Pacific Gas & Electric

Appliance Recycling Program
Process Evaluation Research:
Retailer Haul-Away
Market Intervention

Final Report
CALMAC Study ID: PGE0382.01
April 30, 2016

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Executive Summary

Pacific Gas & Electric (PG&E) contracted with Cadmus (the research team) to assess a proposed business model that JACO Environmental introduced for the appliance recycling market sector. Hereafter, we refer to JACO's proposed program as the retailer haul-away market intervention, or RHAMI, pilot.

The research presented in this report is heavily reliant on JACO's knowledge of the retailer haul-away market. However, in November 2015, just prior to this report being finalized, JACO Environmental ceased operations.

During conversations with JACO regarding the RHAMI program, JACO staff noted that the decline in scrap metal prices was affecting their business and that a significant portion of JACO's business model relied on revenue from scrap metal from recycled appliances. JACO mentioned several times during our discussions that, at present, the price of scrap metal is considerably lower than in recent history.

Given JACO's key role in this concept and their relationship with retailers providing service for haul-away units, their departure raises concerns, in addition to the general findings in this report, about the viability of the pilot without JACO's integral knowledge as well as the stability of the haul-away market.

RHAMI Overview

Through RHAMI, JACO would obtain and recycle the refrigerator and freezer units acquired by Northern California new appliance retailers when they haul away used appliances in conjunction with delivering new appliances to customer homes. JACO anticipated that delivery costs for RHAMI would be lower than the standard Appliance Recycling Program (ARP) costs because activities such as marketing, enrollment, in-home collections, and customer incentives would all be eliminated. RHAMI would focus on those units that new appliance retailers' hauler and recycling providers would resell to local used appliance dealers who, in turn, would sell them to local households where they would remain on PG&E's power grid.

JACO proposed piloting this approach at its facility in Hayward, California in partnership with a national retailer.

Necessary Implementation Conditions

In order for RHAMI to produce energy savings, it must prevent haul-away units from returning to the marketplace and being used in PG&E's service area. Thus, three necessary market conditions for successful RHAMI implementation are:

- Retailer haul-away offerings that (directly or indirectly) return units to the local used appliance marketplace

- The willingness and ability of retailers and other market actors to divert those resold units to RHAMI

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- The program implementer's ability to select and document resalable units that would remain in the local used appliance marketplace without the program

Without the first market condition, the program cannot go forward. If retailer haul-away programs are already destroying or recycling all units, RHAMI would not result in any change in the used appliance market. The research team's findings indicate that this condition exists, but only for some retailers in specific locations.

The second condition—market actors' willingness to divert resold units to RHAMI—could present a barrier to participation for some new appliance retailers. RHAMI would be able to capture only the units over which new appliance retailers have control. In retailer scenarios where a substantial amount of leakage occurs through trucking providers selling units intended for recycling or disposal, this condition would not be met. The portion of its haul-away appliances that are sold by truckers would not be recycled through RHAMI unless further measures were taken to prevent leakage.

The third condition—selecting the correct units for the RHAMI program—requires a highly knowledgeable implementation staff capable of selecting units that would have been resold. This presents a major evaluability barrier. Program managers and evaluators could easily assess UEC (i.e., efficiency) to verify the implementer selected units generating an appropriate level of gross savings. However, assessing whether or not a unit would have been resold locally requires the subjective judgment of someone with experience in the used appliance marketplace in the PG&E service area.

In addition, since JACO is no longer in operation, the RHAMI would have to partner with another entity with a similar understanding of the retailer haul-away market. There is no obvious successor identified in this research.

Key Research Outcomes

The research team's findings illustrate the complexity of the used appliance market in PG&E's territory. This report documents our findings in detail. The key outcomes regarding the proposed RHAMI approach are:

- **There is a low volume of eligible units in PG&E's territory.** At JACO's facility in PG&E's territory, a relatively small[1] number of haul-away units appears to return to the local used appliance marketplace. Based on anecdotal reports and JACO's Hayward facility documentation, the research team estimated that a maximum of 2,234 RHAMI-eligible units come into JACO's facility from the proposed retailer partner annually. Though some eligible units entering JACO's Hayward facility from that retailer are either recycled or shipped out of the United States, there were 208 units resold to the second-hand market within a 34 day sample period for which data was collected[2]. This represents roughly 6% of the annual total of appliances and is considerably

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[1] The number of potential units processed through RHAMI would be considerably less than through the standard appliance recycling program, which collects roughly 25,000 units per year.
[2] Average daily units of 6.12 extrapolated to 365.25 days equals 2,234 units annually.

less than the 35%-40% of units that JACO cited in their RHAMI proposal. The low number of units is consistent with a pilot program through AEP Ohio, which was discontinued largely due to a low number of available units.

- **Limited opportunity exists for expansion with additional retailer partners.** New appliance retailers take a variety of approaches to handling haul-away units. Only those retailers that follow processes resulting in appliances returning to the local marketplace are potential RHAMI partners.
- **Major evaluation barriers exist.** Retailers and recyclers do not currently keep comprehensive documentation regarding haul-away units. Information on unit characteristics is not currently recorded, and recording of unit sales transactions in the local market appear to occur informally. This lack of data would make it very difficult to assess freeridership and secondary market impacts – two of the critical inputs to appliance recycling program net savings computations. In addition, even when unit characteristics documentation is provided, there is currently no way to determine what proportion of units resold are being sold as a second-hand appliance and what proportion are being resold only for parts.

Retailer Haul-Away Market Dynamics

This research found that appliances collected by retailer haul-away programs return to the local used appliance marketplace through one of two mechanisms:

- Recycling providers sell appliances to used appliance retailers or wholesalers who, in turn, sell the units locally or regionally. Some retailers authorize these sales; others require their recycling providers to recycle or export all haul-away units.
- Trucking company drivers, contracting with new appliance retailers to deliver new units and haul-away used ones, sell haul-aways to local used appliance retailers. Retailers do not authorize these sales, and some retailers have taken steps to prevent them.[3]

RHAMI, as designed, would intervene in the first of these two mechanisms. However, the research team's findings indicate that the number of units returning to the local market through the first mechanism—specifically from JACO's Hayward facility—is considerably lower than anticipated. Documentation provided currently shows that RHAMI is likely to recycle fewer than 3,000 units per year based on the average daily volume of units documented.

Additionally, the 2,234 appliances we assume to be resold per year is based on the average number of units sold per day during the period for which JACO sold units and collected data. JACO does not regularly sell this many units, but rather specifically made an effort to contact wholesalers and sell the units during the sample period. JACO expressed confidence that they would be able to sell a similar volume, or more, on a regular basis if they made a consistent effort. However, no firm evidence was provided to support this.

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[3] The existence of leakage was documented through interviews with a few retailers and photographic evidence provided by JACO.

There may be more potential to expand sales, but the counterfactual scenario beyond the 2,234 units annually cited in this report has not been established and increasing the number of units sold increases the likelihood of including units that would be freeriders: most notably, units that would have been sold but used only for parts and units that would have been sold and shipped out of PG&E's territory. In both cases the units would not continue to operate in PG&E's service area and, therefore, would produce no savings for the program.

RHAMI was not designed to address the second mechanism, through which haul-away units would return to the PG&E service area due to trucking contractors selling used units back into the local marketplace. The research team cannot accurately estimate the number of used appliances following this path and returning to use in PG&E households. However, our interviews with used appliance retailers indicate that sales from trucking contractors are a major source of inventory for some used appliance retailers in PG&E's service area. This unauthorized leakage out of the haul-away process reduces the number of re-sellable appliances arriving at JACO's Hayward facility from retailer haul-away programs. It also reduces the ability of RHAMI to divert appliances from the used appliance marketplace.

Recommendations

Recommendation 1: RHAMI Implementation

Based on our findings specific to PG&E's service area, the research team concludes that there are limited opportunities for a successful RHAMI pilot. With the dissolution of JACO, another entity with knowledge of the haul-away market would need to be found. Given available information and JACO's dissolution occurring as this research was concluding, no entity has been identified that could fill this role. If a viable partner could be found, the following outstanding challenges would need to be resolved as a first step:

- The low number of documented eligible units through established channels means that RHAMI would likely face challenges expanding participation.

- Lack of consistent documentation and difficult-to-estimate evaluation inputs could prevent effective evaluation of RHAMI. These include:
    - Establishing a clear counterfactual scenario and eligible population
    - Determining the fate of appliances that would have likely been resold, that is, whether they would they have been used only for parts or resold outside of PG&E's territory
    - Consistent and verifiable documentation of both incoming and outgoing appliances through the implementer's facility as well as clear documentation of sales volume

This may require sampling of unit characteristics as part of the intake process to determine whether a program implementer can accurately predict which units are likely to be resold and determining overall proportion of units being resold.

Recommendation 2: Integrating Market Knowledge

The research team recommends that PG&E's ARP team consider the new information revealed in the study as it relates to their current standard ARP and One-Touch offerings as well as new potential

program designs. PG&E should avoid ARP partnerships similar to RHAMI or the One-Touch program with retailers who already remove all appliances from the PG&E service area (i.e., Approach 2 or Approach 3). Such partnerships would likely result in high freeridership.

Recommendation 3: Addressing Leakage

Based on this study's findings regarding leakage – i.e., trucking contractors' practice of selling haul-away units directly to used appliance retailers – the research team recommends that efforts be made by all key stakeholders and influential parties to work with retailers to address this practice. As a partner to the retailers, PG&E should explore methods for encouraging retailers to eliminate this practice, if such approaches would lead to documentable energy savings. Potential key influencers who could be engaged to help address this challenge would include: appliance manufacturers (with a "cradle to grave" sustainability mission); U.S. Department of Energy; U.S. Environmental Protection Agency; California Regulatory entities (including CPUC and California Department of Toxic Substances Control); and public interest groups. The most viable method for reducing leakage appears to be increased tracking of the haul-away units, similar to the tracking that currently occurs for the One-Touch program. With support of these key influencers, PG&E could explore encouraging retailers to implement this enhanced unit tracking through incentives, but further discussions with current or potential partner retailers would be required to determine the energy savings (if any) that would result from such incentives.

Recommendation 4: Further Research

The 2010-2012 ARP Process Evaluation and Market Characterization study found that approximately 75% of units discarded by PG&E customers are picked up by someone (either a retailer, an appliance hauler, or another individual). PG&E and the California IOUs have sponsored additional research to understand this secondary market for used appliances:

- The RHAMI study examined the subset of used appliances that are picked up from customers by retailers; and
- The 2010-2012 ARP Impact Evaluation examined discarded units more broadly at the statewide level. The study found that peer-to-peer transfers, including sales via the Craigslist online marketplace, represent a large portion of used appliance transfers in California.

Given the complexity of the used appliance market in general, and the remaining uncertainty about the peer-to-peer channel, Cadmus reiterates the Impact Evaluation team's recommendation to conduct further research on peer-to-peer transfers of used appliances.

Introduction

Project Background

In March 2013, JACO, Inc., the implementation contractor for PG&E's Appliance Recycling Program (ARP), proposed a pilot program for refrigerator and freezer recycling. In its proposal, JACO suggested that the current ARP could be enhanced by intervening in a different part of the market—specifically, by removing and de-manufacturing refrigerators and freezers that are acquired by Northern California new appliance retailers when they haul away used appliances in conjunction with delivering new appliances to customers' homes. This proposed approach would benefit PG&E's program by reducing implementation costs, because unlike the standard ARP, RHAMI would not incur costs for marketing, enrollment, in-home collections, or customer incentives. JACO's proposal noted that, although the major new appliance retailers do recycle many of the used appliances they pick up from customers' homes, a substantial portion of the used appliances end up on the appliance resale market. [4]

In fall 2013, Pacific Gas & Electric (PG&E) contracted with Cadmus (the research team) to assess JACO's proposed business model for the appliance recycling market sector. Hereafter, we refer to JACO's proposed program as the retailer haul-away market intervention, or RHAMI, pilot.

Prior to JACO's proposal, PG&E had been considering a variety of approaches for expanding or modifying its ARP offerings. PG&E was considering changes to these offerings for two reasons: first, the energy savings for standard ARP offerings has been decreasing since the 2006-2008 program cycle; and second, the California Public Utilities Commission (CPUC) directed the California investor-owned utilities (IOUs) to investigate other opportunities in the appliance recycling market.

Through a study of the 2010-2012 ARP,[5] PG&E learned that a majority of the used refrigerators and freezers disposed of in its service territory were picked up from customer homes by either a retailer or another party (as opposed to the owner handling disposal). The study also estimated that in 2012 there was potential for PG&E's ARP to collect more than 182,000 additional eligible refrigerators and 54,000 additional eligible freezers that were likely returned to use in PG&E's service area.

Further, PG&E received information from other market actors that additional savings potential existed in the appliance recycling market, specifically in units removed by retailer haul-away programs. An open letter from Jack Cameron, President of ARCA, Inc., stated that nationwide at least 25% of the used appliances collected through retailer haul-away programs (i.e., retailer haul-aways that are not associated with utility programs) are typically resold by used appliance retailers and continue to be used in households (see Appendix A).

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[4] The research team found that in JACO's Hayward facility the percentage of units ending up on the appliance resale market is likely much lower than JACO's original assumption. However, we also found that this percentage may vary greatly among recycling facilities, locations, and retailers. Thus, the average values cited here may still be valid as nationwide averages.

[5] Cadmus. *Appliance Recycling Program Process Evaluation and Market Characterization*. September 18, 2013.

Based on discussions with internal stakeholders, PG&E program staff determined additional research was warranted before they would be ready to approve and launch the RHAMI pilot. PG&E and the research team developed an approach for assessing the viability of the pilot and estimating its market potential. This report contains the results of the research team's assessment.

RHAMI Program Concept

JACO's proposal described the background market conditions (as observed by JACO), proposed RHAMI objectives and goals, and key RHAMI implementation and evaluation, measurement, and verification (EM&V) considerations. The research team reviewed the proposal and identified the key determinants of program cost-effectiveness that formed the basis for the research plan.

JACO's Documentation of Background Market Conditions

As the implementer of PG&E's ARP, JACO conducts all de-manufacturing and recycling at its own recycling facility in Hayward, California. In its RHAMI proposal, JACO stated that, "an immediately adjacent facility currently handles significant volumes of 'haul-away' used appliances for Northern California retailers." The research team clarified that this facility belongs to JACO, and that JACO holds contracts with retailers to purchase and process their hauled-away units. (This process is described in greater detail below in the Haul-Away Process section.)

Drawing on past research, JACO noted that retailers appear to haul away a large volume of used refrigerators and freezers in California: JACO estimated Northern California retailers handle approximately 58,000 units annually.[6] JACO also cited two studies that state between 37% and 45% of discarded or haul-away units are typically resold and returned to use.[7]

Proposed Program Objectives and Goals

The objective of the RHAMI pilot is for JACO to obtain and recycle the refrigerators and freezers that Northern California retailers acquire when they haul away used appliances following delivery of new appliances to customer homes. The pilot would enable PG&E to document whether the RHAMI design could reduce average per-unit program delivery costs and, based on that computation, determine whether a full-scale RHAMI program would be cost-effective. As noted, JACO anticipated that delivery costs for RHAMI would be lower than standard ARP delivery costs.

JACO proposed focusing on units that were "relatively likely to remain on the Western North America power grid in the absence of the pilot." JACO explained that the characteristics of these units (e.g.,

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[6] JACO based this estimate on research conducted by ADM Associates for the 2004-2005 California Statewide ARP Evaluation study. ADM, *California Statewide ARP EM&V for 2004-2005*, April 2008, pp. 6-16.

[7] See: U.S. Department of Energy, *Refrigerator Market Profile*, December 2009, pages 8 and 10; and Navigant, *Com Ed ARP EM&V for PY4 (6/2011 – 5/2012)*, January 22, 2013, page 43. The first value is an estimated national average, and the second is for a specific region in Illinois, so although this study's findings indicate a much lower percentage for JACO's Hayward facility, these averages may be valid estimates.

vintage, size, configuration) would be documented through the RHAMI program procedures and that PG&E could use this information in ARP impact evaluation regression models to determine full-year gross annual kWh savings.[8] The proposed pilot would also allow PG&E to estimate the number of eligible units that could be obtained, including identifying any seasonal and regional variations in program participation or unit characteristics.

JACO's goal for the RHAMI pilot was to recycle 250 units per month over a 12-month period, that is, 3,000 refrigerators/freezers over a one-year pilot period. JACO proposed a per-unit cost paid to JACO of $60, including a $15 per-unit bounty to be paid to the retailer, for a total one-year pilot cost of $180,000.

Implementation and EM&V Considerations

JACO's proposal included specific strategies for program design and implementation. They proposed to begin the pilot in partnership with one retailer, focusing on that retailer's regional distribution center in Northern California. The proposal suggested RHAMI would eventually expand to other retailer locations in Northern California as well as to other retailers in PG&E's service territory.

JACO envisioned RHAMI being implemented in one of two ways:

1. Operating for 12 months using a "cherry picked" sample of the most desirable units from each month in terms of likely gross energy savings and/or net-to-gross (NTG) values. JACO noted that this approach would achieve the most favorable per-unit energy savings.

2. Operating for a shorter duration and with a higher number of units monthly, with the average characteristics of each unit slightly less desirable. By accepting all eligible units during a specified period, this approach would yield a better estimate of the possible total volume of appliances for a full-scale program.

Unit Characteristics and Eligibility

Regardless of the approach PG&E selected, JACO's proposal recommended restricting eligibility to the following unit characteristics:

- Appliance types: refrigerator or freezer units
- Size: 14 to 32 cubic feet
- Condition: currently operational
- Vintage: JACO did not specify a range of target appliance vintages

The proposal noted the difficulty of targeting an "appropriate" vintage. Units manufactured after the 2001 federal appliance standards went into effect use significantly less energy than earlier models and,

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8 The industry standard approach for impact evaluation of ARPs, as documented in the U.S. Department of Energy Uniform Methods Project's Refrigerator Recycling Evaluation Protocol, relies on estimating unit energy consumption using unit characteristics and other information about the units' use prior to recycling.

therefore, represent lower per-unit gross savings. However, JACO stated that these units are highly likely to be resold since they are newer and more desirable to consumers. This means they would likely have a higher NTG value compared to older units. The challenge in designing a RHAMI program is determining how to balance these conflicting factors to ensure the program captures the most cost-effective used appliances (i.e., those with the highest net energy savings).

Implementation Steps

JACO described its general approach for implementing RHAMI, noting that wherever appropriate they would apply the processes used in the standard ARP. The proposed implementation steps are:

1. **Collection:** JACO would collect RHAMI units in bulk from retailers' regional distribution warehouses, as part of JACO's ongoing large appliance haul-away operations.

2. **Assessment:** JACO would assess unit condition at its Hayward facility. Unlike the standard ARP and the One-Touch program, JACO would not disable RHAMI units at the collection location.

3. **Recycling:** JACO would de-manufacture units to the U.S. Environmental Protection Agency (EPA) Responsible Appliance Disposal (RAD) specifications, inclusive of foam insulation removal and degassing (CFC-11) or destruction (HCFC-141b).[9]

4. **Reporting/tracking:** As with the standard ARP, JACO would collect data on unit attributes. Unlike the standard ARP process, however, customer information would not be available for RHAMI units. Instead, JACO would record the location of the retailer's regional distribution warehouse and JACO's collection date.

Evaluation Challenges

JACO noted several challenges to evaluating RHAMI and suggested solutions to each. First, JACO noted that in standard ARPs, both the part-use factor and the NTG adjustment are typically determined through customer surveys.[10] This approach would not be possible in RHAMI since JACO would have no customer information. Thus, JACO suggested that PG&E determine an appropriate part-use factor and NTG based on JACO's benchmarking and on discussions with EM&V consultants. When the research team asked JACO for more detailed recommendations, JACO suggested PG&E assume the same part-use factor as the standard ARP. The NTG, however, would need to be determined based on findings from the current study.

Second, JACO pointed out that RHAMI would not be able to verify that all of its units were coming from PG&E households and suggested that PG&E confirm that this information would not be necessary for evaluation purposes.

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[9]   RAD information is available at: http://www2.epa.gov/rad.

[10]   The part-use factor represents the portion of the year during which an appliance was plugged in and running before it was recycled. This is applied as an adjustment to gross savings to account for the lower energy use of appliances that are plugged in only part of the time.

Finally, JACO noted the difficulty of documenting whether a unit would have returned to the grid as a used appliance in PG&E's service territory without RHAMI. JACO recommended PG&E work with EM&V consultants to determine if JACO's statement that "there is a reasonable chance that such units otherwise would end up on the PG&E/California/Western North America power grid" would be sufficient evidence of savings.

Keys to Program Cost-Effectiveness and Viability

Cadmus and PG&E examined JACO's proposal to determine the keys to designing a viable RHAMI program. Any viable design must appropriately balance program benefits and costs. The two main determinants of program cost-effectiveness are:

- Energy savings potential
  - Gross energy savings for RHAMI, similar to ARP, would be determined largely by the recycled unit's characteristics. Documenting unit characteristics is critical to any appliance recycling program's evaluability.
  - RHAMI's net energy savings—and its NTG ratio—are affected by what would have happened to the units in the program's absence. The research team and PG&E therefore focused this study on determining the current destination and disposition of refrigerators and freezers collected through retailer haul-away programs. The team uses this information as a counterfactual to RHAMI's proposed activity.
- Program implementation and management costs
  - The research team collected information to compare JACO's proposed costs to the value of a used appliance in the marketplace.

Retailers' willingness and ability to partner with PG&E and JACO is also critical to a viable RHAMI. Retailers that participate in RHAMI might be required to collect and track additional data, which can be burdensome. Furthermore, the program would need to align with retailers' corporate goals for handling haul-away appliances.

Research Activities

The research team developed a research plan based on the information contained in JACO's proposal and discussions with PG&E staff. We completed the viability assessment and market potential research for the RHAMI pilot through two key areas of research:

- Market actor interviews
- Data review and quantitative analysis

Market actor interviews were a critical component of our research: the interviews enabled us to collect detailed information about current practices in the appliance haul-away and disposal market. Our research plan initially focused on known actors in this market and included the option to add other important actors we identified through the research. We first developed structured interview guides

with input from PG&E staff, and then conducted interviews via telephone using the interview guides and probing for additional detail in areas of interest.

Table 1 shows the minimum targeted number of interviews for each category of market actor, along with the number of completed interviews, companies represented, and unsuccessful attempts to reach additional companies. Unsuccessful attempts occurred due to two types of circumstances:

- In the New Appliance Retailer and Used Appliance Retailer categories, some companies were simply not interested in completing interviews. In some cases, this was because market actors were not directly involved in PG&E's ARP. Others appeared to have reservations about sharing proprietary details about their businesses. To counteract these factors, the research team offered a $50 incentive to used appliance retailers, which may have helped encourage our respondents to participate.

- In the Wholesale Appliance Purchasing Company category, the research team found potential contacts by searching online for wholesale used appliance buyers in California. This search led to several companies that did not work directly with the retailer haul-away market and were therefore not the correct population for this study. We counted discussions with these individuals as unsuccessful attempts at interviewing appliance purchasing company representatives.

Table 1. Market Actor Interviews

Market Actor Category	Individuals		Companies	
	Minimum Targeted Number of Interviews	Completed Interviews	Represented	Attempted but Interviews Not Completed
JACO Program Actors	2	3	1	0
ARCA Program Actors	1	3	1	0
New Appliance Retailers – Program Managers	3	6	4	1
New Appliance Retailers – Distribution Center Managers	3	8	3	0
Wholesale Appliance Purchasing Companies/Haul-Away Buyers/Recycling Contractors	5	2	2	5
Used Appliance Retailers	N/A*	2	2	8
Total	**14**	**24**	**13**	**14**

* Used appliance retailers were not included in the research team's original scope of work. Under PG&E's guidance, the research team later added these market actors who offered a potential source for additional information.

The second component of our research, the data review and quantitative analysis, relied on data provided by JACO. The research team requested documentation of JACO's acquisitions and sales of

appliances originating in retailer haul-away programs. JACO provided all the available documentation, and the research team reviewed and summarized this information. Table 2 shows the numbers of acquisition and sales records we received from JACO.

Table 2. Data Review (Documentation of Transactions Occurring 8/3/2015-9/8/2015)

Data Received from JACO	Data Format	Number of Records
Units received from retailer partner at JACO Hayward facility	Spreadsheets	208
Units sold to wholesale buyers at JACO Hayward facility	PDF Bills of Lading	14
Documentation of Transactions Occurring 6/1/2013-5/31/2014		
Units received from retailer partner at JACO Hayward facility	Spreadsheets	751
Units sold to wholesale buyers at JACO Hayward facility	PDF Bills of Lading	67

There were two rounds of data collection. JACO first provided data for the period of June 2013 through May 2014. However, the bills of lading provided showed that these units were not entering the secondary market in PG&E's territory, but were being shipped to Tijuana, Mexico. The second round of data provided by JACO showed that the purchasers of the units were located within California, though one of the purchasers was based in San Diego.

The volume of units that were shipped to Mexico suggest this is a likely path for a relatively large proportion of haul-away units.

Because documentation of retailer haul-away appliances was not thorough enough to estimate energy savings, the research team also drew data from secondary sources for household size and climate zone data to supplement our analysis. Only the units resold in California were used to estimate savings.

Market Structure

To establish the baseline market conditions prior to any intervention by RHAMI, the research team sought to understand how the retail haul-away market operates without any utility intervention beyond the current utility ARP offerings. This section describes the general processes retailers follow when they remove appliances from customer homes in the absence of any utility interventions. Process flows for specific retailers are described in more detail in the next section of this report.

Customer Decisions

PG&E customers have many options when they consider getting rid of a refrigerator or freezer. Each option can lead to differing outcomes for the appliance. Figure 1, on the next page, shows these options and the corresponding possible outcomes. Through information gleaned from prior ARP evaluations, as well as in-depth research conducted for this study, the research team found that nearly all would-be disposers of refrigerators and freezers will select one of these five options when considering appliance disposal:

- Recycle the appliance through PG&E's ARP

- Have the appliance picked up by a new or used appliance retailer

- Transfer the appliance to another home or organization (e.g., friend, relative, Craigslist buyer, charity)

- Dispose of the appliance independently

- Keep the appliance (i.e., decide against disposal)

Utilities interested in saving energy offer incentives to customers to choose the options that permanently remove older inefficient units from use. PG&E's ARP has achieved this aim by diverting units from disposal paths that would result in the units' continued use (and high energy consumption). The RHAMI model defines another mechanism for achieving the same goal—diverting units from disposal paths that could result in their continued use.

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Figure 1. Appliance Owner Disposal Decision Tree*
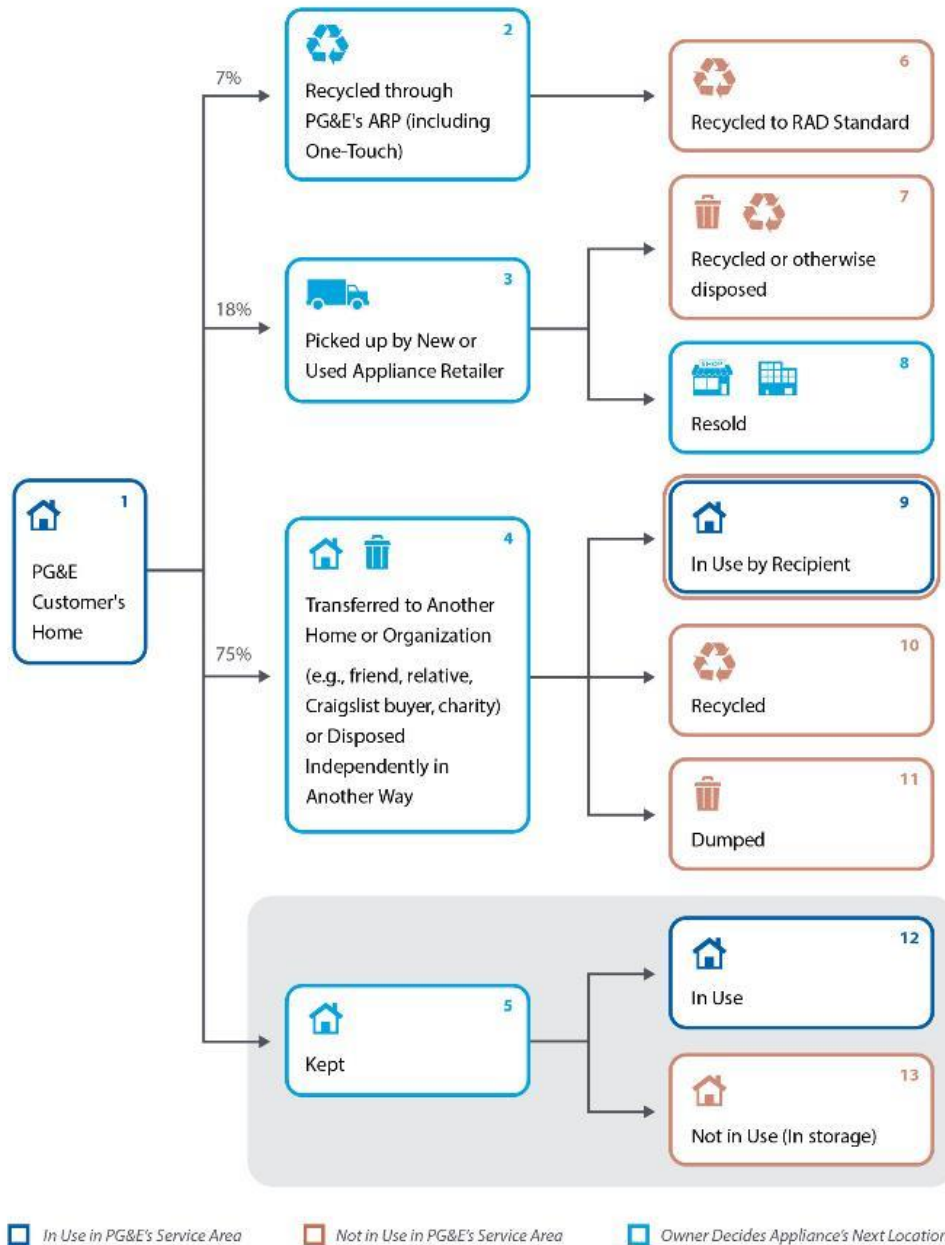
*Source for disposal percentages: Cadmus, *2010-2012 ARP Process Evaluation and Market Characterization*; 2012 estimated disposals in PG&E territory. In the Process Evaluation study, the units picked up by a new or used appliance retailer (Box 3) were reported as a subset of all units that were picked up by someone. This category, "Had it picked up" accounted for approximately 75% of all disposals in 2012. See Figure 61. PG&E Refrigerator Disposals by Method (Relative and Nominal), in the Process Evaluation report.

The focus of this study—and JACO's proposed intervention—is illustrated in box (3) of Figure 1: the unit is picked up by a retailer. Many retailers offer haul-away services to customers who purchase a new refrigerator or freezer, typically arranging for a trucking company to pick up the used unit when the new unit is delivered. These units may be recycled or disposed of in another way (8) or resold to a third party (9) such as a used appliance retailer or wholesaler. Retailer haul-away services vary across retailers and across locations; the specific outcomes documented for this study are explained in greater detail below.

Two additional disposal options lead to continued use of the appliance. The customer may transfer the unit to another user (10) or elect to keep and continue using the appliance (13). This study did not assess either of these options as potential points for PG&E's market intervention through RHAMI since they do not involve the retailer haul-away market.

Retailer Haul-Away Market Overview

Although individual retailers' appliance haul-away services vary, the haul-away market as a whole has some common characteristics, as depicted in Figure 2. The research team established the market's general structure following preliminary interviews with PG&E and JACO. We also used findings from these early interviews to direct our research to areas that would provide the best insight on how successful RHAMI would be at preventing continued use of the older inefficient refrigerators and freezers in PG&E customer households.

Figure 2. Overview of Used Refrigerator/Freezer Retailer Haul Away Market
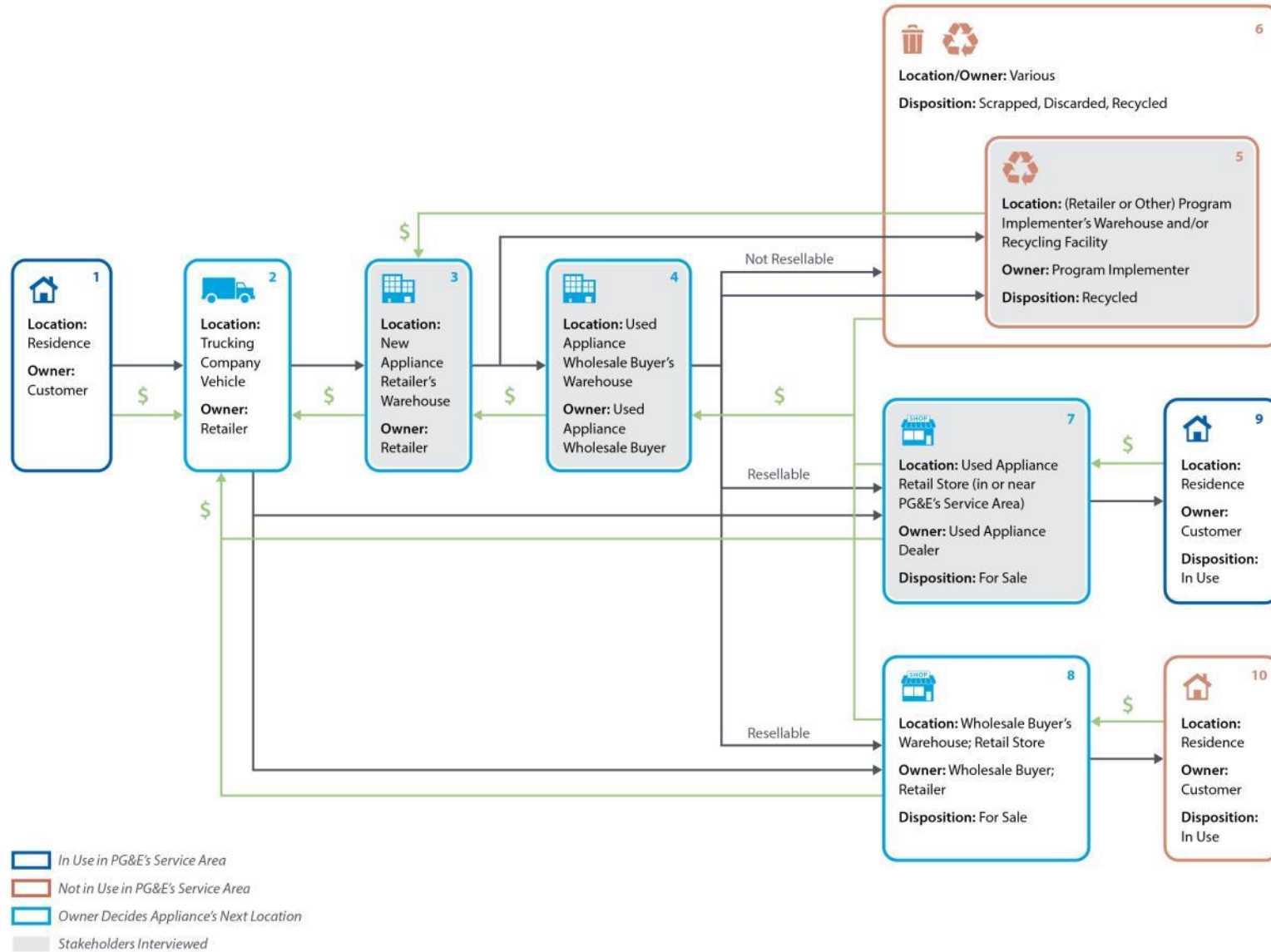
Haul-Away Process

Figure 2 follows the paths a discarded appliance might take through the market. To initiate the haul-away process, the customer signs up to have the appliance hauled away (1). Retailers typically offer this service at no charge for customers who are purchasing a new appliance of the same type. Some retailers also offer a stand-alone haul-away service, typically for a fee.

The second step is common to all retailers providing haul-away services: a trucking company picks up the unit from the customer's home (2). All of the retailers we interviewed reported using third-party vendors for delivery and haul-away services, though one retailer also uses its own trucks and staff. Typically, these companies deliver the new appliance and haul away the used one in a single visit to the customer's home, using only one vehicle to both deliver and haul away. In programs that guarantee the unit will be de-manufactured and recycled, the trucking company is sometimes required to disable the unit at the time of pick-up by cutting the power cord.

The trucking company then delivers the haul-away appliance to the retailer's warehouses (also called distribution centers) (3). However, we learned through our market actor interviews that in some cases truck drivers may sell haul-away appliances directly to used appliance retailers (7) or other buyers (8). This has the effect of diverting appliances that would be eligible for RHAMI out of the retailers' and recycler's chain of custody. For more information on this practice, see the Used Appliance Retailers section below.

Key Market Actors

Each retailer involves its own set of actors in appliance haul-away services. The general categories are:

- **New Appliance Retailers** offer the haul-away service to their customers.
- **Trucking Companies** contract with the retailers for delivery of new units and transportation of haul-away units.
- **Recyclers/Wholesale Buyers** (such as JACO, ARCA, and others) contract with retailers to take ownership of haul-away units to either recycle, resell, or both.
- **Used Appliance Retailers** obtain inventory from wholesale buyers and sometimes from drivers working for the trucking companies who sell haul-away units off the back of the truck.
- **Utilities** can provide incentives to consumers or market actors to encourage behavior that reduces energy consumption by preventing older inefficient units from returning to the marketplace.

Additional actors are involved in some retailers' implementation approaches. For example, one retailer contracts with a management company that handles all contracting with recycling providers. This intermediary party is not portrayed on the overview diagram since it does not affect the destination of the appliances flowing through the haul-away program.

PG&E's Current ARP and One-Touch Program

PG&E's ARP offerings at the time of this research—its standard ARP and its One-Touch program—interact with the haul-away market, as presented in Figure 3 and Figure 4, respectively. However, it should be noted that since JACO has ceased operations the ARP and One-Touch programs have been discontinued. In PG&E's standard ARP, the customer contacts PG&E's implementation contractor (JACO) to schedule a pick up, and the used unit is hauled from the customer's home (1) directly to the implementer's warehouse where it is de-manufactured and recycled in compliance with program rules (5). In the One-Touch program, a customer purchasing a new unit from a new appliance retailer agrees to have their used appliance picked up from their home (1) by the retailer's trucking company when the new appliance is delivered (2). The appliance is initially transported to the new appliance retailer's warehouse (3), where it is stored until it is transported by the program implementer to the implementer's facility for program-compliant recycling (5).

Figure 3. PG&E's Current Appliance Recycling Program (Standard ARP)

Card 6
Location/Owner: Various
Disposition: Scrapped, Discarded, Recycled

Card 5
Location: (Retailer or Other) Program Implementer's Warehouse and/or Recycling Facility
Owner: Program Implementer
Disposition: Recycled

Card 1
Location: Residence
Owner: Customer

Card 2
Location: Trucking Company Vehicle
Owner: Retailer

Card 3
Location: New Appliance Retailer's Warehouse
Owner: Retailer

Card 4
Location: Used Appliance Wholesale Buyer's Warehouse
Owner: Used Appliance Wholesale Buyer

Card 7
Location: Used Appliance Retail Store (in or near PG&E's Service Area)
Owner: Used Appliance Dealer
Disposition: For Sale

Card 9
Location: Residence
Owner: Customer
Disposition: In Use

Card 8
Location: Wholesale Buyer's Warehouse; Retail Store
Owner: Wholesale Buyer; Retailer
Disposition: For Sale

Card 10
Location: Residence
Owner: Customer
Disposition: In Use

Not Resellable

Resellable

Resellable

Legend:
- In Use in PG&E's Service Area
- Not in Use in PG&E's Service Area
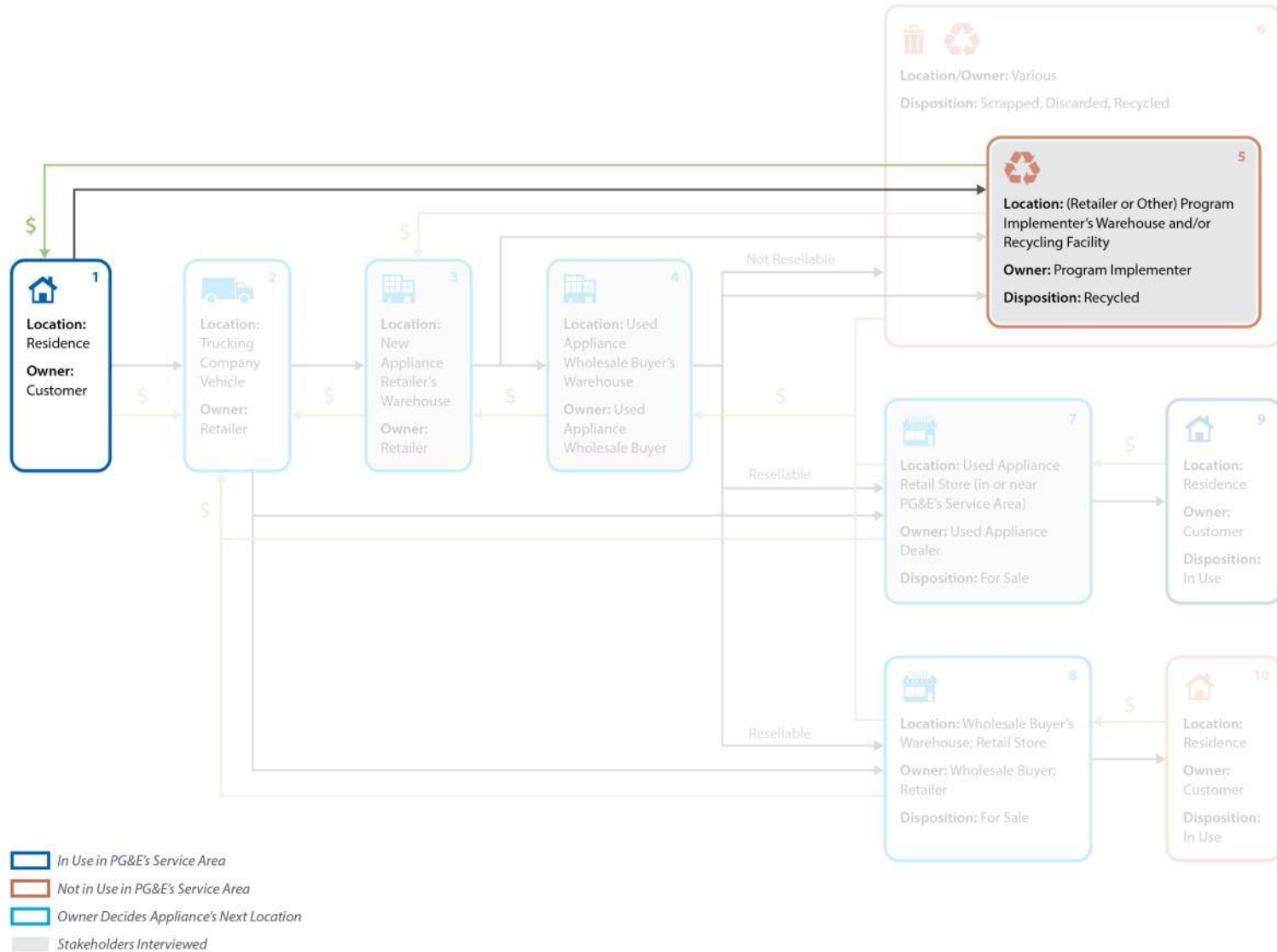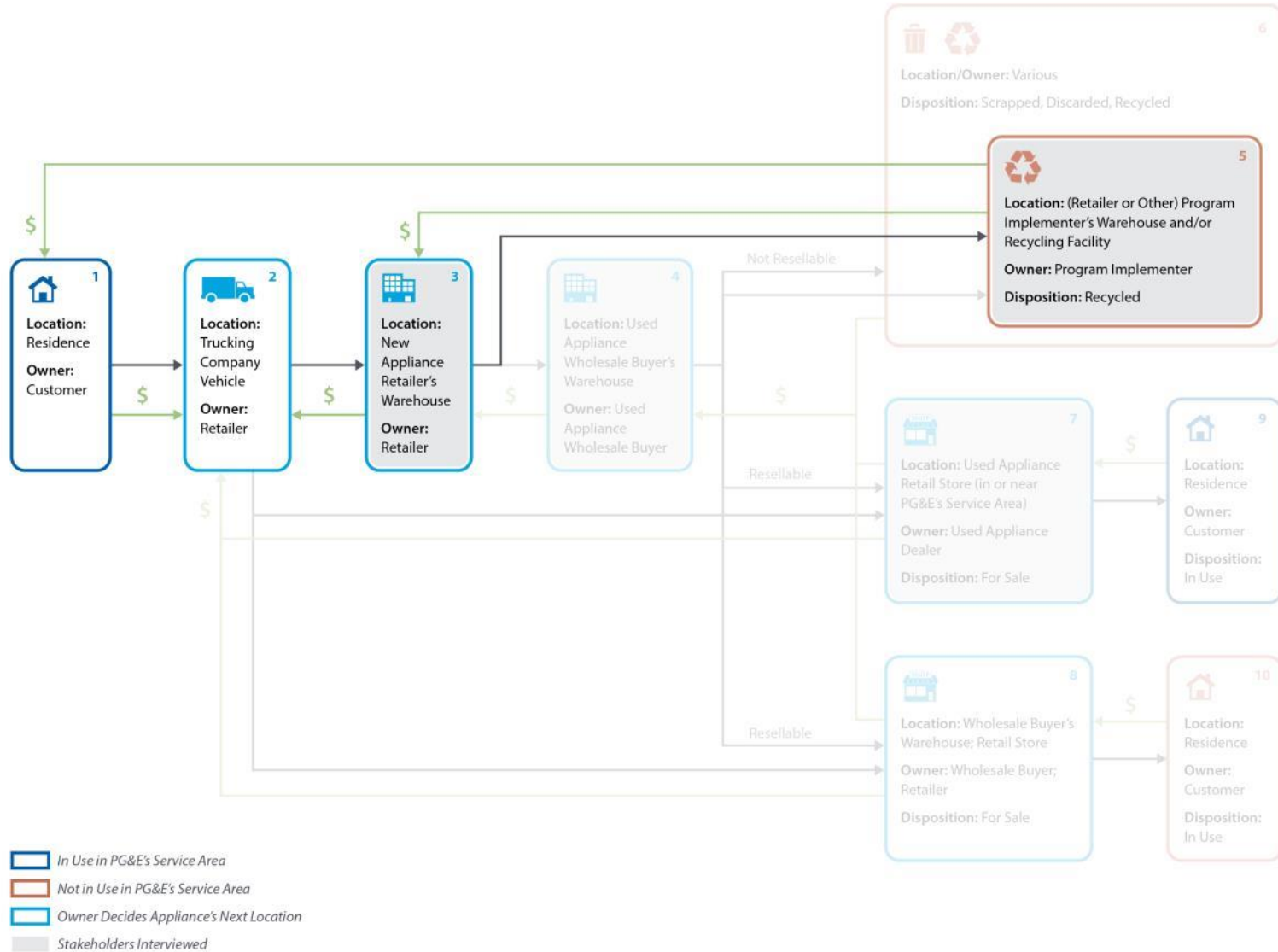- Owner Decides Appliance's Next Location
- Stakeholders Interviewed

Figure 4. PG&E's Current One-Touch Program

RHAMI Approach

To help clarify the proposed design, Cadmus modified the market overview diagram (Figure 2) by fading out the paths that RHAMI intends to eliminate. As shown in Figure 5, RHAMI would eliminate the path from used appliance wholesale buyers (4) to used appliance retail stores (7), which eventually would lead back into PG&E households (9). The units that would have followed this path in RHAMI's absence are redirected into the program implementer's recycling facility (5), where they are de-manufactured and recycled, thus preventing them from reentering the marketplace as used units.

Figure 5. Proposed RHAMI Implementation Model
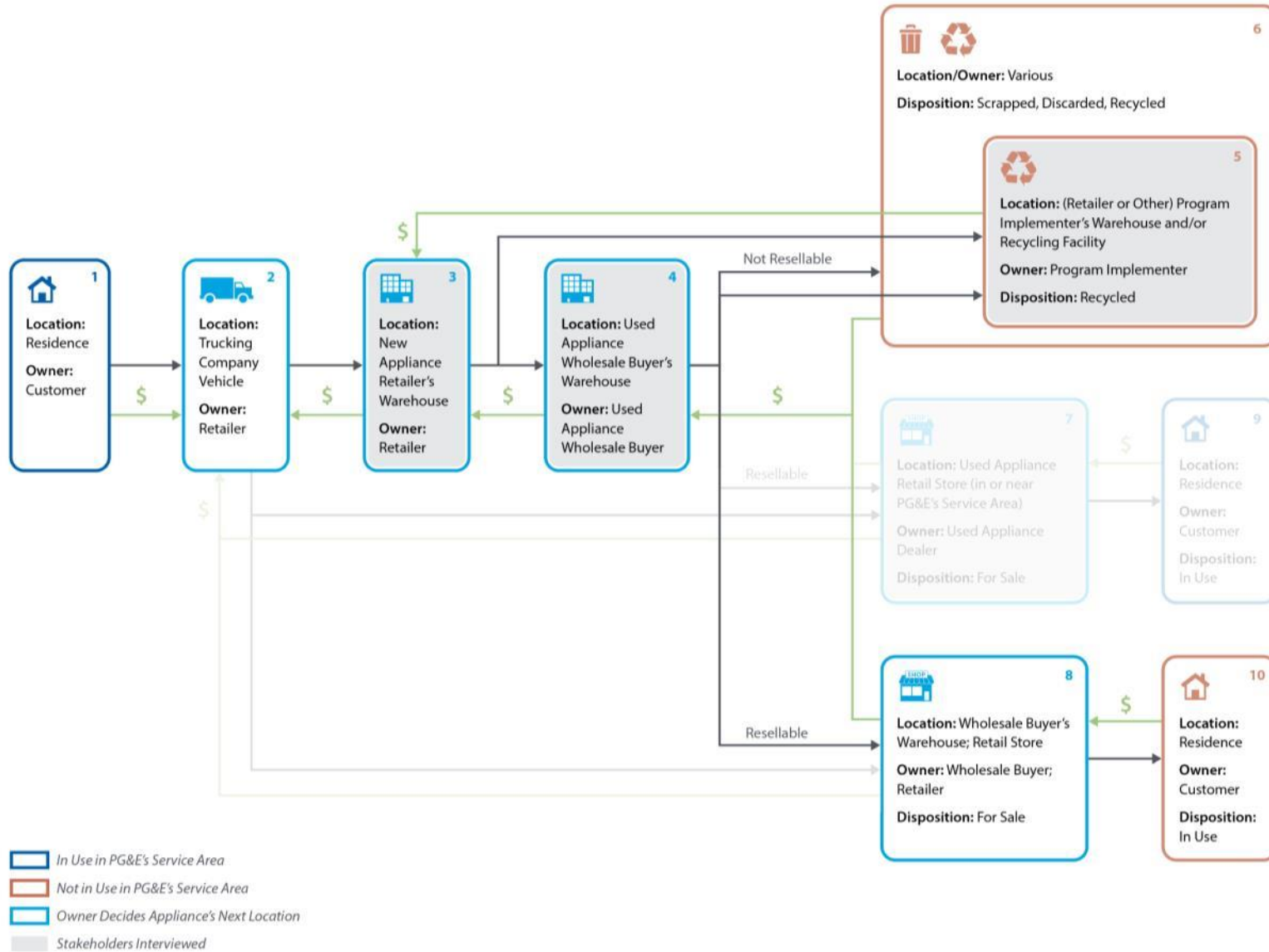
Retailer Haul-Away Scenarios

As shown above in Table 1, the research team interviewed three sets of key market actors in addition to program implementation contractors/recyclers (i.e., JACO and ARCA): new appliance retailers, wholesale used appliance buyers, and used appliance retailers. We also interviewed other parties who are implementing programs similar to RHAMI. From each interviewee we obtained in-depth information about the various steps associated with their retailer haul-away processes. This section presents these findings, describing the general processes of each market actor and how their processes relate to the design of RHAMI. Specific details that would allow individual companies to be identified are not included in this report. PG&E and the research team recognize the importance of confidentiality regarding specific retailer information.

New Appliance Retailers

Each new appliance retailer we interviewed has its own approach to handling haul-away units. Though there are many small variations, these approaches fall into one of three general categories based on the ultimate destination of the appliance:

- Approach 1: Resale Directed by Market Forces

- Approach 2: No Resale in the United States

- Approach 3: 100% Recycling with No Resale

The following sections describe each approach and provide a flowchart to document how each category of retailers handles haul-aways.

Approach 1: Resale Directed by Market Forces

Under the first approach, the retailer allows its recycling contractors (wholesale buyers) to decide what to do with haul-away units. As a result, some of the units may reenter the local market as used appliances if the recycling contractor finds that resale is profitable. This approach, represented in Figure 6, has the potential for successful intervention by RHAMI, since some units end up reentering the local market as used appliances. Approaches 2 and 3 are included as comparisons below.

In Approach 1 haul-away appliances return to the local used appliance market through one of two mechanisms:

- Recycling providers sell appliances to used appliance retailers or wholesalers who, in turn, sell the units locally or regionally. Under Approach 1, these sales are authorized by new retailers.

- Trucking company drivers, contracting with new appliance retailers to deliver new units and haul-away used ones, sell haul-aways to local used appliance retailers. Retailers do not authorize these sales, and some retailers have taken steps to prevent them.

Our interviews with used appliance retailers indicate that sales from trucking contractors are a major source of inventory for some used appliance retailers in PG&E's service area. Because of the anecdotal

evidence of leakage sales to used appliance retailers we cannot accurately estimate the number of used appliances following this path and returning to use in PG&E households.

Figure 6. Haul-Away Approach 1

Figure 6. Haul-Away Approach 1
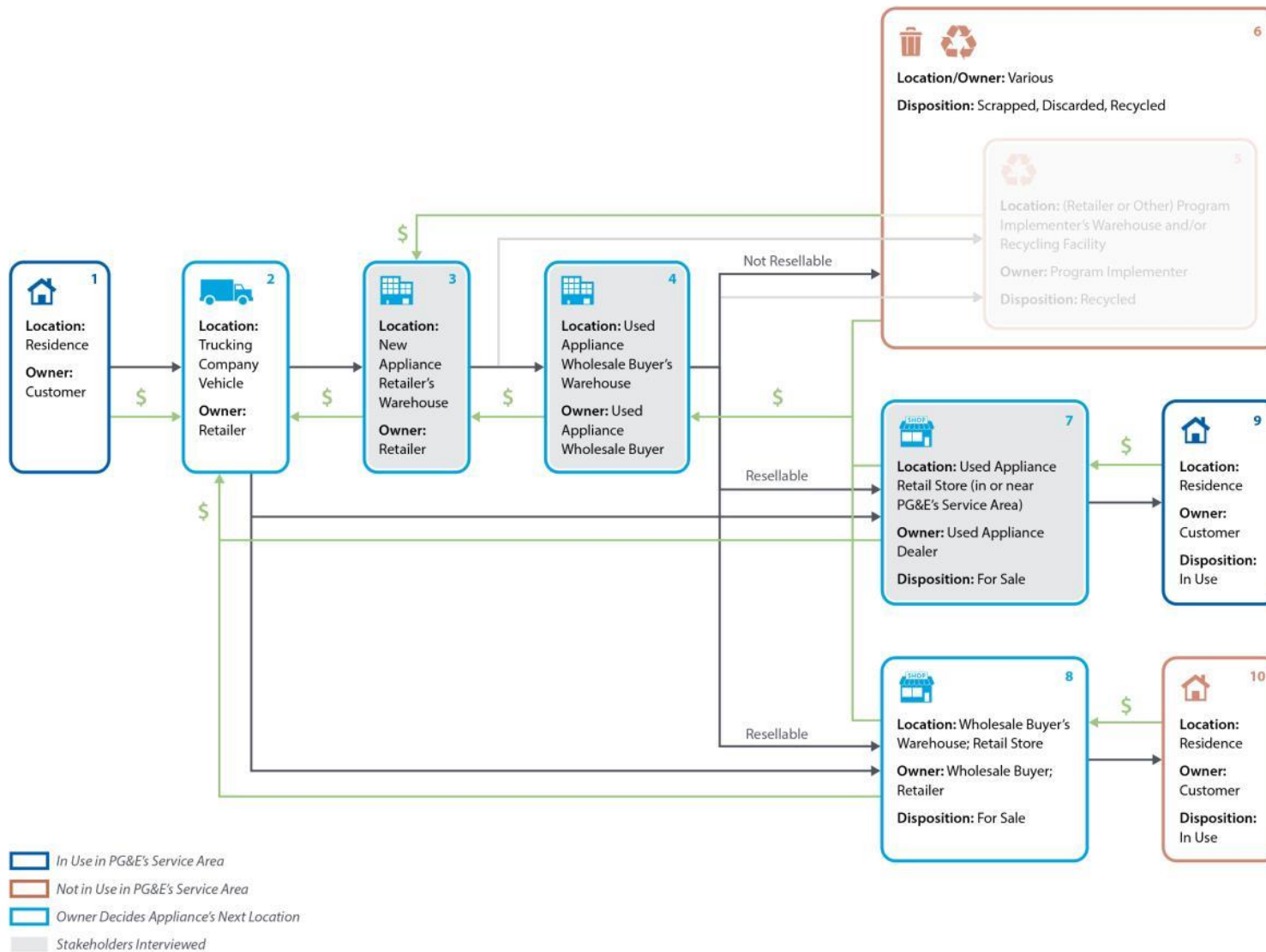
Approach 2: No Resale in the United States

In Approach 2 the retailer requires its recycling contractors (wholesale buyers) to commit to either de-manufacturing and recycling used appliances or exporting them to foreign markets. This approach results in no used appliances resold in the United States. Approach 2, represented in Figure 7 below, would not be affected by RHAMI. All units hauled away through Approach 2—if they are properly handled—are removed from the local market either through recycling or export.

However, leakage occurs in this approach as well: trucking contractors have sold haul-away units "off the back of the truck" to local used appliance dealers, rather than bringing these units back to the retailer's facility for processing.

Figure 7. Haul-Away Approach 2

Figure 7. Haul-Away Approach 2
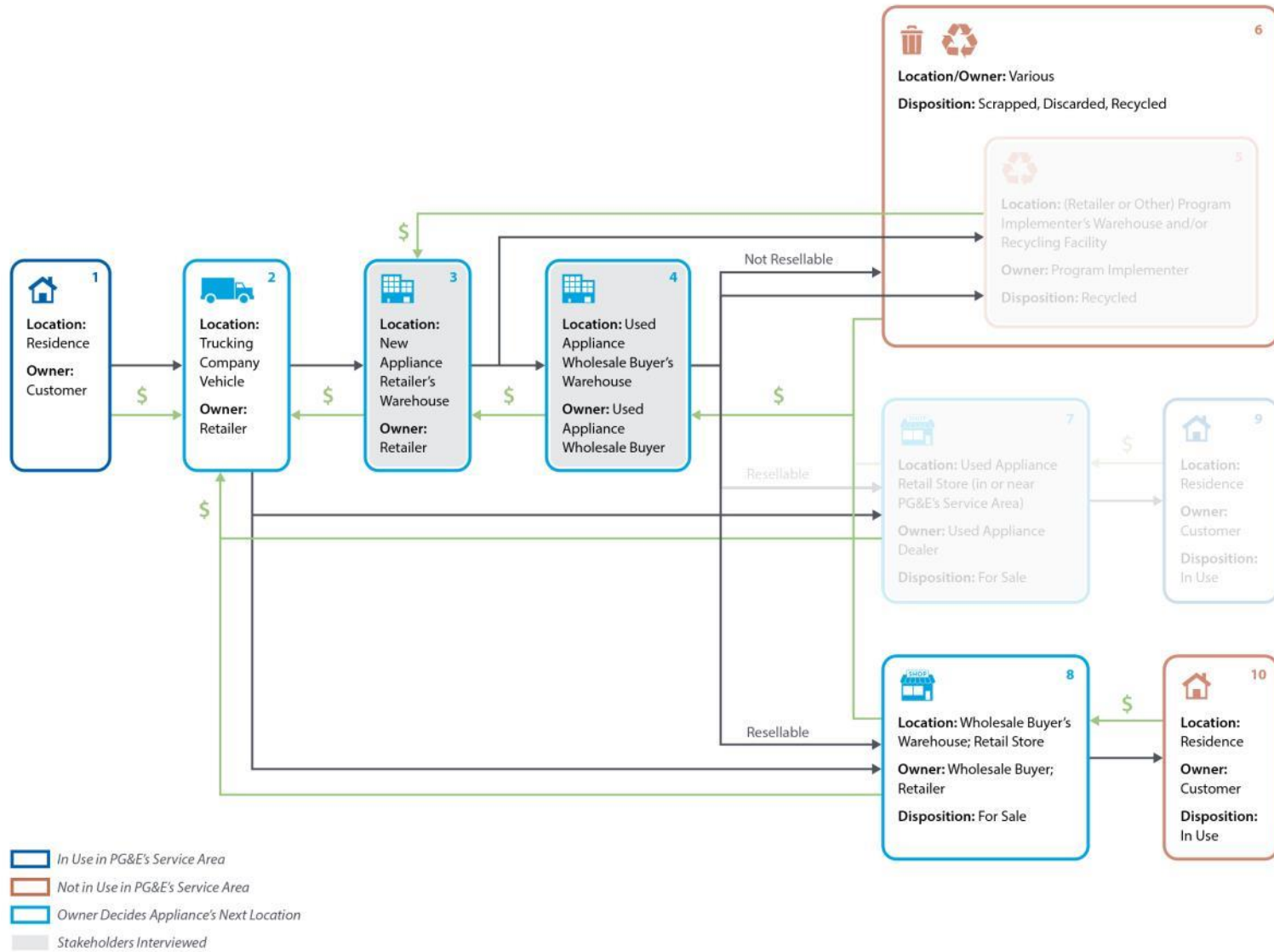
Approach 3: 100% Recycling with No Resale

In the third approach, the retailer and recycling contractor partner to guarantee that 100% of the haul-away appliances are de-manufactured and recycled. This results in no used appliance resale whatsoever. Approach 3, represented in Figure 8, would not be affected by PG&E's implementation of a RHAMI program. All units hauled away through Approach 3 are removed from the local market through recycling.

Figure 8. Haul-Away Approach 3
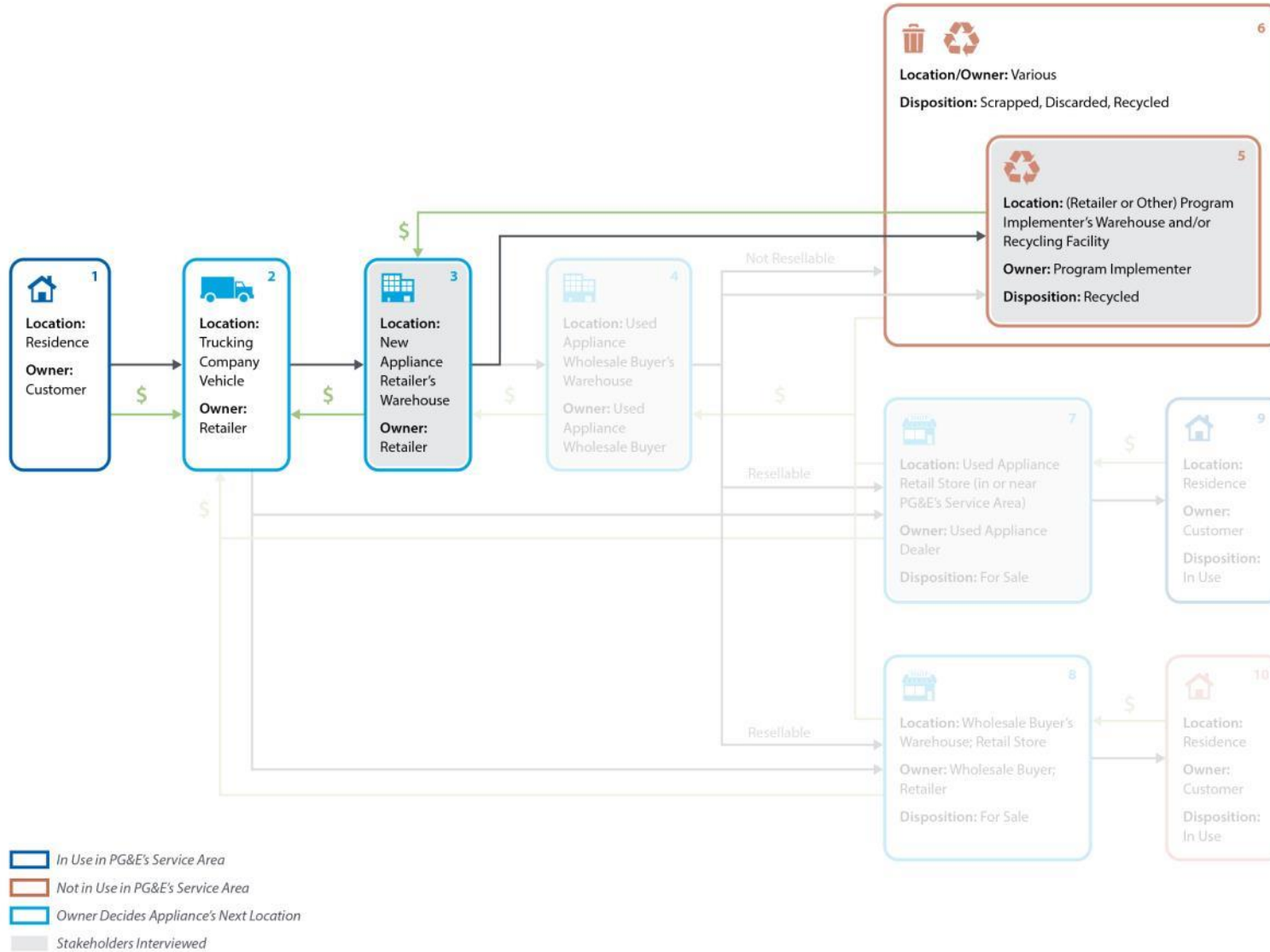
Comparison of Retailer Approaches

As described above, Approach 1 was the only one of the three approaches we documented that would fit into the RHAMI program design. Approaches 2 and 3 do not have potential for partnership with RHAMI because they already result in all haul-away appliances leaving the local marketplace.

All retailers that follow Approach 1 were supportive of the RHAMI concept, but some had concerns about program design. The key concerns were: 1) the potential for RHAMI to include burdensome data tracking requirements, and 2) the introduction of a mechanism that would impede the retailers' desire to follow a uniform haul-away mechanism nationwide.

We found several traits that were common to all retailers across the three approaches:

- All retailers sell or transfer their haul-away appliances to recyclers or other third-party vendors. None of the retailers were able to provide us with specific pricing information about these sales.
- All retailers pay trucking companies to deliver new appliances and haul away old appliances.
- None of the new appliance retailers sell used units at retail. Some retailers (three out of five) reported that removing used appliances from the marketplace was a priority for their businesses. This was because used appliances compete with the new appliance market, and eliminating used appliances would drive more customers to purchase new appliances.

The percentage of haul-away units that retailers reported are recycled or de-manufactured varied across the different retailers. This percentage ranged from 40% to 100%, and all retailers reported that there could be regional variation depending on the practices of haul-away providers or recyclers working in specific regions.

Wholesale Used Appliance Purchasing Companies

The research team interviewed two wholesale appliance purchasing companies.[11] This type of company often provides recycling services to large retailers such as those described in the previous section. The first wholesaler we interviewed (Wholesaler-A) contracts with one of the new appliance retailers the research team interviewed to provide recycling of haul-away appliances. (This retailer follows Approach 1: Resale Directed by Market Forces, described above.) Wholesaler-A operates in several states in the Midwest and South but does not operate in California. The second wholesaler we interviewed (Wholesaler-B) is a California-based company that provides recycling of all major appliances. It also sells appliances wholesale. Wholesaler-B previously sold appliances at retail locations but has since discontinued this portion of its business. Wholesaler-B does not currently contract with any large retailers to provide haul-away recycling services. The vast majority of its sales are in Northern California.

Table 3 compare key traits of the two wholesaler's haul-away and recycling processes. Although these two companies differ in terms of their customers and geographic location, they share many practices. Both companies acquire all types of appliances, without prioritizing any specific characteristics, and both companies prioritize resale over recycling. In other words, for both companies interviewed, it is more profitable to resell an intact whole appliance than to recycle an appliance for scrap metal value.

Wholesaler-A estimated that 70% of the haul-away units it acquires are resold as intact whole units, while the remaining 30% are de-manufactured. Of the resold units, all are resold in local (U.S.) used appliance markets, with the exception of units from one manufacturer. That manufacturer requires its units (when collected as haul-aways) to be shipped to foreign markets, i.e. not resold in the United States.

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[11] The Statewide ARP Impact Evaluation discusses auction houses as a significant market actor in the used appliance disposal market. For this study, we categorized auction houses as wholesale used appliance purchasing companies, since our focus was on the interaction between these companies and retailers. Both this study and the impact evaluation document differences among the various wholesale appliance purchasing companies.

Table 3. Wholesale Purchasing Company Approaches

Wholesaler	Used Appliance Supply Sources	Appliance Characteristics Sought By Wholesaler	Prioritizes Resale Over Recycling?	% De-manufactured / Recycled	Of Resold Units, % Resold in US	Price Charged for Resold Used Units	Data Tracking Perceived as Implementation Barrier?
Wholesaler-A	a) Non-utility retailer haul-aways; b) Returns to major new appliance retailers	None—appliances considered a commodity and all have some value regardless of condition or type	Yes	a) 30% of haul-aways; b) 20% of returns	100% from all but one manufacturer; 0% from that one manufacturer	N/A	No
Wholesaler-B	Homeowners and government, commercial, and industrial organizations	None	Yes	N/A	N/A	$50 to $100	N/A

N/A means interview respondent was not able to provide this information.

Used Appliance Retailers

The research team interviewed two used appliance retailers, both based in the San Francisco Bay Area. Both retailers sell all major appliances, and purchase their inventory locally. Retailer A reported that one of its main sources of inventory is drivers (employed by major new appliance retailers) that stop by its store locations to sell used appliances (haul-aways) obtained from customer homes when delivering new appliances. These transactions consist of the used retailer paying the truck driver and giving the driver a less sellable used appliance in exchange for the haul-away unit. Both used retailers also reported acquiring appliances from individuals and recyclers in the local area. Table 4 shows, where data are available, Retailer A's and Retailer B's appliance sources, average prices paid to acquire used appliances and charged at retail, and other metrics.

Table 4. Retailer Haul-Away Scenarios: Used Appliance Retailer Approaches

Retailer	Used Appliance Supply Source(s)	Average Price Paid for Used Appliances ($/Unit)	Purchase Working and Non-working Used Units?	Average Cost of Repairing Non-Working Units ($/Unit)	Used Appliance Sales		Used Appliance Haul-Aways	
					Customers	Average Price Charged ($/Unit)	Hauls Away Used Units When Delivering Newly Purchased Ones?	Price Charged
A	a) Drivers delivering new units to customers and hauling away customers' used units* b) Individuals and landlords c) Recyclers, including JACO**	$40***	Yes	N/A	Property management companies and individuals	$350 to $450	Yes	$0
B	a) Individuals b) Salvation Army c) Recyclers, when units are worth repairing	$30 to $50	Yes	$30	Individuals	$100 to $175 for refrigerator; $75 to $80 for freezers	Yes	$0****

N/A means interview respondent was not able to provide this information.

* This is the primary source for this retailer's used appliance inventory.

** Retailer A only occasionally purchases units from recyclers.

*** When purchasing units from truck drivers, Retailer A typically pays $20 to $30 and trades an older used unit for a more resalable unit.

**** Retailer B charges a fee to haul away a used appliance that is not associated with the purchase of another appliance.

Existing Programs Similar to RHAMI

The research team asked all market actors if they were familiar with any existing programs similar to RHAMI. Aside from Approach 3: 100% Recycling with No Resale, described above, the research team identified only one program similar to RHAMI—a pilot that is implemented by AEP Ohio in partnership with JACO. We interviewed the program manager at AEP Ohio regarding its program in order to identify any program design or implementation barriers.

AEP Ohio Pilot Program

The program manager for the RHAMI pilot reported that AEP Ohio began researching alternative program designs when it learned through an evaluation of its standard ARP that many used appliances outside of the program were hauled away through retailers. The utility conducted market research to determine what happened to haul-away units in its service territory.

New appliance retailers in the area reported that they hired third-party companies to deliver new units and collect used ones, which were stored at the retailer's warehouse. Someone (a haul-away or recycling contractor) then picked up the used units, but the retailers would not reveal who did the pick-ups. AEP Ohio tried different methods to investigate who was picking up the haul-aways, but was unsuccessful in finding out who took the used units.

AEP Ohio then decided to ask JACO, the implementer of its standard ARP. It learned that JACO is in the business of procuring used units from retailer haul-away offerings and that some of these units end up in used appliance retail stores.

AEP Ohio researched the cost of units sold in these used appliance retail stores and found that the stores charged between $90 and $150. Because these retail prices are low and transport is expensive, AEP Ohio assumed that JACO and other parties buying retailer haul-aways would not transport units very far. AEP Ohio, therefore, concluded that some units collected through retail haul-away offerings remained in its service area and were resold as used appliances.

AEP Ohio worked with JACO to develop a pilot very similar to the proposed RHAMI approach. Through the pilot, JACO picks up units from a specific retail partner and designates certain types of appliances as "secondary market" units—that is, units that are resold and remain in the service area.[12] The retail partner marks each unit with a ZIP Code™, which allows AEP Ohio to determine the original location of the unit; the pilot includes only units coming from AEP Ohio's territory. Some ZIP Codes in its territory overlap with municipal or cooperative utilities. For those, AEP Ohio applies an adjustment to savings that reflects the percentage of households it serves in that ZIP Code.

AEP Ohio and JACO defined participation criteria similar to those in JACO's RHAMI proposal to PG&E. These criteria require units to be in working condition, within a specified size range, and in need of no major repairs. JACO's warehouse staff determine which units qualify based on knowledge of the unit's

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[12] AEP Ohio could not share the identity of its retail partner.

resale value. AEP Ohio considered requiring JACO to take photos or otherwise document the units for evaluation purposes.

At the time of our interview, AEP Ohio was still unsure the pilot would be viable as a full-scale program. It planned to run the pilot, evaluate the results, and then determine if a full-scale program was justifiable in its next program plan. A follow-up conversation with JACO revealed that after several months of implementation, the AEP Ohio pilot had yielded a very small number of eligible participating units.

Rocky Mountain Power Utah Retailer Haul Away Program

JACO noted that in 2015 Rocky Mountain Power Utah began collecting retailer haul-away units through two retailers. The Rocky Mountain Power program uses a decision tree methodology developed by JACO to determine which units would likely be resold. The decision tree uses characteristics such as configuration, size, and features to identify eligible units. Rocky Mountain Power program staff visit the JACO facility on a regular basis to oversee the selection process and verify the condition of units.

This program has not yet been evaluated and there was no available data as to how many units are being collected by the program.

Summary of JACO's Data

JACO provided the research team with documentation of the haul-away refrigerators and freezers entering and leaving their Hayward facility. They provided one dataset on incoming units for the time period January 2015 through September 2015. Another contained records of outgoing units for August and part of September 2015. The data provided included:

- **Incoming Units:** Spreadsheets documenting the monthly number of refrigerators and freezers coming into the Hayward facility from retailer stores in the region through JACO's contract for purchasing haul-away appliances from the retailer

- **Outgoing Units:** PDF scans of bills of lading (BOLs) documenting JACO's sales of used appliances to wholesale appliance buyers as well as some key unit characteristics, such as size, configuration, year of manufacture, brand, and model.

It is important to note that JACO's documentation does not capture the amount of leakage that occurs when trucking contractors sell used units back into the local marketplace. This unauthorized practice results in units leaving the intended chain of custody: neither JACO nor the retailer obtains ownership of the appliances if they are sold before they arrive in retailer warehouses.

Incoming Units

JACO's spreadsheets documenting incoming units show a simple count of the number of refrigerators and freezers delivered to the Hayward facility in a given month. Initially JACO did not report any additional information about these units. However, because additional characteristics are necessary to determining savings potential for the units, PG&E and Cadmus requested additional information and JACO provided characteristics for the sample of only outgoing units in August and September of 2015 and indicated that collecting that level of detail for all units is cumbersome. JACO did confirm that they would be able to collect and provide such characteristics for all resold units in the future if the program were to move forward.

Table 5 summarizes the data provided on incoming units; details regarding the partner retailer have been omitted from this report for confidentiality.

**Table 5. Retailer Haul-Away Units Entering JACO's
Hayward Facility (1/1/2015-9/30/2015)**

	Total	Average Monthly	Annualized
Total refrigerators and freezers delivered	25,147	2,794	33,528

The units documented here represent only that portion of the total number of appliances JACO processes at its Hayward facility that would be potentially eligible for the RHAMI program. JACO also takes in units from other retailers' haul-away programs, as well as units from the curbside appliance

pickup service it offers to Bay Area residents. Additionally, the data JACO provided cover only refrigerators and freezers (the appliances of interest for RHAMI), though JACO also takes in and processes other appliances such as clothes washers and dryers, some of which are also resold.

Outgoing Units

JACO's BOLs documenting outgoing units for a sample time period show the number of trailer loads picked up by each wholesale buyer and a brief description of the contents of the trailer load. The research team reviewed these documents and summarized the documented transactions. These documents included numbers of refrigerator and freezer units as well as well as the resale price per-unit. Table 6 summarizes the documentation JACO provided on outgoing units by buyer location.

Table 6. Outgoing Refrigerator and Freezer Units from JACO's Hayward Facility (8/3/2015-9/8/2015)

	Buyer 1	Buyer 2	Buyer 3	Total
Buyer's Business Location	San Jose, CA	San Diego, CA	Hayward, CA	
Number of Transactions	7	1	6	14
Approximate Total Refrigerators + Freezers	21	80	128	229

As shown, all documented sales were to buyers based in California, suggesting these units will likely remain on the grid. However, 80 of the units (roughly one-third) went to San Diego, though it is not clear whether the address is the base location of a chain, which may have locations that sell units in PG&E's territory, or whether the units were taken to San Diego and, therefore, would not remain on PG&E's grid. For the purposes of establishing potential for the RHAMI program we included these units in our analysis because the units did remain in California, and unit characteristics were provided for these units, which helps to establish what types of units are viable for resale in California.

However, the 21 that went to San Jose were not included in the sample for which unit characteristics were provided. Therefore, we did not include those units in the total number of units that we used to estimate annual potential.

Implications for RHAMI

JACO proposed operating a RHAMI pilot that would capture 3,000 eligible RHAMI units over a period of one year through partnership with one retailer, and JACO's records show they take in roughly 33,000 units annually from that retailer in Northern California (see Table 5). The proposal stated that national estimates indicate approximately 40% of haul-away units return to the grid. However, when the research team investigated what happens specifically at JACO's Hayward facility—where RHAMI would be implemented—the share of units being resold was considerably smaller at roughly 6% of incoming units. Although JACO's documentation was not comprehensive enough to indicate the percentage of units that would return to use in PG&E's territory, the data indicated the following:

- There were 208 units that were resold for which characteristics were provided
- There were 3,253 incoming units during the same time period (after adjusting for partial months consistent with outgoing units)

It is also important to note that, to provide the documentation the research team requested, JACO made a specific effort to call wholesale buyers to find purchasers for the units that were resold. These units would not necessarily have been resold without JACO making a direct effort to sell the units.

This distribution means that the targeted units eligible for RHAMI – those that would return to use in PG&E's territory without program intervention – represent roughly 6% of the haul-away units taken in at JACO's Hayward facility. Thus, of the approximately 33,000 units annually received from the partner retailer, we estimate that only 2,234 would be eligible for RHAMI.

Potential

JACO indicated that they expect there would be potential to increase the number of units resold if they advertised their units to other wholesale buyers or made a more concerted effort to find buyers. They also indicated that with targeted marketing (avoiding retailers whose units would be shipped out of the country) they might have been able to resell up to 600 units monthly. Collecting 600 per month would capture around 21% of the total incoming units, which is still considerably fewer than the 30% to 40% estimated by JACO to return to the grid in their RHAMI proposal.

One important factor contributing to the lower-than expected volume of resale units is the sale of used appliances to international buyers. JACO's Hayward facility provided the research team with documentation of approximately 2,820 refrigerators and freezers (67 trailer loads) that were sold to buyers based in Tijuana, Mexico covering a 13-month period from June 2013 through May 2014. Although these units are very likely to be used in households, those households are not within PG&E's service territory. Thus, although the environmental impact of the internationally sold units is substantially different from the environmental impact of a recycled unit (due to trucking emissions, potential for inappropriate disposal of refrigerant, etc.), the energy impact on the PG&E system is the same. In both cases, the units are removed from PG&E's grid, and thus are not candidates for RHAMI or any other utility-sponsored appliance recycling program.

JACO mentioned that at some of their other California facilities they have been able to resell nearly 100% of their units on a regular basis. However, many of these units were likely sold to wholesalers that would export these units from California and many were also used only for parts. In both of these scenarios the units would not have remained active on the grid and would be considered freeridership if captured in the RHAMI.

However, there may be additional sources of units than the JACO facility. In a recent impact evaluation of the appliance recycling programs[13] for the California investor owned utilities (IOUs) the authors estimated that nearly 100,000 used refrigerators and freezers enter the supply-side retail market

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[13] DNV GL, *2010-2012 Appliance Recycling Program Impact Evaluation*. October 24, 2014.

annually. Roughly half of these sales take place through retailers that deal in new and used appliances and retail chains. The other primary market actors are charity chains, accounting for nearly a quarter of used sales, and auction houses, accounting for about 14%. Of the appliances re-entering the retail market, nearly two-thirds are resold each year, and the vast majority are sold to individuals and those units are assumed to continue operating in the IOUs' territory.

There is little opportunity for RHAMI to capture the units sold through charity chains as they would likely prioritize serving their respective populations. The auction houses may prove to be challenging as well, as documenting unit characteristics would likely be difficult and market pressure may price units beyond what is cost-effective for the RHAMI.

That leaves other retailers as potential sources of additional units. There were no indications in the recent evaluation report indicating which retailers participated in the interviews used to estimate the retail market. However, as PG&E is one of the IOUs operating in California, they may be able to request additional information from the authors at DNV GL. Without that information it is difficult to estimate additional potential with any confidence.

Program Savings and Costs

The research team estimated likely program savings and costs to provide PG&E data for cost-effectiveness screening of RHAMI. We developed the estimates described below based on the best available methodologies and data, but recognize these values could be updated if new data or methodologies become available.

The research team based our approach on the U.S. DOE's Uniform Methods Project for Determining Energy Efficiency Program Savings, Chapter 7: Refrigerator Recycling Evaluation Protocol (UMP protocol) rather than the 2010-2012 California Statewide ARP impact evaluation because the 2010-2012 evaluation had a much smaller metering sample with which to estimate savings. The meter database used to develop the UMP protocol captures a greater variety of appliance characteristics. This protocol, established in 2013, documents industry best practices for evaluating refrigerator recycling programs, and provides recommended values for some inputs into savings calculations.

Gross Savings

RHAMI would achieve energy savings by preventing inefficient units from reentering the marketplace as used appliances. The savings occur when a prospective buyer of a used appliance decides to buy a new (more efficient) appliance in place of a used (less efficient) appliance.. Traditional ARPs also affect energy savings in the same way in addition to encouraging consumers not to keep extra appliances in use in their homes; the research team therefore believes it is appropriate to apply the same framework for estimating gross energy savings for RHAMI as for traditional ARPs.

According to the UMP protocol, the gross energy savings (kWh/year) achieved from recycling refrigerators should be calculated using the following general algorithm:

$$GROSS\_kWh = N * EXISTING\_UEC * PART\_USE$$

Where:

$GROSS\_kWh$	=	Annual electricity savings measured in kilowatt-hours (kWh)
N	=	The number of refrigerators recycled through the program
$EXISTING\_UEC$	=	The average annual unit energy consumption of participating refrigerators
$PART\_USE$	=	The portion of the year the average refrigerator would likely have operated if not recycled through the program

In order to be eligible for RHAMI, units must be likely to be resold in PG&E's territory. JACO's proposal indicated that JACO staff would be able to identify which units would be resold. These units, according to JACO, are typically newer (at least manufactured after 2001, and often even more recently), attractive, defined as having a white or stainless steel finish, and in good condition. Since JACO's haul-away data (summarized above) included unit details, the research team used these data to estimate average unit characteristics of the resold units that would likely be eligible for RHAMI. These characteristics are described in more detail below in Annual Unit Energy Consumption.

Number of Eligible Units

To estimate the first parameter in the gross savings algorithm, N, or the number of participating units, the research team compared JACO's proposed participation numbers to the quantitative findings of this study assuming that JACO would be able to sell a similar number of units each month as they did in the sample period.

As described above in the Summary of JACO's Data, the best information the research team was able to obtain indicates that 6% of the haul-away units taken in at JACO's Hayward facility would eventually return to use in PG&E's territory and, thus, are eligible for RHAMI. According to the data JACO provided, this results in a relatively small eligible population of units coming from the partner retailer: approximately 2,234 units annually.

Annual Unit Energy Consumption

The UMP protocol stipulates that UEC should be calculated using a regression-based analysis relying on metered data collected within the previous five years. Best practice is to use metered data from units participating in the program in question (in this case, RHAMI) to estimate a regression model that predicts UEC. These data are unavailable, since metering was not a component of this study.[14] Another

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[14] Metering for the purposes of evaluating RHAMI would be difficult, since the program would not directly engage the customers disposing the units in question. Unlike with a typical ARP, where the participant customer agrees to have their appliance metered prior to its removal, this would not be possible for RHAMI. Although alternative metering strategies could be developed, since RHAMI units would be similar to certain

viable data source would be metered data representing a similar program in a similar geographical location. For example, the California Statewide ARP Impact Evaluation includes metered data and a regression model, and those data would be appropriate to apply to RHAMI. However, since that study collected a small sample of meter data, the research team elected to estimate UEC in two ways: (1) following the UMP protocol and applying the best available source of data for the present study, which is the previous (2006-2008) California statewide impact evaluation of ARP; [15] and (2) using UECs for appliances comparable to RHAMI-eligible units from a previous version of the Database for Energy Efficient Resources (DEER). [16] This approach resulted in two gross savings values: a high case and a low case. We carry these two values through the net savings analysis as well.

UEC High Case: UMP Protocol with Best-Available Data

First, the evaluation team estimated UEC following the UMP protocol and applying the findings of the 2006-2008 High Impact Measure Evaluation. This evaluation, completed in 2009, estimated the regression model based on *in situ* meter data for a sample of appliances that were scheduled to participate in California IOU ARPs. Table 7 shows the model coefficients from the 2006-2008 study's regression model, which we used to calculate a high case for RHAMI's gross savings. Though this is the most representative model available for estimating RHAMI's savings, the research team recognizes that the metering sample included many older units.

Table 7. Regression Model for Refrigerator UEC: 2006-2008 California Statewide ARP Evaluation

Independent Variable	Estimate Coefficient
Intercept	506.05
Dummy: Single Door	-629.71
Dummy: Side-by-Side	435.71
Age (Years)	25.88
Dummy: 2009 Metering Sample	-340.35
Dummy: Primary Appliance	256.47
Household Size	71.15
Dummy: Warmer Climate Zone	225.77

The UMP protocol recommends calculating average characteristics of participating units based on program tracking data for evaluations. Therefore, the research team estimated average values for unit characteristics from the sample of resold units provided by JACO, and the information gathered through interviews.

Because collecting the unit characteristics for the haul away units is a new process for JACO, the research team reviewed the data for accuracy, particularly the appliance vintage, or year of manufacture, as age is one of the primary explanatory variables. The team matched brand and model

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units in standard ARPs, it would be possible to continue using metering data from the standard ARP as the basis for evaluating RHAMI.

[15] The Cadmus Group. *Residential Retrofit High Impact Measure Evaluation Report*. 2010.
[16] DEER 2004-2005. Table 2-5: 2004-05 DEER New Refrigerator Measure IDs and Savings Estimates. http://www.deeresources.com/files/deer2005/downloads/DEER2005UpdateFinalReport_ItronVersion.pdf

numbers provided by JACO to the CEC database of non-commercial refrigerators and freezers, using the date added to verify when each model was tested and, therefore, presumably available on the market.

Many appliance models were available for multiple years and so had a range of dates. If JACO's reported vintage fell within this range then the vintage was determined to be accurate. If the range did not match, the date added from the CEC database was listed. We then compared the reported vintages and year of the date added from the CEC data.

The team verified vintages for a sufficient sample to test for differences in reported vintages at the 90% confidence level. The team found that the mean vintage of the reported and verified were identical and no significant difference was found.

Additionally, the team requested details of the process used to determine the appliance vintage used by JACO. JACO confirmed they used the same process to determine vintage as the standard ARP programs, which has generally been accepted as valid.

We used an assumption of 100% as the proportion being primary appliances, reasoning that a newer appliance that is replaced with a new appliance (and, therefore, eligible for the retailer haul-away service) is much more likely to be used as a primary appliance.

The research team used an average household size of 2.7, which was the average participant household size identified in the 2010-2012 ARP Process Evaluation.[17]

Table 8 shows the calculation of refrigerator UECs. We calculated UEC values by summing the products of each model coefficient and the value of its corresponding explanatory variable.

Table 8. Refrigerator UEC Calculation: High Case

Independent Variable	Estimate Coefficient	Value
Intercept	506.05	1
Dummy: Single Door	-629.71	0
Dummy: Side-by-Side	435.71	0.42
Age (Years)	25.88	18.73
Dummy: 2009 Metering Sample	-340.35	1
Dummy: Primary Appliance	256.47	1
Household Size	71.15	2.7
Dummy: Warmer Climate Zone	225.77	0
Annual UEC (kWh)		**1,283**

This regression model was developed based on a metering sample of 350 refrigerators that included predominately older refrigerators: only 5.3% of the appliances in the sample were manufactured after 2000. Furthermore, since the study was conducted in 2009, no appliances manufactured after 2009

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[17]   Cadmus, *Appliance Recycling Program Process Evaluation and Market Characterization, Volume 2,* 2013.

were included. Consequently, the UEC estimated through this analysis should be regarded as the upper limit of the possible UECs for RHAMI units.

This model is, nonetheless, the most representative model currently available for the RHAMI assessment. That said, the research team expects that, because of the characteristics of the underlying meter data, the model is likely to overstate UEC values for the newer units eligible for RHAMI.

UEC Low Case: Adjusted DEER UECs

Because the regression model method likely overstates UECs, the research team also estimated a low case UEC by adjusting the baseline UEC values found in the 2004-2005 DEER report. We selected the 2004-2005 version of DEER in order to align with the approximate vintage of units being recycled through RHAMI. The unadjusted baseline UECs for various refrigerator configurations and the corresponding unit sizes are shown in Table 9, along with the calculated average kWh consumption per cubic foot for each configuration.

Table 9. Unadjusted DEER Baseline UECs and Unit Volumes

Measure	UEC	Unit Volume (Cu. Ft.)	Consumption Per Cubic Foot
Refrigerator: Bottom Mount Freezer without through-the-door ice	550	17.5	31
Refrigerator: Bottom Mount Freezer without through-the-door ice	579	23.0	25
Refrigerator: Top Mount Freezer without through-the-door ice	450	15.5	29
Refrigerator: Top Mount Freezer without through-the-door ice	469	17.5	27
Refrigerator: Top Mount Freezer without through-the-door ice	532	23.0	23
Refrigerator: Side Mount Freezer without through-the-door ice	595	15.5	38
Refrigerator: Side Mount Freezer without through-the-door ice	636	23.0	28
Refrigerator: Side Mount Freezer with through-the-door ice	670	23.0	29
Refrigerator: Side Mount Freezer with through-the-door ice	761	28.0	27

Cadmus calculated a weighted average of the DEER baseline UECs based on the distribution of configurations found in the sample of resold units provided by JACO, limiting the eligibility as shown in Table 10.

Table 10. Low Case Eligibility Criteria

Characteristic	Eligibility Criteria
Age (in 2012)	Manufactured after 2006
Configuration	Side-by-Side, Top Freezer, or Bottom Freezer
Color	White or Stainless Steel

Next, we applied a degradation factor. This adjustment accounts for the fact that an appliance's efficiency declines over time due to mechanical wear and tear. For consistency, we used an annual degradation factor of 2.2%, the degradation value applied in the 2006-2008 *Residential Retrofit High Impact Measure Evaluation Report*.

The resulting UEC, shown in Table 11, is considerably lower than the high case UEC estimated above using the 2006-2008 regression model. The research team believes that the low case UEC is likely to be closer to the actual UEC a RHAMI program would produce as the units resold are more likely to be in better operating condition than units recycled through a traditional ARP program.

Table 11. Refrigerator UEC Calculation: Low Case

Estimate	Low Case: DEER-based UECs with Limited Eligibility
Average UEC (Adjusted for Degradation)	685

Part-Use Factor

After calculating the average UEC, the next step in estimating gross savings is applying a part-use factor adjustment. For a typical ARP, the part-use factor is estimated through surveys with participating customers. Because customers would not be engaged directly with RHAMI, the part-use factor needs to be estimated through benchmarking against prior ARP impact evaluations and making an assumption about the percentage of RHAMI units that are primary. The research team employed different part-use factors for the high and low cases. For the high case we applied a 0.996 adjustment, based on the findings of the 2013 SCE Retailer Trial study. For the low case we applied a 0.95 adjustment, based on the participant part-use factor estimated in the 2010-2012 process evaluation. The gross per-unit savings values adjusted for part-use factors, are shown in Table 12.

Table 12. Refrigerator Gross Per-Unit Savings: High and Low Cases

Savings Case	Estimated Average UEC (kWh)	Part-Use Factor	Estimated Average Gross Per-Unit Savings (kWh)
High	1,283	0.966	1,278
Low	685	0.95	651

Net Savings

The UMP protocol states, "In the case of refrigerator recycling, net savings are only generated when the recycled appliance would have continued to operate absent program intervention (either within the participating customer's home or at the home of another utility customer)."

The UMP protocol designates two parameters involved in calculating net savings. The first, Freeridership and Secondary Market Impacts, applies to RHAMI and is explained below. The second, Induced Replacement, does not apply to RHAMI, so is not included in the research team's calculations.[18]

Freeridership and Secondary Market Impact

The UMP protocol recommends using data from surveys with program participants, surveys with nonparticipant appliance disposers, and market research to estimate freeridership and secondary market impacts. It recommends combining these data to populate a decision tree of all possible savings scenarios, and taking a weighted average of those scenarios to calculate net savings. According to the protocol, "This decision tree is populated based on what the participating household would have done outside the program and, if the unit would have been transferred to another household, whether the would-be acquirer of that refrigerator finds an alternate unit instead."

In RHAMI, because the customer has already discarded the unit by having it hauled away by a retailer, there are two possible scenarios for what happens in the program's absence:

- The unit would have been sold to a third party (such as a used appliance dealer) who would return the unit to use in another customer's household, or
- The unit would have been sold to a third party (such as a recycler or exporter) who would remove the unit from service.

These two scenarios encompass what is referred to as "freeridership," or the proportion of units that would have been taken off the grid absent the program's intervention. The research team's quantification of freeridership is described below in the Freeridership section.

As with freeridership, RHAMI differs slightly from the standard ARP in terms of its so-called "secondary market impacts." As described in the UMP:

"In the event that the unit would have been transferred to another household, the question then becomes what purchasing decisions are made by the would-be acquirers of participating units now that these units are unavailable. These would-be acquirers could:

1. Not purchase/acquire another unit
2. Purchase/acquire another used unit.

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[18]   Induced Replacement occurs when a recycling program causes a participating customer to choose to purchase a replacement appliance. Since RHAMI does not involve direct participation or incentives for customers, this effect is not applicable to RHAMI

Adjustments to savings based on these factors are referred to as the program's secondary market impacts. However, unlike the standard ARP, RHAMI operates solely through retail channels. That is, no haul-away units (according to the findings of this study) are likely to be sold or given away by individuals. Rather, the haul-away units that return to the grid are likely to do so via a used appliance retail store. Due to this difference, the research team made slightly different assumptions in quantifying the secondary market impact of RHAMI. These are described below in the Secondary Market Impacts section.

Freeridership

Determining the freeridership percentage for RHAMI is difficult. Retailers and recyclers do not currently collect detailed information about the characteristics and eventual disposition of units they process through their haul-away operations outside of utility interventions. This means the research team has no documentation upon which to establish a counterfactual, i.e., a determination about the disposition of each unit in the absence of program intervention.

For the purpose of testing the RHAMI program concept, the research team must assume a prospective accuracy rate, i.e., a freeridership ratio. We did so, as we did for gross savings, by considering two scenarios. For the high case, we used a zero freeridership scenario that assumes JACO would be able to identify with 100% accuracy units that would have otherwise gone on to be resold in the local used appliance market. For the low case, we used a slightly higher level of freeridership, assuming that JACO's accuracy is 75%. Our assumptions are based on the research team's interviews with JACO and the used appliance retailers, which found the process of selecting re-sellable appliances is based partly on subjective criteria such as the attractiveness of the unit.

However, evaluating freeridership for RHAMI would be difficult. The research team brainstormed possible approaches for assessing freeridership in RHAMI. One possible approach that the team deemed viable would be collecting characteristics for a sample of units within the pilot period. JACO established a decision tree that uses specific unit characteristics that make an appliance more likely to be resold. The team recommends collecting unit characteristics for a sample of all appliances collected through the haul away program and evaluating JACO's decision tree to assess how well the decision tree predicts which will be sold. The accuracy rate of the decision tree could replace the assumed accuracy rates described above.

Secondary Market Impacts

To estimate secondary market impacts, the research team made informed assumptions about the effect the removal of haul-away units from the used appliance market would have on prospective buyers. Even if JACO staff accurately select the units they would have otherwise resold in the local used appliance market, the effects on would-be acquirers of used appliances (i.e., the secondary market impacts) still cannot be measured. This challenge exists for standard ARP evaluations as well: it is impossible to measure the hypothetical action of a consumer in a hypothetical situation.

The UMP protocol explores this issue in great detail, and recommends for a standard ARP that evaluators assume 50% of the would-be acquirers of program units would find an alternate unit. However, the prospective buyers affected by RHAMI would differ from those affected by a standard ARP. In a standard ARP, some prospective buyers are acquiring the appliance (sometimes for free) through informal channels, e.g., from friends or neighbors. The RHAMI program design, however, affects only units that would be resold through formal retail channels, i.e., at used appliance stores. The research team believes that consumers shopping for appliances at retail stores are more determined to find appliances than those acquiring appliances through informal channels. Thus, we adjusted the assumption recommended in the UMP protocol. We again created two scenarios for RHAMI: a high case assuming 75% of the would-be acquirers of program units would find an alternate unit, and a low case assuming 100% would find an alternate unit.

The next step in estimating secondary market impacts is to assess 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, a new standard-efficiency unit.[19] The UMP protocol recommends assuming that of the would-be acquirers who found an alternate unit, 50% would find a similar, used appliance and 50% would acquire a new, standard-efficiency unit. The research team does not believe that RHAMI's design would result in different outcomes for this parameter, and therefore adopted the 50% assumption recommended in the UMP protocol for RHAMI.

Figure 9 and Figure 10 depict the application of the assumptions for estimating the secondary market impacts of RHAMI. As shown, accounting for market effects results in three savings scenarios in each case: full savings (i.e., per-unit gross savings), no savings, and partial savings (i.e., the difference between the energy consumption of the program unit and the new, standard-efficiency appliance acquired instead).

Figure 9. RHAMI Secondary Market Impacts: High Case

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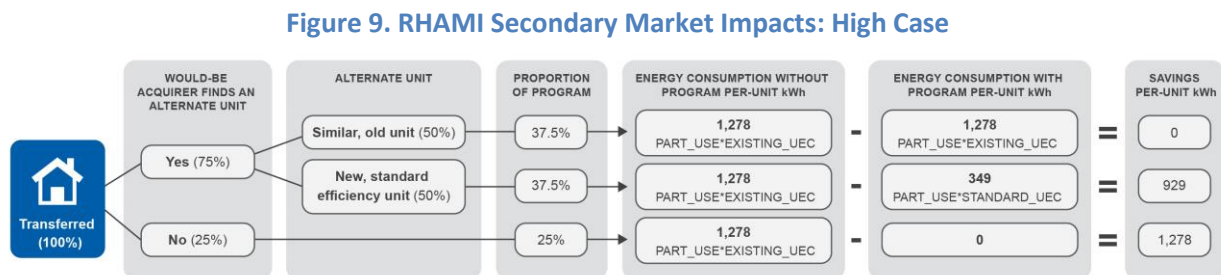
[19] The research team followed the UMP protocol's recommendation to assume the consumption of a used unit would be equal to that of a unit recycled through the program. For the average consumption of a new unit we took a weighted average of the standard-efficiency consumption values listed in the ENERGY STAR Appliance Savings Calculator (last updated May 2014, http://www.energystar.gov/buildings/sites/default/uploads/files/appliance_calculator.xlsx). We weighted these values based on the distribution of configurations in the sample of resold units provided by JACO.

Figure 10. RHAMI Secondary Market Impacts: Low Case
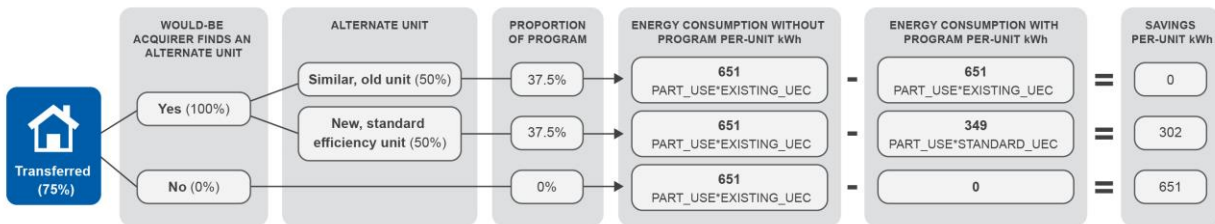
Estimating Net Savings

After estimating the parameters for freeridership and secondary market impacts, the research team used a decision tree to calculate the average per-unit program savings net of the combined (freeridership and secondary market impacts) effect. These calculations are shown in Figure 11 and Figure 12 for the high and low cases, respectively. Freeridership is represented at the first branch of the decision tree: transferred units are non-freeriders, and disposed units are freeriders. Each computation uses a weighted average of the possible savings scenarios, resulting in the estimated per-unit net savings.

Figure 11. RHAMI Savings Net of Freeridership and Secondary Market Impacts: High Case
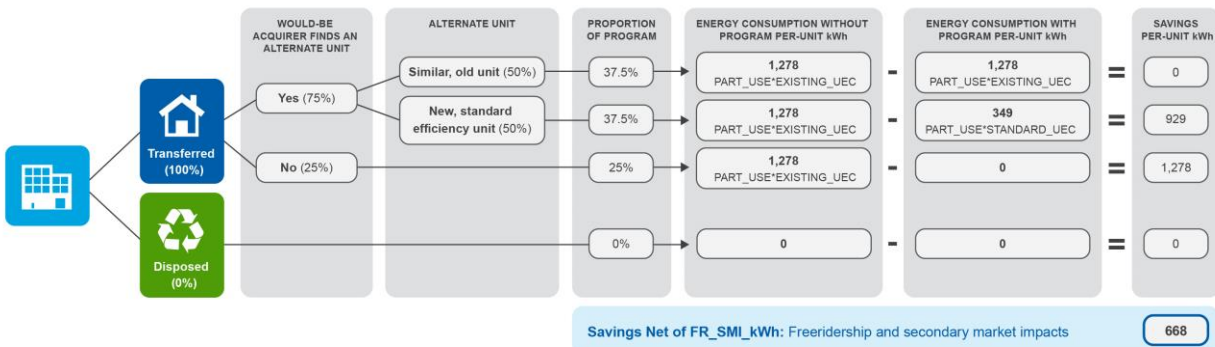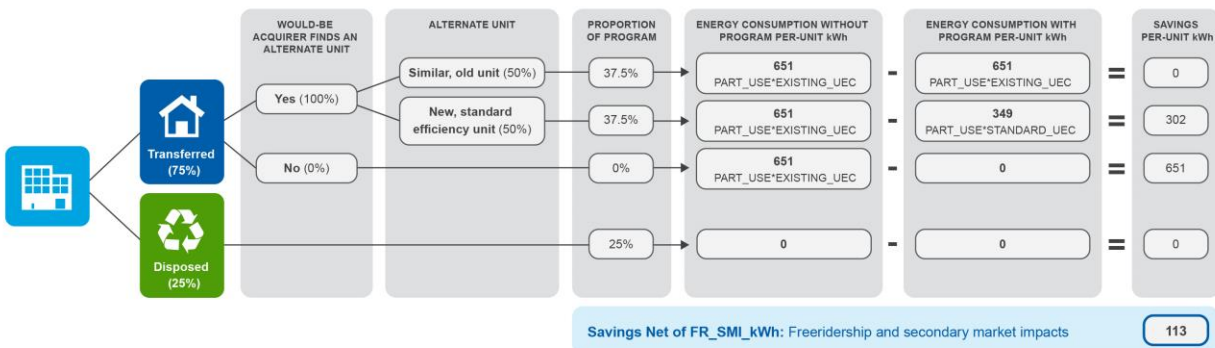

Figure 12. RHAMI Savings Net of Freeridership and Secondary Market Impacts: Low Case

Summary of Total Potential Program Savings

Applying the estimated per-unit savings to the estimated number of eligible units based on our review of JACO's data, the research team calculated the total potential gross and net savings for a RHAMI program, in both the high and low savings scenarios outlined above. Table 13 shows total potential savings and the calculated NTG ratio for each scenario.

Table 13. RHAMI Potential Gross and Net Savings and NTG Ratios

Savings Scenario	Potential Participating Units	Total Program Potential Gross Savings (kWh)	Total Program Potential Net Savings (kWh)	Calculated Net to Gross Ratio
High Case	2,234	2,855,836	,492,699	52%
Low Case	2,234	1,454,702	253,316	17%

Program Costs

Program costs for RHAMI fall into two categories: implementation costs and PG&E's program management costs. JACO's proposed implementation costs include a bounty to be paid to the partnering retailer. The research team assessed and benchmarked costs in both categories through interviews with PG&E's program team, JACO, ARCA, and new appliance retailers.

Implementation Costs

As stated above, JACO's proposed implementation cost was $60 per unit, including a $15 per-unit bounty for new appliance retailers. The research team gathered cost information from as many interviewees as possible, though many interviewees were unable to share costs due to confidentiality agreements or concerns about competing businesses gaining access to this private information.

The reported (though admittedly approximate) costs indicated that JACO's proposed per-unit cost for RHAMI appears to be reasonable. Assuming JACO's fixed costs are similar to those reported by retailers, they would be approximately $45+ per unit:

- $15 per unit: retailer bounty
- $5 per unit: transportation
- $25 per unit: de-manufacturing
- Unknown cost for program administration

Program Management Costs

RHAMI does not require any marketing or outreach costs, and according to interviews with PG&E, the internal program management costs would be minimal. PG&E staff expects that RHAMI's administration

would be similar to administration of the standard ARP and One-Touch programs. Therefore, internal program management processes would remain similar, and have already been established. Adding a RHAMI pilot to the current suite of ARP offerings is unlikely to require increasing PG&E ARP staffing levels. Nonetheless, some administrative time would be required. As a working assumption, the research team estimated that PG&E's program management costs would equal 10% of RHAMI program implementation costs for a 2,234 unit pilot. If PG&E were to pursue a full-scale RHAMI administrative costs may increase if program staff were to inspect units to verify appliance characteristics as is being done in Rocky Mountain Power's program.

Summary of Likely Program Costs

Table 14 summarizes the likely program costs for implementing a RHAMI pilot, assuming PG&E accepts JACO's proposed implementation costs. These estimates also assume that the pilot would take in only 2,234 units, rather than JACO's originally proposed 3,000 units, and that JACO's costs would remain the same despite the smaller scale program.

Table 14. Estimated RHAMI Costs

Cost Category	Per-Unit Cost	Total Cost for Pilot
Implementation	$60	$134,068
Program Management*	N/A	$13,407
Total	**$66**	**$147,475**

* Includes fixed administrative costs; value provided for comparison purposes only.

Necessary Implementation Conditions

For RHAMI to realize energy savings, it must prevent haul-away units from returning to the used appliance marketplace and being used in PG&E's service area.

Thus the three most critical market conditions for successful RHAMI implementation are:

- Retailer haul-away programs that (directly or indirectly) return units to the local used appliance marketplace
- The willingness and ability of retailers and other market actors to divert those resold units to RHAMI
- The program implementer's ability to select and document resalable units that would remain in the local used appliance marketplace without the program

Without the first market condition, the program cannot go forward. If retailer haul-away programs are already destroying or recycling all units, RHAMI would not result in any change in the used appliance market.

The second condition—market actors' willingness to divert resold units to RHAMI—could present a barrier to participation for some new appliance retailers. For example, Retailer B expressed some reluctance to participate because it anticipated (based on past experience) that PG&E's documentation and data tracking requirements could be unduly burdensome. Furthermore, RHAMI would be able to capture only the units over which new appliance retailers have control. In retailer scenarios where a substantial amount of leakage occurs through trucking providers, this condition would not be met. For example, Retailer D reported having difficulty preventing trucking providers from selling haul-away units off the back of the truck. The portion of its haul-away appliances that are sold by truckers would not be recycled through RHAMI unless further measures were taken to prevent leakage.

The third condition—selecting the correct units for the RHAMI program—requires a highly knowledgeable implementation staff capable of selecting the right types of units. This presents a major evaluability barrier. Program managers and evaluators could easily assess UEC (i.e., efficiency) to verify the implementer selected units generating an appropriate level of gross savings. However, assessing whether or not a unit would have been resold locally requires the subjective judgment of someone with experience in the used appliance marketplace in the PG&E service area.

Conclusions and Recommendations

Conclusions

The research team's findings indicate that the number of units returning to the local market through the first mechanism–specifically from JACO's Hayward facility—is considerably lower than anticipated. Documentation provided currently shows that RHAMI is likely to recycle fewer than 3,000 units per year based on the average daily volume of units documented.

Additionally, the 2,234 appliances we assume to be resold per year is based on the average number of units sold per day during the period for which JACO sold units and collected data. JACO does not regularly sell this many units, but rather specifically made an effort to contact wholesalers and sell the units during the sample period. JACO expressed confidence that they would be able to sell a similar volume, or more, on a regular basis if they made a consistent effort. However, no firm evidence was provided to support this.

There may be more potential to expand sales, but the counterfactual scenario beyond the 2,234 units annually cited in this report has not been established and increasing the number of units sold increases the likelihood of including units that would be freeriders: most notably, units that would have been sold but used only for parts and units that would have been sold and shipped out of PG&E's territory. In both cases the units would not continue to operate in PG&E's service area and, therefore, would produce no savings for the program.

Barriers to RHAMI Implementation and Evaluation

In addition to the design issues related to market dynamics described above, RHAMI's design presents several practical barriers to implementation and evaluation. The most critical practical barriers are:

- **Lack of documentation.** Currently, not all retailers and recyclers keep comprehensive documentation of haul-away units. This means that establishing a thorough understanding of the market baseline conditions is difficult.

- **EM&V needs can be burdensome for new appliance retailers.** Conducting thorough data collection and quality control adds cost to the haul-away process for new appliance retailers. This could prevent some retailers from participating in RHAMI.

- **Several net savings inputs are difficult or impossible to measure.** Program planners and evaluators will necessarily need to make assumptions about key savings parameters, leading to a high degree of uncertainty around savings.

Prospective RHAMI Savings and Costs

The research team's analysis estimated that refrigerators recycled through RHAMI would result in net savings of between 113 and 668 kWh per unit. Based on the number of annual participating units we

estimated from the data provided by JACO, , total program net savings could range from 253,316 to as much as 1,492,699 kWh annually.

Per-unit implementation costs would be lower than those of the standard ARP and the One-Touch program. However, the low unit volume RHAMI is likely to experience may not justify the costs of initiating a new program concept.

Implications for ARP

The reported destinations of retailer haul-away units have implications for net savings in both the standard ARP and the One-Touch program. Past assessments of ARP net savings may reflect different assumptions regarding the disposition of units disposed through retailer haul-away programs. Those assumptions may be outdated, or they may not apply in PG&E's territory.

Determining the destinations of used refrigerators and freezers in the retail channel is a complex and dynamic market research question. Both this study and the California Statewide Impact Evaluation study conducted by DNV-GL approached this question, and began to build a body of knowledge on the market dynamics in California. It should be noted that while the findings of this study apply for the JACO facility in Hayward, these findings are not necessarily representative of what happens with other market actors elsewhere in the state.

Recommendations

Recommendation 1: RHAMI Implementation

Based on our findings specific to PG&E's service area, the research team concludes that there are limited opportunities for a successful RHAMI pilot. With the dissolution of JACO, another entity with knowledge of the haul-away market would need to be found. Given available information and JACO's dissolution occurring as this research was concluding, no entity has been identified that could fill this role. If a viable partner could be found, the following outstanding challenges would need to be resolved as a first step:

- The low number of documented eligible units through established channels means that RHAMI would likely face challenges expanding participation.

- Lack of consistent documentation and difficult-to-estimate evaluation inputs could prevent effective evaluation of RHAMI. These include:
  - Establishing a clear counterfactual scenario and eligible population
  - Determining the fate of appliances that would have likely been resold, that is, whether they would they have been used only for parts or resold outside of PG&E's territory
  - Consistent and verifiable documentation of both incoming and outgoing appliances through the implementer's facility as well as clear documentation of sales volume

This may require sampling of unit characteristics as part of the intake process to determine whether a program implementer can accurately predict which units are likely to be resold and determining overall proportion of units being resold.

Recommendation 2: Integrating Market Knowledge

The research team recommends that PG&E's ARP team consider the new information revealed in the study as it relates to their current standard ARP and One-Touch offerings as well as new potential program designs. PG&E should avoid ARP partnerships similar to RHAMI or the One-Touch program with retailers who already remove all appliances from the PG&E service area (i.e., Approach 2 or Approach 3). Such partnerships would likely result in high freeridership.

Recommendation 3: Addressing Leakage

Based on this study's findings regarding leakage – i.e., trucking contractors' practice of selling haul-away units directly to used appliance retailers – the research team recommends that efforts be made by all key stakeholders and influential parties to work with retailers to address this practice. As a partner to the retailers, PG&E should explore methods for encouraging retailers to eliminate this practice, if such approaches would lead to documentable energy savings. Potential key influencers who could be engaged to help address this challenge would include: appliance manufacturers (with a "cradle to grave" sustainability mission); U.S. Department of Energy; U.S. Environmental Protection Agency; California Regulatory entities (including CPUC and California Department of Toxic Substances Control); and public interest groups. The most viable method for reducing leakage appears to be increased tracking of the haul-away units, similar to the tracking that currently occurs for the One-Touch program. With support of these key influencers, PG&E could explore encouraging retailers to implement this enhanced unit tracking through incentives, but further discussions with current or potential partner retailers would be required to determine the energy savings (if any) that would result from such incentives.

Recommendation 4: Further Research

The 2010-2012 ARP Process Evaluation and Market Characterization study found that approximately 75% of units discarded by PG&E customers are picked up by someone (either a retailer, an appliance hauler, or another individual). PG&E and the California IOUs have sponsored additional research to understand this secondary market for used appliances:

- The RHAMI study examined the subset of used appliances that are picked up from customers by retailers; and
- The 2010-2012 ARP Impact Evaluation examined discarded units more broadly at the statewide level. The study found that peer-to-peer transfers, including sales via the Craigslist online marketplace, represent a large portion of used appliance transfers in California.

Given the complexity of the used appliance market in general, and the remaining uncertainty about the peer-to-peer channel, Cadmus reiterates the Impact Evaluation team's recommendation to conduct further research on peer-to-peer transfers of used appliances.

Appendix A: Open Letter from ARCA, Inc. President Jack Cameron

Appendix B. Letter
from Jack Cameron