

# **Fridge Freezer Recycle Rewards Program PY6 Evaluation Report**

**Final**

**Energy Efficiency / Demand Response Plan:  
Plan Year 6  
(6/1/2013-5/31/2014)**

**Presented to  
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## E. Executive Summary

This report presents a summary of the findings and results from the Impact and Process Evaluation of the PY6<sup>1</sup> Fridge Freezer Recycle Rewards (FFRR) program. The FFRR program is designed to achieve energy savings through the retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners (Room ACs). The primary objectives of the program are to decrease the retention of high energy-use refrigerators and freezers and deliver long-term energy savings. A secondary objective is to dispose of these older units in an environmentally safe manner.

### E.1. Program Savings

Table E-1. summarizes the electricity savings from the FFRR Program. Note that verified gross savings excluding the part-use factor, are virtually identical to ex-ante gross savings. Both sets of values were computed using the regression specified in the TRM, without applying the part-use factor, and are comparable. However, since the part-use factor is an element of the gross savings calculation, it was subsequently applied to these initial values to yield final verified gross savings impacts.

**Table E-1. PY6 Total Program Electric Savings**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Peak Demand Savings (MW)
Ex-Ante Gross Savings	38,274	N/A	N/A
Verified Gross Savings – Excluding Part Use Factor	38,230	N/A	N/A
Verified Gross Savings – Including Part Use Factor	35,478	4.80	4.80
Verified Net Savings	25,331	3.22	3.22

*Source: ComEd tracking data and Navigant team analysis.*

### E.2. Program Savings by Measure Type

Table E-2 summarizes the program savings by measure. Note that the verified Net-to-Gross ratio is based on a combination of deemed values plus research findings for the Program Induced Replacement (PIR) component. The PIR, which is pertinent to refrigerators and freezers only, was calculated using the procedure specified in the Illinois Technical Reference Manual (TRM), version 2.0.

<sup>1</sup> The PY6 program year began June 1, 2013 and ended May 31, 2014.

**Table E-2. PY6 Program Results by Measure Type**

Savings Category	Refrigerators	Freezers	Room ACs
Ex-Ante Gross Savings (MWh)	33,232	4,921	121
Ex-Ante Gross Peak Demand Reduction (MW)	N/A	N/A	N/A
Deemed Part-Use Factor	0.876	0.825	1
Verified Gross Savings (MWh)	31,192	4,164	122
Verified Gross Peak Demand Reduction (MW)	3.85	0.49	0.17
Verified Gross Realization Rate	93.9%	84.6%	100.6%
Deemed Net to Gross Ratio (NTGR) †	0.73	0.82	0.72
Program Induced Replacement (PIR) ‡	0.039	0.013	N/A
Final Net to Gross Ratio (NTGR and PIR)	0.70	0.81	0.72
Verified Net Savings (MWh)	21,873	3,371	88
Verified Net Demand Reduction (MW)	2.70	0.40	0.12

Source: ComEd tracking data and Navigant team analysis.

† A deemed value without the PIR. Source: ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

‡ Based on evaluation research findings.

### ***E.3. Impact Estimate Parameters for Future Use***

In the course of our PY6 research, the evaluation team did research on parameters used in impact calculations including those in the Illinois TRM. Some of those parameters are eligible for deeming for future program years or for inclusion in future versions of the TRM. The evaluation team's parameters recommended for future use are shown in the following table.

**Table E-3. Impact Estimate Parameters for Future Use**

Parameter	Refrigerators	Freezers	Room ACs	Data Sources
<b>NTG</b>				
Retailer <sup>2</sup>	0.15	0.16	N/A	PY6 Retailer surveys
Non-Retailer	0.63	0.57	0.50	PY6 Participant Survey
Weighted Average Retailer + Non-Retailer (excluding PIR)	0.44	0.55	0.50	PY6 Participant Survey PY6 Retailer surveys
Program-Induced Replacement factor	(0.039)	(0.013)	N/A	PY6 Participant Survey
Part-Use Factor	0.79	0.79	1.00	PY6 Participant Survey
Verification Factor	100%	100%	100%	PY6 Participant Survey

Source: Evaluation Analysis

<sup>2</sup> The Retailer NTGR values for Refrigerators and Freezers are based on survey responses from the 3 retailers who currently participate in ComEd's program, plus two additional retailers that sold replacement units to survey respondents. Because of low program influence, ComEd is considering adjusting the participating retailer component of its program in PY8 to exclude the largest local retailer. Should this local retailer be excluded, the Retailer NTGR values for Refrigerators and Freezers would increase to 0.292 and 0.300, respectively.

As in PY4 and PY5, the net-to-gross ratios for refrigerators and freezers incorporate a retailer-based net-to-gross ratio for primary units that were subsequently replaced by participants. Many participant-replacers indicated that in the program's absence, they would have given their units to the retailer they bought the new one from. In turn, those retailers indicated they would have deconstructed and/or recycled many of those units via their normal collection procedures. The research report section of this document (Section 7, Appendix) provides a fully detailed analysis and reporting of the retailer based NTGR and participant survey-based NTGR results. Directionally, the PY6 NTG ratios are slightly lower than PY5 values, in part because a greater percentage of respondents indicated they would have turned their unit over to the retailer they bought the new unit from than in PY5.

In addition, the research report part-use factors in PY6 are somewhat less than the PY5 values for refrigerators and freezers. The PY6 value for refrigerators and freezers is 0.79 (versus 0.92 for refrigerators and 0.83 for freezers in PY5).

Finally, all participants surveyed stated that ComEd's subcontractor JACO did pick up their unit resulting in a verification rate of 100%. This value is based on responses to a phone survey question (and related follow-up questions) regarding whether the respondent recalled having the program pick up their unit.

#### ***E.4. Program Volumetric Detail***

According to program tracking data, there were 40,140 participants in PY6 contributing a total of 42,313 recycled measures to the program. In PY5, the program recycled a total of 48,805 units, which were contributed by 43,328 participants. Since the unit pick-up was verified by 100% of surveyed participants, resulting in a 100% verification rate, no further reduction was necessary to the program-claimed unit count. These values are shown in the following table.

**Table E-4. PY6 Volumetric Findings Detail**

	Program-Reported Number of Units	Verification Factor	Verified Participation Units	% of Total Units
<b>Number of Participants</b>	<b>40,140</b>	<b>100.0%</b>	<b>40,140</b>	<b>100%</b>
<b>Units by Measure Type</b>				
Refrigerators	36,403	100.0%	<b>36,403</b>	86%
Freezers	5,395	100.0%	<b>5,395</b>	13%
Room ACs	515	100.0%	<b>515</b>	1%
<b>Total Measures</b>	<b>42,313</b>	<b>100.0%</b>	<b>42,313</b>	<b>100%</b>

*Source: ComEd tracking data and Navigant team analysis.*

#### ***E.5. Results Summary***

The following table summarizes the key metrics from PY6.



**Table E-5. PY6 Results Summary**

Participation	Units	PY6
Verified Net Savings	MWh	25,331
Verified Net Demand Reduction	MW	3.22
Verified Gross Savings	MWh	35,478
Verified Gross Demand Reduction	MW	4.80
Program Realization Rate (Gross)	%	0.93
Deemed Net to Gross Ratio (NTGR) †	#	Refrigerators 0.73 Freezers 0.82 Room A/C 0.72
Program Induced Replacement (PIR) ‡	#	Refrigerators (0.039) Freezers (0.013) Room A/C N/A
Final Net to Gross Ratio (NTGR and PIR) †	#	Total Program 0.71 Refrigerators 0.70 Freezers 0.81 Room A/C 0.72
Refrigerators picked-up - Non-retail	#	26,389
Refrigerators picked-up - Retail	#	10,014
Freezers picked-up - Non-retail	#	5,009
Freezers picked-up - Retail	#	386
AC Units picked-up	#	515
Customers touched	#	40,140

Source: ComEd tracking data and Navigant team analysis.

† A deemed value. Source: ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

## **E.6. Findings and Recommendations**

The Fridge and Freezer Recycle Reward Program continues to recycle a high volume of units and provides a reliable source of savings for ComEd. Verified savings have decreased significantly from PY5 values due to a combination of factors. Overall, the number of units recycled through the program is down 13% from PY5, although it is still significantly higher than the original program goal of 40,000 units (which was later revised to 45,000 units). In addition, the updated regression specifications for refrigerators and freezers in the Illinois Statewide TRM version 2.0 result in a lower savings per unit. The deemed part-use factors used in this evaluation are also slightly lower. However, offsetting this is an increase in the net-to-gross ratios applied in PY6 versus those applied in the PY5 evaluation. The PY6 values are based on the SAG-approved values minus the Program induced replacement factor specified in the TRM.

The following provides insight into key program findings and recommendations.<sup>3</sup>

### **Program Savings Goals Attainment**

**Finding 1.** The starting PY6 net energy savings goal for this program was 25,000 MWh, which about 22% lower than the final PY5 goal. The ex-ante net energy savings was about 33% higher than the goal, at 33,253 MWh.

**Finding 2.** The PY6 verified gross energy savings is 35,478 MWh, while evaluation-verified net savings is 25,331 MWh, which is 71% of the verified gross savings.

### **Gross Realization Rates**

**Finding 3.** The Program realization rate (Gross) is based on the Gross realization rate and the Verification rate. The Gross realization rate reflects the difference between ex-ante gross savings (kWh) and verified gross savings. Because the ex-ante gross savings did not include application of the part-use factor which is a Gross savings element, verified gross savings (including the part-use factor) were about 7% lower than ex-ante gross savings. Therefore, a verified gross realization rate of 0.93 (total program) was achieved. The Verification rate is based on responses to a phone survey question regarding whether the respondent recalled having the program pick up their units. In total, 100% (320 of 320) of participants surveyed said that the program did pick up their units, resulting in a Verification rate of 100%.

### **Net-to-Gross Ratio**

**Finding 4.** The NTG ratios used to calculate verified savings were based on the SAG approved values minus the Program Induced Replacement (PIR) factor as specified in the TRM v. 2.0. Specific values applied were: Refrigerators – 0.70, Freezers – 0.81 and Room A/C units – 0.72, for a total program value of 0.71.

**Recommendation 4.** The Evaluation team believes the Program Induced Replacement (PIR) factor concept is implausible because an incentive ranging from \$35 to \$50 is unlikely to be sufficient motivation for purchasing an otherwise-unplanned replacement unit (which can cost \$500 to \$2,000). For this reason, it is recommended that the PIR be eliminated from the TRM calculation, starting in PY7.

**Finding 5.** The Evaluation Research Findings NTG ratios are 0.40 for refrigerators (based on a weighted average of a Customer NTGR of 0.63, a Retailer NTGR of 0.15, and net of a PIR factor of 0.039), 0.54 for freezers (based on a weighted average of a Customer NTGR of 0.57, a Retailer NTGR of 0.16, and net of a PIR factor of 0.013) and 0.50 for room ACs (based on participating customers only) for a total program NTG ratio of 0.42. The Research Findings NTG ratio is a weighted average of participating customer and retailer responses to survey questions. It also includes a term for Program Induced Replacements, per the TRM.

**Recommendation 5.** Based on the high level of free ridership for replaced primary units associated with the three retailers that participated in ComEd's PY6 program, and in particular, retailer #1, free ridership can be reduced by reducing reliance on units originating from such retailers' customers. A parallel strategy is to increase marketing to those who

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<sup>3</sup> Numbered findings and recommendations in this section are the same as those found in the Findings and Recommendations section of the evaluation report for ease of reference between each section.

have secondary units since they tend to have lower free ridership than those who are replacing former primary units.

### Energy and Demand Savings Estimates

**Finding 6.** The PY6 verified gross energy savings is 35,478 MWh, while evaluation-verified net savings is 25,331 MWh. These are significantly down from the PY5 verified savings values of 44,674 gross kWh and 30,531 net kWh, and are reflective of the much lower per-unit savings values based on the regression formula in the Illinois Statewide TRM version 2.0. For refrigerators, gross energy savings per unit have dropped from 1,026 kWh in PY5 to 912 kWh in PY6, or by 11.1%. For freezers, gross energy savings per unit have dropped from 1,243 kWh in PY5 to 913 kWh in PY6, or by 26.5%. The number of recycled units in PY6 is also down 13% from PY5 levels, although it is still significantly higher than the original program goal of 40,000 units (which was later revised to 45,000 units). This reduction in units has the effect of further depressing savings achievements.

**Finding 7.** Gross peak demand savings are 4.80 MW and net savings are 3.22 MW. These are also significantly down from PY5 savings values and are reflective of the much lower per-unit savings values based on the regression formula in the Illinois Statewide TRM version 2.0, and the lower number of units recycled.

**Finding 8.** Nearly 7,000 records were missing the prior location of the units and whether the unit is a primary or secondary unit. Most of the missing records were from participating retailers. This is important data that is used in the Illinois Statewide TRM version 3.0 regression model and will be applied in the evaluations going forward. For this evaluation, survey findings on unit location were used in place of the missing records in the regression process.

**Recommendation 6 / 7 / 8.** We recommend that steps be taken to capture and populate the missing prior location and primary/secondary fields. JACO has indicated they are trying to reduce the frequency of such missing data by instituting callbacks to customers during its data reconciliation process. This is a first step towards improving the accuracy of tracking data related to the unit's prior location.

### Program Participation

**Finding 9.** Program participation, based on the number of participants, remains strong but is down about 8% from PY5. However, it should be noted that ComEd's participation goal was also down. The lower participation resulted, in part, from ComEd's decision not to extend the time period of higher incentives in order to drive participation to higher levels.

**Recommendation 3.** To meet increased goals planned for PY8 and PY9, ComEd will need to increase incentives, and expand marketing efforts.

## 1 Introduction

### 1.1 Program Description

The Residential Fridge and Freezer Recycle Rewards (FFRR) program was designed to achieve energy savings through the retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners (Room ACs). The primary objectives of the program are to decrease the retention of high energy-use refrigerators and freezers and deliver long-term energy savings. A secondary objective is to dispose of these older refrigerators and freezers in an environmentally safe manner.

### 1.2 Evaluation Objectives

The Evaluation Team identified the following key researchable questions for EPY6:

#### 1.2.1 Impact Questions

1. What are the gross impacts from this program?
2. What are the net impacts from this program? What is the level of free ridership with this program? How can free ridership be reduced?
3. Did the program meet its energy and demand goals? If not, why not?
4. Does spillover exist in the program? If so, how much spillover is occurring?
5. How has the program influenced the market for used refrigerators and freezers?
6. Should the program design be modified to reduce free ridership, and if so, how?

#### 1.2.2 Process Questions

1. Has the program as implemented changed from PY5? If so, how, why, and was this an advantageous change?
2. What are the strengths and weaknesses of the program? How can the program be improved?
3. What are key barriers to participation and how can they be addressed by the program:
  - a. For eligible FFRR participants?
  - b. For eligible retailers of new refrigerators and freezers?
4. How do customers become aware of the program? What marketing strategies could be used to boost program awareness?
5. What is the program satisfaction among participating customers and retailers?
6. Is the program outreach to customers and eligible retailers effective in increasing awareness of the program opportunities?
  - a. What is the format of the outreach?
  - b. How often does the outreach occur?
  - c. Are the messages within the outreach clear and actionable?
7. Are program incentive levels appropriate to encourage participation?
  - a. What is the influence of the incentive level versus the marketing effort on program participation levels?

## 2 Evaluation Approach

This section of the evaluation report presents the approaches used to verify gross and net kWh and kW savings from the FFRR program. Key data sources are described. The methodologies for verifying program participation and estimating gross and net kWh and kW savings are discussed.

### 2.1 Overview of Data Collection Activities

The core data collection activities included a review of the tracking data, in depth interviews with the ComEd and JACO program managers, and a series of telephone surveys. The latter included surveys of participating and nonparticipating customers, participating and nonparticipating retailers of new units, and used appliance dealers and haulers. The full set of data collection activities is shown in the following tables.

**Table 2-1. Primary Data Collection Activities**

What	Who	Target Completes	Completes Achieved	When	Comments
Tracking Data Analysis	All Program Participants	All	All	July 2014	
In-Depth Interviews	ComEd and JACO Program Managers	2	2	August 2014	
CATI Telephone Surveys	Sample of Program Participants	300	320	July-August 2014	Supports both Impact and Process elements
CATI Telephone Surveys	Nonparticipating Customers	80	75	Sept - October 2014	Recent acquirers and disposers of used units
In-Depth Interviews	Participating Retailers	3	3	Aug-Sept 2014	Determine used appliance disposal practices in the program's absence
In-Depth Interviews	Non-Participating Retailers	Up to 8	3	Oct 2014	Determine used appliance disposal practices in the program's absence
In-depth Interviews	Used Appliance Dealers; Haulers	Up to 6	1	Oct 2014	Determine program's effect on used appliance market.

**Table 2-2. Additional Resources**

Reference Source	Author	Gross Impacts	Process
Illinois Technical Reference Manual, version 2.0	VEIC	X	

## 2.2 Verified Savings Parameters

The PY6 verified gross energy savings were calculated directly using procedures specified in the Illinois Technical Reference Manual (TRM) version 2.0<sup>4</sup>. These procedures call for energy savings to be computed using the regression equations specified below, which have been revised since version 1.0 of the TRM was published. Note that all of the factors in the regression equations are derived from pooled data from metering studies conducted by several Midwestern utilities, including one done by the ComEd evaluation team in PY4. None of these factors are subject to change based on this PY6 evaluation.

The final TRM version 2.0 regression specifications and part-use factors for refrigerators, and freezers, respectively are below:

### 2.2.1 Energy Savings

**Table 2-3: Energy savings for refrigerators<sup>5</sup>:**

Independent Variable	Coefficient	Source
Intercept	116.84	TRM
Age (years)	10.89	TRM
Pre-1990	431.79	TRM
Size (Cubic Feet)	19.42	TRM
Single Door	-795.37	TRM
Side-by-side	426.41	TRM
Primary Unit	170.41	TRM
Unconditioned Space X CDD	17.34	TRM
Unconditioned Space X HDD	-11.78	TRM
Part Use Factor	0.876	TRM

$$\Delta \text{kWh} = [116.84 + (\text{Age} * 10.89) + (\text{Pre-1990} * 431.79) + (\text{Size} * 19.42) + (\text{Single-Door} * -795.37) + (\text{Side-by-side} * 426.41) + (\text{Primary Unit} * 170.41) + (\text{CDDs} * \text{unconditioned} * 17.34) + (\text{HDDs} * \text{unconditioned} * -11.78)] * \text{Part Use Factor}$$

<sup>4</sup> Source: <http://www.ilsag.info/technical-reference-manual.html>

<sup>5</sup> Energy savings are based on an average 30-year TMY temperature of 51.1 degrees. Coefficients provided in January 31, 2013 memo from Cadmus, "Appliance Recycling Update".

**Table 2-4: Energy savings for freezers<sup>6</sup>:**

Independent Variable	Coefficient
Intercept	132.12
Age (years)	12.13
Pre-1990	156.18
Size (cubic feet)	31.84
Chest	-19.71
Unconditioned Space X CDD	9.78
Unconditioned Space X HDD	-12.76
Part-use factor	0.825

$$\Delta \text{kWh} = [132.12 + (\text{Age} * 12.13) + (\text{Pre-1990} * 156.18) + (\text{Size} * 31.84) + (\text{Chest} * -19.71) + (\text{CDDs} * \text{unconditioned} * 9.78) + (\text{HDDs} * \text{unconditioned} * -12.76)] * \text{Part Use Factor}$$

Total kWh saved =  $\Delta \text{kWh} * \text{Number of Units} * \text{Installation Rate}$

Where:

Age = Age of retired unit

Pre-1990 = Pre-1990 dummy (=1 if manufactured pre-1990, else 0)

Size = Capacity (cubic feet) of retired unit

Side-by-side = Side-by-side dummy (= 1 if side-by-side, else 0)

Single-Door = Single-Door dummy (= 1 if Single-Door, else 0)

Chest = Chest freezer dummy (=1 if chest freezer, else 0)

Primary Usage = Primary Usage Type (in absence of the program) dummy  
(= 1 if Primary, else 0)

Interaction: Located in Unconditioned Space x CDDs = Proportion of units in  
unconditioned spaces interacted with CDDs

Interaction: Located in Unconditioned Space x HDDs = Proportion of units in  
unconditioned spaces interacted with HDDs

Part Use Factor = To account for those units that are not running throughout the entire  
year.

After savings have been computed, a part-use factor was then applied. This factor is also based on the values specified in TRM version 2.0.

### 2.2.2 Summer Coincident Peak Demand Savings

$$\Delta \text{kW} = \text{kWh}/8760 * \text{CF}$$

<sup>6</sup> Energy savings are based on an average 30-year TMY temperature of 51.1 degrees. Coefficients provided in January 31, 2013 memo from Cadmus: "Appliance Recycling Update".

Where:

- kWh = Savings provided in algorithm above
- CF = Coincident factor defined as summer kW/average kW
- = 1.081 for Refrigerators
- = 1.028 for Freezers<sup>7</sup>

### Room Air Conditioner Savings

**Room AC.** Room AC gross savings were estimated using the algorithm specified in TRM version 2.0 and shown below.

$$\Delta kWh = ((FLH_{RoomAC} * BtuH * (1/EE_{Rexist}))/1000)$$

Where:

- FLH<sub>RoomAC</sub> = Full Load Hours of room air conditioning unit
- BtuH = unit capacity [BTU/h] is a nameplate value
- EE<sub>Rexist</sub> = unit efficiency [EER] of the recycled unit
- $\Delta kW = (BtuH * 1/EE_{Rexist})/1000 * CF$

Where:

$$CF = 0.3$$

The following table presents the parameters that were used in the verified gross and net savings calculations, and indicates which were examined through evaluation activities and which were deemed.

**Table 2-5. Verified Savings Parameter Data Sources**

Gross Savings Input Parameters	Data Source	Deemed † or Evaluated?
Unit Energy Consumption	Illinois 2013 TRM v 2.0	Deemed
Unit Energy Demand	Illinois 2013 TRM v 2.0	Deemed
Net-to-gross ratio	SAG Spreadsheet †	Deemed (SAG spreadsheet)
	PY6 Participant Surveys	Evaluated (Program Induced Replacement Factor)
Part-Use Factor	Illinois 2013 TRM v 2.0	Deemed
Verification Factor	PY6 Participant Surveys	Evaluated

† Source: ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

### 2.2.3 Verified Gross Program Savings Analysis Approach

The evaluation-verified savings for the FFRR program are based on an in-depth review and analysis of tracking data, application of the regression-based algorithms and part-use factors per the Illinois 2013

<sup>7</sup> Cadmus memo to TRM Working Group, February 12, 2013; “Appliance Recycling Update”



TRM version 2.0, and a separate verification via a telephone survey of whether units were picked up by the program. The verification was based on a screening question in the telephone survey to confirm the appliances were picked-up as reported in the program tracking database.

### 2.2.3.1 *Approach Used for Refrigerators and Freezers*

Gross savings are based on: (1) The regression specifications in the TRM version 2.0 for each appliance type; (2) The part-use factors in the TRM version 2.0 by appliance type; and (3) Appliance characteristics from the PY6 tracking data, except for unit location. The unit location variable is important because it is a separate term in the regression specification for TRM version 2.0<sup>8</sup>.

The unit location is based on the participating customer survey findings which are considered more accurate than the unit location data in the tracking data. The latter data source is not fully populated at present, primarily because participating retailers have not been supplying this data. These survey findings are based on responses to a counterfactual question of the decision maker regarding where the unit would have been located if the program hadn't picked it up. Tracking data unit locations are based on what the truck driver observes at the time the unit is picked up (which may have been a temporary location in anticipation of the unit's impending removal). The no program unit location based on the counterfactual response by the decision maker is the appropriate value for the Gross savings calculation.

The following procedure was used to compute verified gross savings for refrigerators and freezers. For each of the 320 sites represented by a completed survey, gross savings was calculated twice: first using the tracking data unit location, and second using the survey data unit location. Savings under each calculation method were then summed for each appliance type, and a multiplier was developed based on the ratio of tracking+survey/tracking only savings. The resulting multipliers were 1.076 (refrigerators) and 0.993 (freezers). These multipliers were then applied to savings across all collected measures for the given appliance type which were based on tracking data only. The 100% Verification factors, also based on Participant survey results, were then applied.

The verified gross savings estimates for both energy (kWh) and peak demand (kW) rely on regression equations developed from the results of 5 metering studies conducted by evaluators for several Midwestern utilities, including one done by the ComEd evaluation team in PY4. This methodology corresponds to Option D (Calibrated Simulation) in PJM's Manual 18b, Energy Efficiency Measurement and Verification. This Option allows the use of a model, in this case the regression equations that have been calibrated using actual data (in this case, the *in situ* metered data).

Gross energy savings are initially expressed in terms of Full-year Unit Energy Consumption (UECs). The regression-based approach that underlies UEC estimates models full-year energy savings as a function of several independent variables. These include appliance characteristics (e.g., age, size and unit location), and several dummy variables (e.g., unit type, configuration, whether the unit was manufactured before 1993 or not). A part-use adjustment is then applied.

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<sup>8</sup> This is a new variable, which was not present in the versions of regression formulas used in previous evaluations.

*Negative Unit Energy Consumption and Demand.* The application of the regression based savings algorithm resulted in a small number of refrigerator units with negative unit energy consumption and demand values. A total of 487 (1.3%) refrigerator units fell into this category. The negative UECs are primarily single door and manual defrost refrigerators or those that are less than 10 years old and less than 15 cubic feet in size.

For such units with negative energy consumption, 100 kWh was used in place of the negative value. To correct the negative demand value, the TRM demand equation was then applied. When the energy savings was set to 100 kWh, the demand value, based on the equation was 0.01234 kW/unit.

*Part-Use Adjustment.* The full-year UEC value is then adjusted for part-use, based on the deemed part-use factors specified in the TRM, version 2.0. The TRM part-use adjustment is based on prior evaluations' results which, in turn, are based on responses to phone survey questions regarding the actual intended use of units in the program's absence. This adjustment pro-rates the full-year value for the proportion of the year that the unit would have been operated in the program's absence. The values of these factors were calculated directly from verified evaluation results for ComEd and Ameren and are specified separately for refrigerators and freezers.

#### **2.2.3.2 Approach Used for Room A/Cs**

Gross savings are based on: (1) The engineering algorithm and associated full-load hours in the TRM version 2.0; and (2) A/C unit characteristics from the PY6 tracking data, except for unit location. No part-use adjustment was needed.

#### **2.2.3.3 Verification Factor**

A verification factor is applied to the calculated Gross saving for each appliance type. This value is based on responses to a series of phone survey questions regarding whether the respondent recalled having the program pick up their units. All 320 respondents contacted indicated that the program did pick up their unit, resulting in a verification rate of 100% for PY6.

### **2.2.4 Verified Net Program Savings Analysis Approach**

Verified net energy and demand (coincident peak and overall) savings were calculated by multiplying the Verified Gross Savings estimates by a net-to-gross ratio (NTGR). In PY6, the NTGR estimates used to calculate the Net Verified Savings were based on past evaluation research and defined through a negotiation process through SAG as documented in a spreadsheet.<sup>9</sup> These values are subsequently adjusted by a Program Induced Replacement factor, as specified in the 2013 TRM, version 2.0.

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<sup>9</sup> Source: ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

#### **2.2.4.4 Free-Ridership**

The values for PY6 approved by SAG were based on participant self-reported information from the telephone surveys on alternative disposal methods in the program's absence. Responses that correspond to a method that permanently removes the unit from the grid are considered free riders.

#### **2.2.4.5 Program-Induced Replacement Factor**

The SAG approved NTG values for PY6 were subsequently adjusted for by a program-induced replacement (PIR) factor, as required by the 2013 TRM, version 2.0. This term accounts for the role played by the FFRR program and incentive in inducing a customer to replace their unit after the old unit was removed by the program and recycled. Per the TRM procedure, only replacements that result from the program incentive as a factor named by the respondent are to be reflected in the PIR adjustment. In calculating this factor, savings from participants who indicate that the program incentive caused them to replace their old unit are reduced by the estimated consumption of the replacement unit. The consumption of the replacement units was estimated using the Energy Star Appliance Savings Calculator available on the Energy Star website. The average characteristics of new units captured in the survey are used for inputs into the Appliance Savings Calculator.

#### **2.2.4.6 Spillover**

The FFRR program design and program theory do not support an expectation of significant spillover. However, spillover was investigated in this evaluation, based on self-reported responses to a set of spillover questions in the participating customer survey. Any spillover reported that is associated with a high degree of program influence is quantified directly using engineering equations, and then incorporated into the NTGR calculation.

### **2.3 Process Evaluation**

The process evaluation relied primarily on two data sources, program staff interviews, and telephone surveys of program participants. Nonparticipant surveys also provided information on the secondary market for used refrigerators and freezers.

- *Program Staff interviews.* The interview with the Appliance Recycling Program Managers focused on program processes in order to better understand the goals of the program, how the program was implemented, the perceived effectiveness of the program, and also verified evaluation priorities. The interviews with the JACO managers focused on the recycling process and the details of the appliance pickup.
- *Telephone surveys.* The process evaluation component of the surveys obtained information on sources of program awareness, program satisfaction, rebate satisfaction, and awareness of program features (e.g., rebates, technical assistance, marketing materials).

### **2.4 Sampling Plan**

*Participant survey.* The sample of FFRR participants was randomly selected from the FFRR program Tracking Database provided by ComEd. Basic data cleaning steps were undertaken before the sample was pulled from the database to, among other things, remove records with missing or invalid phone numbers. A total of 963 participants who recycled more than one of the same types of a major appliance

were dropped from the survey effort for ease of survey administration. (Also, to avoid survey fatigue, participants were only asked about one major appliance.) In addition, 78 participants were dropped because of missing phone numbers or the tracking database indicated they were a business. These records could not be included in the surveying efforts, but were included in the final impact results. The final participant population from which the survey sample was drawn was 41,798 participants.

The sample was stratified by appliance type and quotas were set based on the proportion of each appliance in the general population. Each participant was first assigned to one of three main strata based on the nature of usage and type of unit recycled: Primary Refrigerator, Secondary Refrigerator, and Freezer. For Refrigerators, these main categories were further stratified based on their association with Retailer #1, other [program] retailers, and non-retailers. Quotas were then set for each stratum. The Retailer #1 and Freezer strata were oversampled to ensure sufficient data would be available. No separate quota was set for room A/C recyclers, since those units account for a very small percentage of the total population.

The survey staff was instructed to randomly select and dial participants until they had reached the designated quotas. There was no separate quota for Room AC Recyclers because A/C participants would naturally end up in the refrigerator and freezer quotas. Table 2-6 shows the population sizes and number of completed surveys for each of the strata.

**Table 2-6. PY5 Participant Survey Population and Sample Sizes by Stratum**

Appliance Recycled	Retailer	Population Size* (N)	Sample Quotas	Completed Surveys (n)
Primary Refrigerator	Retailer #1	1,316	14	15
	Other	1,840	47	49
	Non-Retailer	5,622	16	12
Secondary Refrigerator	Retailer #1	5,773	61	60
	Other	1,084	28	23
	Non-Retailer	20,768	59	67
Freezer	N/A	5,395	75	94
<b>Total</b>		<b>41,798</b>	<b>300</b>	<b>320</b>

*\*Source: PY6 FFRR Participant Survey Sample Frame from Program Tracking Database*

## 2.5 Sampling Error

Table 2-7 gives population sizes, completed interviews and the associated statistical confidence intervals for each appliance type. A 90% confidence interval was used in the analysis.

**Table 2-7. PY6 Participant Survey Population,  
Sample Sizes and Sampling Error by Appliance Type**

Strata	Population Size* (N)	Completed Surveys (n)	Sampling Error (90% CI)
Recycled Refrigerators	36,403	226	5.99%
Recycled Freezers	5,395	94	7.17%
<b>Totals</b>	<b>41,798</b>	<b>320</b>	<b>4.24%</b>

*\*Source: PY6 FFRR Participant Survey Sample Frame from Program Tracking Database*

## 2.6 Survey Disposition

**Participant Survey.** Table 2-8 shows the final dispositions for the 3,200 program participants we attempted to contact for this evaluation. As the table shows, we completed interviews with 320 participants, or 10% of the sample. We were unable to reach 43.8% for a variety of reasons such as no one answering, an answering machine, or a busy signal. Another 7.2% requested to be called back later to complete the survey but did not end up doing so. There were problems with the phone number, such as a disconnected number, for 9.5%. Finally 26.9% of participants who answered refused to participate in the survey.

The remaining reasons why surveys were not completed were a language barrier (1.5%), not enough time to complete (0.10%) or ComEd was not their electric utility (0.40%). For the last category, we speculate that the respondents were confused between their electricity supplier, which can be someone other than ComEd, and their delivery services company, which is always ComEd.

**Table 2-8. Participant Survey Sample Disposition**

Sample Disposition	Customers	%
Participants Attempted to Contact	3,200	100.0%
Completes	320	10.0%
Appliance not picked up	0	0.0%
Appliance removed, unsure of removal company	15	0.5%
Electric company not ComEd	13	0.4%
Incomplete	3	0.1%
Refusal	862	26.9%
Unable to Reach	1,402	43.8%
Language Barrier	49	1.5%
Phone Number Issue	305	9.5%
Non-Specific Callback/Appointment Scheduled	231	7.2%

*Source: Evaluation Team analysis.*

**Nonparticipant Survey.** Table 2-9 shows the final dispositions for the 1,784 ComEd nonparticipants we attempted to contact for this evaluation. As the table shows, we completed interviews with 75 nonparticipants, or 4.2%. We were unable to reach 54% for a variety of reasons such as no one answering, an answering machine, or a busy signal. Another 7% requested to be called back later to complete the survey but did not end up doing so. There were problems with the phone number, such as a disconnected number, for 6%. Finally, 23% of participants who answered refused to participate in the survey.

The remaining reasons why surveys were not completed were a language barrier (2%), not enough time to complete (2%) or ComEd was not their electric utility (1%). For the last category, we cannot say if the nonparticipant database included some people in error or if these respondents had recall problems.

**Table 2-9. Nonparticipant Survey Sample Disposition**

Sample Disposition	Customers	%
Participants Attempted to Contact	1,784	100%
Completes	75	4%
Does not have qualifying unit/Did not dispose of Qualifying Unit	33	2%
Electric company not ComEd	14	1%
Refusal	415	23%
Unable to Reach	958	54%
Language Barrier	38	2%
Phone Number Issue	99	6%
Non-Specific Callback/Appointment Scheduled	120	7%
Quota Filled	2	0%
Mid-Interview Terminate	30	2%

*Source: evaluation analysis*

### 3 Gross Impact Evaluation

Program activity remained relatively high in PY6 although the volume of activity was down from PY5. A total of 42,313 units were verified as being recycled, and these achieved 35,478 MWh and 4.51 MW of verified gross savings. It should be noted that the PY6 verified gross MWh savings is just under 80% of PY5 verified gross MWh savings. Verified savings have decreased significantly from PY5 values for two main reasons: (1) Overall, the number of units recycled through the program is down 13% from PY5. (2) The updated regression specifications for refrigerators and freezers in the Illinois Statewide TRM version 2.0 result in a lower savings per unit. The deemed part-use factors used in this evaluation are also slightly lower.

#### 3.1 Tracking System Review

A detailed review of the tracking system data surfaced some minor issues that should be addressed going forward. Nearly 7,000 units listed “Cust NA” for prior location, unit usage (primary or secondary) if the unit was replaced or not, and seasonal usage if applicable. According to program tracking data, almost all of the cases of missing data are units that were recycled by the program’s retailer partners. The unit’s prior location is currently required to estimate program savings based on the regression specification in the 2013 Illinois TRM, Version 2.0. Therefore, those fields will need to be populated, if at all possible.

Key findings are:

1. The tracking data is high quality and is generally sufficient to estimate program savings accurately under the current and future TRM regression specifications (versions 2.0 and 3.0).
2. Prior location, unit usage, unit season, and unit replaced are missing in nearly 7,000 records mostly due to the retail partners not collecting those data elements.

#### 3.2 Program Volumetric Findings

According to program tracking data, the program had 40,140 participants, contributing a total of 42,313 units to the program. All of these could be verified through evaluation survey efforts, resulting in a verification rate of 100% for each appliance type, based on responses to the phone survey. The volume of units processed through the program is down from PY5, when 48,805 units were verified as being recycled through the program.

The breakdown of units is 86% refrigerators, 13% freezers, and 1% air conditioners, which is almost identical to the proportions in PY4 and PY5.

Key findings include:

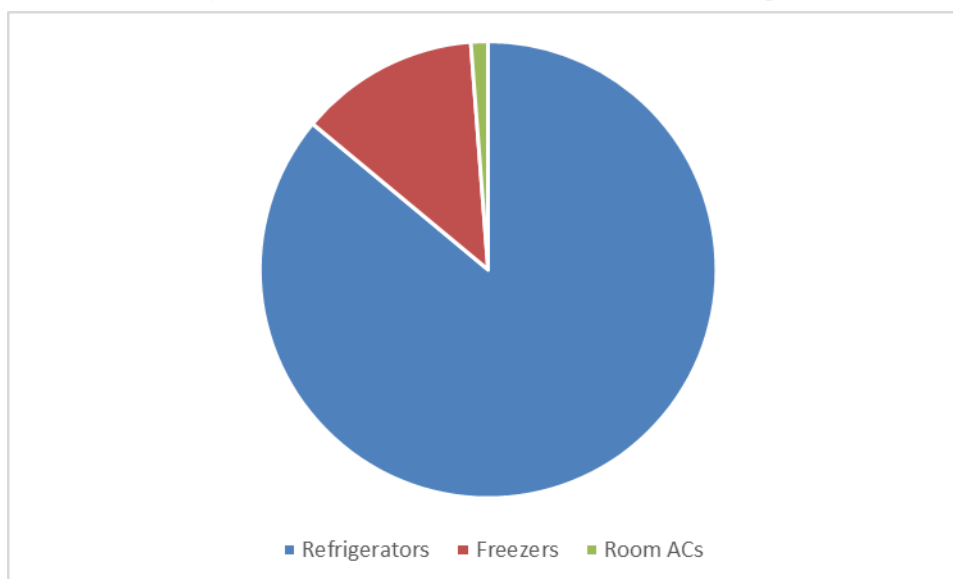
1. Program activity is down 13% from PY5, although it is still significantly higher than the original program goal of 40,000 units (which was later revised to 45,000 units).
2. The proportions of units by unit type are similar to those in PY4 and PY5

**Table 3-1. PY6 Volumetric Findings Detail**

	Program-Reported Number of Units	Verification Factor	Verified Participation Units	% of Total Units
<b>Number of Participants</b>	<b>40,140</b>	<b>100.0%</b>	<b>40,140</b>	<b>100%</b>
<b>Units by Measure Type</b>				
Refrigerators	36,403	100.0%	<b>36,403</b>	86%
Freezers	5,395	100.0%	<b>5,395</b>	13%
Room ACs	515	100.0%	<b>515</b>	1%
<b>Total Measures</b>	<b>42,313</b>	<b>100.0%</b>	<b>42,313</b>	<b>100%</b>

Source: ComEd tracking data and Navigant team analysis.

**Figure 3-1. Number of Measures Installed by Type**



Source: Evaluation Analysis

### 3.3 Gross Program Impact Parameter Estimates

As described in Section 2, energy and demand savings for refrigerators and freezers are estimated using a detailed set of regression equations specified in the TRM. In addition, the TRM procedure includes a separate formula for developing engineering-based estimates of room A/C savings.

The EM&V team conducted research to validate the parameters that were not specified in the TRM. The results are shown in the following table.



**Table 3-2. Verified Gross Savings Parameters**

Input Parameters	Data Source	Deemed or Evaluated?
Unit Energy Consumption	Illinois 2012 TRM v 2.0 †	Deemed
Unit Energy Demand	Illinois 2012 TRM v 2.0	Deemed
Net-to-gross ratio	SAG Spreadsheet ‡ PY6 Participant Surveys	Deemed - Base NTGR Evaluated - PIR factor
Part-Use Factor	Illinois 2012 TRM v 2.0	Deemed
Verification Factor	PY6 Participant Surveys	Evaluated

† State of Illinois Technical Reference Manual version 2.0 from <http://www.ilsag.info/technical-reference-manual.html>.

‡ Source: ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

### ***3.4 Verified Gross Program Impact Results***

The resulting total program verified gross savings is 35,478 MWh and 4.51 MW as shown in the following table. The table presents savings at the measure group level including the room AC measure, where the estimate is not statistically significant at the 90/10 level. Note that verified gross savings excluding the part-use factor, are virtually identical to ex-ante gross savings. Both sets of values were computed using the regression specified in the TRM, without applying the part-use factor, and are comparable. However, since the part-use factor is an element of the gross savings calculation, it was subsequently applied to these initial values to yield final verified gross savings impacts. This difference is reflected in the Gross Realization Rate based on savings including Part-Use Factor components in Table 3-3 below.

**Table 3-3. PY6 Verified Gross Impact Savings Estimates by Measure Type**

	Gross Energy Savings (MWh)	Gross Peak Demand Savings (MW)
<b>Refrigerators</b>		
Verification Factor	1.00	1.00
Gross Realization Rate based on savings excluding Part-Use Factor	1.00	
Gross Realization Rate based on savings including Part-Use Factor	0.94	
Part Use Factor	0.876	0.876
Verified Gross Savings	31,192	3.85
<b>Freezers</b>		
Verification Factor	1.00	1.00
Gross Realization Rate based on savings excluding Part-Use Factor	1.00	
Gross Realization Rate based on savings including Part-Use Factor	0.85	
Part Use Factor	0.825	0.825
Verified Gross Savings	4,164	0.49
<b>Room ACs</b>		
Verification Factor	1.00	1.00
Gross Realization Rate	1.01	
Part Use Factor	1.00	1.00
Verified Gross Savings	122	0.17
<b>Total</b>		
Ex-Ante PY6 Gross Savings	33,253	N/A
Verified Gross Realization Rate	1.00	1.00
Gross Realization Rate based on savings excluding Part-Use Factor	1.00	
Gross Realization Rate based on savings including Part-Use Factor	0.93	
Verified Gross Savings	35,478	4.51

Source: Evaluation analysis

## 4 Net Impact Evaluation

The SAG consensus process determined<sup>10</sup> that the NTG values for each of the measures recycled through this program should be deemed prospectively and used to calculate verified net savings. The TRM, Version 2.0 procedure for Refrigerator and Freezer Recycling that was adopted subsequent to this determination requires that the NTG value also include a term for Program Induced Replacements (PIR). These are replacements of refrigerators or freezers that are directly attributable to the incentive provided by the program.

Thus, the NTG ratio consists of 2 elements, the SAG adopted values (reflecting free ridership) and the PIR. The PIR was calculated from findings from the PY6 participating customer surveys; the procedure for determining it is described in Section 2.

The table below shows the deemed SAG NTG values adjusted by the Program Induced Replacement factor, and the resulting PY6 verified net savings.

**Table 4-1. PY6 Verified Net Impact Savings Estimates by Measure Type**

	Sample Size	Energy Savings (MWh)	Significant at 90/10?	Coincident Peak Demand Savings (MW)	Significant at 90/10?
<b>Refrigerators</b>					
Verification Factor	226	1.00	Yes	1.00	Yes
Gross Realization Rate including part use factor		0.94			
Verified Gross Savings		31,192	Yes	3.8	Yes
Part Use Factor		0.876	N/A	0.876	N/A
Free Ridership + PIR factor		0.30		0.30	
Spillover		N/A		N/A	
NTG	226 <sup>11</sup>	0.70	Yes	0.70	Yes
Verified Net Savings		21,873	Yes	2.70	Yes

<sup>10</sup> Source: ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

<sup>11</sup> Sample size applies to Program Induced Replacement (PIR) component of NTG ratio.

	Sample Size	Energy Savings (MWh)	Significant at 90/10?	Coincident Peak Demand Savings (MW)	Significant at 90/10?
<b>Freezers</b>					
Verification Factor	94	1.00	Yes	1.00	Yes
Gross Realization Rate including part use factor		0.85			
Verified Gross Savings		4,164	Yes	0.5	Yes
Part Use Factor		0.825	N/A	0.825	N/A
Free Ridership + PIR factor		0.19		0.19	
Spillover		N/A		N/A	
NTG <sup>12</sup>	94	0.81	Yes	0.81	Yes
Verified Net Savings		3,371	Yes	0.40	Yes
<b>Room A/Cs</b>					
Verification Factor	2	1.00	No	1.00	No
Gross Realization Rate		1.01			
Verified Gross Savings		122	No	0.2	No
Part Use Factor		1	N/A	1	N/A
Free Ridership		0.28		0.28	
Spillover		N/A		N/A	
NTG		0.72		0.72	
Verified Net Savings		88	No	0.12	No
<b>Total</b>					
Ex-Ante Gross Savings		33,253		N/A	
Verification Factor		1.00	Yes	1.00	Yes
Gross Realization Rate including part use factor		0.93			
Verified Gross Savings		35,478	Yes	4.5	Yes
Part Use Factor		0.88		0.88	
Free Ridership + PIR factor		0.29		0.29	
Spillover		N/A		N/A	
NTG		0.71	Yes	0.71	Yes
Verified Net Savings		25,331	Yes	3.2	Yes

Source: Evaluation Team analysis.

The Evaluation team believes the Program Induced Replacement (PIR) factor concept is implausible because an incentive ranging from \$35 to \$50 is unlikely to be sufficient motivation for purchasing an otherwise-unplanned replacement unit (which can cost \$500 to \$2,000). For this reason, it is recommended that the PIR be eliminated from the TRM calculation, starting in PY7.

<sup>12</sup> Sample size applies to Program Induced Replacement (PIR) component of NTG ratio.

## 5 Process Evaluation

The process evaluation of the PY6 Residential Fridge Freezer Recycling Rewards Program Evaluation focused on program satisfaction, drivers of participation, motivations for appliance disposal, marketing and promotional strategies, and participation in additional ComEd programs. The primary data sources for the process evaluation were the surveys of participating customers (n = 320), the program tracking database, and in-depth interviews of the ComEd Program Managers and JACO staff (n = 2). Complete process evaluation results are presented in Appendix Section 7.2. Key process findings from the study are below:

- **Overall Program Satisfaction.** Overall satisfaction among participants was very high again this year, with an average satisfaction rating of 9.2 on a 0 to 10 point scale. Satisfaction levels have been consistently high since the program began 6 years ago.
- **Reasons for Participating.** As in previous years, the most important reasons for participating in the program included the convenience of the service, the \$35 or \$50 incentive, and the relief from the burden of having to dispose of the appliance. Fully 96% of participants reported that they were likely<sup>13</sup> to recommend the program to a friend or colleague.
- **Reasons for Disposing of the Appliance** vary depending whether the unit is the primary or secondary appliance in the home. Over half (54%) of participants recycling their primary refrigerator wanted to upgrade to a newer appliance with more modern features, while 24% were concerned about the expense of running their previous unit. Secondary refrigerator and freezer recyclers turned in their units because they used them infrequently (56% and 44%, respectively) and were also concerned with the expense of running the unit (39% each).
- **Sources of Program Awareness.** Participants found out about the program through a variety of channels. Over one-third (35%) found out about the program from bill inserts. Another 29% learned of the program through a retailer, presumably when purchasing a new refrigerator or freezer. Thirteen percent of participants became aware of the program through word of mouth.

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<sup>13</sup> Likelihood of 7 or higher on a 0-10 scale

## 6 Findings and Recommendations

Overall, the Fridge and Freezer Recycle Reward Program performed strongly and was very popular with participating customers. The program continues to recycle a high volume of units and provides a reliable source of savings for ComEd. Verified gross and net savings have decreased significantly due primarily to the lower savings per unit based on the regression equations specified in the Illinois Statewide TRM version 2.0. This regression specification is based on the pooled results of five metering studies completed for Midwestern utilities, including the study the evaluation team completed in PY4 for ComEd. Offsetting this somewhat are higher net-to-gross ratios in this evaluation versus the values used in PY5.

This section summarizes the key impact and process findings and recommendations.

### Program Savings Goals Attainment

**Finding 1.** The starting PY6 net energy savings goal for this program was 25,000 MWh, which is about 22% lower than the final PY5 goal. The ex-ante net energy savings was 33% higher than the goal, at 33,253 MWh.

**Finding 2.** The PY6 verified gross energy savings is 35,478 MWh, while evaluation-verified net savings is 25,331 MWh, which is 71% of the verified gross savings. Based on these values, the program has exceeded its PY6 net savings goal slightly.

### Gross Realization Rates

**Finding 3.** The Program realization rate (Gross) is based on the Gross realization rate and the Verification rate. The Gross realization rate reflects the difference between ex-ante gross savings (kWh) and verified gross savings. Because of a difference in gross savings estimation methods, a verified gross realization rate of 0.93 (total program) was achieved. The Verification rate is based on responses to a phone survey question regarding whether the respondent recalled having the program pick up their units. In total, 100% (320 of 320) of participants surveyed said that the program did pick up their units, resulting in a Verification rate of 100%.

**Finding 4.** Additional follow up questions added to the PY6 survey in response to a recommendation in the PY5 evaluation for those that answer “no” to the verification question were effective. These questions probed in more detail on their answer. In all cases, the respondent verified the pick-up had occurred, but was unsure who had picked up their old unit. These additional probing questions are effective to resolve initial confusion by customers about the details of the pick-up, and should be retained going forward.

### Net-to-Gross Ratio

**Finding 5.** The NTG ratios used to calculate verified savings were based on the SAG approved values minus the Program Induced Replacement (PIR) factor as specified in the TRM v. 2.0. Specific values applied were: Refrigerators – 0.70, Freezers – 0.81 and Room A/C units – 0.72, for a total program value of 0.71.

**Recommendation 5.** The Evaluation team believes the Program Induced Replacement (PIR) factor concept is implausible because an incentive ranging from \$35 to \$50 is unlikely to be

sufficient motivation for purchasing an otherwise-unplanned replacement unit (which can cost \$500 to \$2,000). For this reason, it is recommended that the PIR be eliminated from the TRM calculation, starting in PY7.

**Finding 6.** The Evaluation Research Findings NTG ratios are 0.40 for refrigerators (based on a weighted average of a Customer NTGR of 0.63, a Retailer NTGR of 0.15, and net of a PIR factor of 0.039), 0.54 for freezers (based on a weighted average of a Customer NTGR of 0.57, a Retailer NTGR of 0.16, and net of a PIR factor of 0.013) and 0.50 for room ACs (based on participating customers only) for a total program NTG ratio of 0.42. The Research Findings NTG ratio is a weighted average of participating customer and retailer responses to survey questions. It also includes a term for Program Induced Replacements, per the TRM.

**Recommendation 6.** Based on the high level of free ridership for replaced primary units associated with the three retailers that participated in ComEd's PY6 program, and in particular, retailer #1, free ridership can be reduced by reducing reliance on units originating from such retailers' customers. A parallel strategy is to increase marketing to those who have secondary units since they tend to have lower free ridership than those who are replacing former primary units.

### Energy and Demand Savings Estimates

**Finding 7.** Based on the specified regression in the TRM, a small number of refrigerator units have negative energy and demand consumption. These are a function of the unit size and age, and comprise a very small fraction of the population. For such units with negative consumption, 100 kWh and 0.01234 were used in place of the negative value.

**Recommendation 7.** For units with negative energy and demand consumption, we recommend that additional language be added to the TRM to address this situation. The language could be: "The regression based savings algorithm produces negative unit energy or demand consumption values for a very small percentage of units. For such units with negative consumption, the average consumption of similar size and age units should be used in place of the negative value. For example, refrigerator units with negative consumption have an average age of 21 years and average size of 13 cubic feet so the average consumption of similar aged and sized units should be used instead of regression-based estimates."

**Finding 8.** The PY6 verified gross energy savings is 35,478 MWh, while evaluation-verified net savings is 25,331 MWh. These are significantly down from the PY5 verified savings values of 44,674 gross kWh and 30,531 net kWh, and are reflective of the much lower per-unit savings values based on the regression formula in the Illinois Statewide TRM version 2.0. For refrigerators, gross energy savings per unit have dropped from 1,026 kWh in PY5 to 912 kWh in PY6, or by 11.1%. For freezers, gross energy savings per unit have dropped from 1,243 kWh in PY5 to 913 kWh in PY6, or by 26.5%. The number of recycled units in PY6 is also down 13% from PY5 levels, further depressing savings achievements.

**Finding 9.** Gross peak demand savings are 4.80 MW and net savings are 3.22 MW. These are also significantly down from PY5 savings values and are reflective of the much lower per-unit savings values based on the regression formula in the Illinois Statewide TRM version 2.0, and the lower number of units recycled.

**Finding 10.** Nearly 7,000 records were missing the prior location of the units and if the unit is a primary or secondary unit and most of the missing records were from participating retailers. This is important data that is used in the Illinois Statewide TRM version 3.0 regression

model and will be applied in the evaluations going forward. For this evaluation, survey findings on unit location were used in place of the missing records in the regression process.

**Recommendation 10.** We recommend that steps be taken to capture and populate the missing prior location and primary/secondary fields. JACO has indicated they are trying to reduce the frequency of such missing data by instituting callbacks to customers during its data reconciliation process.

#### **Program Participation**

**Finding 11.** Program participation, based on the number of participants, remains strong but is down about 8% from PY5, although it is still significantly higher than the original program goal of 40,000 units (which was later revised to 45,000 units). While participation levels met ComEd's participation goals for PY6, the decline in such levels does not bode well for future years when program goals are increasing.

**Recommendation 4.** To meet increased goals planned for PY8 and PY9, ComEd will need to offer a combination of increased incentives and expanded marketing efforts.



## 7 Appendix

### 7.1 Evaluation Research Impact Approaches and Findings

This section presents PY6 program savings using the part-use factors and net-to-gross ratios derived from the PY6 surveys of program participants. The savings estimates are based on the same regression-based coefficients used to develop the evaluation-verified estimate of savings including a correction for a small number of units with negative savings. We also present trends in unit characteristics over time and summarize any significant changes in program trends.

#### 7.1.1 Evaluation Research Gross Impact Findings

**Unit Energy Consumption (UECs) and Demand.** The research report gross impact savings estimates are based on the same Illinois 2012 TRM v 2.0 regression based coefficients that were used to develop the evaluation-verified gross impact savings estimates. Refer to Section 3.1 for more details. The small fraction of units with negative savings resulting from this method were also addressed. The specific treatment for those units is discussed below.

*Negative Unit Energy Consumption and Demand.* The application of the regression based savings algorithm results in a small number of refrigerator units with negative unit energy consumption and demand values. A total of 487 (1.3%) refrigerator units fall into this category. The negative UECs are primarily single door and manual defrost refrigerators or those that are less than 10 years old and less than 15 cubic feet in size.

For such units with negative energy consumption, 100 kWh was used in place of the negative value. To correct the negative demand value, the TRM demand equation was then applied. When the energy savings was set to 100 kWh, the demand value, based on the equation is 0.01234 kW/unit.

**Part-use factors.** The Research Findings part-use factors are based on the PY6 participant survey findings. These account for the fact that a unit that would have stayed in use would have been in use only part of the time. For example, the savings due to removal of a unit that would have been used only three months of the year is only one-quarter (3/12) the savings associated with full-year use (assuming essentially constant use over the year for a full-use unit). The part-use factor is used to adjust gross savings UECs to yield estimates of annualized gross savings that can be attributed to the program.

**Refrigerators.** The assumption is that any refrigerator that would otherwise have been kept in use would have been used as a secondary, not as a primary refrigerator. Therefore, the part-use factor for all primary refrigerators that would otherwise have been kept is set at the average part-use reported by participants who disposed of a secondary refrigerator. This part-use was the number of months, divided by 12, that the participant reported the unit would have been plugged in and running had the program not picked it up. For PY6, this average was determined to be 79% or 0.79. As Table 7-1 indicates, the UEC adjusted for the part-use factor yields an average refrigerator consumption of 722 kWh per year.

**Freezers.** For freezers, the average part-use factor is based on a similar question for all participants who disposed of a freezer. For PY6, this average was determined to be 79% or 0.79. The supplemental data

collected in the survey provide no further insight into the part-year usage, nor do the tracking data. Adjusted for part-use, the average freezer consumes 724 kWh per year.

**PY6 versus PY5 Part-Use Factors.** The PY6 part-use factors of 0.79 for both refrigerators and freezers are down significantly from PY5 levels which were 0.92 for refrigerators and 0.83 for freezers. This, in turn, leads to lower overall savings per unit compared to PY5 values, and also helps to explain why overall gross savings for the program are much lower in PY6 compared to PY5.

**Table 7-1. Research Findings Gross Savings (UECs) Adjusted for Part-Use**

Appliance Type	Gross Savings (UECs)	Part-Use Factor	UEC Adjusted for Part-Use
Refrigerators	912	79%	722
Freezers	913	79%	724

*Source: Evaluation analysis*

**Verification rate.** The Verification rate is based on responses to a phone survey question regarding whether the respondent recalled having the program pick up their units. If the respondent indicated that the program did not pick up any units, then they were thanked for their time and the survey was ended without gathering additional information. In PY6, all survey respondents were able to verify their units were picked up by the program, resulting in a Verification rate of 100% for all 3 measure types.

### 7.1.2 Gross Impact Results

The Research findings verified gross energy savings for PY6 is 30,294 MWh, while the coincident peak demand savings is 4.83 MW. The tables below present the details behind these estimates.

**Table 7-2. PY6 Research Findings Gross Impact Parameter and Energy Savings Estimates (MWh)**

Gross Impact Parameter and Savings Estimates	Refrigerators	Freezers	Room AC	Total Program
Total units recycled through the Program	36,403	5,395	515	42,313
<b>Research Findings Annual kWh Savings Impacts</b>				
Research Findings annual Gross kWh savings per unit (full-load operating hours)	912	913	235	---
Part-Use Factor	0.79	0.79	1.00	---
Verification Factor	100.0%	100.0%	100.0%	100.0%
Research Findings annual Gross kWh savings per unit adjusted for part-use	722	724	235	---
<b>Research Findings Program Gross MWh</b>	<b>26,269</b>	<b>3,904</b>	<b>121</b>	<b>30,294</b>

*Source: Evaluation analysis*

**Table 7-3. PY6 Research Findings Gross Impact Parameter and Demand Savings Estimates (MW)**

Gross Impact Parameter and Savings Estimates	Refrigerators	Freezers	Room AC	Total Program
Total units recycled through the Program	36,403	5,395	515	42,313
Verification Factor	100.0%	100.0%	100.0%	
Verified Participation Units	36,403	5,395	515	42,313
Research Findings Annual kW Savings Impacts				
Annual Gross kW savings per unit (full-load operating hours)	0.113	0.127	0.040	---
<b>Research Findings Program Gross MW</b>	<b>4.12</b>	<b>0.68</b>	<b>0.02</b>	<b>4.83</b>

### 7.1.3 Evaluation Research Net Impact Findings

The primary objective of the research findings net savings analysis for the FFRR program was to determine the program's net effect on customers' electricity usage. This requires estimating what would have happened in the absence of the program. Thus, after gross program impacts adjusted for part-use have been assessed, net program impacts are derived by estimating a Net-to-Gross (NTG) ratio which quantifies the percentage of the gross program impacts that can reliably be attributed to the program.

The PY6 NTG assessment of retailer-sourced units continues with the expanded scope implemented in PY5, which had a goal of assessing program influence in all cases where an existing unit has been replaced. Such an inquiry included both the three participating retailers in the program, and two of the largest nonparticipating retailers associated with unit replacements. Responses from the existing participant survey were used to guide the analytical approach for the retailer associated units, as well as the non-replaced units picked up by JACO at customers' homes. The current "no program" question battery was expanded to include additional probing surrounding the participating customer's disposal options associated with the retailer they purchased the new unit from, and their rationale for recycling the unit via ComEd's program rather than choosing to have the retailer remove it. This helps to ensure consistency and a fuller understanding of the responses given to the critical survey question used to determine free ridership for the program.

Data sources included the following:

- *Telephone surveys with participating customers.* As in previous years, we relied heavily on findings from telephone surveys of participating customers to determine how their units would have been disposed of if the program hadn't picked them up.
- *Telephone surveys with nonparticipating customers.* These survey findings were not used directly in assessing the program NTGR, but instead provided contextual information on disposal options available to customers that were getting rid of a used appliance.
- *In-depth interviews with participating retailers.* These findings were used to determine the disposition of used appliances absent the program for those who purchase a new unit via these channels and who indicated they would have had the retailer remove the unit if the ComEd program had not been available.
- *Telephone surveys with nonparticipating retailers associated with unit replacements.* The evaluation team also obtained contact information, and conducted interviews with the two largest nonparticipating retailers associated with unit replacements. These interviews shed light on the

disposition of used appliances absent the program **for those participants that indicate that absent ComEd's program, they would have given the unit away to the retailer** they bought their new unit from. In such cases, the NTG ratio is based on that retailer's own disposal practices absent the program, which is revealed during these phone surveys.

The retailer interviews and participating customer phone surveys provide all inputs needed for the calculation of the program's net-to-gross ratio. The *participating customer survey* provided the self-reported percentage of units that: (1) would have been kept and used; (2) would have been kept by a household but not used; and (3) would have been discarded by a household through a method in which the refrigerator would have been destroyed. The retailer interviews provide the percentage of units that are discarded and destroyed by each retailer absent the program. Units that would have been kept but not used, and those that would have been discarded and destroyed absent ComEd's program, are considered free riders. The program's NTG ratio is then calculated from these results.

The program NTG ratio is a weighted average resulting from calculations for two categories of participants:

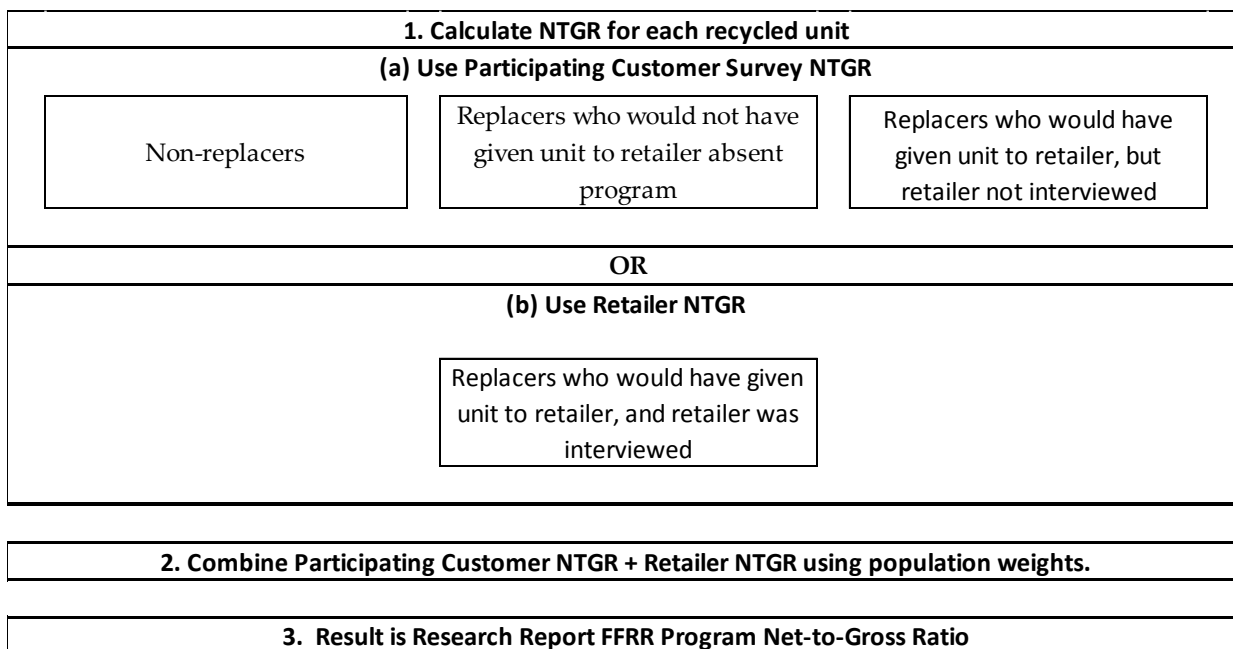
1. Participating customer survey responses are used directly in the calculation of the NTGR for three categories of participants:
  - Those who did not replace their unit.
  - Those who replaced it but indicated they would have used a disposal method not involving the retailer they bought the new unit from.
  - Those who replaced it, would have used a disposal method involving the retailer, but where an interview with the retailer was not completed.

This includes participants who indicated they would have otherwise sent the unit to a recycling facility, taken the unit to a landfill, or used another method that would have permanently removed the unit from the grid.

2. For the remaining customers, the NTG ratio was determined based on the disposal practices of each retailer interviewed. Those remaining are ones who would have used a method involving the retailer they bought the replacement unit from, would have used a disposal method involving the retailer, and where an interview with the retailer was completed. Interviews were completed with 5 major retailers that sold replacement units to participating customers. NTG ratios were then calculated for each retailer firm.

Figure 7-1 below provide a graphical representation of this framework.

**Figure 7-1. – Research Report NTG Framework**



Information regarding participant spillover was also collected, but ultimately did not support a finding of any spillover. For this program, because the program approach does not support a theory for how meaningful spillover might occur, a finding of no spillover was not surprising. From the survey, there were two respondents who cited the program as being ‘very influential’ for their taking additional energy efficiency actions – however, both respondents did so by participating in another ComEd residential program (for which the savings was presumably claimed). There were additional respondents who also undertook further actions to reduce their energy use, however, they indicated the FFRR program was either only moderately or not at all influential in their decision making.

Of those survey respondents that replaced their units, some 39% (78 of 199) indicated they would have had their unit removed by the dealer (i.e., retailer). The remaining 59% (121 of 199) would have used various other methods such as donating it to a charity, hauling it to the dump and recycling center, hiring someone to haul it away, and keeping it stored unplugged.

**Participating Customer findings.** In total, 45 out of 199 refrigerator respondents (23%) and 30 of 71 freezer respondents (42%) revealed they would have used a method to dispose of their unit that would have permanently destroyed it or would have kept the unit but not used it, indicating they are free riders. Resulting NTG ratios are 0.77 for refrigerators, and 0.58 for freezers. These values were applied to both non-replaced units, and those who would have used a method not involving the retailer they bought the replacement unit from in calculating the Research Findings program NTG ratio.

Additional questions were added this year to the participating customer surveys to probe deeper into any disposal options other than ComEd’s program that they may have considered. These were intended to assess the realism of the “no program” responses given and provide further insight into the responses given to the critical survey question used to determine free ridership for the program. Key findings from this battery are:

- A relatively small fraction of participants even considered selling/transferring their unit, or using Craigslist to either sell or give away the unit.
- Among the options available to *refrigerator* respondents (n = 199),
  - Just 16% (n = 30) thought of giving the unit away to a charity or a private party
  - An additional 12% (n = 24) would have had the garbage collector remove the unit
  - Just 8% (n = 16) would have hauled the unit to a recycling center
  - Only 4% (n = 7) considered selling to a private party or appliance dealer
  - Just under 5% (n = 8) considered using Craigslist to dispose of their unit
  - Those considering disposing of the unit themselves (n = 58) were asked about their ability to physically move and transport the unit. Less than half (43%, n = 25) said they could do this themselves, while over half (57%, n = 33) said they would need assistance.
  - Just 2% of participants (n = 4) attempted to trade in or sell the unit to a dealer. Three-fourths (n = 3) could not get the price they wanted, while another one-fourth (n = 1) said the unit's condition was not good enough for the dealer. Among those who wanted to sell the unit, prices sought were \$25, \$100, and \$300.
- Among the options available to *freezer* respondents (n = 71),
  - Only 11% (n = 15) would have hauled the unit to a recycling center
  - Just 1% (n = 1) considered selling to a private party or appliance dealer
  - Just under 9% (n = 6) considered using Craigslist to dispose of their unit
  - Those considering disposing of the unit themselves (n = 26) were asked about their ability to physically move and transport the unit. Less than half (42%, n = 11) said they could do this themselves, while over half (58%, n = 15) said they would need assistance.
  - Just 1 respondent (1.4%) attempted to trade in or sell the unit to a dealer. That respondent could not get the price they wanted. The price sought was \$50.

**Retailer findings.** A total of five retailers that provided replacement units to participating customers were interviewed thoroughly to learn of their appliance disposal practices in the absence of ComEd's program. Retailers were asked a series of questions regarding the following:

- Pickup and disposal services for replaced units
  - Charges, if any for such services
  - Percentage of customers that receive such services
- Recycling and/or deconstruction of units picked up by the retailer
  - Approach for units outside of ComEd's program – percentage of units affected
  - Approach prior to the start-up of ComEd's program – percentage of units affected
- Other disposition of units
  - Percentage that are picked up by a hauler/third party and resold (i.e., remain grid connected)

Each retailer provided specific answers to each of these topic areas. In general, a high percentage of units turned over to retailers are being disposed of via a method that permanently removes them from the grid. Only a small percentage – the newest units in the best condition – are resold.

From this information, we were able to construct a retailer-specific NTG ratio, representing 1 minus the percentage of units that would otherwise have been recycled or deconstructed in the absence of ComEd's program. As indicated by the table below, the rate of recycling varies significantly by retailer. The five retailers interviewed represent 39% of the new units purchased by program participants.

**Table 7-4. PY6 Net-to-Gross Ratios for Participating Retailers**

Retailer	NTGR ratio	Percentage of Program Units Given to Retailer Absent the Program (Survey based)
Retailer # 1 – local firm	0.02	61%
Retailer #2 – national chain	0.30	56%
Retailer #3 – national chain	0.20	50%
Retailer #4 – national chain	0.25	0%
Retailer #5– national chain	1.00	0%
<b>Total Retailer Units</b>		<b>39%</b>

*Source: Retailer interviews*

**Weighted Average NTGR.** A weighted average of the two net-to-gross ratios are then calculated separately for refrigerators and freezers using the proportions of participants who fall into each of the 2 categories of Participating Customer Survey NTGR and Retailer Survey NTGR. The proportion of participants in the retailer category (2) is combined for both refrigerators and freezers since the retailer interviews did not distinguish between unit type.

The formula for this calculation is:  $(NTGR_{nr} * \%nr) + (NTGR_r * \%r)$

Where:

NTGR<sub>nr</sub> = non retailer-based net-to-gross ratio

%t = percentage of participants who receive non retailer-based net-to-gross ratio<sup>14</sup>

NTGR<sub>r</sub> = retailer-based net-to-gross ratio

%r = percentage of participants who receive retailer-based net-to-gross ratio

The resulting NTGR is then applied to the average unit energy consumption per unit recycled by the respective retailers or by JACO and also weighted by the number of units recycled by each retailer or JACO. The result produces a weighted NTGR for refrigerators and freezers that takes into account both non-retailer and retailer based NTGRs. Table 7-5 presents the non-retail and retailer based recycling channels and the resulting weighted NTGR by appliance type.

<sup>14</sup> 1. Participating customer survey responses are used directly in the calculation of the NTGR for three categories of participants: (1) those who did not replace their unit; (2) those who replaced it but indicated they would have used a disposal method not involving the retailer they bought the new unit from; and (3) those who replaced it, would have used a disposal method involving the retailer, but where an interview with the retailer was not completed. This third category includes participants who indicated they would have otherwise sent the unit to a recycling facility, taken the unit to a landfill, or used another method that would have permanently removed the unit from the grid.



**Table 7-5. PY6 Research Findings Net-to-Gross for Retailer and Non-Retailer Participants**

Unit Type	NTGR Non-Retailer	NTGR Retailer <sup>15</sup>	NTGR Wtd Average (before PIR)
Refrigerator	62.8%	14.9%	44.0%
Freezer	56.5%	16.0%	55.4%
Room ACs	50%	N/A	50%

*Source: Evaluation Team analysis.*

#### 7.1.4 Used Appliance Dealer Interview Results

As in PY4, interviews were also conducted with several used appliance dealers as a cross-check on program's effect on the market for used appliances. The information obtained did not provide any evidence to counter the NTGR findings above. These interviews were with the same firms as in PY4<sup>16</sup>, since there have been no new entrants into the used appliance market during the past 2 years. Consequently, the interviews served to review answers provided previously, and to obtain any updated information. In general, the information provided was essentially the same as in PY4. General themes were that

- **Only the nicest and newest units are re-sold.** These comprised a very small percentage, less than 5%, of the used appliance population. The remainder are deconstructed and/or used for parts.
- The majority of respondents were again reluctant to provide definitive estimates of the age range at which units still had resale market value, preferring to make statements like, "We only sell the newer ones. . . the nice looking ones", and referring to operating condition rather than a given age range.
- One used dealer, who actively works with two of the program's three participating retailers, corroborated statements made in PY4, stating his company only removes units in "really good condition and fairly new (1-3 years old), people want really nice units. They are tight with their money now, and rather than buying a cheap older unit, they would rather try to patch their existing unit and make it work for a while longer before buying a newer one." He estimated that his firm removed only 5% of the newly replaced units for eventual resale, and the remaining 95% were deconstructed for the metals. Of the 5%, only 2% are resold and the balance are deconstructed and used for spare parts.

<sup>15</sup> The Retailer NTGR values for Refrigerators and Freezers are based on survey responses from the 3 retailers who currently participate in ComEd's program, plus two additional retailers that sold replacement units to survey respondents. Because of low program influence, ComEd is considering adjusting the participating retailer component of its program in PY8 to exclude the largest local retailer. Should this local retailer be excluded, the Retailer NTGR values for Refrigerators and Freezers would increase to 0.292 and 0.300, respectively.

<sup>16</sup> The sample size was relatively small (n=5) and the businesses dealt with a mix of both working and nonworking units. The small sample size reflected only those larger firms with websites that were the real target of the interview - used dealers.



### 7.1.5 Nonparticipant Survey Results

This section presents selected impact-related findings from the Nonparticipant survey. This survey serves two purposes. It provides: (1) general information on the secondary market for used refrigerators and freezers, and (2) information to help explain the program's net-to-gross ratio.

Findings are presented for two distinct subgroups:

- Acquirers – those that acquired a used refrigerator or freezer during the past 4 years
- Discarders – those that disposed of a used refrigerator or freezer during the past 4 years

In total, 75 surveys were completed, 50 with Acquirers, and 17 with Discarders. The majority of respondents had both discarded and acquired units. There were another 45 respondents that had either a secondary refrigerator or freezer, which also qualified them to complete the survey.

#### Acquirers

Acquirers were asked a series of questions regarding the characteristics of the used refrigerator or freezer they had obtained during the past 4 years. First, they were asked about the type of appliance they had acquired, whether the unit was new or used, and if it was operated as a primary or secondary unit. As shown in Table 7-6, nearly three-fourths of acquired units were refrigerators (82%) and most of these (66%) are new units. Only about 18% of acquired units are freezers, and three-fourths of them are new units. (Some respondents obtained both refrigerators and freezers in the past 4 years; thus, the totals exceeds 100%.)

**Table 7-6. Types of Units Obtained by Acquirers**

Appliance Type	Percentage of Households that Obtained in Past 4 Years (N=50)	
	New Unit	Used Unit
<i>Refrigerator (Any) (N = 49)</i>	66%	38%
-Refrigerator (Main)	62%	32%
-Refrigerator (2nd)	6%	14%
<i>Freezer (Any) (N = 11)</i>	16%	6%
-Freezer (Main)	4%	2%
-Freezer (2nd)	12%	4%

Next, acquirers were asked about the condition, age, and nature of use of the used unit they had obtained. Table 7-7 below reports these findings. Note that the number of respondents is relatively small for Refrigerator acquirers, and very small for Freezer acquirers. All of the acquired refrigerator units and two-thirds of the freezer units were working, and between one-fourth and one-third were newer models (i.e., less than 4 years old) when they were obtained. Note that the condition of acquired units has declined from the PY2 nonparticipant survey, when all acquired units were working, and the majority were less than 4 years old. In addition, refrigerator units are predominantly Primary (Main) units, while all freezer units are Secondaries (Spares). Finally, all refrigerator units and two-thirds of freezers are operating year-round.

**Table 7-7. Characteristics of Acquired Unit**

Characteristics of Acquired Used Unit	Percent of Respondents	
	Refrigerators (N=26)	Freezers (N=3)
Condition when Acquired		
-Working	100%	67%
-Working but in need of repair	0%	33%
Age		
-Less than 4 years old	24%	33%
Main vs. Spare		
-Main	82%	0%
-Spare	18%	100%
Total months used in past 12 months		
-12 months	100%	67%
-Refused	0%	33%

#### Discarders

All respondents were asked if they had disposed of a unit during the past 4 years, and roughly one-third of those interviewed had done so. Those who had, the “Discarders”, were asked a series of questions regarding the characteristics of the used refrigerator or freezer they had disposed of during the past 4 years. The majority of the discarded units (81%) were refrigerators. The incidence of disposal is fairly low, 7% for refrigerators and 1% for freezers. These findings are reported in Table 7-8 below. Note the very small numbers of completed surveys. Characteristics of the discarded units are shown in Table 7-9. Since only one Freezer discarder completed the survey, the findings are extremely limited and are therefore not being reported.

**Table 7-8. Incidence of Disposal of Used Units**

Appliance Type	Percentage of Households that Discarded Unit in Past 4 Years *
Refrigerator (N = 7)	7%
Freezer (N = 1)	1%

\* Number of discarders as a percentage of respondents who confirmed they did or did not discard a unit (n = 108)

With respect to the discarded units of Refrigerator discarders:

- The methods for disposing of the unit were:
  - Gave it away for free (N = 2)
  - Had it removed by the dealer who sold you the new unit (N = 2)
  - Sold it (N = 1)

- Half were replaced with another unit (50% of respondents). This reflects a drop from PY2, when all discarded units were replaced by another unit.
- Were working when they were disposed of (67%), or working but needed repair (33%)
- Reflected a wide range of age categories
- Were predominantly Secondary (Spare) units. This reflects a shift from the PY2 survey when units were primarily Main units.

**Table 7-9. Characteristics of Discarded Units**

Characteristics of Discarded Units	Percent of Respondents	
	Refrigerators (N=6)	Freezers (N=0)
Replaced with another Unit	50%	
Condition when Discarded		
-Working	67%	
-Working but needed repair	33%	
-Not working	0%	
Age		
-0 to 10 years	17%	
-10 to 20 years	33%	
-Over 20 years	17%	
-Don't know	33%	
Main vs. Spare Unit		
-Main	33%	
-Spare	67%	
-Other	0%	

Information was also sought on the cost of disposal. Unfortunately, no Refrigerator or Freezer disposers responded to this question.

*Program-induced replacements.* The final NTG ratio also includes a term for program-induced replacements (PIR). This term accounts for the role played by the FFRR program and specifically, the incentive in inducing a customer to replace their unit after the old unit was removed by the program and recycled. Per the TRM procedure, such inducement is to be based on the influence of the program incentive only. Savings from participants who indicate that the incentive provided by the program caused them to replace their old unit are reduced by the estimated consumption of the replacement unit. In calculating the PIR, a savings of 100 kWh per year per appliance was assumed for the consumption of the new replacement units. This is in line with the values estimated using the Energy Star Appliance Savings Calculator available on the Energy Star website. Incorporating the PIR factors into the NTG ratio causes the value to decline by the magnitude of the adjustment, similar to the effect of free ridership.

Table 7-10 and Table 7-11 below illustrate the PIR calculation used for refrigerators and freezers, respectively. For those who replaced a refrigerator, 15% cited the FFRR program as having induced the replacement, and of those, just over half (or 7.5% of respondents) said the incentive was the primary factor in their replacement decision. Similarly, for freezer replacers, 17% said the program caused them to replace their unit and of those, one-third (or 6% of respondents) cited the incentive as the causal factor. The PIR factors associated with incentives only are -4% for refrigerators and -1% for freezers.

**Table 7-10. PY6 Program-Induced Replacement Calculation – Refrigerators**

Replaced Recycled Unit?	Percent of Respondents	Program Induced Replacement?	Percent of Respondents	Motivated by Incentive	Percent of Respondents	Percent of Total Population	Induced kWh/Unit	Number of Units	Total Induced kWh
Yes	84%	Yes	15%	Yes	57%	7%	477	2,577	1,229,415
		No	85%	No	43%	5%	0	1,933	0
						71%	0	25,933	0
No	16%					16%	0	5,960	0
<b>Totals</b>								36,403	1,229,415
Weighted Average Program Induced Replacement Factor (all units)								33.8	3.9%

**Table 7-11. PY6 Program-Induced Replacement Calculation – Freezers**

Replaced Recycled Unit?	Percent of Respondents	Program Induced Replacement?	Percent of Respondents	Motivated by Incentive	Percent of Respondents	Percent of Total Population	Induced kWh/Unit	Number of Units	Total Induced kWh
Yes	38%	Yes	17%	Yes	33%	2%	465	115	53,402
		No	83%	No	67%	4%	0	230	0
						32%	0	1,722	0
No	62%					62%	0	3,329	0
<b>Totals</b>								5,395	53,402
Weighted Average Program Induced Replacement Factor (all units)								9.9	1.3%

After accounting for Program Induced Replacements, the final NTGRs are shown below in Table 7-12.

**Table 7-12. PY5 Research Findings Final Program Net-to-Gross Ratios**

Unit Type	NTGR Non-Retailer	NTGR Retailer	NTGR Wtd Average (before PIR)	PIR Factor	NTGR Wtd Average (after PIR)
Refrigerator	0.628	0.149	0.44	(0.039)	<b>0.401</b>
Freezer	0.565	0.160	0.554	(0.012)	<b>0.541</b>
Room ACs	0.500	N/A	0.500	N/A	<b>0.500</b>

#### 7.1.6 Net Program Impact Results

The research findings indicate that the PY6 net program savings is 12,714 MWh, which is 40% of the gross MWh research findings. The continuation of the retailer-based- net-to-gross ratios in PY6 reduces the net savings attributable to the program since many of the major appliance retailers also recycle used

units according to the retailer surveys. The research findings net MWh savings are 50% of the evaluation-verified net MWh savings.

**Table 7-13. PY6 Research Findings Net Impact Parameter and Savings Estimates (MWh and MW)**

Research Findings Annual Net MWh Savings Impacts	Refrigerators	Freezers	Room AC	Total Program
Research Findings Program Gross MWh	<b>26,228</b>	<b>3,891</b>	<b>119</b>	<b>30,238</b>
Free Ridership %	56.0%	44.6%	50.0%	
Program Induced Replacement %	3.9%	1.3%	N/A	
Net-to-Gross Ratio (1-Free Rider % + Program Induced %)	0.401	0.541	0.500	0.420
<b>Total Sixth-Year Research Findings Net MWh Savings</b>	<b>10,542</b>	<b>2,111</b>	<b>61</b>	<b>12,714</b>
Net MWh Savings Claimed by the Program	N/A	N/A	N/A	31,869
Research Findings Program Gross MW	4.11	0.68	0.02	4.81
Net-to-Gross Ratio (1-Free Rider %)	0.401	0.541	0.500	0.420
<b>Total Sixth-Year Research Findings Net MW Savings</b>	<b>1.65</b>	<b>0.37</b>	<b>0.01</b>	<b>2.03</b>

#### 7.1.7 Unit Characteristics

Both age (in years) and size (in cubic feet) are key explanatory variables that drive the savings estimates. In general, the older a unit is, the larger it is and the more electricity it uses. This is the case for two reasons:

1. Because of a change in energy efficiency standards in 1993, units built since that time are much more energy efficient than units made prior to the standards change.
2. There is degradation of a unit's efficiency over time, as the unit ages.

Table 7-14 and Table 7-15 below provide the age and size characteristics of the units collected in PY5 through ComEd's program.

The ages of refrigerators, freezers and room A/C unit in PY6 are significantly younger than in PY5 and previous years. The average age of both refrigerators and freezers in PY6 is 5 years younger than in PY5. This reflects the effectiveness of the program in removing older units from the market over time. Despite this, the stock of appliances going through the program is still quite old. For example, well over half of refrigerators are between 16 and 30 years old. Freezers tend to be older than refrigerators with nearly three-fourths of the units between 21 and 35 years old. The room air conditioner units that were recycled in the program in PY6 are also much younger than room air conditioner units recycled in PY5. There were significantly more units between 16 and 25 years old in PY6, which caused the average age of an AC unit in PY6 to be 24 years old compared to 34 in PY5.

The average size of refrigerators in the program is 19.5 cubic feet and 15.7 cubic feet for freezers. The size of units has not changed significantly since PY5.

**Table 7-14. Age Characteristics of Recycled Appliances**

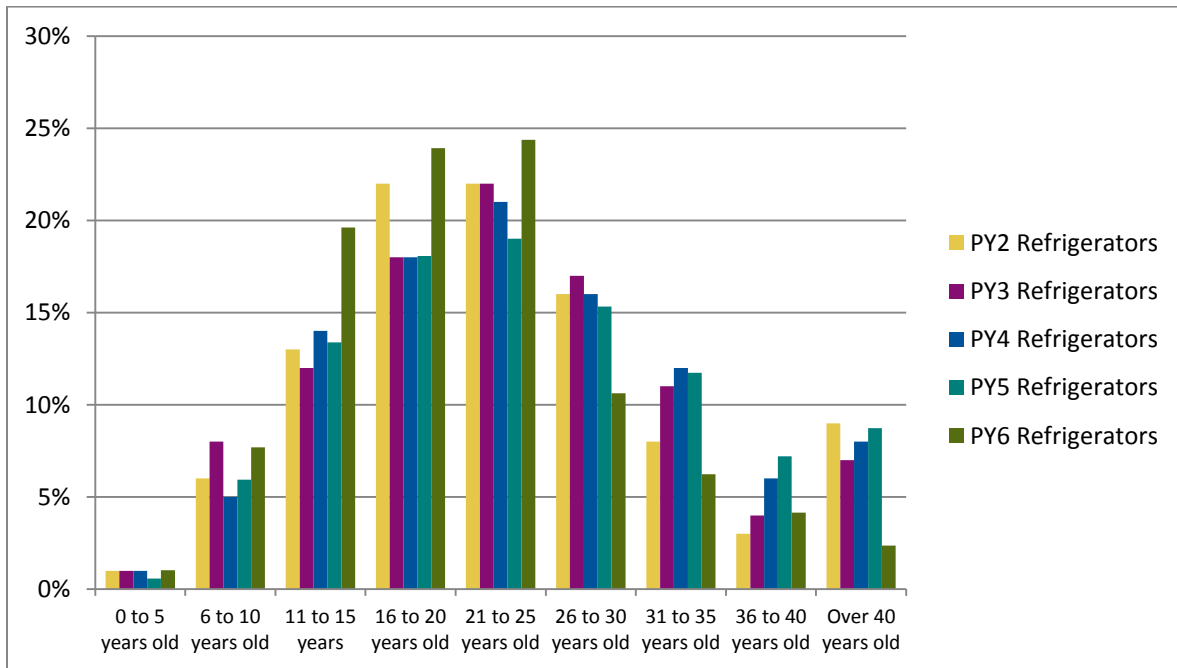
Appliance Type	Age in Years									Average
	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	Over 40	
Refrigerators	1%	8%	20%	24%	24%	11%	6%	4%	2%	<b>20.9</b>
Freezers	1%	4%	9%	14%	28%	18%	14%	7%	6%	<b>25.5</b>
Room Air Conditioners	1%	2%	12%	21%	23%	16%	14%	6%	4%	<b>24.4</b>

**Table 7-15. Size Characteristics of Recycled Appliances**

Appliance Type	10 cubic feet and smaller	11 to 15 cubic feet	16 to 20 cubic feet	21 cubic feet and larger	Average
Refrigerators	2%	12%	48%	39%	<b>19.5</b>
Freezers	12%	38%	42%	8%	<b>15.7</b>

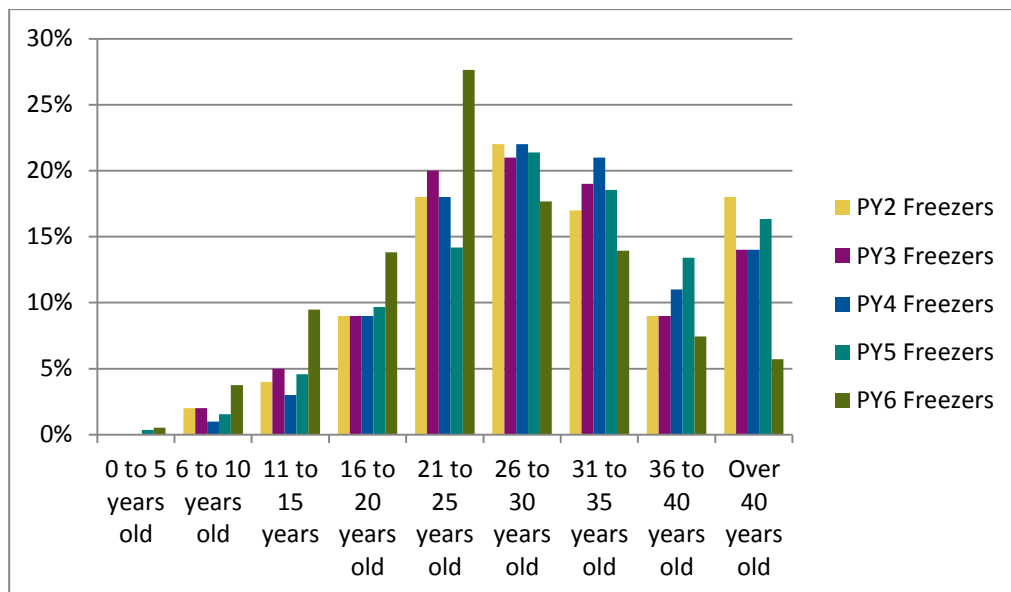
The PY6 unit data reverses the trend seen in the past several years' data towards older refrigerators in the program over time. This prior years' trend was particularly dominant in the 31-35 and 36-40 years old categories where each year had slightly more refrigerators in these age categories. This year's data appropriately reflect the decline in the stock of older appliances over time due to the program and the movement pick-up of newer units in the 16 to 25 year age category, specifically.

Figure 7-2: Age of Refrigerators



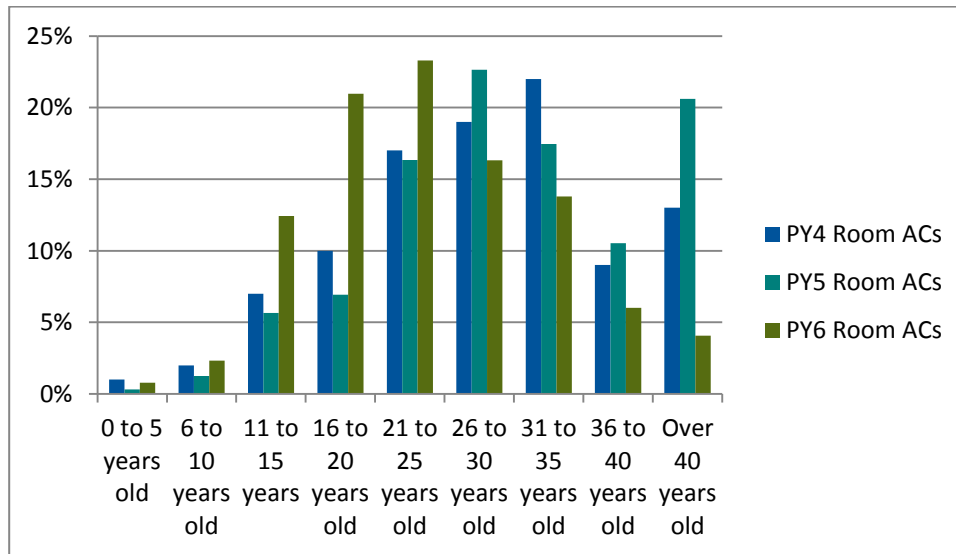
Similarly, the freezer data reflects a jump in the pickup of newer aged appliances, particularly in the 21 to 25 age category.

Figure 7-3: Age of Freezers



Room AC units show a similar trend toward newer units in PY6, based on the significant drop in units aged 26 years and older. This trend is shown in Figure 7-4.

Figure 7-4: Age of Room Air Conditioners



## 7.2 Detailed Process Findings

The process component of the FFRR evaluation focused on program satisfaction, drivers of participation, motivations for appliance disposal, marketing and promotional strategies, and participation in additional ComEd programs. Key data sources for the process evaluation include the participant telephone survey, the program tracking database, and in-depth interviews with the ComEd Program Managers and JACO staff.

In PY6, ComEd continued to partner with one local retailer and two national chain stores. The local retailer has been participating since PY1, and their single location accounts for 19% of the appliances recycled through the program in PY6. The partnerships with the two national chain stores began in PY3 and collectively, they account for 8% of the recycled appliances. Customers that participate via these retailer partners enroll in the program at the time they are purchasing their new appliance from the retailer. The remaining customers participate directly through JACO in PY6, placing orders either via phone or through JACO's website. About 70% of their orders are made over the phone and the remaining 30% are placed on-line.



**Table 7-16. Number of Appliances Recycled by Channel**

Channel	Room AC	Freezer	Refrigerator	Total	Percent
JACO pick up	397	3,999	22,749	27,145	73%
Retailer Channel:	-	356	9,599	9,955	27%
<i>Local retailer</i>	-	270	6,774	7,044	19%
<i>National chain stores</i>	-	86	2,825	2,911	8%
<b>Total</b>	<b>397</b>	<b>4,355</b>	<b>32,348</b>	<b>37,100</b>	<b>100%</b>

*Source: Program tracking database*

The process of collecting appliances from participants signing up through the retail channel has not changed significantly in recent years. At the time the new unit is delivered, the retailer's delivery teams pick up the old appliance and bring it back to their warehouse where such units are sorted and held in an area separate from non-participating units until they are picked up by JACO.

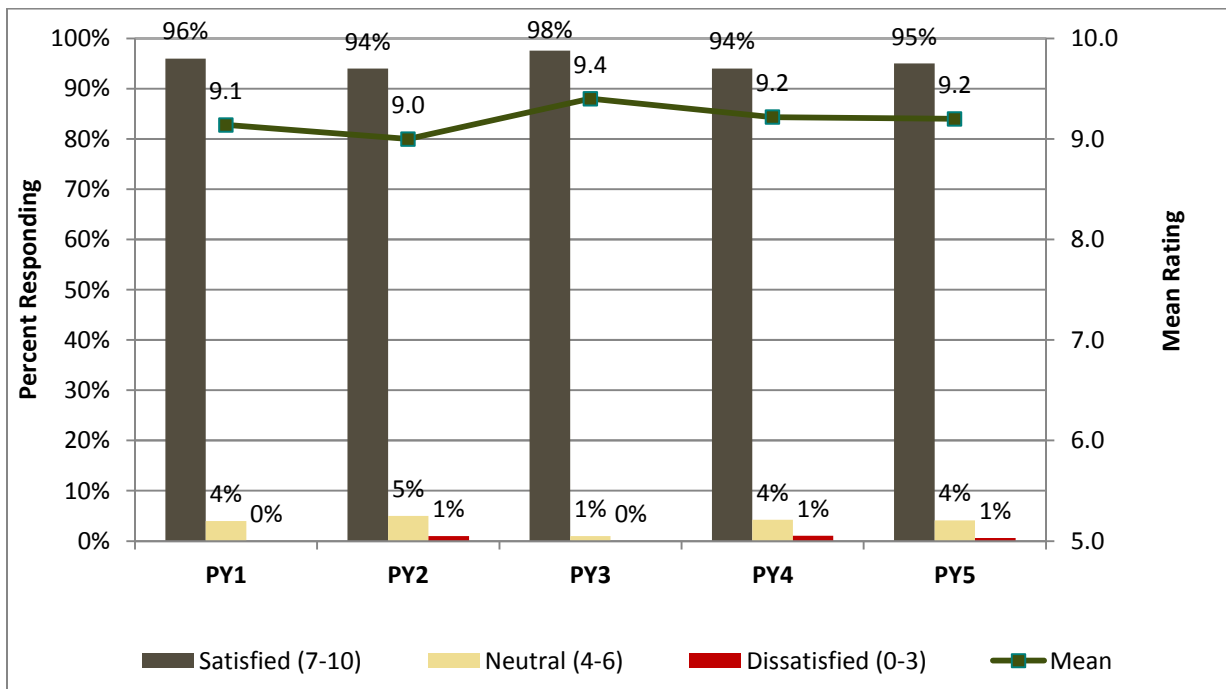
Most of the general program marketing is conducted by ComEd, including bill inserts, radio and television advertisements, and billboards. However, JACO provides point-of-sale materials, enrollment software and support, and training to sales associates. Retail partners market the program to ComEd customers, verify customer eligibility, enroll customers in the program, and remove unwanted appliances from participant homes (usually upon delivery of a new appliance).

### **7.2.1 Overall Program Satisfaction**

Once again, program satisfaction scores reveal just how popular this program is with ComEd's customers. As in prior years, participants are very satisfied with the program, as shown in Figure 7-5. Overall satisfaction among participants was quite high again this year, with 95% of respondents indicating they were satisfied<sup>17</sup> with the service they received throughout their entire experience, representing an average rating of 9.2. Since PY1, overall program satisfaction rates have consistently stayed at or above 94%.

<sup>17</sup> Responded 7 or higher on a 0-10 scale

**Figure 7-5. Overall Satisfaction with the FFRR Program**



Source: Participant Survey

Respondents reporting an overall satisfaction rating of five or greater were asked to describe what they particularly liked about the program. Top reasons for high satisfaction included the convenience or ease of the service (38%), the \$35/\$50 incentive (29%), and relief from the burden of having to dispose of the old unit (28%). These findings are consistent with previous years' results. Related, 96% of participants reported that they are likely<sup>18</sup> to recommend the program to a friend or colleague.

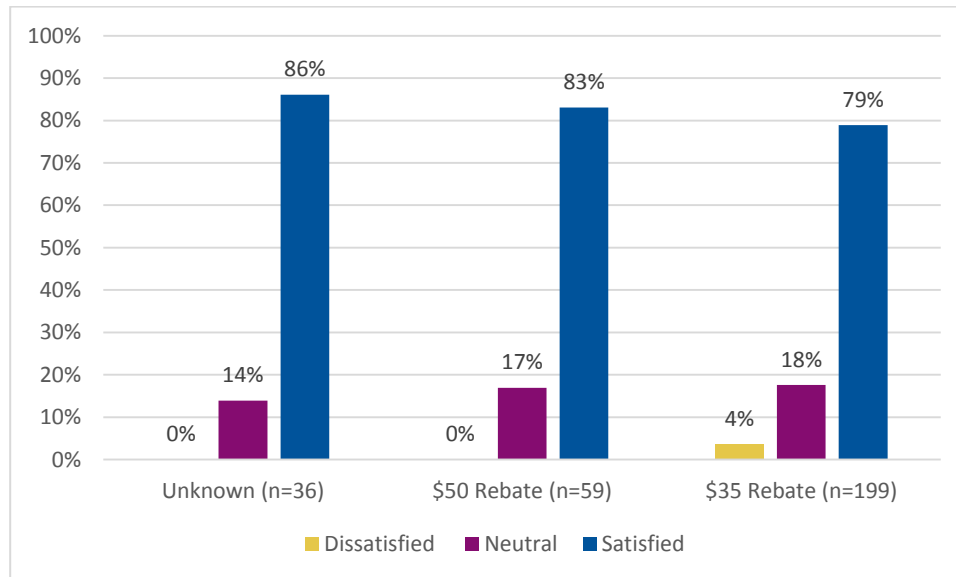
Satisfaction with particular program components is also high. For example, 80% of respondents were satisfied<sup>19</sup> with the size of payment they received and 82% were satisfied with the amount of time it took to receive the incentive. These satisfaction ratings have dropped slightly from PY4, when 85% of respondents were satisfied with the payment amount and 88% were satisfied with the time it took to receive the payment.

Since PY4, the program has offered a standard \$35 incentive from April through December and an increased incentive of \$50 in January, February, and March in an effort to boost participation levels during those months. The higher incentive has been effective in increasing participation during those months, however, the increased incentive does not favorably affect participant satisfaction, as shown in Figure 7-6. Participants who received the \$50 incentive reported similar levels of satisfaction with the rebate amount as those receiving the standard \$35 incentive.

<sup>18</sup> Responded 7 or higher on a 0-10 scale

<sup>19</sup> Responded 7 or higher on a 0-10 scale

**Figure 7-6. Satisfaction with Rebate Amount<sup>20</sup>**



Source: Participant Survey

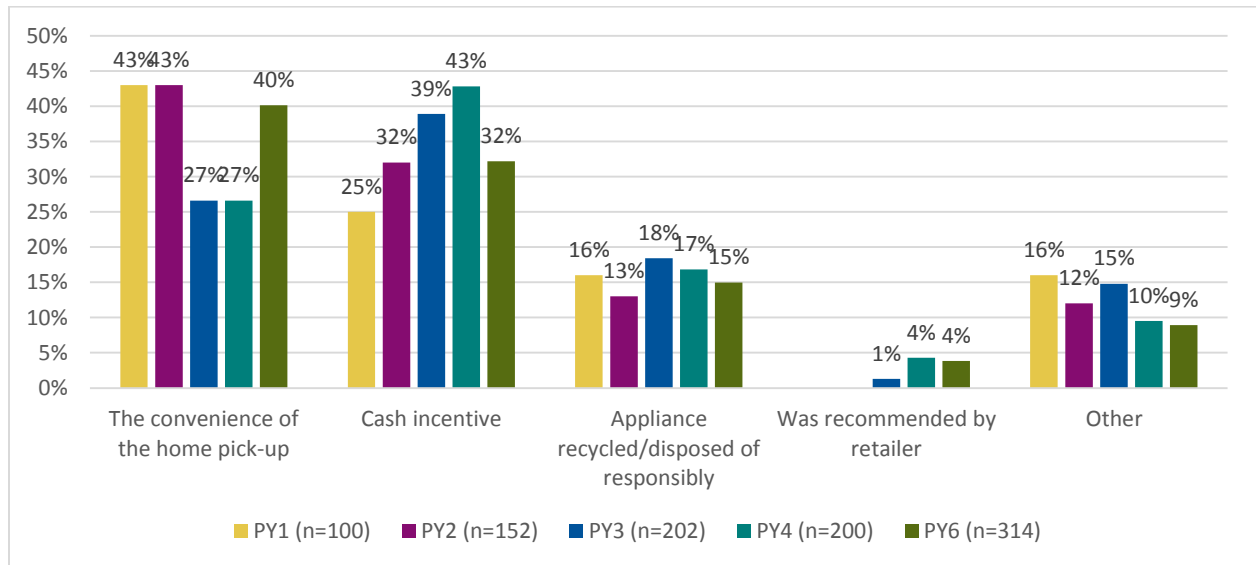
Although satisfaction levels are quite high, nearly two-thirds (63%) of participants reported that they had not seen a reduction in their electric bill since their unit was removed. An additional 17% were unsure if their bill had gone down. However, 28% of participants (including 27% of refrigerator recyclers and 29% of freezer recyclers) reported they had seen a decrease in their energy bill since the old unit was removed.

### 7.2.2 Drivers of Participation

Participants were also asked about their main reasons for participating in the FFRR program. In PY6, 40% of customers reported that the convenience of the home pick up was their primary reason for participating in the program, as seen in Figure 7-7. An additional 32% were motivated by the cash incentive, while 15% joined the program because the appliance was recycled or disposed of in an environmentally responsible manner. The reasons for participation have shifted some from the PY4 evaluation, when the largest share of participants, 43%, was primarily motivated by the program incentive and another 39% was motivated by the convenience of the program. Since the program's inception, the importance of disposing of the appliance in an environmentally friendly manner has consistently ranked third (ranging between 13% and 18%). A recommendation from the retailer was also cited by a small percentage of respondents.

<sup>20</sup> The rebate level was unknown for some customers. The rebate amount was not part of the program database, therefore the evaluation team used the appliance removal date as a proxy for rebate amount. Customers could receive a \$50 rebate if they booked by March 31 and had the unit removed before April 26, but if they had their appliance removed during this time frame and booked after March 31, their rebate would be \$35. Therefore, the rebate level for participants removing their unit between April 1 and April 26 was not known by the evaluation team.

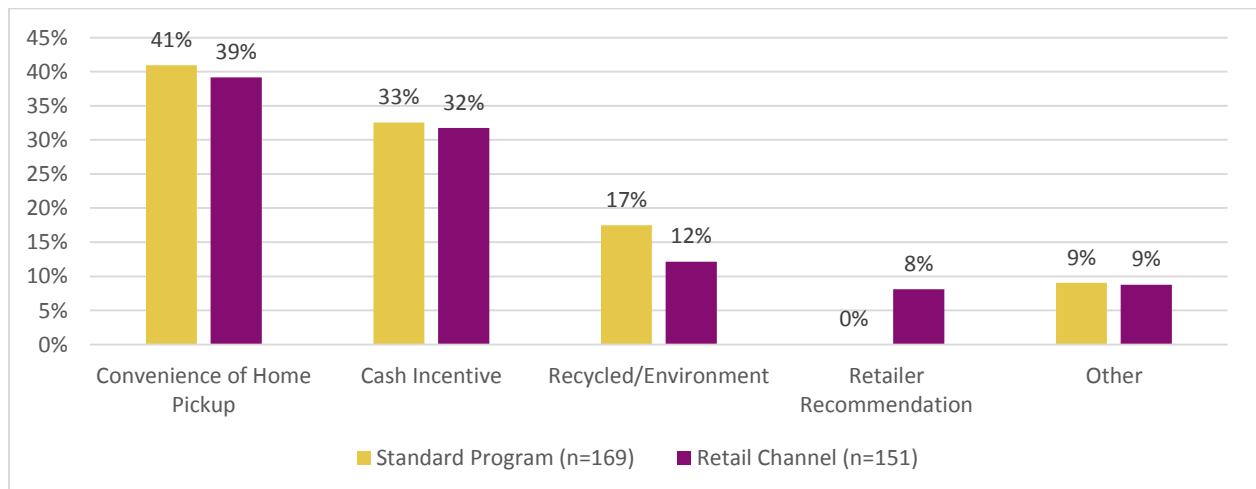
**Figure 7-7. Main Reasons for Participating in the FFRR Program**



Source: Participant Survey

Primary motivations for participating do not vary significantly by how the participating customer came to the program. Customers entering the program through the retailer channel and the traditional channel join for similar reasons, as shown in Figure 7-8. However, participants who joined through the retailer channel are more likely to enter because of a retailer recommendation than those who enter through the traditional channel.

**Figure 7-8. Motivation for Participation in FFRR by Program Entry Channel**



Source: Participant Survey

### 7.2.3 Reasons for Disposing of the Appliance

Reasons for disposing of the old unit vary depending whether it is the primary or secondary appliance in the home. Over half (54%) of participants recycling their primary refrigerator wanted to upgrade to a

newer appliance with more modern features, while 24% were concerned about the expense of running their previous unit. Participants recycle both secondary refrigerators and freezers for similar reasons.<sup>21</sup> Participants are more likely to recycle a secondary refrigerator and freezer because they use it infrequently (56% and 44%, respectively) and are also concerned with the expense of running the refrigerator or freezer (39% each).

**Table 7-17. Reasons for Disposing of Appliance**

Reasons for Disposing Unit	Percent Rating Reason As Important (score of 7 and higher)		
	Primary Refrigerators (n=161)	Secondary Refrigerators (n=54)	Freezers (n=79)
Expense of running unit	24%	39%	39%
Wanted newer appliance or more modern features	52%	11%	19%
Infrequent use of appliance	0%	56%	44%
Wanted a larger unit	4%	2%	1%

Source: Participant Survey

#### 7.2.4 Marketing and Promotion Strategy

ComEd is responsible for most of the marketing and promotion of the program. ComEd runs TV and radio advertisements, publishes a newsletter and hosts a website, and this year, began advertising on electronic billboards. Since PY4, ComEd has reduced marketing around the winter holidays and increased marketing and rebates in January, February, and March to increase program participation. JACO, which works with other utilities implementing similar appliance recycling programs, views ComEd's marketing as an industry benchmark and invited ComEd to speak to the other appliance recycling programs about marketing at an October 2013 meeting.

JACO leads the in-store marketing and promotion component of the program at the three partnering retailers. This advertising includes in-store materials such as flyers, tear sheets, and refrigerator "cling" (stick-on advertising), most of which are provided by the ComEd program. One retail partner also advertises the program through newspaper and in-store ads, and in flyers throughout the community.

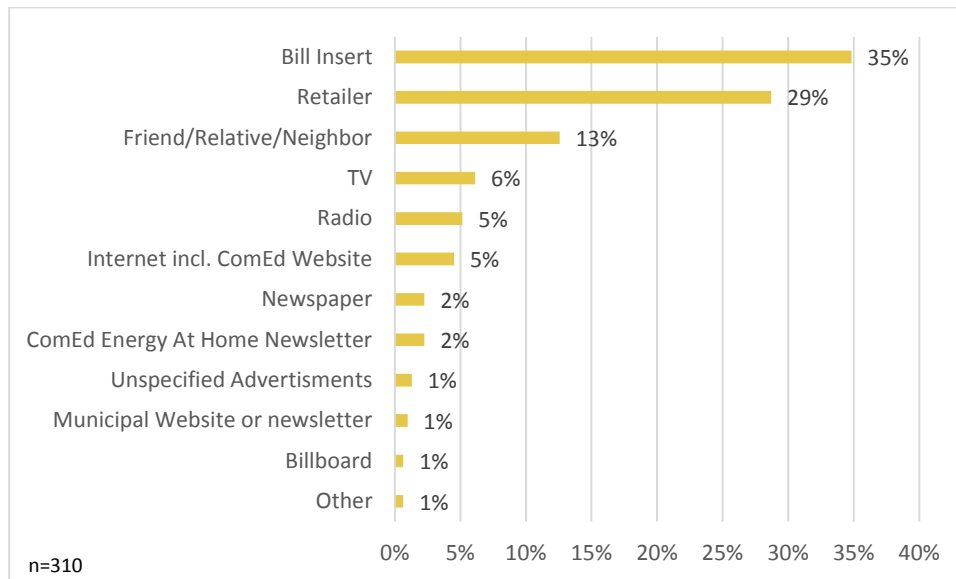
JACO also trains sales associates to discuss the program – including eligibility requirements – with appliance customers on the sales floor or at the point of sale, often in the context of what they might do with their old unit. Sales associates at two retail partners are trained to ask a set of questions to assess program eligibility. These include whether they are ComEd customers, how they intend to dispose of their old or secondary appliance, and the size and condition of their old appliance.

<sup>21</sup> Although many customers have one stand-alone freezer, it is considered a secondary unit because they also have access to the freezer in their primary refrigerator.

#### 7.2.4.1 Program Awareness

Participants find out about the program through a variety of channels. As shown in Figure 7-9, over one-third (35%) found out about the program from bill inserts. A smaller proportion, (29%), learned of the program through a retailer, likely when purchasing a new refrigerator or freezer. Third in importance is word of mouth (13%), presumably reflecting the program's popularity with participants from prior years. Respondents are also likely to find out about the program from a variety of media channels, reflecting the effectiveness of ComEd's comprehensive marketing campaign.

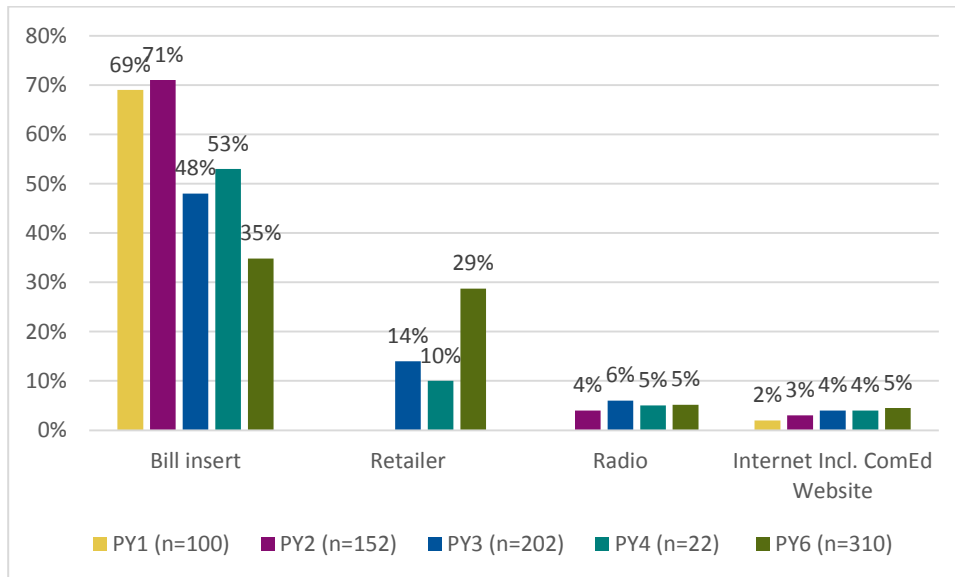
**Figure 7-9. How FFRR participants first learned about the program**



Source: Participant Survey

Sources of program awareness have evolved over the years. For example, when the program was started in PY1, over two-thirds (69%) of customers found out about the program through a bill insert. In PY6, now that the program is mature, the share of customers learning about the program from a bill insert has dropped to half that level (35%), as represented in Figure 7-10. Similarly, the role of retailers in building program awareness has changed significantly. Retailers played a very minor role in PY1, when there was only one retail partner in the program, and only accounted for 1% of appliances recycled through the program. The PY1 survey found no evidence that customers were finding out about the program through retailers. However, in PY6, more than a quarter (29%) of participants found out about the program through a retailer, reflecting their increased role in building awareness of the FFRR program.

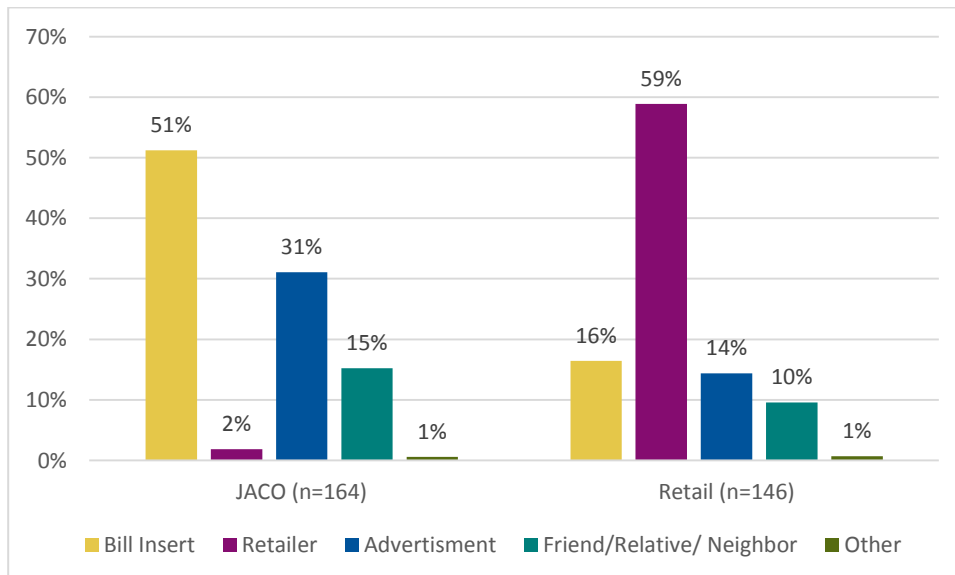
**Figure 7-10. How FFRR Participants Learned about the Program by Year**



Source: Participant Survey

Customers participating in the different program channels (retailer and traditional) are likely to have learned about the program from different sources. Over half of PY6 participants enrolling through the traditional channel (51%) first learned about the program via a bill insert, while most that enrolled through the retail channel (59%) first learned of the program from the retailer, as shown in Figure 7-11.

**Figure 7-11. Program Awareness by Channel**

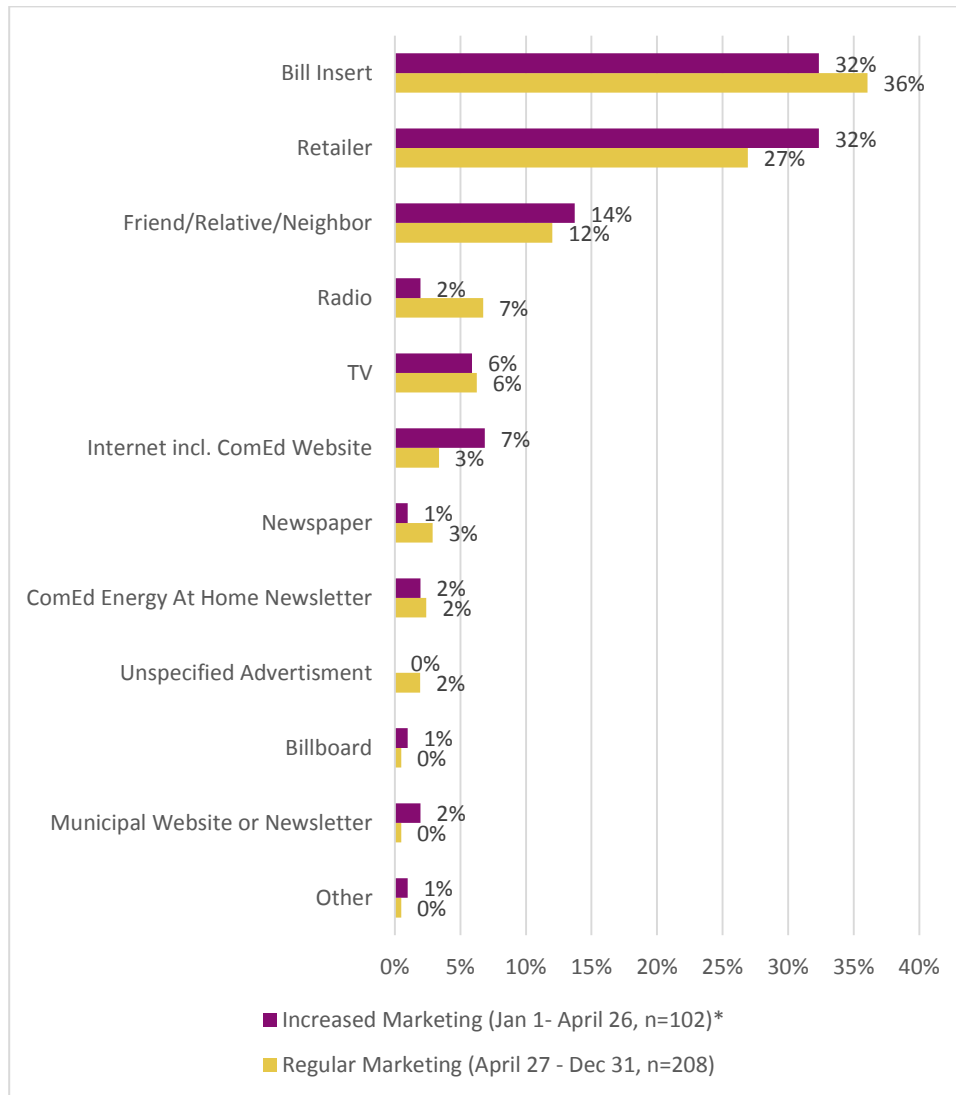


Source: Participant Survey

Following the busy holiday season when interest in the FFRR program ebbs, ComEd seeks to increase participation in the first three months of the calendar year by increasing program incentives and

marketing during that period. However, ComEd’s increased marketing during this same time period is no more effective than other methods, as shown in Figure 7-12. Participants were just as likely to cite the retailer as their main source of program awareness during this time. However, it is possible that it was a combination of methods that prompted their participation in the program. Individuals may have first heard of the program through the retailer but it was ComEd’s advertising that reminded them about the program and ultimately led to their participation.

**Figure 7-12. Awareness of Program by Appliance Removal Date**



Source: Participant Survey

\*Increased marketing extended through April 26 removal date because higher rebate is extended through this time if requested.



### 7.2.5 Participation in Additional ComEd Programs

For a small share of participants, involvement in the FFRR program has led to participation in other ComEd energy efficiency programs. Just 7% of respondents indicated that they have participated in other ComEd energy efficiency or pricing programs following their participation in the FFRR program, the same as in PY4. The most frequently mentioned program was the Central AC cycling program, which was cited by 2% of respondents.

## 7.3 TRM Recommendations

The two recommendations below are specific to the TRM.

**Recommendation 5.** The Evaluation team believes the Program Induced Replacement (PIR) factor concept is implausible because an incentive ranging from \$35 to \$50 is unlikely to be sufficient motivation for purchasing an otherwise-unplanned replacement unit (which can cost \$500 to \$2,000). For this reason, it is recommended that the PIR be eliminated from the TRM calculation, starting in PY7.

**Recommendation 7.** For units with negative energy and demand consumption, we recommend that additional language be added to the TRM to address this situation. The language could be: “The regression based savings algorithm produces negative unit energy or demand consumption values for a very small percentage of units. For such units with negative consumption, the average consumption of similar size and age units should be used in place of the negative value. For example, refrigerator units with negative consumption have an average age of 21 years and average size of 13 cubic feet so the average consumption of similar aged and sized units should be used instead of regression-based estimates.”

## 7.4 PJM Data and Findings

The table below provides the MW savings associated with the FFRR program, which was estimated in accordance with the requirements by PJM for savings bid in.

### PY6 Research Findings Gross Impact Parameter and Demand Savings Estimates (MW)

Gross Impact Parameter and Savings Estimates	Refrigerators	Freezers	Room AC	Total Program
Total units recycled through the Program	36,403	5,395	515	42,313
Verification Factor	100.0%	100.0%	100.0%	
Verified Participation Units	36,403	5,395	515	42,313
Annual Gross kW savings per unit (full-load operating hours)	0.113	0.127	0.040	---
<b>Research Findings Program Gross MW</b>	<b>4.12</b>	<b>0.68</b>	<b>0.02</b>	<b>4.83</b>

Source: Evaluation analysis