008	1,420	1,196	80
	2009	1,757	1,715	80
Consumers Energy	2010	939	1,011	N/A
Massachusetts	2009–2010	755	658	N/A
Northeast Utilities	2004	1,383	1,181	53 with replacement; 191 without
OPA	2007	605	470	N/A
	2010	1,126	1,045	371
PG&E	2004–2005	1,647	N/A	N/A
	2006–2008	1,130	N/A	N/A
	2009	848	874	N/A
	2010–2012	848	874	N/A
Pacific Power (WA)	2006	1,556	1,513	N/A
	2007	1,454	1,441	N/A
	2008	1,461	1,399	N/A
PNM	2008	1,306	1,548	N/A
Rocky Mountain Power (ID)	2006	1,332	1,467	N/A
	2007	1,482	1,462	N/A
	2008	1,431	1,439	N/A
Rocky Mountain Power (UT)	2006	1,426	1,503	N/A
	2007	1,311	1,238	N/A
	2008	1,242	1,290	N/A
Rocky Mountain Power (WY)	2009–2010	1,158	900	N/A
Salt River Project	2009	1,248	780	N/A
Snohomish Public Utility District	2006	1,340	1,340	N/A
SCE	2004–2005	1,656	N/A	N/A
	2006–2008	1,087	N/A	N/A
	2009	737	917	N/A
	2010	737	917	N/A

Table 28. Cost-Effectiveness Ratios of Comparison Programs

Utility	PY	TRC
ComEd	2008	2.58
	2009	3.06
Massachusetts	2009–2010	N/A
PG&E	2004–2005	N/A
	2006–2008	N/A
	2010–2011	0.98
Pacific Power (WA)	2006	2.97
	2007	3.10
	2008	3.33
PNM	2008	2.61
Rocky Mountain Power (ID)	2006	2.02
	2007	1.85
	2008	2.00
Rocky Mountain Power (UT)	2006	2.43
	2007	2.34
	2008	2.51
Rocky Mountain Power (WY)	2009	2.67
	2010	3.15
Salt River Project	2009	1.59
Snohomish Public Utility District	2006	1.84*
SCE	2004–2005	N/A
	2006–2008	2.40
	2010–2011	1.46

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

E. Appendix— References

ADM Associates, Inc. *Evaluation Study of the 2004-05 Statewide Residential Appliance Recycling Program*. Written on behalf of the California Public Utilities Commission. 2008.

ADM Associates, Inc. *Final Annual Report to the Pennsylvania Public Utility Commission For the Period*

June 2012 through May 2013 Program Year 4. Written on behalf of the California Public Utilities Commission. 2008.

ADM Associates, Inc. *Measure and Verify Savings of Refrigerator Recycling Program*. Prepared for Sacramento Municipal Utility District. 2007. Available online: library.cee1.org/sites/default/files/library/1729/907.pdf.

Ameren Illinois. 2012. "Fridge and Freezer Recycling." Accessed August 23, 2014. http://www.actonenergy.com/for-my-home/explore-incentives/refrigerator-freezer-recycling.

Bushman, Kate, and J. Keeling. "A Meta-Analysis of Drivers of Freeridership in Appliance Recycling Programs." Paper presented at The International Energy Program Evaluation Conference (IEPEC), Boston, Massachusetts, August 16, 2011, through August 18, 2011.

Bushman, Kate, K. Kansfield, and J. Keeling. "Primary Refrigerators: An Examination of Appliance Recycling Program Design." Paper presented at The International Energy Program Evaluation Conference (IEPEC), Boston, Massachusetts, August 16, 2011, through August 18, 2011.

The Cadmus Group, Inc. *Ameren Illinois Appliance Recycling Program Evaluation – PY2.* 2011. Accessed September 14, 2014. http://ilsagfiles.org/SAG_files/Evaluation_Documents/Ameren/AIU%20Evaluation%20Reports%20EPY2/AIU%20EPY2%20Final/AIU_Appliance_Recycling_Eval_Report_PY2.pdf

The Cadmus Group, Inc. *Consumers Energy 2010 Evaluation Activity and Summary Report Prepared for Consumers Energy.* 2011.

The Cadmus Group, Inc. *Rocky Mountain Power 2009-2010 Utah Cool Cash Program Evaluation.* 2011. Accessed August 23, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/UT_Cool_Cash_2009_2010_FINAL_Evaluation_Report.pdf

The Cadmus Group, Inc. *Rocky Mountain Power Wyoming Evaluation 2009–2010 Report.* 2011. Accessed August 23, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/DSM_WY_SYLR_2011.pdf

The Cadmus Group, Inc. *Rocky Mountain Power Wyoming See ya later, refrigerator®: Program Evaluation Report 2011-2012.* 2013. Accessed August 23, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/2013/2011-2012_SYLR_Wyoming_SeeYaLaterRefrigerationProgramEvaluation.pdf

The Cadmus Group, Inc. *2008 and 2009 Great Refrigerator Roundup Program—Impact Evaluation.* Prepared for Ontario Power Authority. 2010. Accessed September 14, 2014.

http://www.powerauthority.on.ca/sites/default/files/new_files/2009/2009%20Residential%20Great%20Refrigerator%20Roundup%20Program%20Evaluation.pdf

The Cadmus Group, Inc. *Appliance Recycling Program Evaluation—PY1.* Prepared for Ameren Illinois Utilities. 2010. Accessed September 14, 2014. http://ilsagfiles.org/SAG_files/Meeting_Materials/2010/April%2027,%202010%20Meeting/Ameren_EPY1_Annual_Report_wo_appendices.pdf

The Cadmus Group, Inc. *Idaho Refrigerator and Freezer Recycling Program 2006-2008.* Prepared for Rocky Mountain Power. 2010. Accessed September 14, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/ID_SYLR_Report.pdf

The Cadmus Group, Inc. *Rocky Mountain Power Idaho See ya later, refrigerator®: Program Evaluation Report 2011-2012.* 2013. Accessed September 15, 2014. http://rtf.nwcouncil.org/subcommittees/fridgerecycle/ID_SYLR_Report_2011-2012.pdf

The Cadmus Group, Inc. et al. *Residential Retrofit High Impact Measure Evaluation Report.* Prepared for the California Public Utilities Commission Energy Division. 2010. Accessed August 23, 2014. http://www2.epa.gov/sites/production/files/documents/CA_PUC_Assessment.pdf

The Cadmus Group, Inc. *Utah Refrigerator and Freezer Recycling Program 2006-2008.* Prepared for Rocky Mountain Power. 2010. Accessed August 23, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/DSM_UT_SYLR.pdf

The Cadmus Group, Inc. *Rocky Mountain Power Utah See ya later, refrigerator®: Program Evaluation Report 2011-2012.* 2013. Accessed September 15, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/2013/UT_2011-2012_SYLR_Report_FINAL.pdf

The Cadmus Group, Inc. *Washington Refrigerator and Freezer Recycling Program 2006-2008.* Prepared for Pacific Power. 2010. Accessed September 15, 2014. http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Demand_Side_Management/DSM_WA_SYLR.pdf

The Cadmus Group, Inc. *Pacific Power Washington See ya later, refrigerator®: Program Evaluation Report 2011-2012.* 2013. Accessed September 15, 2014. http://rtf.nwcouncil.org/subcommittees/fridgerecycle/WA_2011-2012_SYLRReportFINAL23OCT13.pdf

The Cadmus Group, Inc. *Focus on Energy Calendar Year 2012 Evaluation Report Volume II.* 2013. Accessed September 15, 2014. https://focusonenergy.com/sites/default/files/FOC_XC_%20CY%2013%20Evaluation%20Report_Volume%20II.pdf

California Public Utilities Commission. "2008 Database for Energy-Efficient Resources, Version 2008.2.04 October 30, 2008. For Use in the California IOU 2006-2007 Energy Efficiency Claims Ex Ante Update." Accessed August 23, 2014. http://www.deeresources.com/index.php/ex-ante-guidance.

California Public Utilities Commission. "2008 Database for Energy-Efficient Resources, Version 2008.2.05 December 16, 2008. For Use in California IOU 2009-2011 Energy Efficiency Planning and Reporting." Accessed August 23, 2014. http://www.deeresources.com/index.php/deer2008-for-09-11-planning-reporting.

California Public Utilities Commission. *2010-2011 Energy Efficiency Annual Progress Evaluation Report*. 2012. Accessed September 15, 2014. http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf

Commonwealth Edison. "Save money by recycling your old fridge or freezer." Accessed August 23, 2014. https://www.comed.com/home-savings/rebates-incentives/pages/refrigerator-recycling.aspx.

Consumers Energy. "How appliance recycling works for you and your budget." Accessed August 23, 2014. http://www.consumersenergy.com/eeprograms/RHome.aspx?id=4117.

Dohrmann, D., J. Peterson, J. Reed, S. Samiullah, and S. Westberg. "Net Savings Estimation in Appliance Recycling Programs: A Review and Empirical Analysis with Recent California Data." Paper presented at The International Energy Program Evaluation Conference (IEPEC), Chicago, Illinois, August 14, 2007, through August 16, 2007.

Energy Efficiency Groupware Application (EEGA). PG&E and SCE Q1 2006 through Q4 2009 Quarterly Reports. http://eega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=7.

Energy Information Administration. "Table 6. Class of ownership, number of consumers, sales, revenue, and average retail price by State and utility: residential sector." 2004, 2005, 2006, 2007, 2008, 2009, 2010, and 2011. Accessed August 23, 2014. http://www.eia.gov/electricity/sales_revenue_price/pdf/table6.pdf.

Heschong Mahone Group, Inc. *Measurement and Verification of SB5X Energy Efficiency Programs for the Sacramento Municipal Utility District.* 2003.

Itron, Inc. *DEER Database: 2011 Update Documentation.* November 8, 2011.

Itron, Inc. *Database for Energy Efficient Resources: 2011 Update. Appendix A-1, last updated November 19, 2011.* 2011.

KEMA, Inc. *2009 California Residential Appliances Saturation Study.* CEC-200-2010-004. Prepared for California Energy Commission. October 2010.

KEMA, Inc. *Evaluation Measurement and Verification of Public Service Company of New Mexico's Electric Energy Efficiency Programs October 2007 – December 2008 Program Year.* 2009.

KEMA-Xenergy, Inc. *Measurement and Evaluation Study of 2002 Statewide Residential Appliance Recycling Program Prepared for Southern California Edison.* 2004.

Lawrence Berkley National Laboratory. "Energy Efficiency Standards: Refrigerators." Accessed August 23, 2014. http://efficiency.lbl.gov/news/refrigerators-refrigerator-freezers-and-0.

MassSave. "Offers: Receive $50 when you recycle your second refrigerator or freezer." Accessed August 23, 2014. http://www.masssave.com/residential/offers/refrigerator-and-freezer-recycling-rebates.

National Renewable Energy Laboratory. "Chapter 7: Refrigerator Recycling Evaluation Protocol". April 2013. Accessed September 15, 2014. http://energy.gov/sites/prod/files/2013/05/f0/53827-7.pdf

Navigant Consulting. *Energy Efficiency / Demand Response Plan: Plan Year 2 (6/1/2009 – 5/31/2010). Evaluation Report: Residential Appliance Recycling Presented to Commonwealth Edison Company*. 2010. Accessed September 15, 2014. https://www.ceeforum.org/sites/default/files/library/8613/CEE_Eval_ComEdApplianceRecyclingPY2EvaluationReport2010_12_21_Final_21Dec2010.pdf

Nexus Market Research Group, Inc. *Massachusetts Appliance Turn-In Program Impact Evaluation FINAL 6/15/2011.* 2011. Accessed September 15, 2014. http://ma-eeac.org/wordpress/wp-content/uploads/Impact-Evaluation-Final-Report.pdf

Nexus Market Research Group, Inc Impact, Process, and Market Study of the Connecticut Appliance Retirement Program: Overall Report. 2005. Accessed September 15, 2014. http://library.cee1.org/sites/default/files/library/8827/CEE_Eval_CTApplianceRetirement_23Dec2005.pdf

Ontario Power Authority. "Fridge & Freezer Pickup." Accessed November 29, 2012. https://saveonenergy.ca/Consumer/Programs/Appliance-Retirement.aspx.

Pacific Power. "Refrigerator Recycling." Accessed November 29, 2012. http://www.pacificpower.net/res/sem/epi/washington/roa.html.

PNM. "PNM Refrigerator Recycling Rebate." Accessed August 23, 2014.

https://www.pnm.com/fridge.

Quantec. *Impact and Evaluation of Ontario Power Authority's Great Refrigerator Roundup Program.* Prepared for Ontario Power Authority. 2008. Accessed September 15, 2014. http://www.powerauthority.on.ca/sites/default/files/new_files/2007/2007%20OPA%20Great%20Refrigerator%20Roundup%20Program%20Evaluation.pdf

Robert Mowris & Associates. *Measurement and Verification Report for NCPA SB5X Refrigerator Recycling.* Final Report to Northern California Power Agency. 2003.

Rocky Mountain Power. "Refrigerator Recycling." Accessed August 23, 2014. https://www.rockymountainpower.net/res/sem/idaho/roa.html.

Salt River Project. "Clean up your patio or garage and save." Accessed August 23, 2014. http://www.srpnet.com/energy/powerwise/savewithsrp/ApplianceRecycling.aspx.

Snohomish Public Utility District. "Appliance Recycling." Accessed November 29, 2012. http://www.snopud.com/?p=1289.

Snohomish Public Utility District. *2006 Refrigerator/Freezer Recycling Program Evaluation Prepared for Sacramento Municipal Utility District.* 2007. Accessed September 15, 2014. http://rtf.nwcouncil.org/meetings/2007/04/snohpudrefrigeval_2006.doc

Summit Blue Consulting. *Commonwealth Edison Company Energy Efficiency/Demand Response Plan Year 1 (6/1/2008-5/31/2009).* 2009. Accessed September 15, 2014. http://library.cee1.org/sites/default/files/library/8614/CEE_ComEdApplianceRecyclingY1EvaluationReport2009_12_02FINAL_.2Dec2009.pdf

For more information, please contact:

Mary Sutter
Vice President of Energy Evaluation

510 444 5050 tel
510 444 5222 fax
msutter@opiniondynamics.com

1999 Harrison Street, Suite 1420
Oakland, CA 94612