Guidehouse

ComEd Fridge and Freezer Recycling Impact Evaluation Report

**Energy Efficiency / Demand Response Plan:
Program Year 2019 (CY2019)
(1/1/2019-12/31/2019)**

**Presented to
ComEd**

FINAL

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ComEd Fridge and Freezer Recycling Impact Evaluation Report

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ComEd Fridge and Freezer Recycling Impact Evaluation Report

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ComEd Fridge and Freezer Recycling Impact Evaluation Report

1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's CY2019 Fridge and Freezer Recycling (FFR) Program. It includes a summary of the energy and demand impacts for the total program broken out by relevant measure and program structure details. The appendix provides the impact analysis methodology and details of the Total Resource Cost inputs. CY2019 covers January 1, 2019 through December 31, 2019.

2. PROGRAM DESCRIPTION

The FFR Program achieves energy savings through the retirement and recycling of older, inefficient refrigerators, freezers, dehumidifiers, and room air conditioners (ACs). The primary objectives of the program are to decrease the retention of high energy-use refrigerators and freezers and to deliver long-term energy savings. A secondary objective is to dispose of all of these older units in an environmentally safe manner.

The program had 44,290 participants in CY2019 contributing a total of 51,822 recycled measures to the program as shown in the following table and graph.

Table 2-1. CY2019 Volumetric Findings Detail

Participation	Program Reported # of Units	% of Total Units
Participants	44,290	-
Units by Measure Type		
Refrigerators - Recycled	40,543	78.2%
Freezers - Recycled	6,224	12.0%
Room ACs - Recycled	2,666	5.1%
Dehumidifiers - Recycled	2,286	4.4%
Small Refrigerators - Recycled	103*	0.2%
Total Measures	51,822	100%

* 847 small unit refrigerators were picked up as part of the CY2019 program, however only 103 of them were eligible to be claimed for savings.
*Source: ComEd tracking data and evaluation team analysis*

Figure 2-1. Percent of Measures Installed by Type
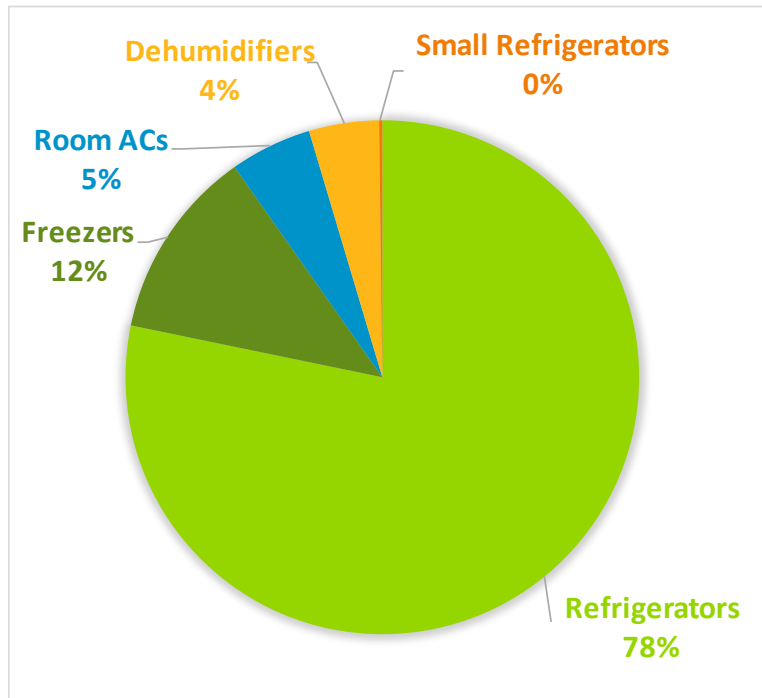
Source: ComEd tracking data and evaluation team analysis

3. PROGRAM SAVINGS DETAIL

Table 3-1 summarizes the incremental energy and demand savings the FFR Program achieved in CY2019. The FFR Program did not claim any gas savings in CY2019. The program's verified gross kWh savings are approximately 3% higher than ex ante gross kWh savings. The ex ante savings were computed using the equations specified in the Illinois Technical Reference Manual (TRM) v6.0. The verified gross energy savings were computed using the equations specified in the Illinois Technical Reference Manual (TRM) v7.0 an evaluation memo dated December 3, 2018 titled "Savings Estimation for Small Refrigerator Units". The refrigerator and freezer TRM savings calculation methods are the same between the two TRM versions, however, a slight difference emerges due to an equation variable that indicates whether the appliance was located in a conditioned space. The verified gross savings calculations use the proportion of appliances located in conditioned space that are derived from the most recently completed participating customer surveys,[1] whereas ex ante gross savings calculations are based on appliance locations in the program tracking database. The TRM also stipulates the use of a part-use factor for refrigerator and freezer savings calculations. Both the ex ante and verified estimates used the PY9 Research Findings part-use factors. For room ACs, the calculation in the TRM has a difference in the efficiency of the existing unit between the two versions (from 7.7 in v6.0 to 9.8 in v7.0), resulting in a kWh realization rate of 0.79. Dehumidifiers had a kWh realization rate of 1.0. Small unit refrigerators did not have any ex ante savings documented in the tracking database. However, the evaluation team calculated verified gross savingsfor 103 units picked up on June 23, 2019 for a special event. An evaluation memo dated December 3, 2018 titled "Savings Estimation for Small Refrigerator Units," describes a method used to verify gross savings for these units..

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[1] Based on survey findings from the CY2018 evaluation, since the CY2019 surveys have not been completed yet.

Table 3-1. CY2019 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Non-Coincident Demand Savings (kW)	Summer Peak* Demand Savings (kW)
Electricity			
Ex Ante Gross Savings	39,932,322	NR	NR
Program Gross Realization Rate	1.03	NA	NA
Verified Gross Savings	40,959,489	7,620	5,855
Program Net-to-Gross Ratio (NTG)	Varies	Varies	Varies
Verified Net Savings	20,378,327	3,798	2,916
Converted from Gas			
Ex Ante Gross Savings	NA	NA	NA
Program Gross Realization Rate	NA	NA	NA
Verified Gross Savings	NA	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA	NA
Verified Net Savings	NA	NA	NA
Total Electric Plus Gas			
Ex Ante Gross Savings	39,932,322	NR	NR
Program Gross Realization Rate	1.03	NA	NA
Verified Gross Savings	40,959,489	7,620	5,855
Program Net-to-Gross Ratio (NTG)	Varies	Varies	Varies
Verified Net Savings	20,378,327	3,798	2,916

NR = Not reported
NA = Not applicable
* The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.
Source: ComEd tracking data and evaluation team analysis

4. CUMULATIVE PERSISTING ANNUAL SAVINGS

Table 4-1 and Figure 4-1 show the measure-specific and total verified gross savings for the FFR Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2019. The electric CPAS across all measures installed in 2019 is 20,378,327 kWh (Table 4-1). The EM&V team did not evaluate gas savings for this program, and as such, electric CPAS is equivalent to total CPAS. The "historic" rows in each table are the CPAS contribution back to CY2018. The "Program Total Electric CPAS" and the "Program Total Gas CPAS" are the sum of the CY2019 contribution and the historic contribution. The majority of CPAS savings are from refrigerator measures (86.5%), followed by freezers (11.9%), room ACs (1.2%), dehumidifiers (0.3%), and small unit refrigerators (0.0%).

Table 4-1. Cumulative Persisting Annual Savings (CPAS)) – Electric

End Use Type	Research Category	EUL	CY2019 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings								
						2018	2019	2020	2021	2022	2023	2024	2025	2026
Appliances	Refrigerators - Recycled	6.5	35,258,967	0.50	114,591,643		17,629,484	17,629,484	17,629,484	17,629,484	17,629,484	17,629,484	8,814,742	
Appliances	Freezers - Recycled	6.5	5,070,885	0.48	15,821,161		2,434,025	2,434,025	2,434,025	2,434,025	2,434,025	2,434,025	1,217,012	
Appliances	Room ACs - Recycled	4.0	490,415	0.50	980,831		245,208	245,208	245,208	245,208				
Appliances	Dehumidifiers - Recycled	6.0	121,196	0.50	363,589		60,598	60,598	60,598	60,598	60,598	60,598		
Appliances	Small Refrigerators - Recycled	6.5	18,025	0.50	58,581		9,013	9,013	9,013	9,013	9,013	9,013	4,506	
CY2019 Program Total Electric Contribution to CPAS			40,959,489		131,815,805		20,378,327	20,378,327	20,378,327	20,378,327	20,133,119	20,133,119	10,036,260	-
Historic Program Total Electric Contribution to CPAS‡						21,697,981	21,697,981	21,697,981	21,697,981	21,519,377	21,519,377	21,519,377	21,519,377	-
Program Total Electric CPAS						21,697,981	42,076,308	42,076,308	42,076,308	41,897,704	41,652,496	41,652,496	31,555,637	-
CY2019 Program Incremental Expiring Electric Savings§							-	-	-	245,208	-	10,096,859	10,036,260
Historic Program Incremental Expiring Electric Savings‡§							-	-	-	178,604	-	-	-	21,519,377
Program Total Incremental Expiring Electric Savings§							-	-	-	178,604	245,208	-	10,096,859	31,555,637

Note: The green highlighted cell shows program total first year electric savings. The gray cells are blank, indicating values irrelevant to the CY2019 contribution to CPAS.

* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.

† Lifetime savings are the sum of CPAS savings through the EUL.

‡ Historical savings go back to CY2018

§ Incremental expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n

Source: Evaluation team analysis

Figure 4-1. Cumulative Persisting Annual Savings
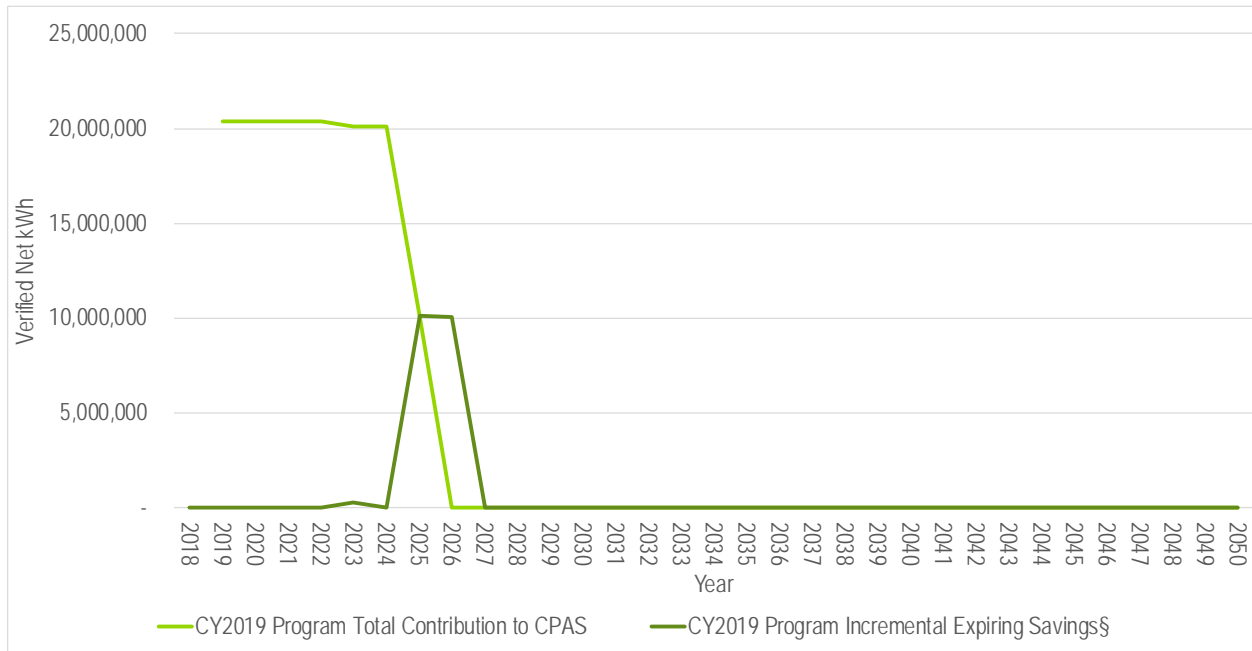
§ Expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n
Source: Evaluation team analysis

5. PROGRAM SAVINGS BY MEASURE

The program includes five measures as shown in the following tables. The refrigerator measure contributed the greatest portion of net energy savings (86.5%, see Figure 5-1). Freezers accounted for another 11.9%, while the other measures comprised 1.5%. This breakdown of savings is similar to the proportions in PY4, PY5, PY6, PY7, PY8, PY9, and CY2018.

Figure 5-1. Verified Net Savings by Measure – Electric
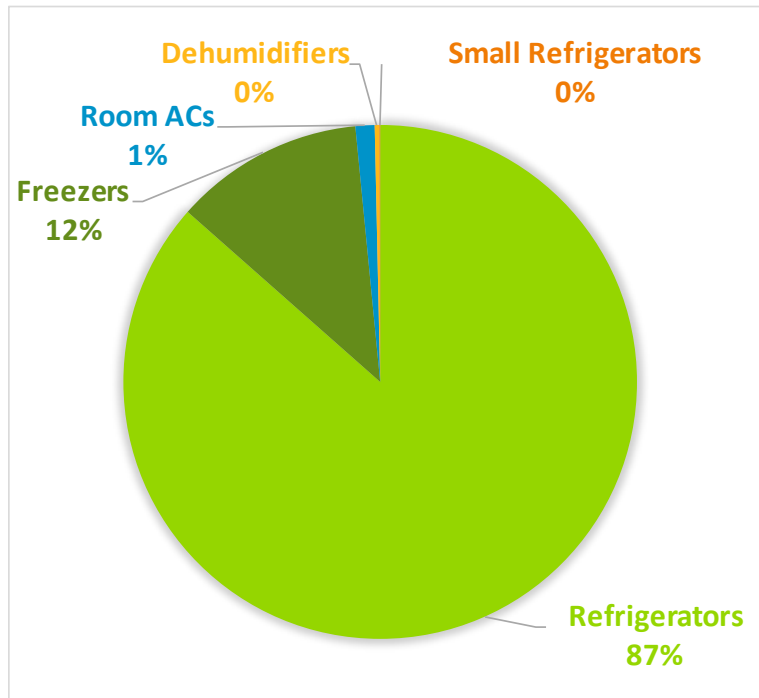
Table 5-1. CY2019 Energy Savings by Measure – Electric

End Use Type	Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)	EUL (years)
Appliances	Refrigerators - Recycled	34,252,164	1.03	35,258,967	0.50	17,629,484	6.5
Appliances	Freezers - Recycled	4,934,797	1.03	5,070,885	0.48	2,434,025	6.5
Appliances	Room ACs - Recycled	624,164	0.79	490,415	0.50	245,208	4.0
Appliances	Dehumidifiers - Recycled	121,196	1.00	121,196	0.50	60,598	6.0
Appliances	Small Refrigerators - Recycled	0	-	18,025	0.50	9,013	6.5
	Total	39,932,322	1.03	40,959,489	NA	20,378,327	NA

NA = Not applicable

* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.

Source: ComEd tracking data and evaluation team analysis

Table 5-2. CY2019 Non-Coincident Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Non-Coincident Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Non-Coincident Demand Reduction (kW)	NTG*	Verified Net Non-Coincident Demand Reduction (kW)
Appliances	Refrigerators - Recycled	NR	NA	4,022.24	0.50	2,011.12
Appliances	Freezers - Recycled	NR	NA	578.47	0.48	277.67
Appliances	Room ACs - Recycled	NR	NA	2,942.99	0.50	1,471.49
Appliances	Dehumidifiers - Recycled	NR	NA	74.26	0.50	37.13
Appliances	Small Refrigerators - Recycled	NR	NA	2.06	0.50	1.03
	Total	**NR**	**NA**	**7,620.02**	**NA**	**3,798.44**

NA = Not applicable
NR =Not reported
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
Source: ComEd tracking data and evaluation team analysis

Table 5-3. CY2019 Summer Peak Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kW)	NTG*	Verified Net Peak Demand Reduction (kW)
Appliances	Refrigerators - Recycled	NR	NA	4,348.04	0.50	2,174.02
Appliances	Freezers - Recycled	NR	NA	594.67	0.48	285.44
Appliances	Room ACs - Recycled	NR	NA	882.90	0.50	441.45
Appliances	Dehumidifiers - Recycled	NR	NA	27.48	0.50	13.74
Appliances	Small Refrigerators - Recycled	NR	NA	2.22	0.50	1.11
	Total	**NR**	**NA**	**5,855.31**	**NA**	**2,915.76**

NA = Not applicable
NR = Not reported
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
Source: ComEd tracking data and evaluation team analysis

6. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

6.1 Impact Parameter Estimates

The evaluation team used the procedures specified in the TRM v7.0 to calculate the verified gross energy savings for the refrigerator, freezer, and room AC measures. These procedures use equations to calculate energy savings, which are shown in Section 7 (Appendix 1). Section 8 (Appendix 2) shows the input parameters used by the EM&V team to calculate verified energy and peak demand savings. Note that all the factors in the regression equations below are derived from pooled data from metering studies conducted by several Midwestern utilities, including one done by the ComEd evaluation team in PY4.

The lifetime energy and demand savings are estimated by multiplying the verified savings by the effective useful life for each measure.

The EM&V team conducted research to validate the parameters for small unit refrigerators that were not specified in the TRM. Data sources for all of the factors used in the savings calculations are shown in the following table.

Table 6-1. Savings Parameters

Measure	Custom Input Parameters	Gross Savings Input Parameters	Source *
Refrigerators - Recycled	Part-Use Factor	Regression coefficients and intercepts for Unit Energy Consumption calculations, CDD/HDD zonal values, Summer Peak Coincidence Factor	TRM v7.0 Section 5.1.8
Freezers - Recycled	Part-Use Factor	Regression coefficients and intercepts for Unit Energy Consumption calculations, CDD/HDD zonal values, Summer Peak Coincidence Factor	TRM v7.0 Section 5.1.8
Room ACs - Recycled	NA	Full Load Hours (FLH), Btu/H, EERexist, Summer Peak Coincidence Factor	TRM v7.0 Section 5.1.9
Small Refrigerators - Recycled	NA	De-Rating Factor, Part-Use Factor, Summer Peak Coincidence Factor	Evaluation memo dated Dec 3, 2018
Dehumidifiers - Recycled	NA	Unit capacity, Run hours per year, Efficiency, Summer Peak Coincidence Factor	TRM v7.0 Section 5.1.3

* TRM is the State of Illinois Technical Reference Manual version 7.0 from http://www.ilsag.info/technical-reference-manual.html. The NTG values can be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.

6.2 Other Impact Findings

The evaluation team has developed findings and recommendations from the CY2019 evaluation, as follows:

6.2.1 Program Savings Target Attainment

Finding 1. The evaluation-verified gross energy savings is 40,959,489 kWh, exceeding the program's CY2019 gross energy savings target of 34,979,000 kWh[2].

Finding 2. The evaluation-verified net energy savings is 20,378,327 kWh, achieving 93.9% of the program's CY2019 net energy savings target of 21,703,000 kWh[3].

6.2.2 Gross Realization Rates

Finding 3. Verified gross savings are approximately 3% higher than ex ante gross savings, which is the equivalent of a gross realization rate of 1.03. Gross realization rates by measure type showed some variation, with a refrigerator and freezer value of 1.03, a room air conditioner value of 0.79, and a dehumidifier value of 1.00. Small unit refrigerators did not have ex ante savings reported in the tracking data, so a realization rate could not be calculated for this measure.

Finding 4. The evaluation-verified gross realization rate exceeded 1.00 is due to differences in the percentages of refrigerators and freezer units in unconditioned spaces between the

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[2] Commonwealth Edison Company's 2018 – 2021 Energy Efficiency and Demand Response Plan (June 30, 2017)
[3] Commonwealth Edison Company's 2018 – 2021 Energy Efficiency and Demand Response Plan (June 30, 2017)

telephone survey and tracking data. For the 241 telephone survey respondents with refrigerators in CY2018, the percentage in unconditioned spaces was 57%, compared to 73% according to the CY2019 tracking data. Similarly, for the 120 telephone survey respondents with freezers in CY2018, the percentage in unconditioned spaces was 54%, compared to 67% according to the CY2019 tracking data. A lower percentage of units in unconditioned spaces caused the estimated energy savings to increase.

6.2.3 Program Participation

Finding 5. The CY2019 FFR Program recycled a total of 51,822 units and exceeded its CY2019 unit participation target of 45,000 units. Therefore, program marketing and promotion efforts appear to be on track, and the $50 incentive level is effective at achieving the desired level of participation.

7. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

The EM&V team calculated verified gross and net savings using the following regression specifications as defined by the TRM v7.0 in CY2019.

7.1 Verified Gross Program Savings Analysis Approach

Savings estimates were developed for the full population of units collected in CY2019 to estimate CY2019 Unit Energy Consumption (UEC). The ex post savings estimates of energy (kWh) savings rely on regression equations as specified in the TRM v7.0 for all measures except for small unit refrigerators. Small unit refrigerator gross energy savings are estimated based on an evaluation memo dated December 3, 2018 titled "Savings Estimation for Small Refrigerator Units". Gross energy savings are expressed in terms of full-year UECs. Refrigerator and freezer UEC estimates were made using a regression-based approach that models full-year energy savings as a function of unit characteristics (i.e., age, size, configuration, defrost mode, and unit location prior to being recycled). Room AC UEC estimates were made using Full Load Hours (FLH), Btu per hour, and EER. Dehumidifier UEC estimates were made using unit capacity, run hours per year, and unit efficiency. Small unit refrigerator UEC estimates were made using a de-rating factor and part-use factor. Gross peak demand (kW) savings were also calculated according to the algorithm specified in the TRM v7.0. The coincidence factors in the TRM v7.0 were used with the regression equations to predict consumption on summer peak days.

Both energy (kWh) and peak demand (kW) savings estimates were made based on the characteristics of the population of units collected by the program during CY2019. In addition, gross energy savings estimates were adjusted for part-use, by applying part-use factors from the PY9 evaluation.

7.1.1 Refrigerators

First year energy savings from a recycled refrigerator is calculated based on Equation 1 below, as found in the Illinois TRM v7.0, section 5.1.8. After energy savings based on full load hours have been computed, a part-use factor is then applied. This factor is based on the value from the most recent part-use factor participant survey results available at the start of the CY2019 program year, in this case, 0.91 from the PY9 evaluation.

Equation 1. Refrigerator Recycling Energy Savings Calculation

ΔkWh = [83.32 + (**Age** * 3.68) + (**Pre-1990** * 485.04) + (**Size** * 27.15) + (**Side-by-side** * 406.78) + (**Primary Usage** * 161.86) + (**CDD**/365.25 * **unconditioned** * 15.37) + (**HDD**/365.25 * **unconditioned** * -11.07)] * **Part Use Factor**

Where:

Age	= Age of retired unit
Pre-1990	= 1 if manufactured pre-1990, else 0
Size	= Capacity (cubic feet) of retired unit
Side-by-side	= 1 if side-by-side, else 0
Primary Usage	= 1 if primary unit (in absence of the program), else 0
Unconditioned	= 1 if located in unconditioned space, else 0
CDD	= Cooling Degree Days[4]
HDD	= Heating Degree Days[5]
Part Use Factor	= Accounts for units not running throughout the entire year (0.91)

Table 7-1 below reports the average CY2019 values for each independent variable of the regression equation for refrigerators.

Table 7-1. CY2019 Values for Independent Variables - Refrigerators

Independent Variable	Average Value	Source
Age (years)	25.9	CY2019 Tracking Data
Pre-1990	0.26	CY2019 Tracking Data
Size (Cubic Feet)	19.7	CY2019 Tracking Data
Side-by-side	0.31	CY2019 Tracking Data
Primary Unit	0.43	CY2019 Tracking Data
Unconditioned Space	0.73	CY2019 Tracking Data
Primary Unit - Surveyed*	0.49	CY2018 Participant Survey
Unconditioned Space - Surveyed*	0.57	CY2018 Participant Survey
CDD	835.7	CY2019 Tracking Data, TRM v. 7.0
HDD	6,404.8	CY2019 Tracking Data, TRM v. 7.0

* Based on the 241 surveyed refrigerator respondents from CY2018.

Summer coincident peak demand savings from a recycled refrigerator is calculated based on Equation 2 below, as found in the TRM v7.0, section 5.1.8.

Equation 2. Refrigerator Recycling Summer Coincident Peak Demand Savings Calculation

ΔkW = **ΔkWh** / 8766 * **CF**

Where:

ΔkWh	= Energy savings as calculated in Equation 1
CF	= 1.081 (Coincident factor defined as summer kW/average kW)

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[4] Dependent on geographic location.
[5] Dependent on geographic location.

7.1.2 Freezers

First year energy savings from a recycled freezer is calculated based on Equation 3 below, as found in the TRM v7.0, section 5.1.8. After energy savings based on full load hours have been computed, a part-use factor is then applied. This factor is based on the value from the most recent part-use factor participant survey results available at the start of the CY2019 program year, in this case, 0.86 from the PY9 evaluation.

Equation 3. Freezer Recycling Energy Savings Calculation

ΔkWh = [132.12 + (**Age** * 12.13) + (**Pre-1990** * 156.18) + (**Size** * 31.84) + (**Chest** * -19.71) + (**CDD** * **unconditioned** * 9.78) + (**HDD** * **unconditioned** * -12.75] * **Part Use Factor**

Where:

Age	= Age of retired unit
Pre-1990	= 1 if manufactured pre-1990, else 0
Size	= Capacity (cubic feet) of retired unit
Chest	= 1 if chest freezer, else 0
Unconditioned	= 1 if located in unconditioned space, else 0
CDD	= Cooling Degree Days[6]
HDD	= Heating Degree Days[7]
Part Use Factor	= Accounts for units not running throughout the entire year (0.86)

Table 7-2 below reports the average CY2019 values for each independent variable of the regression equation for freezers.

Table 7-2. CY2019 Values for Independent Variables - Freezers

Independent Variable	Average Value	Source
Age (years)	30.0	CY2019 Tracking Data
Pre-1990	0.43	CY2019 Tracking Data
Size (Cubic Feet)	15.6	CY2019 Tracking Data
Chest	0.27	CY2019 Tracking Data
Unconditioned Space	0.67	CY2019 Tracking Data
Unconditioned Space - Surveyed*	0.54	CY2018 Participant Survey
CDD	833.9	CY2019 Tracking Data, TRM v. 7.0
HDD	6,424.1	CY2019 Tracking Data, TRM v. 7.0

* Based on the 120 surveyed freezer respondents from CY2018.

Summer coincident peak demand savings from a recycled freezer is calculated based on Equation 4 below, as found in the TRM v7.0, section 5.1.8.

Equation 4. Freezer Recycling Summer Coincident Peak Demand Savings Calculation

ΔkW = **ΔkWh** / 8766 * **CF**

Where:

ΔkWh = Energy savings as calculated in Equation 3

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[6] Dependent on geographic location.
[7] Dependent on geographic location.

CF	= 1.028 (Coincident factor defined as summer kW/average kW)

7.1.3 Room Air Conditioners

Room AC gross energy savings are estimated using the algorithm specified in TRM v7.0 and shown in Equation 5 below.

Equation 5. Room AC Recycling Energy Savings Calculation

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

Where:

FLH_{RoomAC}	= Full Load Hours of room air conditioning unit (dependent on location)
BtuH	= Unit capacity of retired unit (if unknown assume 8500)
EERexist	= Efficiency of the existing unit (9.8)

Summer coincident peak demand savings from a recycled room AC is calculated based on Equation 6 below, as found in the TRM v7.0, section 5.1.9.

Equation 6. Room AC Recycling Summer Coincident Peak Demand Savings Calculation

$$\Delta kW = ((BtuH * 1/EERexist)/1000) * CF$$

Where:

BtuH	= Unit capacity of retired unit (if unknown assume 8500)
EERexist	= Efficiency of the existing unit (9.8)
CF	= Summer peak coincidence factor (0.3)

7.1.4 Small Unit Refrigerators

Small unit refrigerator gross energy savings are estimated based on an evaluation memo dated December 3, 2018 titled "Savings Estimation for Small Refrigerator Units". This memo defines the gross energy savings of a recycled small unit refrigerator as shown in Equation 7 below.

Equation 7. Small Unit Recycling Energy Savings Calculation

$$\Delta kWh = Mid\ Est\ kWh * (1 - De\text{-}Rate\ Fact) * Part\ Use = 175\ kWh/year$$

Where:

Mid Est kWh	= Analysis of the average small unit refrigerator savings values from the USDOE/Energy Star and the California Energy Commission sources indicates that they range from 287 (USDOE/Energy Star source) to 431 (CEC source) kWh per year. The midpoint of these two estimates is 359 kWh.
De-Rate Fact	= De-Rating Factor is 25%
Part Use	= Part-Use Factor is 65%

Summer coincident peak demand savings from a recycled small unit refrigerator is calculated based on Equation 8 below, as found in the TRM v7.0, section 5.1.8, for regular sized refrigerators.

Equation 8. Small Unit Recycling Summer Coincident Peak Demand Savings Calculation

$$\Delta kW = \Delta kWh / 8766 * CF$$

Where:

ΔkWh	= Energy savings as calculated in Equation 7

CF = 1.081 (Coincident factor defined as summer kW/average kW)

7.1.5 Dehumidifiers

Dehumidifier gross energy savings are estimated based on algorithms in the TRM v7.0, section 5.1.3 which defines the savings of installing an Energy Star dehumidifier in place of an existing unit with the following equation:

$$\Delta\text{kWh} = (\text{Avg Capacity} / 24) * 0.473 * \text{Hours} * (1 / \text{Base Eff} - 1 / \text{EStar Eff})$$

Where:

Avg Capacity = Average Capacity of the unit (pints/day)
Hours = 1632 hours
Base Eff = Baseline Efficiency of the existing unit (liters/kWh)
EStar Eff = Energy Star Efficiency of the newly purchased and installed unit (liters/kWh)

The above equation can be modified to define the gross energy savings of a recycled dehumidifier as shown in Equation 9 below.

Equation 9. Dehumidifier Recycling Energy Savings Calculation

$$\Delta\text{kWh} = (\text{Avg Capacity} / 24) * 0.473 * \text{Hours} * (1 / \text{Eff})$$

Where:

Avg Capacity = Average Capacity of the unit (pints/day)
Hours = 1632 hours
Eff = Efficiency of the recycled dehumidifier (liters/kWh)

Summer coincident peak demand savings from a recycled dehumidifier is calculated based on Equation 10 below, as found in the TRM v7.0, section 5.1.3.

Equation 10. Dehumidifier Recycling Summer Coincident Peak Demand Savings Calculation

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

Where:

ΔkWh = Energy savings as calculated in Equation 9
Hours = 1632 hours
CF = Summer peak coincidence factor (0.37)

7.2 Verified Net Program Savings Analysis Approach

Verified net energy and demand (coincident peak and overall) savings are calculated by multiplying the verified gross savings estimates by an NTG ratio. In CY2019, the NTG ratio estimates used to calculate the net verified savings are based on past evaluation research and approved through the Illinois Stakeholder Advisory Group (SAG) consensus process.

7.3 Survey Questions Used to Determine Part-Use Factor

The survey question structure used by the evaluation team to calculate the part-use factor for a refrigerator or a freezer is designed to determine what the participant would have done with the unit if the program had not picked it up. The structure of the questions asked is as follows:

- At the time this MEASURE was picked up, were you using it as your main MEASURE, or had it been a secondary or spare?
- How long had you been using this MEASURE as a secondary or spare?
- Thinking just about the past year, was the spare MEASURE plugged in and running all the time, for special occasions only, during certain months of the year only, or was it never plugged in and running?
- If you add up the total time your spare MEASURE was plugged in and running during the last 12 months that you had it, about how many total months would that be?
- Was the MEASURE running during the summer or was it mainly running during other times of the year?
- Where would the MEASURE have been located if it had not been removed by ComEd? If the MEASURE was your primary unit, we're interested in whether you would have left it in the kitchen or moved it to another room.

8. APPENDIX 2. IMPACT ANALYSIS DETAIL

Table 8-1 summarizes the program savings by measure. The verified NTG ratio is based on deemed values. There are separate SAG-approved NTG values for refrigerators and freezers, delineated by whether the unit is assigned a Retailer NTG ratio or a Non-Retailer NTG ratio. The Retailer NTG ratio is assigned to customers based on the disposal practices of the retailers they bought the replacement unit from. For those participants that reported they would have either kept the unit or used a disposal method not involving the retailer, absent the program, the Non-Retailer NTG ratio is applied.[8] The NTG ratios in the table below, which have been used to determine verified net savings, are a weighted average of the Retailer and Non-Retailer NTG ratio values for each appliance type. These NTG ratios are 0.50 for refrigerators (based on a weighted average of Retailer NTG ratio of 0.072 and Non-Retailer NTG ratio of 0.649), 0.48 for freezers (based on a weighted average of Retailer NTG ratio of 0.067 and Non-Retailer NTG ratio of 0.52) and 0.50 for room ACs, dehumidifiers, and small units.

Table 8-1. CY2019 Total Annual Incremental Savings, Detailed Calculation

Savings Category	Refrigerators	Freezers	Room ACs	Dehumidifiers	Small Units
Ex-Ante Gross Savings (kWh)	34,252,164	4,934,797	624,164	121,196	0
Ex-Ante Gross Peak Demand Reduction (kW)	NR	NR	NR	NR	NR
Deemed Part-Use Factor	0.91	0.86	NA	NA	NA
Verified Gross Savings (kWh)	35,258,967	5,070,885	490,415	121,196	18,025
Verified Gross Peak Demand Reduction (kW)	4,348	595	883	27	2
Verified Gross Realization Rate	103%	103%	79%	100%	-
Deemed Net to Gross Ratio (NTG Ratio)*	0.50	0.48	0.50	0.50	0.50
Verified Net Savings (kWh)	17,629,484	2,434,025	245,208	60,598	9,013
Verified Net Peak Demand Reduction (kW)	2,174	285	441	14	1

NR =Not reported

* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.

Source: ComEd tracking data and EM&V team analysis

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[8] For further details on Retailer and Non-Retailer NTG see memo: ComEd FFR CY2018 NTG Results Memo 2019-08-27.docx

9. APPENDIX 3. TOTAL RESOURCE COST DETAIL

Table 9-1 shows the Total Resource Cost (TRC) cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to the evaluation team later.

Table 9-1. Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Verified Gross Electric Energy Savings (kWh)	Verified Gross Peak Demand Reduction (kW)	Verified Gross Gas Savings (Therms)	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG (kWh)	NTG (kW)	NTG (Therms)	Verified Net Electric Energy Savings (kWh)	Verified Net Peak Demand Reduction (kW)	Verified Net Gas Savings (Therms)	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
Appliances	Refrigerators - Recycled	Each	40,543	6.5	No	35,258,967	4,348.04	NA	NA	NA	0.50	0.50	NA	17,629,484	2,174.02	NA	NA	NA
Appliances	Freezers - Recycled	Each	6,224	6.5	No	5,070,885	594.67	NA	NA	NA	0.48	0.48	NA	2,434,025	285.44	NA	NA	NA
Appliances	Room ACs - Recycled	Each	2,666	4.0	No	490,415	882.90	NA	NA	NA	0.50	0.50	NA	245,208	441.45	NA	NA	NA
Appliances	Dehumidifiers - Recycled	Each	2,286	6.0	No	121,196	27.48	NA	NA	NA	0.50	0.50	NA	60,598	13.74	NA	NA	NA
Appliances	Small Refrigerators - Recycled	Each	103	6.5	No	18,025	2.22	NA	NA	NA	0.50	0.50	NA	9,013	1.11	NA	NA	NA
	Total		51,822	6.5		40,959,489	5,855	NA	NA	NA	NA	NA	NA	20,378,327	2,916	NA	NA	NA

NA = Not applicale
* The total of the EUL column is the weighted average measure life (WAML) and is calculated as the sum product of EUL and measure savings divided by total program savings.
† Early Replacement (ER) measures are flagged as YES, otherwise a NO is indicated in the column.
Source: ComEd tracking data and evaluation team analysis