Table 5. Program Performance Aug 1, 2012 - July 31, 2013

		Freezers			Refrigerators			Combined Units		
State	Collection Period	Goal	Actual	% Goal	Goal	Actual	% Goal	Goal	Actual	% Goal
OH	Aug 1 – Dec 31, 2012	113	137	127 %	450	387	86%	563	524	93%
OH	Jan 1 – July 31, 2013	871	526	60%	3500	1558	45%	4371	2084	48%
OH	Combined	984	663	67%	3950	1945	49%	4934	2608	53%
KY	Aug 1 – Dec 31, 2012	0	32	--	0	91	--	0	123	--
KY	Jan 1 – July 31, 2013	150	98	65%	900	357	40%	1050	455	43%
KY	Combined	150	130	87%	900	448	50%	1050	578	55%

While this level of collections falls well below the program's designated goals, TecMarket Works finds that the performance gap has reasonably less to do with marketing, call center practices, or collection handling—all of which appear to be generally strong—and more to do with the initially projected harvest rates, which were calculated by an external consultant in 2006 based upon an incentive level of $30 per unit. Despite the fact that the program did not begin collecting units until six years after that study was conducted, the harvest rates and incentive levels remained the same while the marketplace and economy continued to change. This appears to be one factor in the difference between projected and actual collection numbers. Other factors are discussed in more detail in the following management section.

Methodology

Overview of the Evaluation Approach

The process evaluation consists of three primary components: management interviews, interviews with new and used appliance dealers, and participant surveys.

Study Methodology

Management Interviews

TecMarket Works conducted interviews with the Duke Energy's product manager and with its customer marketing campaign manager. We also spoke with JACO's program manager and its call center coordination manager, as well as the general manager of Appliance Distribution Inc. (ADI), the subcontractor responsible for collections in Kentucky, Ohio, and Indiana. We also talked to the account manager with Runyon, Saltzman, and Einhorn (RSE), the JACO subcontractor responsible for program marketing.

The interviews considered program design, execution, operations, staff and customer interactions, data tracking and transfer methods, and personal experiences in order to identify any implementation issues and discuss opportunities for improvement. Interview guides were used to ensure a full and complete battery of questions were addressed to the interview subjects.

Sample guides are shown in *Appendix A: Management Interview Instrument* and *Appendix B: Vendor Interview Instrument.*

Appliance Dealer Interviews

TecMarket Works conducted phone interviews with new and used appliance dealers to assess refrigerators and freezers, their opinions of the program, and its effect on their businesses. Dealers included national retailers, regional chains, and local businesses. Conversations ranged from five minutes to more than 30 minutes. Interview guides are shown in *Appendix C: Used Appliance Dealer Survey Instrument* and *Appendix D: New Appliance Dealer Survey Instrument.*

Participant Surveys

This survey focused on customers who, according to program tracking records, recycled refrigerators and/or freezers through the Appliance Recycling program from Duke Energy. The survey was conducted by telephone by TecMarket Works staff from a list of 2,357 customers in Ohio and Kentucky who recycled freezers and/or refrigerators, and 161 survey respondents completed the survey by telephone. The survey instrument can be found in *Appendix G: Participant Survey Instrument.*

Engineering Analysis

For this analysis, field technicians installed meters in situ at each of 33 selected sites to monitor energy consumption, room temperature, and door openings. Daily average outdoor temperatures were gathered from a web-based historical weather database (weatherunderground.com), using weather data for the monitoring dates and city of residence for each participant. Annual energy usage was determined by multiplying the average hourly kWh from the power meter data by 8,760. To account for differences in temperature throughout the year, data from the temperature loggers was used to plot a regression line for each unit correlating average kWh with the average

room and average outdoor temperature. The equation of the regression line was then applied to a typical meteorological year's (TMY3 data) outdoor temperature data for the Cincinnati, OH weather station to provide weather normalized annual consumption. Units were then mapped to one of the 16 paths based on participant survey responses to calculate average net savings per unit recycled (see Table 9 on page 27).

Data collection methods, sample sizes, and sampling methodology

Management Interviews

Interviews and follow up exchanges were conducted by phone with six staff members from Duke Energy, JACO, ADI, and RSE. Conversations ranged from half an hour to two and half hours. The interview instruments can be seen in *Appendix A: Management Interview Instrument* and *Appendix B: Vendor Interview Instrument*.

Appliance Dealer Interviews

Phone interviews were conducted with 24 new and used appliance dealers found via an internet search for businesses operating within Duke Energy's designated service areas of Ohio and Kentucky. Sample interview guides are provided in *Appendix C: Used Appliance Dealer Survey Instrument* and *Appendix D: New Appliance Dealer Survey Instrument*.

Participant Surveys

Duke Energy provided TecMarket Works with a list of 3,123 records for recycled appliances in Ohio (1,907 refrigerator records and 655 freezer records) and Kentucky (431 refrigerator records and 130 freezer records). After removing records with missing contact information, duplicate records, "do not contact" numbers and customers who have recently been surveyed about other programs, the sample list consisted of 2,357 contactable customers. The survey was conducted by telephone by TecMarket Works staff from the list of 2,357 customers in Ohio and Kentucky who recycled freezers and/or refrigerators, and 161 survey respondents completed the survey by telephone.

Engineering Analysis

This analysis uses a combination of in situ metering data and participant survey data. The survey was conducted by TecMarket Works staff from a random sample from a list of 3,123 customers in Ohio and Kentucky who recycled freezers and/or refrigerators, and 161 survey respondents completed the survey by telephone. Metering participants were recruited over the phone, independent of the phone survey, from a list of upcoming scheduled appliance pickups. From a list of 410 customers, there were 35 sites recruited.

Number of completes and sample disposition for each data collection effort

Management Interviews

From May to November 2013, TecMarket Works interviewed six program managers and vendors for this evaluation. This represents a completion rate of 100%.

Appliance Dealer Interviews

Between July 28 and August 22, 2013, TecMarket Works completed 24 appliance dealer phone interviews in Ohio and Kentucky. Appliance dealers were contacted a maximum of four times or until the contact resulted in a completed interview or a refusal to participate.

Participant Surveys

From the sample list of 2,357 customers (1,923 in Ohio and 434 in Kentucky), 724 participants were called between August 21 and September 6, 2013, and a total of 161 telephone surveys were conducted yielding a response rate of 22.2% (161 out of 724). Thirty interviews were completed with Kentucky customers, and 131 were completed with Ohio customers.

Engineering Analysis

For the in situ metering, from the sample list of 350 customers, all were called and 35 were recruited yielding a recruitment rate of 8.5% (35 out of 410).

Table 6. Summary of Data Collection Efforts

Data Collection Effort	State	# Available Contacts	# of Successful Contacts	Sample Rate
Management Interviews	OH, KY	6	6	100%
Dealer Interviews	OH	20	13	65%
	KY	10	11	91%
Participant Surveys	OH	1,923	131	6.8%
	KY	434	30	6.9%
Participant Surveys	OH, KY	2,357	161	6.8%
Appliance Monitoring	OH, KY	410	35	8.5%

Expected and achieved precision

Participant Surveys

The survey sample methodology for the telephone survey had an expected precision of 90% +/- 6.3% and an achieved precision of 90% +/- 6.3%.

Engineering Analysis

The expected precision of the engineering analysis was +/- 10% at 90% confidence. The achieved precision was +/-16.5% at 90% confidence. This is based on the mean energy savings and the standard deviation of the individual estimates compared to the mean. Achieved precision is less than planned as a result of a low sample size caused by recruiting difficulties and records being dropped from the sample due to bad data. Additionally, a wide range of unit consumption was observed in the metering study, resulting in a higher than expected coefficient of variation.

Description of Measures and Selection of Methods by Measure(s) or Market(s)

To qualify for the ARP, a refrigerator or freezer must be between 10-30 cubic feet and in working condition. Both primary and secondary units were eligible. All customers are in the residential market.

Threats to validity, sources of bias and how those were addressed

This analysis relies on a short term metering study with a sample size of 32. All savings estimates are a product of the conditions observed in the sample. The sample was drawn at random and is assumed to be representative of all participating customers, however, the response rate was low, indicating a potential for self-selection bias. The monitoring occurred over a short-term period and was extrapolated to annual consumption using a regression model based on outdoor temperature changes. The potential for extrapolation error associated with the regression model exists for outdoor temperatures outside the range of the monitored data. A longer metering period and a larger sample size would better represent the full spectrum of variation in characteristics and circumstances and therefore provide a more accurate estimation of savings, however, the risk to estimation accuracy is expected to be small as a result of our regression approach and the range of units included in our meter sample. The kWh consumption of a replacement unit used to calculate gross savings, where survey data indicated the recycled unit was replaced by another unit, is based on industry engineering and operation assumptions determined using a combination of historical data (adjusted for degradation based on the age of the appliance) and calculations cited in the Energy Star specifications. Customer specific data on replacement units was not available.

Net to Gross Methodology

TecMarket Works employs a direct net energy impact analysis approach that complies with USDOE's Uniform Methods Protocol (UMP). The evaluation approach used in this study is considered a best practice approach because it accounts for in-home use conditions and usage patterns as well as market operations impacts that impact energy use on the local grid. The approach is explained in the *Sixteen Path Direct Net Analysis Approach* on page 26.

Impact Estimates: Engineering

This section presents the results of the refrigerator and freezer in-situ metering study of Duke Energy's Appliance Recycling Program in Ohio and Kentucky.

The metering study was conducted by TecMarket Works and included metering at 35 sites metered from May 15 to August 19, 2013. After data processing, there were a total of 32 units with usable data sets (24 refrigerators and 8 freezers). All units were evaluated in the participants' homes using: a "Watts up?" power meter installed directly to the refrigerator; two "Onset HOBO" temperature meters, one inside the refrigerator compartment (for refrigerator/freezer combinations) or inside the freezer box (for freezers), and one measuring the temperature of the air in the space immediately surrounding the refrigerator or freezer; and a "DENT SMARTlogger" time-of-use monitor to determine door openings. A summary of the results is shown in Table 7 below.

Table 7. Summary of Engineering Savings Estimates

Estimate	Gross Savings		Net Savings	
	kWh	kW	kWh	kW
Per Participant Annual kWh Savings: Overall	528	0.0601	411	0.0468
Per Participant Annual kWh Savings: Refrigerator	485	0.0516	414	0.0441
Per Participant Annual kWh Savings: Freezer	665	0.0872	357	0.0468

Power Meter Results

The average annual raw, unadjusted consumption, as measured by the "Watts up?" power meters, of a unit recycled through ARP, including both refrigerators and freezers, is 970 kWh. Refrigerators used slightly more energy than freezers, 975 kWh compared to 954 kWh. As there were no refrigerators in the metering sample identified as primary, no comparison of primary versus secondary refrigerators is available. All freezers are considered secondary by default.

Weather Normalized Savings

The metering results, in their raw, unadjusted form, represent the energy consumption of the sampled units during the monitoring period, not for the entire year. To account for temperature differences throughout the year, the "Onset HOBO" temperature meters were used to establish a relationship between kWh and the temperature in the vicinity of the unit. Outdoor temperatures were researched in a historical weather database and found to have a strong correlation with energy consumption, since outdoor temperature affects indoor temperature in unconditioned spaces. This adjustment takes into account a waste heat factor for units in conditioned spaces.

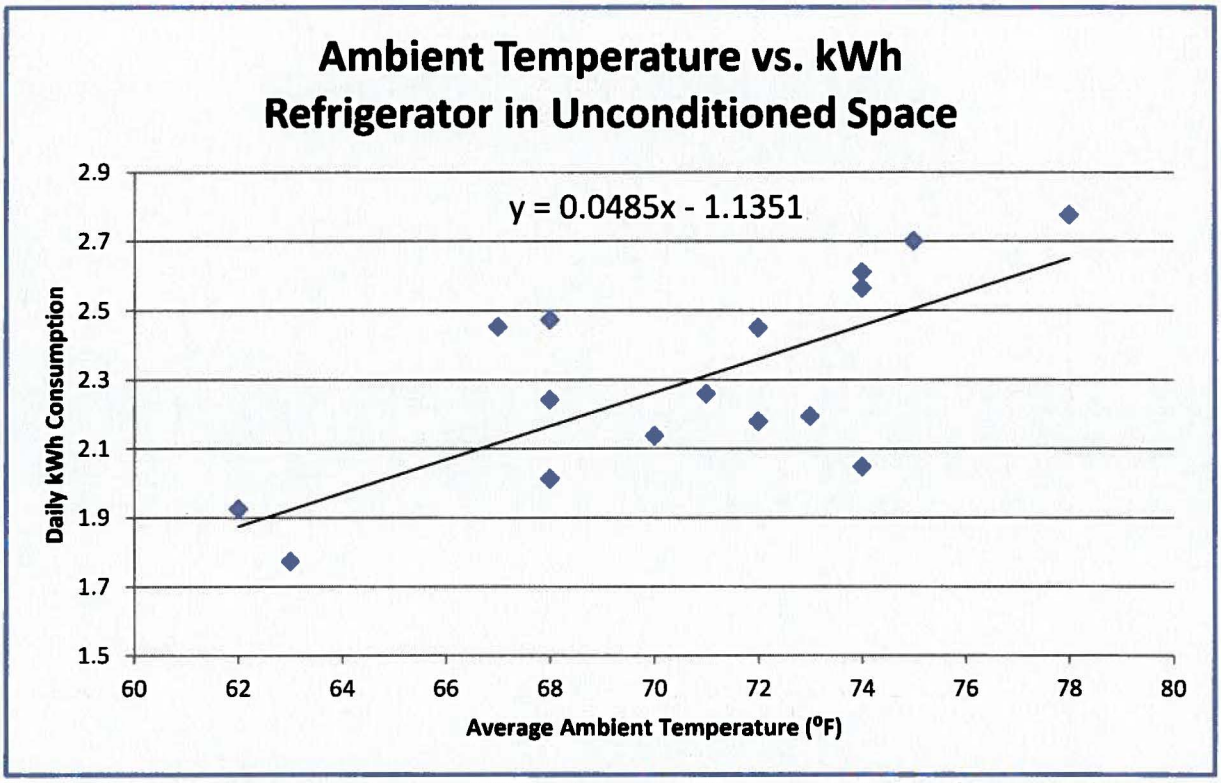


Figure 1. Ambient temperature vs. kWh: strong positive correlation; refrigerator in unconditioned space

Figure 1 is an example of a unit whose consumption has a strong positive correlation with ambient temperature. That is, as temperature increases, so does kWh consumed. The unit represented in Figure 1 is a 14 year old refrigerator located in an unconditioned space. By contrast, Figure 2 shows the regression line for a unit that has a weak correlation with ambient temperature. The unit represented in Figure 2 is a 25 year old refrigerator located in a conditioned space.

As anticipated, units in unconditioned spaces exhibit a much stronger relationship with ambient temperature than do units in conditioned spaces. The refrigerator in Figure 1 is able to use much less energy when it is cooler outside. The refrigerator in Figure 2 is largely unaffected by ambient temperature; usage pattern fluctuations drive differences in its daily consumption.

The strong predictive nature of this relationship allows for straightforward extrapolation of the monitoring period to a full meteorological year using the equation of the regression line to estimate the average year's kWh consumption based on average daily temperatures from TMY3 data for the typical (long-term average) meteorological year. The average annual weather normalized consumption of a unit recycled through ARP, including both refrigerators and freezers, is 910 kWh. Refrigerators used less energy than freezers, 862 kWh compared to 1,052 kWh. The slopes and intercepts for each unit's regression line and the accompanying weather normalized annual kWh consumption estimate can be seen in *Appendix K: Regression Table.*

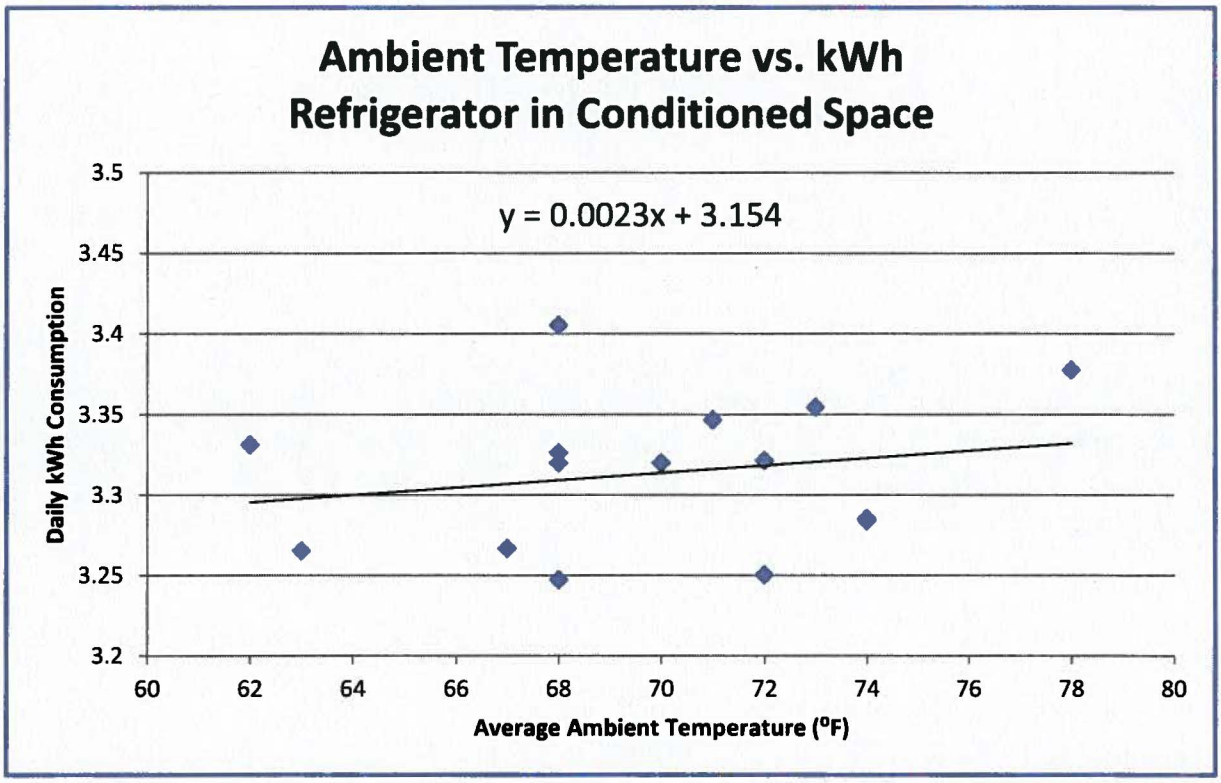


Figure 2. Ambient temperature vs. kWh: weak correlation; refrigerator in conditioned space

In-Service Rate

The in-service rate is defined as the proportion of the year a given recycled appliance had been in use rather than unplugged. If recycling a secondary refrigerator or a freezer, respondents to the participant survey were asked to add up the time the unit in question was plugged in and running during the last 12 months. The average secondary refrigerator has an in-service rate of 75.2% (9.02 months out of 12). The weighted average in-service rate for all refrigerators is then 80.4%, assuming primary units are always in service and using the ratio of primary to secondary refrigerators from the total population as seen in Table 8. The average freezer has an in-service rate of 73.9%.

Table 8. Refrigerator and Freezer In-Service Rates

In-Service Rate	Refrigerator		Freezer
	Primary	Secondary	
Participation	222	826	623
In-Service Months	12	9.02	10.11
In-Service Rate	80.4%		73.9%

These in-service rates function as an adjustment to gross savings. The average annual weather normalized consumption of a unit recycled through ARP after adjusting for the in-service rate,

including both refrigerators and freezers, is 714 kWh. Refrigerators used less energy than freezers, 694 kWh compared to 778 kWh.

Sixteen Path Direct Net Analysis Approach

TecMarket Works has developed a set of sixteen paths as a net energy impact evaluation approach for appliance recycling programs. The sixteen path approach was developed in coordination with the development of the USDOE's Uniform Evaluation Protocols (UMP). Both the sixteen path approach and the UMP were developed because it provides a more reliable approach compared to the use of participant-focused billing analysis or engineering analysis approaches. The direct-net sixteen path (and the UMP) approach assesses the way in which the program impacts energy use in the homes of participants and non-participants. The difference between the sixteen path approach and the UMP is that the sixteen path approach individually assesses each market path, while the UMP simplifies the analysis by collapsing multiple paths into single paths. The sixteen path analysis allows program managers and stakeholders to see each of the program impact paths and understand the energy impacts associated with each path.

In the sixteen path approach, each of the paths represents a particular course of action taken by a participant as it relates to a single recycled unit. This approach compares the outcome of the program to what would have happened in the absence of the program, where savings achieved is the delta of the two situations (what would have happened in the market without the program versus what happened in the market as a result of the program). This type of analysis is required for recycling programs because the program affects more than just the energy use of the participating homes. It affects both the new and used appliance stream by changing what is bought and sold in the new and used markets. Not all paths are affected by all appliance recycling programs. The paths that are changed are representative of a program on a specific market located within the geographical area served by that program.

Each of the sixteen paths is explained in detail in Table 9. These sixteen paths can be divided into four major categories according to what the participant would have done in the absence of the Appliance Recycling Program:

- Units that would have been kept in use by the household that recycled them (paths 1-4)
- Units that would have been sold or given to another household to be used (paths 5-8)
- Units that would have been taken off the grid and disposed of anyway without the program (paths 9-12)
- Units that would have gone to dealers or charities that accept used appliances (paths 13-16)

In the first two categories above, without the program the recycled unit would have remained on the grid either in the participant's household (if they kept it) or someone else's household (if they sold it or gave it away). In the third category of paths (disposal), the recycled unit would have been taken off the grid even without the program. The fourth category (dealers and charities) represents a combination of recycled units that would have returned to the grid through the secondary market and units that would have been disposed of anyway. When these types of organizations acquire used appliances, they resell the units that can be resold profitably, while those that cannot be resold are disposed of (through recycling and sometimes dismantling for

spare parts) and do not return to the power grid. Since units that would have been taken off the grid without the program do not contribute to program savings, only the proportion of "resalable" recycled units that would have gone to dealers and charities contribute to program savings.

Each of these four categories of action is further subdivided into four paths based on whether the recycled unit was replaced, and the participants' intention to replace the unit (or not) before the program:

- Recycled unit was replaced but would not have been without the program,
- Recycled unit was replaced and would have been replaced anyway without the program
- Recycled unit was not replaced but would have been replaced without the program
- Recycled unit was not replaced and would not have been without the program.

The sixteen path analysis is a result of four absence-of-the-program outcomes multiplied by four replacing-the-recycled unit outcomes.

Table 9. Sixteen Paths Scenario Descriptions

Path number	Description of scenario	Energy savings calculation
1	Unit that was picked up by the program would have remained in use and not been replaced. With the program, the unit was recycled and replaced.	Savings from old unit removed less new unit induced by the program
2	Unit that was picked up by the program would have remained in use and also been replaced (the old primary unit would have been "demoted" to use as a secondary unit). With the program, the unit was recycled and replaced.	Savings from old unit removed
3	Unit that was picked up by the program would have remained in use and not been replaced. With the program, the unit was recycled and not replaced.	Savings from old unit removed
4	Unit that was picked up by the program would have remained in use and been replaced (the old primary unit would have been "demoted" to use as a secondary unit). With the program, the unit was recycled and not replaced. *For refrigerator recycling, this scenario only applies to a household that had at least two refrigerators before the program (because primary refrigerators are always replaced).*	Savings from old unit removed plus new unit not purchased
5	Unit that was picked up by the program would have been sold or given to someone else for continued use and not replaced. With the program, the unit was recycled and replaced.	Savings from old unit removed less new unit induced by the program
6	Unit that was picked up by the program would have been sold or given to someone else for continued use and replaced. With the program, the unit was recycled and replaced.	Savings from old unit removed
7	Unit that was picked up by the program would have been sold or given to someone else for continued use and not replaced. With the program, the unit was recycled and not replaced.	Savings from old unit removed

8	Unit that was picked up by the program would have been sold or given to someone else for continued use and replaced. With the program, the unit was recycled and not replaced.	Savings from old unit removed plus new unit not purchased
9	Unit that was picked up by the program would have been recycled anyway and not replaced. With the program, the unit was recycled and replaced.	Program induced a new purchase (negative savings)
10	Unit that was picked up by the program would have been recycled anyway and replaced. With the program, the unit was recycled and replaced.	No savings
11	Unit that was picked up by the program would have been recycled anyway and not replaced. With the program, the unit was recycled and not replaced.	No savings
12	Unit that was picked up by the program would have been recycled anyway and replaced. With the program, the unit was recycled and not replaced.	Savings from new unit not purchased
13	A portion* of units picked up by the program would have been sold or given to someone else for continued use and not replaced. With the program, the unit was recycled and replaced.	Portion* of savings from old unit removed less new unit induced by the program
14	A portion* of units picked up by the program would have been sold or given to someone else for continued use and replaced. With the program, the unit was recycled and replaced.	Portion* of savings from old unit removed
15	A portion* of units picked up by the program would have been sold or given to someone else for continued use and not replaced. With the program, the unit was recycled and not replaced.	Portion* of savings from old unit removed
16	A portion* of units picked up by the program would have been sold or given to someone else for continued use and replaced. With the program, the unit was recycled and not replaced.	Portion* of savings from old unit removed plus savings from new unit not purchased

* A portion of units that are picked up by dealers or accepted as donations by charities find their way to the secondary market for resale. Energy savings for these paths is based on the proportion of units that would be resold.

The sixteen paths approach requires, as inputs:

- Average annual kWh consumption of a recycled unit
- Average annual kWh consumption of a replacement unit (new and used)
- Percentage of dealer/donation units that are sold on the secondary market
- Count of units following each path

The average annual kWh consumption of a recycled unit is the value determined by the "Watts up?" power meters adjusted for weather and in-service rate. An estimate for the average annual kWh consumption of a replacement unit was calculated using the Energy Star Refrigerator Retirement Savings Calculator. This assumption is necessary because data on replacement units was not collected for the metering sample and was sparse for the participant survey (56% of respondents did not know cubic footage, but 63% were the same size or larger units). For refrigerators, the estimate is the simple average of the annual kWh for a 19-21.4 cubic foot top freezer model and a 21.5-24.4 cubic foot side by side model. For freezers, the average annual kWh consumption of a replacement unit is estimated as the simple average of the annual kWh for

a below 16.5 cubic foot chest model and a 16.5-18.9 cubic foot upright model. These values are shown in Table 10.

Table 10. New and Used Replacement Refrigerators and Freezers kWh

Used Refrigerator	kWh	Used Freezer	kWh
19-21.4 ft^3 top freezer	537	Below 16.5 ft^3 chest	404
21.5-24.4 ft^3 side by side	713	16.5-18.9 ft^3 upright	747
AVERAGE	**625**	**AVERAGE**	**575.5**
New Refrigerator	**kWh**	**New Freezer**	**kWh**
19-21.4 ft^3 top freezer	404	Below 16.5 ft^3 chest	341
21.5-24.4 ft^3 side by side	540	16.5-18.9 ft^3 upright	639
AVERAGE	**472**	**AVERAGE**	**490**

In the participant survey, if a respondent indicated that the unit recycled through the program had since been replaced, they were asked if it was replaced with a new or a used unit. Of the 94 refrigerators and 81 freezers recycled, 46 refrigerators and 24 freezers were replaced, replacement rates of 49% and 30% respectively. Of the 46 refrigerator replacements, 45 survey respondents provided the vintage of the replacement unit, 28 (62%) were new units and 17 (38%) were used. Of the 24 freezer replacements, 18 (75%) were new and 6 (25%) were used. Table 11 shows how these ratios were used to calculate the weighted average kWh for replacement units.

Table 11. Weighted Average Replacement Refrigerator and Freezer kWh

Refrigerators	Percentage	kWh	Freezers	Percentage	kWh
Used Refrigerator	38%	625	Used Freezer	25%	575.5
New Refrigerator	62%	472	New Freezer	75%	490
WEIGHTED AVERAGE		**530**	**WEIGHTED AVERAGE**		**511**

The percentage of units that are either donated or picked up by new appliance dealers that are resold on the secondary market is assumed to be the percentage of units recycled through the program that are in saleable condition. In Ohio and Kentucky, a unit is considered saleable if it is no more than 10 years old and in good working condition. This information is taken from the results of the participant survey, where respondents were asked to estimate the age of the unit and also to assess its condition. Only those customers who indicated that, in the absence of the program, their unit would have been either donated or picked up by a dealer were considered. Six (28.6%) out of 21 units were reported to be saleable, thus the estimated percentage of units in saleable condition is 28.6%.[2]

[2] Recycled units in saleable condition are newer than the average recycled unit, thus they consume less energy. When calculating consumption without the program, recycled units in saleable condition that would have been donated or picked up by dealers are assigned the kWh value corresponding to a used replacement unit (625 for refrigerators and 575.5 for freezers in Ohio and Kentucky, as seen in Table 10) rather than the kWh values for "all recycled units."

Finally, the weight for each path is determined by the proportion of the participant population following it. Which path a participant follows is determined by their responses to three questions in the participant survey:

1. What would you have done with the unit if ARP was not available?
2. Have you since replaced the unit that was recycled?
3. Would you have replaced the unit if ARP was not available?

Figure 3 and Figure 4 show the sixteen paths diagrams for freezers and refrigerators along with the savings associated with each and the proportion of the participant population following each. Note that although there are sixteen possible logical outcomes with this analysis approach, some of the sixteen paths are unlikely outcomes that may not occur in a survey with a relatively small sample size: for example, from the 2013 participant survey in Ohio and Kentucky, there were no responses corresponding to path numbers one, nine, and thirteen among the 94 refrigerators that were recycled (see Figure 3).

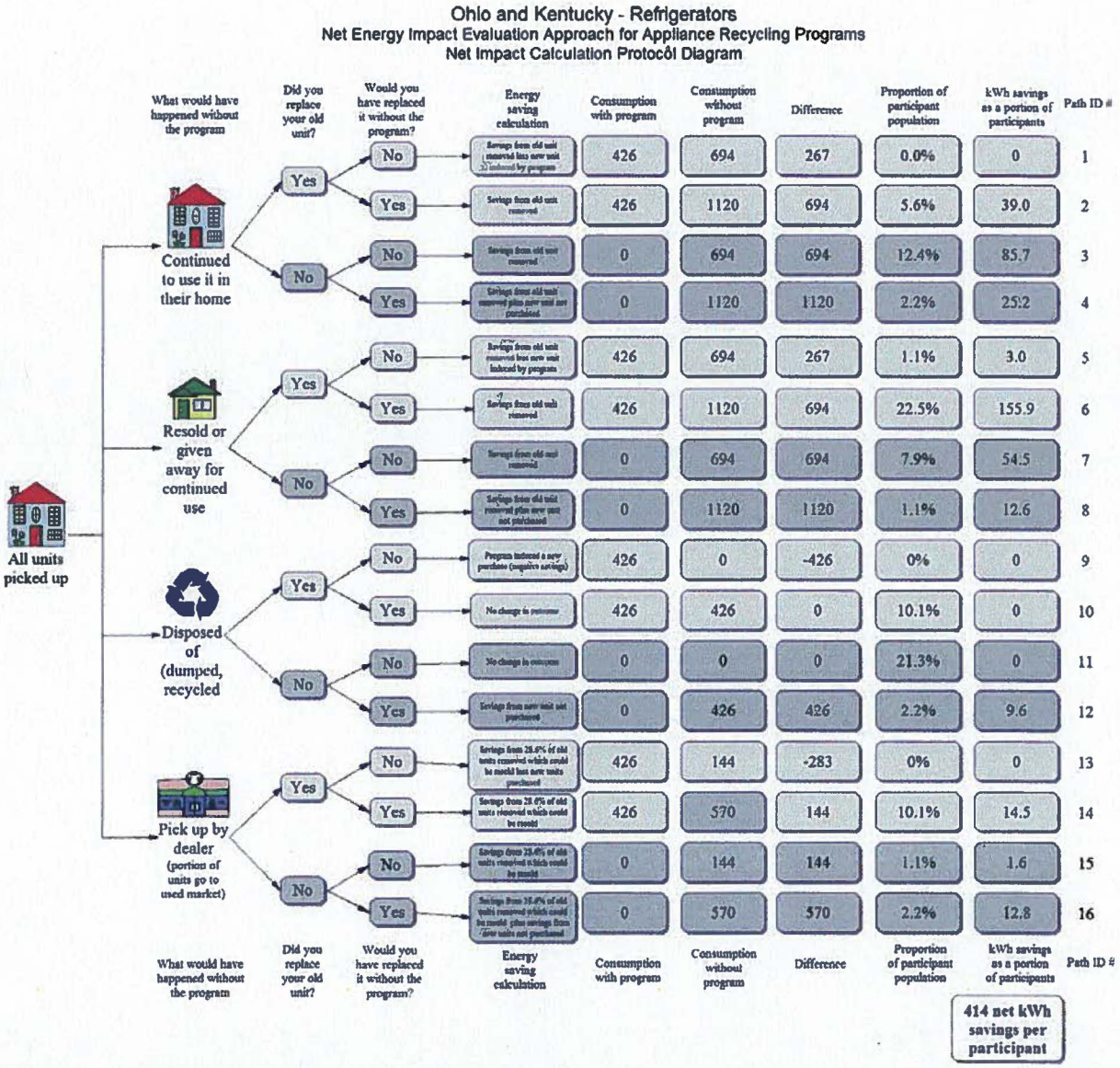


Figure 3. Sixteen Paths Analysis for Refrigerators

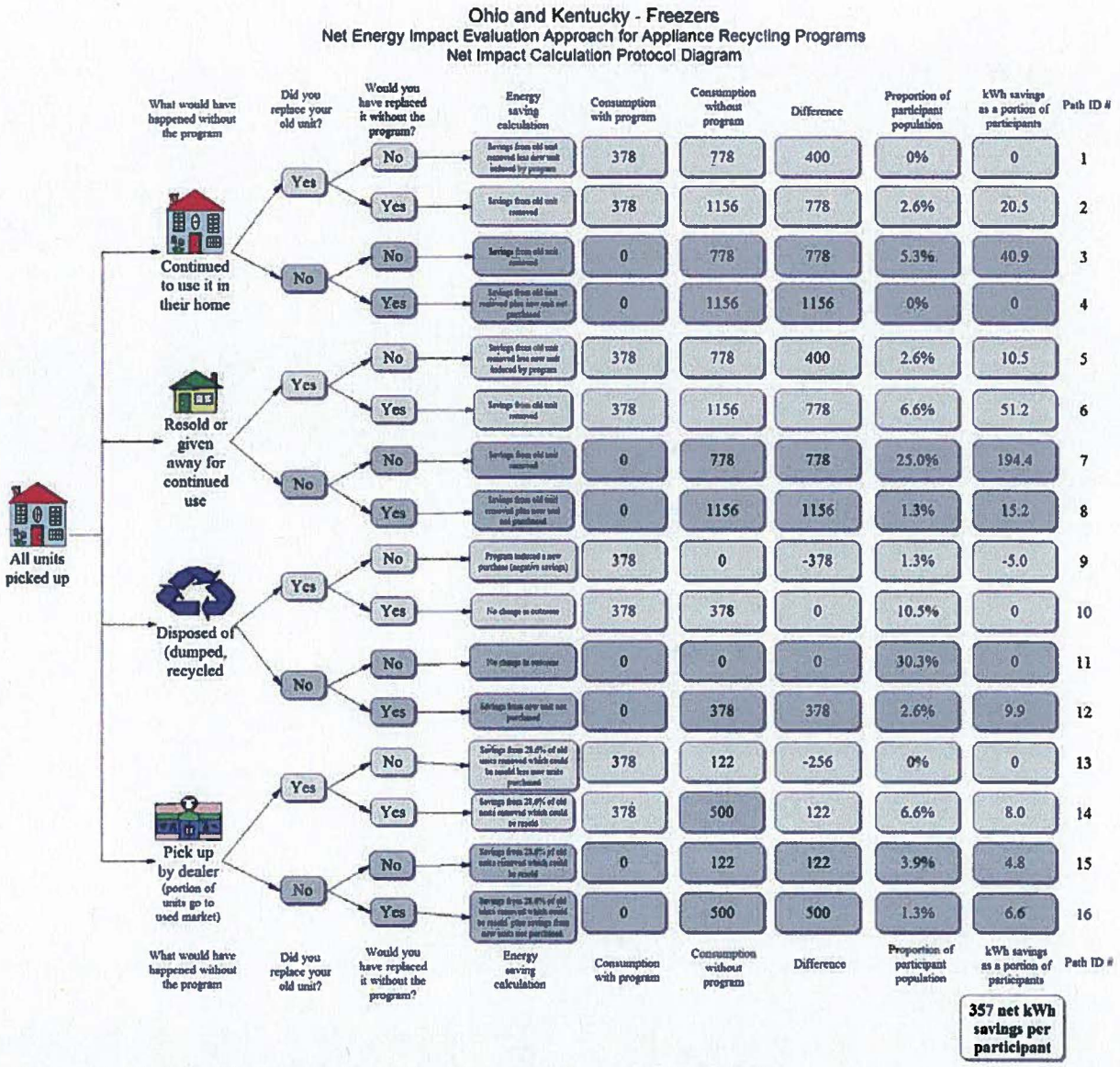


Figure 4. Sixteen Paths Analysis for Freezers Demand Reduction

The summer coincident peak demand savings is calculated using the regression lines comparing kWh to temperature and selecting the highest average daily temperature for the corresponding weather station. A load shape adjustment factor[3] is used coincident with the hour beginning 3PM and ending at 4PM (1.026 for refrigerators and 1.025 for freezers).

$$kW = kWh/day(Tmax) / 24 \times LSAF$$

where:

[3] Daily load shape adjustment factor also based on Blasnik, Michael, "Measurement and Verification of Residential Refrigerator Energy Use, Final Report, 2003-2004 Metering Study", July 29, 2004 (p. 48, using a weighted average Existing And New Units Summer Profile for hour beginning 15)

Tmax	= maximum daily average temperature for each weather city
kWh/day	= daily consumption predicted from regression model
LSAF	= load shape adjustment factor

ARP achieved gross coincident peak demand reduction of 0.0516 kW for refrigerators and 0.0872 kW for freezers. To compute net peak demand reduction, the net to gross ratios from the *Net to Gross Analysis* section are applied, yielding 0.0441 kW for refrigerators and 0.0468 kW for freezers.

Metered Unit Characteristics

In most cases, field technicians were able to determine the age, size, and location of the metered units. As seen in Table 12, there was a wide range of ages among the sampled units recycled through the program. The youngest unit was just seven years old while the oldest was 61 years old. The average age of the sampled units was 31 years for refrigerators, 44 years for freezers, and 34 years overall for refrigerators and freezers combined. The sampled units' average age is considerably higher than that of the data from the overall participation database where the average refrigerator is 24.2 years old, the average freezer is 26.1 years old, and the combined average is 24.7 years old.

Table 12. Age of Units in Metering Study

Age	Refrigerator		Freezer	
	Count	Percent	Count	Percent
5 to 10 years	1	6%	0	0%
11 to 15 years	2	12%	0	0%
16 to 20 years	0	0%	0	0%
21 to 25 years	7	41%	1	17%
26 to 30 years	2	12%	1	17%
31 to 35 years	5	29%	4	67%
Average age	31 years		45 years	
Overall average	35 years			

Table 13 shows that the average size of a sampled unit was 17 cubic feet for refrigerators, 16 cubic feet for freezers, and 17 cubic feet overall for refrigerators and freezers combined. Sizes ranged from eight to 34 cubic feet. Note that the eight cubic foot refrigerator's capacity is below the minimum 10 cubic feet required for program eligibility. Nevertheless, since the unit was selected at random to be part of the metering study, it is assumed to be representative of other ineligible units recycled through the program. According to the EIA Residential Energy Consumption Survey (RECS) from 2009, the average refrigerator size was approximately 19 cubic feet and the average freezer size was about 17 cubic feet.

Table 13. Size of Units in Metering Study

Size	Refrigerator		Freezer	
	Count	Percent	Count	Percent
5 to 10 cubic feet	2	15%	0	0%
11 to 15 cubic feet	5	38%	1	33%
16 to 20 cubic feet	4	31%	2	67%
21 to 25 cubic feet	1	8%	0	0%
26 + cubic feet	1	8%	0	0%
Average cubic feet	17 ft^3		16 ft^3	
Overall average	17 ft^3			

The majority (90%) of recycled units participating in the metering study were located in either a basement or a garage (45% each in basements and garages). This includes 91% of refrigerators and 86% of freezers as shown in Table 14. Overall, twelve (38%) units were located in a conditioned space. This matches up well with the overall participation figures where 39% of units were in conditioned spaces.

Table 14. Location of Units in Metering Study

Location	Refrigerator		Freezer	
	Count	Percent	Count	Percent
Basement	8	36%	5	71%
Garage	12	55%	1	14%
Outside	1	5%	0	0%
Other	1	5%	1	14%

Remaining Useful Life

The remaining useful life (RUL) of the recycled appliance is the period over which energy savings are realized. The US Department of Energy (DOE) developed a technical support document (TSD) in 2009 to establish a survival probability curve for appliances. Mortality trends for technologies tend to follow a Weibull distribution. This allows for a "time-to-failure" calculation and it provides a distribution for which the failure rate is proportional to a power of time, eliminating the need for estimating RUL as a function of a deemed EUL value.

In this TSD, the DOE fitted mortality data collected through the Residential Energy Consumption Survey (RECS) to a cumulative Weibull distribution of the form:

$$P(x) = e^{-\left(\frac{x-\theta}{\alpha}\right)^{\beta}} \text{ and } P(x) = 1 \; for \; x \leq \theta$$

Where:

$P(x)$ = probability that the appliance is still in use at age x
x = appliance age
α = scale parameter; corresponds to decay length in an exponential distribution
= 13.91
β = shape parameter; determines the way in which the failure rate changes through time
= 1.68
θ = delay parameter; allows for a delay before any failures occur
= 5

The delay parameter (θ) is included to account for equipment failure within the first five years of an appliance purchase. This is assumed to be the warranty period, wherein a unit would be replaced free of charge if it were to fail.

To calculate an RUL schedule from the survival probability curve, the integral values are normalized by the survival probability at each age resulting in the curves in Figure 5.[4] In this study, the average age of a recycled unit is 35 years, as seen in Table 12. This corresponds to a program wide average RUL of 5 years. This value appears in *Appendix L: DSMore Table* and functions as the EUL of program savings for cost effectiveness calculations.

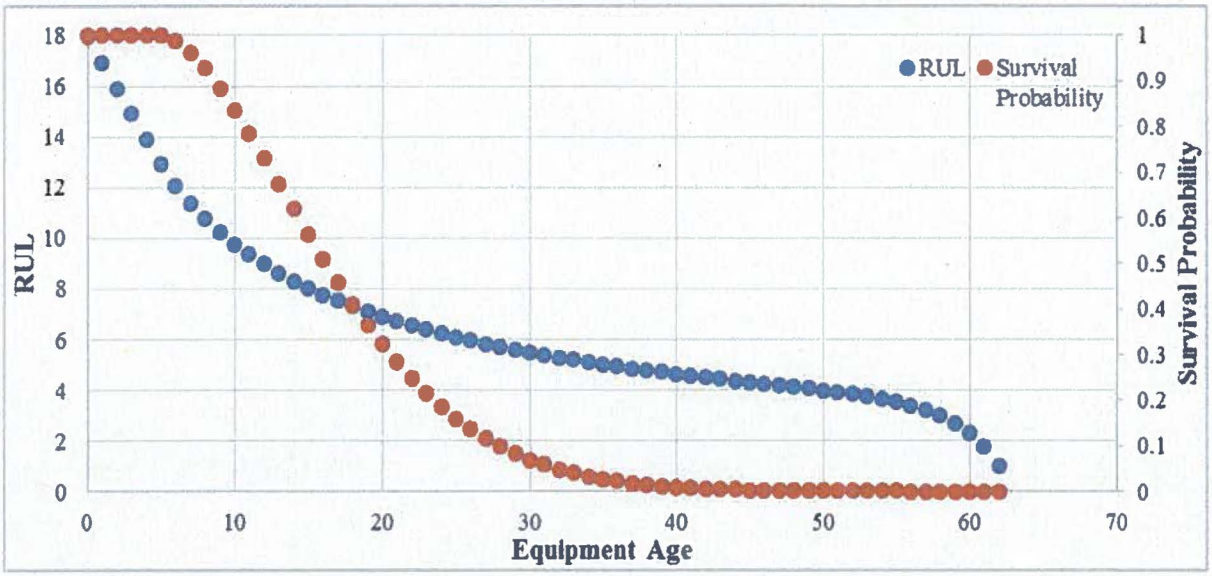


Figure 5. Survival Probability and RUL Curves

Net to Gross Analysis

The engineering analysis used the sixteen path market impact analysis approach to calculating net savings from raw consumption data. This approach is an enhanced (expanded) approach from USDOE's Uniform Practices Protocol for residential programs and allows program designers

[4] Mohit Singh-Chhabra, Ptarmigan Research and Angie Lee, Navigant Consulting, Inc. "Savings from Appliance Recycling Programs: Think Outside the Grid." 2013 International Energy Program Evaluation Conference, Chicago. Page 3.

and managers to see the energy impacts associated with each market path for both new and used units that are affected by the program and to more completely understand the energy effects of the program on the individual paths. Calculating gross savings is not necessary for this approach. An appropriate way to calculate gross savings would be to compare the average annual weather normalized and ISR adjusted kWh consumption of a unit recycled through the program (694 kWh for refrigerators and 778 kWh for freezers) to the average ISR adjusted wattage of a replacement unit (426 kWh for refrigerators and 378 kWh for freezers).

From the participant survey, 49% of refrigerators were replaced. Gross savings and the net to gross ratio for refrigerators can be calculated as follows:

Refrigerator Gross Savings = 694 * 0.51 + (694 – 426) * 0.49 = 485 kWh
Refrigerator NTGR = 414 / 485 = 85.4%

Where:

694 =	consumption of a recycled refrigerator
426 =	consumption of a replacement refrigerator
0.49 =	fraction of refrigerators replaced
0.51 =	fraction of refrigerators not replaced

From the participant survey, 30% of freezers were replaced. Gross savings and the net to gross ratio for freezers can be calculated as follows:

Freezer Gross Savings = 778* 0.7 + (778 – 378) * 0.3 = 665 kWh
Freezer NTGR = 357 / 665 = 53.7%

Where:

778 =	consumption of a recycled freezer
378 =	consumption of a replacement freezer
0.3 =	fraction of freezers replaced
0.7 =	fraction of freezers not replaced

Total Program Savings Extrapolation

As seen in the *Program Goals and Participation* section, from August 1, 2012 through July 31, 2013, there were a total of 3,186 appliances recycled through ARP, 2,393 refrigerators and 793 freezers. Table 15 shows how net unit energy savings (UES), from Figure 3 and Figure 4, is extrapolated to program savings.

Table 15. Program Level Net Savings Extrapolation

Total Program Net Savings Extrapolation	Refrigerator		Freezer	
	Count	UES	Count	UES
Measure data	2,393	414	793	357
Total net measure savings	990,702 kWh		283,101 kWh	
Total net program savings	1,273,803 kWh			

Management Interview Results

Overview of Refrigerator Recycling

Utility-sponsored refrigerator recycling programs first arose in the 1970s along with early demand side management programs. In the ensuing decades, numerous utilities and public benefit programs have initiated collection efforts. Although the details of program design vary, the general purpose of the programs has consistently focused on reducing electric energy demand by removing less efficient refrigerators and freezers from residences and businesses.

What happens to the units after removing them from customer homes has changed over time. In some cases, units were simply sent to landfills. In others, working units were resold on the secondary market, dismantled and parted out, or sold for scrap metal. Such activities are now far less common as increasingly stringent environmental regulations have been enacted to ensure that refrigerants and other toxic elements are properly handled.

According to the U.S. Environmental Protection Agency (EPA), a typical refrigerator contains approximately 140 pounds of metal, 20 pounds of plastic, and 3 pounds of glass, most of which can be recycled and reused. Perhaps more importantly, a typical refrigerator may contain half a pound in refrigerants, another pound of CFC-laced foam insulation, PCPs, mercury containing components, and contaminated motor oils, as shown in Figure 6. As a result, measures for safe disposal and procedures for the legal transfer of custody of the units must now be included in program design. Duke Energy and its implementation partner JACO Environmental, exceed these requirements through voluntary participation in the EPA's Responsible Appliance Disposal (RAD) program.

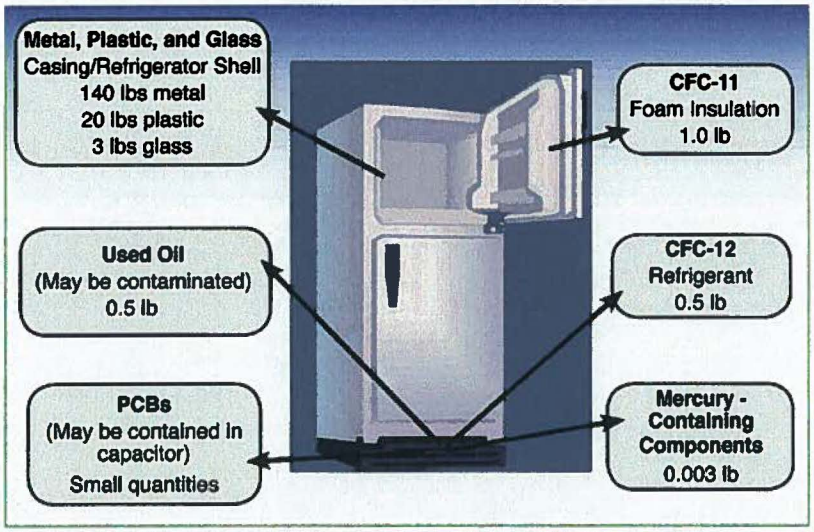


Figure 6. Constituent Elements within a Refrigerator (source US EPA) [5]

[5] US Department of Environmental Protection, Safe Disposal of Refrigerated Household Appliances: Frequently Asked Questions (FAQ), Washington, DC: Accessed on August 5, 2013, source: http://www.epa.gov/spdpublc/title6/608/disposal/household.html

Program Operations and Oversight

The Duke Energy Appliance Recycling Program is a turnkey refrigerator and recycling program provided by JACO Environmental of Bothell, WA. Duke Energy provides the overall administration of the program, including strategic guidance, vendor oversight, customer eligibility confirmation, utility-based marketing, website administration, incentive payment auditing, and overall quality assurance.

Meanwhile, day-to-day implementation is contracted to JACO, which handles all operational functions including: call center activities, scheduling, pick up and collection, environmentally appropriate dismantling and recycling, incentive payments, and quality assurance. JACO-provided marketing services for the program are subcontracted to Runyon, Saltzman, and Einhorn of Sacramento, CA.

After completing a successful RFP process, including a thorough review of JACO's operations and environmental protocols, Duke Energy and JACO signed their contract in January of 2012. The agreement calls for operations in North Carolina, South Carolina, Kentucky, Ohio, and Indiana. The Indiana program launched on May 25, 2012, making it the first service territory to begin collecting units. Formal operations in the Carolina system began on August 1, 2012 after regulatory approval in North Carolina and South Carolina. Ohio and Kentucky collections began on October 4, 2012.

Eligibility

While open to all Duke Energy residential customers in Ohio and Kentucky who wish to recycle their refrigerators and freezers, the program particularly targets homeowners who are empty-nesters, people whose children are grown and who are replacing or have replaced their approximately 20 year old units with new ones. The program attempts to preempt these customers from using their second units as backup coolers. It also seeks to intercept the older primary units from entering the used market or going directly to scrap dealers and landfills. Renters represent a smaller percentage of potential customers since they are less likely to own their refrigerators.

The program's customer eligibility, unit eligibility, and removal stipulations are shown below.

- Customer must have an active residential electric account with Duke Energy at the address where the pickup is to occur.
- The unit must meet the size requirement of 10 - 30 cubic feet.
- There is a limit of two units per customer address within a 12 month period. Any numeric combination of refrigerators or freezers is acceptable.
- An adult, 18 years of age or older, must be present to sign and release the unit at the time of the pickup.
- The unit must be emptied and defrosted.
- The unit must be plugged in and cooling on the day of the pickup.
- The unit must be disconnected from waterlines prior to the pickup crew's arrival.

- There must be a clear and safe removal path since crews cannot risk injury, move personal effects, modify the home (e.g., remove doors or railings) to remove units.

Marketing

Duke Energy and JACO used the interval between contract agreement and regulatory approval to prepare operational infrastructure, customer handling procedures, geographic maps, reporting tools, data transfer methods, and security protocols. Such efforts helped ensure the program was prepared to enter the market as swiftly as possible. Nonetheless, because the program launched during October of 2012, it started after the high season was over and the number of potential units available for collection was dropping from its summer peak. This meant that the program had relatively little time to build awareness and momentum before year end. This was accounted for when planning to meet the 2012 collection goals, according to Duke Energy, JACO, and RSE.

Program marketing is coordinated between Duke Energy, JACO, and RSE, which also provides marketing services for nearly 200 of JACO's utility clients in 25 states. Representatives from all three firms meet weekly and communicate regularly to plan strategies, coordinate efforts, review results, and make adjustments as necessary.

Once per year, RSE prepares a comprehensive marketing plan for each of Duke Energy's program service territories. The plan has three primary components: 1) utility marketing efforts, 2) paid media buys, and 3) earned media via public relations activities. Each of the three components consists of multiple marketing channels that are scheduled to overlap, reinforce, and sustain the annual marketing plan as it ramps up in the spring for the busy summer season, makes its push toward annual goals in the autumn, and goes into maintenance mode during the slower winter months.

Duke Energy's utility marketing efforts for Ohio and Kentucky ran independently with occasional overlaps given their shared media markets. Unique marketing efforts in Ohio consisted of two on-bill messages, two bill inserts, while Kentucky customers received one on-bill message and four bill inserts. Other marketing activities were shared or conducted in parallel. These included two email blasts to customers who've agreed to them and a year round presence via the Duke Energy website and OLS promotions.

Media buys included twice weekly newspaper ads in the *Cincinnati Enquirer* and 15 and 30 second ads on Cincinnati metro radio for 10 weeks during the high season. Targeted digital ads included Google pay-per-click ads and Yahoo banners. These geo-demographically targeted ads collectively generated approximately 75,000 impressions per week in high customer count, high participation zip codes.

RSE's creative team works closely with their marketing counterparts at Duke Energy to develop collateral and ads that tout the program's benefits, while also complying with the utility's specific branding requirements. Marketing messages use positive motivations by discussing benefits, and negative consequences by discussing results of non-action. Brief marketing formats, such as web ads and bill inserts, focus on convenience (Free pick up), the incentive (Earn $30), and energy savings (Save $150 a year on energy). Longer marketing formats, such as

emails and newspaper ads, also focus on the environmental attributes (Keep harmful materials out of landfills). Samples ads are shown in *Appendix E: Marketing Samples*.

The RSE team also generates a social media contact calendar and drafts two Twitter tweets and one Facebook message about refrigerator recycling for Duke Energy to send out via its social media accounts each month.

The earned media component of the marketing strategy utilizes press releases and interesting media events. The center piece of JACO's public relations component is a media and public demonstration event called "Filet of Fridge" at which a JACO spokesperson displays a partially deconstructed refrigerator along with samples of the various materials that are reclaimed during the recycling process, including metal, plastic, glass, foam, oils, and refrigerants. The events make interesting television topics, garnering mentions, brief segments, and even lengthier interviews on local and regional news programs. JACO plans at least one Filet of Fridge event per year in a media market in each of Duke Energy's service territories. For 2103, it was held at the Duke Energy Queensgate District Office in Cincinnati, OH on May 30, 2013 and generated media coverage by WXIX-CIN, WPCO-CIN, NPR Radio WXVU, and the *Cincinnati Inquirer*. A sample of the components displayed is shown in Figure 7.

Figure 7. Filet of Fridge Recycling Samples

For another prolonged media campaign, Duke Energy partnered with three other JACO client utilities in Ohio to encourage its customers to participate in a JACO-sponsored Ohio's Oldest Fridge contest, which rewarded one customer from each utility with a $250 gift card for turning in the oldest refrigerator, which the overall oldest refrigerator earned a $1000 gift card to be used toward the purchase of Energy Star appliances. This campaign helped the program to generate its highest participation rates to date during June of 2013 in Ohio and Kentucky.

Duke Energy Website

The program's primary online presence is hosted on the Duke Energy website. The program is regularly promoted on the home page via a rotating ad with a direct link to the program's main web page. It is also reachable within two clicks of the home page via standard website navigation. The program's main page is simple, with graphics and brief messages that replicate those seen in other marketing vehicles. The page offers four links for additional action. The first

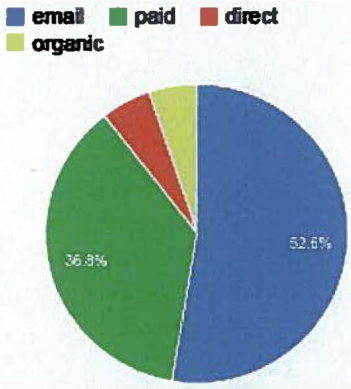
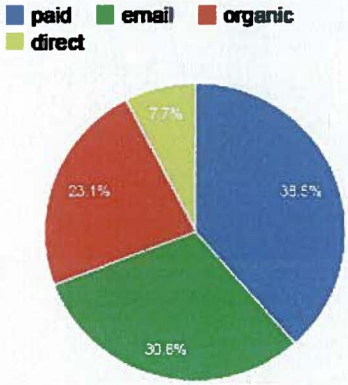
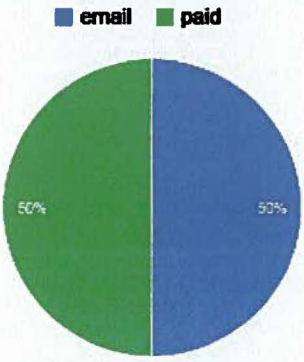
link takes web visitors to an online scheduling module, which is discussed under *Scheduling and Customer Inquiries* below. The second link is to an embedded video of a humorous advertisement showing a refrigerator stealing money from a family. The third link leads to frequently asked questions that cover topics including: benefits of the program, how to find out if your appliance qualifies, how to schedule a pickup, what happens to old refrigerators, and incentive questions. The fourth link takes site visitors to an online appliance calculator that people can use to determine how much money and energy they will save by removing or replacing their old refrigerator.

The Duke Energy marketing campaign manager uses Google Analytics to track all website traffic for the program, including the volume of visits, time on page, inbound sources of traffic, and exits to other destinations within the program or elsewhere on the Duke Energy website. Each month, inbound traffic is analyzed by referral source to assess the relative cost effectiveness of the program's various marketing efforts, including direct access, email links, social media, pay-per click ads, banner ads, Pandora ads, and organic search engine sources. Advertising expenditures and other resources are then adjusted as appropriate.

According to the web tracking data, the Ohio website had 1,235 visitors during 2012 and an average time on page of 1:09 minutes. These numbers increased in 2013, with North Carolina customers making 2,465 web page visits for an average time of 1:14 minutes on page. During 2012, email drove the largest amount of site visitors, representing nearly 53% of traffic. In 2013, paid advertising became the largest driver, accounting for more than one third (39%) of site's traffic. The table below provides a graphic comparison of traffic sources.

Kentucky customers visited the program web page 130 times during 2012 with an average of 1:05 minutes on the page. In 2013 the site had 380 hits and an average time of 0:58 per visit. Unlike Ohio, paid advertising was the only source of traffic in 2012. Paid advertising and email were evenly split traffic sources during 2013.

Table 16. Website Traffic Sources

OH Web Traffic Sept 1 to Dec 31 2012	KY Web Traffic Sept 1 to Dec 31 2012
	
OH Web Traffic Jan 1 to July 31, 2013	**KY Web Traffic Jan 1 to July 31, 2013**
	

Traffic was tracked by visits directly to the individual state's website. Visitors could have also come in from the state landing page where they could choose their state and then enter the website. That data is not included in the above analysis because it was not available at the time of this review. The traffic to the state landing pages would be additive to the above numbers.

Marketing Effectiveness

To track the effectiveness of the many marketing channels used by the program, RSE and Duke Energy use unique URLs for each promotion that refers people to the online program sign up process. In a similar fashion, to measure the effectiveness of each channel in driving participants to the call center, all callers are asked how they heard about the program. According to these measurements, bill inserts are the most effective marketing vehicle by far, drawing 44% of program participants in Ohio and nearly two thirds (63%) in Kentucky (Table 17). Television news and word of mouth via friends and neighbors rounded out the top three marketing vehicles. Other traffic sources accounted for somewhat less; their contributions can be measured in single digit percentages.

Table 17. How Participants Heard About the Program as of July 31, 2013

Tactic	% How Heard		
	OH	KY	OH & KY
Utility bill insert	44.3%	63.3%	48.3%
Television advertising/news	13.0%	7.5%	11.9%
Friend/neighbor	10.0%	11.9%	10.4%
Newspaper advertising	9.7%	2.8%	8.3%
Utility company web site	8.4%	5.8%	7.8%
Web Advertisement/Search	7.2%	3.9%	6.5%
Appliance retailer	3.4%	1.9%	3.1%
Utility newsletter	1.9%	1.4%	1.8%
Electric utility office	0.6%	0.8%	0.6%
Truck sign	0.5%	0.6%	0.5%
Magnet mailer	0.5%	0.0%	0.4%
Repeat customer	0.4%	0.0%	0.4%
Total	100%	100%	100%

RSE compares these "how heard" metrics with overall weekly program enrollment numbers to better understand the effectiveness of each marketing channel and then adjusts marketing spend and mix as appropriate.

Scheduling and Customer Inquiries

Customers have two ways to make an appointment for collection of their units: via the call center or via a scheduling module on the Duke Energy website. According to JACO records, appointments placed via the call center outnumber web appointments by approximately two to one, as shown in Figure 8. Between program inception in October of 2012 and August 15, 2013, Duke Energy customers placed a total of 5,061 pickup requests, of which 3,256 arrived via phone, compared to 2,046 via the web. More specifically, Ohio customers placed a total of 4,150 orders, with 2,586 arriving by phone and 1,564 via the web. This compared to Kentucky customers who made 911 appointments, with 670 by phone and 241 via the web. Each ordering method is discussed separately below.

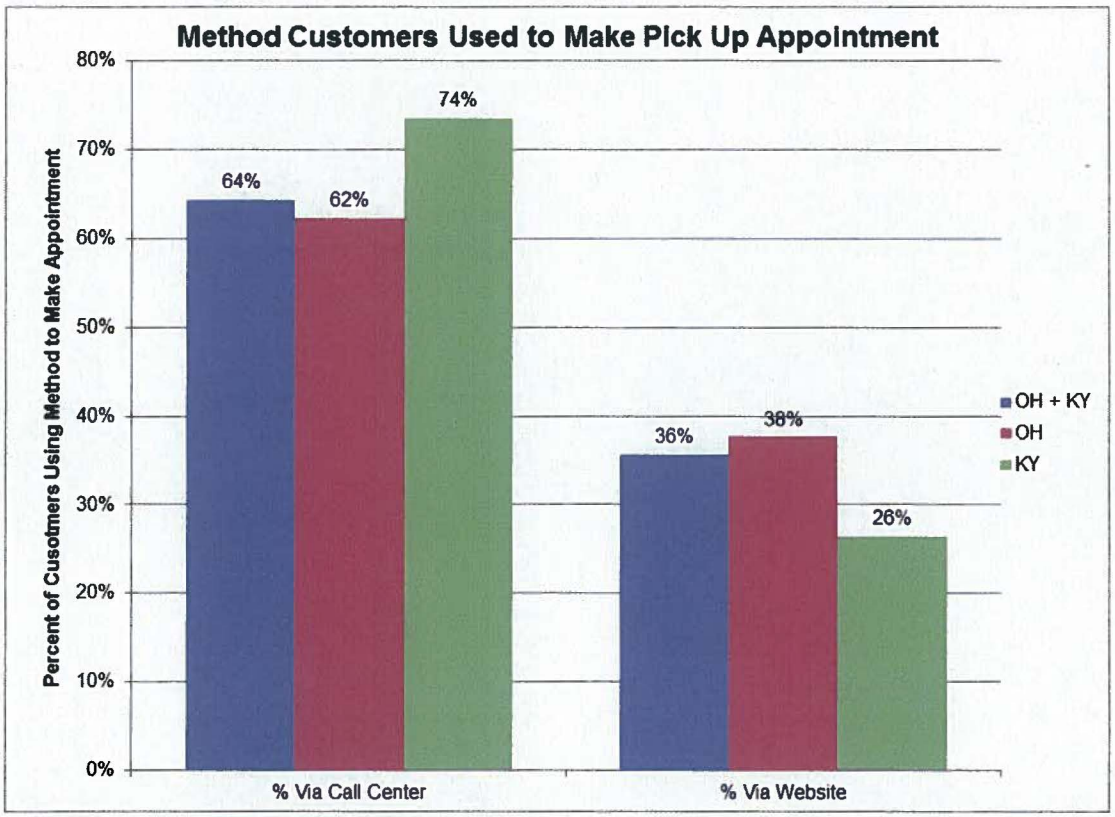


Figure 8. Customer Appointment Methods

Call Center

JACO's call center provides telephone support for Duke Energy's ARP operations in North Carolina, South Carolina, Kentucky, Ohio, and Indiana.[6] Customer appointments and questions are all routed through a single toll free phone number to JACO's call center, which is staffed Monday through Friday from 7 am to 8 pm, and on Saturdays from 10 am to 5 pm. A brief intercept message welcomes callers to the Duke Energy Appliance Recycling Program and then asks them to press a specific number to specify their state for tracking purposes. Calls are then routed to the call center and answered by JACO's customer service representatives (CSRs) who follow specific scripts to greet the callers, answer questions, verify customer information, and schedule appointments for appliance collection.

The CSRs cross check the information provided by callers with an internet-accessible Duke Energy database to confirm their status as residential customers with open and active accounts. In the rare event the customer cannot be verified, the CSR refers the matter to JACO's verification department, which maintains a confirmation request list that is reviewed by the Duke Energy product manager. Once the customer's account has been verified, the CSRs use JACO's collections database to confirm unit eligibility requirements. They also review customer ownership of the appliance and discuss program guidelines, including Duke Energy's rule that incentive checks must be made out and mailed to the name and address associated with the

[6] Former Progress Energy customers are served by a separate program not discussed in this evaluation.

account. With all this clarified, scheduling begins based upon the zip code at the collection address.

JACO's service level agreements require that customers be offered at least one collection date within 14 days of the call. In many cases, JACO will have several dates available to provide customers with a choice of day of the week, although some of these additional options may be beyond the two week window. Because of the way that pick up routes are scheduled for cost-effectiveness, fewer dates tend to be possible for customers in outlying areas, while more options are possible for customers who live closer to the collection hubs since they can be a part of a greater number of routes. Nonetheless, JACO strives to offer all customers a number of options, including Saturday pick up, although not necessarily within the two week window. If customers can't make any available date, they can be placed on a waiting list and notified when new options become available. The waiting list is not for any specific day.

When customers select a date, they are initially told that their pick up will occur between 7 am and 7 pm on that day. Then 48 hours prior to the collection day, they will receive an automated phone call and email reminder if customer provided email address specifying a four hour time frame for the collection appointment to help them finalize the arrangements they need in order to be home when necessary. The call also reminds customers of size requirements, and that the unit must be plugged in, running, and disconnected from all waterlines. The four hour time slots cannot be provided earlier because JACO needs to know all the collection addresses on the given route and calculate the most efficient travel plan prior to informing customers of the specific time window. Because actual pick up times vary, drivers also call customers 30 minutes prior to arrival as a further courtesy to help ensure they are ready.

JACO has a service level agreement to answer 80 percent of calls from Duke Energy customers within 20 seconds. During slow times its initial staffing was adequate to the call volume, but as the 2013 busy season ramped up the call center had challenges with this metric. To ensure it meets standards, the company added employees to the Duke Energy-dedicated team. Performance has since improved. JACO now provides 15 CSRs to assist Duke Energy customers from among its staff of 60 representatives, plus supervisory staff and managers who can provide additional coverage if necessary. All Duke Energy-dedicated CSRs receive additional training beyond JACO's basic requirements in order to ensure that the utility's specific protocols and scripts are followed.

Calls typically take between three and seven minutes to complete. JACO indicates that this is slightly longer than for other utility clients and can be attributed to Duke Energy's more rigorous call handling requirements. Approximately one in three phone calls to the call center end in a new customer appointment, according to the JACO call center spokesperson we interviewed. The purposes for the other calls include: cancelations, time window changes or questions, collection issues, general questions, and wrong numbers. The JACO representative indicated that Duke Energy's 1:3 appointment ratio is better than most other utility clients. She attributed the strong performance to Duke Energy's requirement for strict script adherence, which helps to ensure that important messages are clearly and consistently conveyed.

JACO's quality assurance practices are another factor. CSR calls are monitored regularly, at random, monthly, and quarterly intervals. The Duke Energy product manager also monitors live calls with JACO supervisors on a monthly basis. Calls are evaluated to ensure that CSRs follow scripts, collect all necessary information, answer questions, and provide effective customer service. Any problems are discussed with the employee and rapidly addressed, followed by monitoring to ensure the correction is in place.

Periodic training sessions and updates about program activities also help ensure that the call center remains appropriately informed. Despite these periodic updates, call center representatives indicate that they are still occasionally surprised by spikes in call volume. They request that JACO management, RSE, and Duke Energy strive to communicate more frequently and fully about planned marketing activities so that CSRs can be as fully ready as possible.

Scheduling via the Program Website

Customers can also make appointments for the program via Duke Energy's website. The internet scheduling tool is an embedded JACO web module that appears to the customer to be on the Duke Energy website. Scheduling works similarly to the call center, except that customers must enter all information themselves.

As with the call center, the first page of the scheduling module begins by asking for the customer zip code. This is what helps determine the dates available for collection. The first page also lists the requirements for program participation (see section titled *Eligibility* above) and reasons why customers may want to participate. Page two presents customers with a choice of collection dates. One of which must be selected to continue. The program requirements are also reiterated on this page and a box must be checked to confirm that the rules are understood. This step helps in preventing future misunderstandings.

The third page of the module collects relevant customer data such as account information, service address, and information regarding the refrigerator. The fourth page provides a summary of information and offers an opportunity to return to editing or click to submit the request. A final confirmation page confirms the collection date and customer information. It also provides an ATO number, which is unique to the appliance. This ATO number is used for tracking the specific appliance during its presence throughout the collection and recycling process. Screenshots of the online scheduling process are provided in *Appendix F: Online Scheduling Module*.

One notable difference between the web scheduling module and the call center is that web customers receive a confirmed collection date without being formally validated as Duke Energy residential customers with active and open accounts. That validation happens later behind the scenes through JACO's verification department. If a customer is not eligible, someone from JACO contacts them to explain the situation and to collect additional information as necessary. Typically eligibility issues arise based on typos or confusion about account names and addresses. Although it is possible that someone may think they are a Duke Energy customer when they are not. In those cases, people are redirected to their appropriate utility.

One issue that arose early in the Duke Energy program was that customers would complete the online scheduling form but fail to click the submit button. Without clicking submit, none of the information is saved or sent to JACO. As a result, the customer would not receive a confirmation, but they would erroneously believe that they had made an appointment. Then later they would phone the call center to ask why the collection truck never arrived. To mitigate this problem JACO implemented clear language on the last page of the scheduling form and a pop up message warning customers that they must click the submit button. JACO indicates that these steps greatly reduced the number of such errors.

While this technological fix appears to have alleviated the issue regarding unfinished online scheduling, integration between the web scheduling module and appointments made the call center remains imperfect simply due to human nature. A joint Duke Energy-JACO review of cancellation rates indicates that some customers who successfully complete an online enrollment subsequently decide to phone the call center to make an appointment that way as well. This results in a double booking and necessitates a cancellation of the extra pick up request. While not problematic from a customer service or an operational point of view, the extra cancellations are reflected in the cancellation rates discussed below.

Cancellation Rates

According to tracking records provided by JACO, the program had an overall cancellation rate of 15% in Ohio and 14% in Kentucky during 2012, and slightly higher rates of 19.3% in Ohio and an 18.8% rate in Kentucky during 2013. Both JACO and Duke Energy felt that these rates were higher than desired and expressed a preference for rates in the low teens or less.

To better understand the overall cancellation rate, JACO records nine different reasons for pick up cancellations via its call center. An additional eleven types of reasons are tracked for driver-reported cancellations as shown in the table below.

Table 18. Reasons for Customer Cancellation

	#	Code Name	Definition
DRIVER	40	Non-working unit	Non-working units are not qualified
	41	Non-qualifying size requirement	Unit does not qualify due to being too small or large
	42	Missed appointment, customer not home	Customer missed appointment
	43	Cancel customer request	Driver informed by customer at home or on phone to cancel; no reason
	44	Emergency cancelation	Crew cancels due to illness, personal issue.
	45	Unable to arrive due to road conditions	Crew cancels due to weather, construction or other road blockage
	46	Reschedule appointment with operator	Customer tells driver they want to re-schedule
	48	Crew couldn't locate customer home, called and no answer	Crew could not find & could not reach customer for directions
	50	Cancel no clear path for removal of unit	Unit access blocked by materials or structure.
	51	Cancel due to safety risk	Removal risks injury

CALL CENTER	90	Cancel admin	Order removed from system. This occurs for multiple reasons, although usually when an order is marked incorrect. This typically happens during the QA process when a manager decides to remove the customer for customer service reasons.
	91	Cancel decided to keep	Customer changes mind - decides to keep unit
	92	Cancel reschedule customer to new date	Customer cancels due to schedule conflict.
	93	Cancel unit quit working	Non-working units are not qualified
	94	Cancel sold or gave the unit away	Customer sells or gives away
	95	Customer unable to be rescheduled	Re-schedule dates do not work for customer
	99	Customer found to be ineligible	Customer was found to not have service with the participating utility

The most common reasons for cancellation are because the customer missed the appointment (#42), the customer decided to keep the unit (#91), and the customer sold or gave the unit away (#94). According to JACO, the Duke Energy program's cancellation rates in these areas are higher than they typically see for other utility clients.

JACO attributes these higher cancellation rates to the length of time that customers have between the day they make the appointment and the day the unit is actually collected. Having two or three weeks is enough time to 1) sell the unit on Craigslist for more than the incentive amount, 2) decide to give the unit away, 3) decide to keep it, or 4) have the desire to get rid of it fade in importance. "We're probably not going to keep them from changing their minds directly, but decreasing the time interval would help to improve those numbers," explained one JACO representative. But the time interval is a function of the number of trucks that JACO can cost-effectively roll, and that depends on the number of units available on the collection route. "So, one way to lower the cancellation rate is to make the phone ring with a more attractive incentive. As we schedule more appointments, we roll more trucks, and have closer appointment dates available," he said. Duke Energy and JACO are exploring this and other possibilities as a means of decreasing their cancellation rates.

TecMarket Works identifies these cancellation rates as an important area for improved program performance; not least because the marketing and scheduling teams have already effectively executed their assigned roles and obtained the customers' commitment to program participation.

Appliance Collection

JACO locates its primary collection facilities in the most populous and centrally located areas that it serves. Its collection facilities for Ohio and Kentucky are staged out of Columbus, OH. Collection routes are optimized for efficiency and are finalized 48 hours in advance so that JACO's automated dialing system can provide customers with their four hour time window.

Trucks typically collect between 20 and 30 units in a day, depending upon the number of stops, missed or cancelled appointments, size of the units, and the distances to be covered. Crews

usually have between four and six stops within a four hour time window. They call the next home on the route when they are 30 minutes away in order to provide one final reminder. If they are less than 30 minutes away from the next home on the route, such as when two pick-ups are in nearby neighborhoods, they call as soon as possible. If they call ahead and no one answers, they leave a voice mail and proceed to the house. If no one is home when they arrive, they wait 15 minutes and then leave a "Sorry we missed you" door hanger that provides the mobile phone number of the crew and invites the customer to phone them. Depending upon the route, it may or may not be possible to revisit the customer later the same day to complete the collection. The crew also takes a photo of the house to document their visit and calls their supervisor to report the missed appointment.

If crews happen to finish their time window early, they can call the first customer in the next time window to see if they're available early. Otherwise, they need to wait unit the time window opens. Once crews complete their time window, they call to update their location manager. They also inform their managers about delays. The location manager updates the call center twice daily to ensure that CSRs have updated information.

Collection Practices

Upon arrival, crew members introduce themselves and show their Duke Energy photo identification cards. They also confirm they're in the correct location and then ask the customer to lead them to the unit so they can assess the best way to remove it from the home. Once they reach the unit, they visually inspect it to confirm that it is plugged in and cooling, emptied and defrosted, and that any water lines have been disconnected.

Although program requirements specify that collection crews will not move or alter items in customers' homes, crews can remove the doors from refrigerators if necessary to transport the item outside. Normally, however, they prefer to take the unit outside before they begin cataloging and dismantling it.

When the unit is loaded on the truck, the crew uses a pocket PC to record the:

- Unique appliance tracking order (ATO) number,
- Refrigerator model number,
- Unit color,
- Unit type (top or bottom freezer, side by side, etc.),
- Unit's amperage (located on model info plate),
- Unit location,
- Whether the unit's location was in air conditioned space,
- Whether unit was used 12 months per year or periodically, and
- Whether unit is to be replaced or not.

Next they write the ATO directly onto the unit, along with the date, their personal initials, and the program ID for Duke Energy. Then they attach a sticker with a bar code that is scanned by the pocket PC. Lastly, they take a photograph of the refrigerator. Once everything is entered into the system, they ask the customer to verify the information and sign the pocket PC.

This signature releases the refrigerator into the legal custody of JACO. As filed, the program allows customers 18 years or older to leave a signed note releasing the unit to JACO. This enables JACO crews to retrieve the unit if the customer cannot be home during the collection, but this method is rarely used since leaving the unit unattended outside the customer's home places it a risk of being stolen by roving scrap collectors.

When the paperwork is complete, the crew begins to dismantle the unit while still at the customer's home in order to demonstrate to the customer that it is indeed being rendered inoperative. To do that, the crew knocks a hole in the side of the refrigerator with a hammer, cuts the power cord and the door gasket, and physically breaks the thermostat control switch.

Once everything has been completed at the customer's home, the crew continues on to the next address on the route, gradually working their way back to the central JACO warehouse. When the trucks arrive at the JACO central dismantling facility the units are offloaded, counted, and checked in to ensure that all are accounted for. First, the bar codes stickers on each unit are scanned. This calls up the digital photo of the unit so the technician can confirm the ATO numbers on the refrigerators and in the JACO computer system. The physical units are also cross checked with 1) the end-of-day reports generated by the pocket PCs and 2) the route update reports to ensure that final counts are accurate. For instance, if a crew sets out to collect 20 units in a day and only returns with 18, the remaining two items will show as customer-cancelled appointments. If discrepancies arise, the units are set aside and the technician goes back through the extensive documentation process to verify the chain of custody to find the error.

No challenges or issues with collection were reported by any of the parties we interviewed. Two people did, however, make similar suggestions for process improvement. While JACO makes every effort to pick up all scheduled units, in rural areas some houses may occasionally be difficult or impossible to reach in the collection trucks due to their large size relative to height limitations caused by tree branches, weight restrictions on small bridges, and narrowness of country lanes and driveways. Therefore, those we spoke with requested that additional language be added to the FAQs or program requirements to better manage customer expectations about the accessibility of their properties. While a minor change perhaps, it may nonetheless help to improve customer satisfaction with the program.

In an interesting augmentation to their residential collection practices, Duke Energy and JACO indicated that they were in the process of establishing a retail partnership with Sears stores in the greater Indianapolis area to begin during the fourth quarter of 2013. Under this partnership, when Sears representatives deliver new refrigerators and freezers they will collect qualifying used units from eligible customers and bring the units to a central secure collection point, from which JACO can retrieve the units. All tracking details regarding the units are to be collected as if JACO representatives had originally picked up the units from customers. No units yet had been retrieved by JACO as of the time of this evaluation in November of 2013. Nonetheless, TecMarket Works considers this an innovative addition to the overall program design. We encourage Duke Energy to monitor progress in Indiana and if the effort proves effective there to consider expansion of the Sears partnership into the utility's Ohio and Kentucky territories.