Guidehouse

ComEd Residential HVAC 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 Residential HVAC Impact Evaluation Report

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. Introduction

This report presents the results of the impact evaluation of ComEd's CY2019 Residential HVAC (HVAC Rebates) 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 HVAC Rebates Program offers incentives for the installation of qualifying high efficiency equipment including central air conditioning systems, air source heat pumps, ductless mini-split heat pumps, furnace blower motors (electronically commutated motors (ECMs)), ground source heat pumps, and smart thermostats.

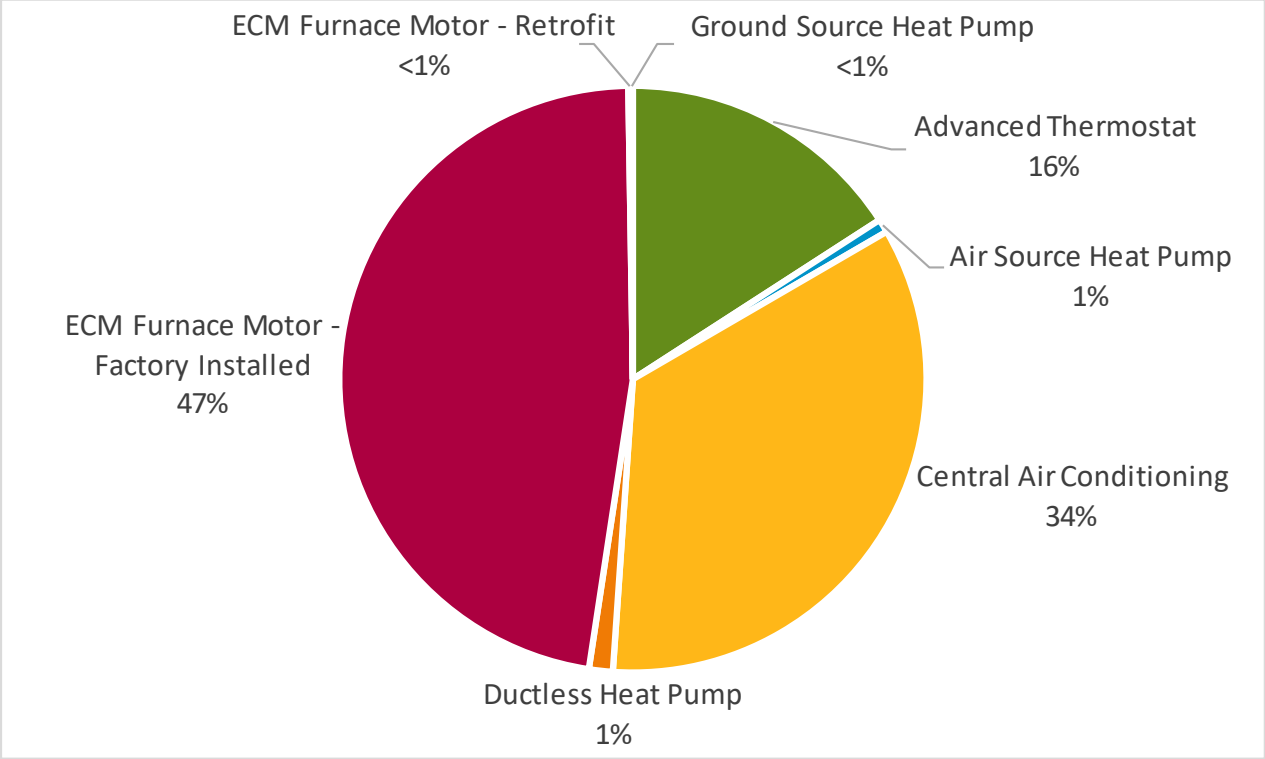
The program had 16,701 participants in CY2019 and distributed 27,394 measures as shown in the following table and graph.

Table 2-1. CY2019 Volumetric Findings Detail

Participation	HVAC Rebates Total
Participants*	16,701
Total Measures	27,394
Installed Projects†	17,604
Advanced Thermostat‡	4,347
Air Source Heat Pump	205
Central Air Conditioning	9,444
Ductless Heat Pump	359
ECM Furnace Motor - Factory Installed	12,970
ECM Furnace Motor - Retrofit	33
Ground Source Heat Pump	36
Total	27,394

* Unique Participants are defined as unique ComEd account numbers
† Unique projects are defined as unique record IDs
‡ Includes all thermostat quantities reported in tracking data but thermostat savings capped at one per ComEd account number
Source: ComEd tracking data and evaluation team analysis

Figure 2-1. Distribution 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 HVAC Rebates Program achieved in CY2019. The gas savings are only those that ComEd may be able to claim, which excludes savings the gas utilities claim, either via joint or non-joint programs.[1]

[1] The evaluation will determine which gas savings will be counted toward goal while producing the portfolio-wide Summary Report.

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	14,532,315	NR	5,329
Program Gross Realization Rate	0.94	NA	0.76
Verified Gross Savings	13,668,872	9,480	4,052
Program Net-to-Gross Ratio (NTG)	Varies	Varies	Varies
Verified Net Savings	9,566,845	6,734	2,776
Converted from Gas†			
Ex Ante Gross Savings	13,986,807	NA	NA
Program Gross Realization Rate	0.90	NA	NA
Verified Gross Savings	12,597,631	NA	NA
Program Net-to-Gross Ratio (NTG)	Varies	NA	NA
Verified Net Savings	10,908,850	NA	NA
Total Electric Plus Gas			
Ex Ante Gross Savings	28,519,122	NR	5,329
Program Gross Realization Rate	0.92	NA	0.76
Verified Gross Savings	26,266,502	9,480	4,052
Program Net-to-Gross Ratio (NTG)	Varies	Varies	Varies
Verified Net Savings	20,475,695	6,734	2,776

NR = Not reported (refers a piece of data that was not reported, i.e., non-coincident demand savings)
NA = Not applicable (refers a piece of data cannnot be produced or does not apply)
* The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.
† Gas savings converted to kWh by multiplying therms * 29.31 (which is based on 100,000 Btu/therm and 3,412 Btu/kWh). The evaluation will determine which gas savings will be converted to kWh and counted toward ComEd's electric savings goal while producing the portfolio-wide Summary Report. According to Section 8-103B(b-25) of the Illinois Public Utilities Act, "In no event shall more than 10% of each year's applicable annual incremental goal as defined in paragraph (7) of subsection (g) of this Section be met through savings of fuels other than electricity."
Source: ComEd tracking data and evaluation team analysis

4. Cumulative Persisting Annual Savings

Table 4-1 to Table 4-3 and Figure 4-1 show the measure-specific and total verified gross savings for the Heating and Cooling (HVAC) Rebates Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2019. The electric CPAS across all measures installed in 2019 is 9,566,845 kWh (Table 4-1). The CY2019 gas contribution to CPAS (converted to equivalent electricity) is 10,908,850 kWh (Table 4-2). Adding the gas and electric contributions produces 20,475,695 kWh of total CY2019 contribution to CPAS (Table 4-3). 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.

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
HVAC	ECM Furnace Motor - Factory Installed	15.0	7,818,247	0.68	79,746,116		5,316,408	5,316,408	5,316,408	5,316,408	5,316,408	5,316,408	5,316,408	5,316,408
HVAC	Central Air Conditioning - TOS	18.0	2,613,561	0.65	30,578,661		1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815
HVAC	Advanced Thermostat	11.0	1,300,894	NA	14,309,831		1,300,894	1,300,894	1,300,894	1,300,894	1,300,894	1,300,894	1,300,894	1,300,894
HVAC	Ductless Heat Pump - TOS	15.0	548,426	0.68	5,593,949		372,930	372,930	372,930	372,930	372,930	372,930	372,930	372,930
HVAC	Central Air Conditioning - ER	18.0	531,211	0.65	3,196,115		345,287	345,287	345,287	345,287	345,287	345,287	93,699	93,699
HVAC	Ductless Heat Pump - ER	15.0	312,181	0.68	2,620,541		212,283	212,283	212,283	212,283	212,283	212,283	149,649	149,649
HVAC	Air Source Heat Pump - TOS	16.0	219,904	0.57	2,005,525		125,345	125,345	125,345	125,345	125,345	125,345	125,345	125,345
HVAC	Ground Source Heat Pump - ER	25.0	133,706	0.59	1,852,603		78,887	78,887	78,887	78,887	78,887	78,887	78,887	78,887
HVAC	Ground Source Heat Pump - TOS	25.0	103,801	0.59	1,531,069		61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243
HVAC	Air Source Heat Pump - ER	16.0	64,341	0.57	307,939		36,675	36,675	36,675	36,675	36,675	36,675	8,789	8,789
HVAC	ECM Furnace Motor - Retrofit	15.0	22,599	0.80	271,188		18,079	18,079	18,079	18,079	18,079	18,079	18,079	18,079
CY2019 Program Total Electric Contribution to CPAS			13,668,872		142,013,539		9,566,845	9,566,845	9,566,845	9,566,845	9,566,845	9,566,845	9,224,738	9,224,738
Historic Program Total Electric Contribution to CPAS‡						9,255,057	9,255,057	9,255,057	9,255,057	9,255,057	9,255,057	8,640,310	8,640,310	8,635,915
Program Total Electric CPAS						9,255,057	18,821,901	18,821,901	18,821,901	18,821,901	18,821,901	18,207,155	17,865,048	17,860,653
CY2019 Program Incremental Expiring Electric Savings§								-	-	-	-	-	342,107	-
Historic Program Incremental Expiring Electric Savings‡§							-	-	-	-	-	614,746	-	4,395
Program Total Incremental Expiring Electric Savings§							-	-	-	-	-	614,746	342,107	4,395

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
HVAC	ECM Furnace Motor - Factory Installed	5,316,408	5,316,408	5,316,408	5,316,408	5,316,408	5,316,408	5,316,408					
HVAC	Central Air Conditioning - TOS	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815		
HVAC	Advanced Thermostat	1,300,894	1,300,894	1,300,894									
HVAC	Ductless Heat Pump - TOS	372,930	372,930	372,930	372,930	372,930	372,930	372,930					
HVAC	Central Air Conditioning - ER	93,699	93,699	93,699	93,699	93,699	93,699	93,699	93,699	93,699	93,699		
HVAC	Ductless Heat Pump - ER	149,649	149,649	149,649	149,649	149,649	149,649	149,649					
HVAC	Air Source Heat Pump - TOS	125,345	125,345	125,345	125,345	125,345	125,345	125,345	125,345				
HVAC	Ground Source Heat Pump - ER	71,853	71,853	71,853	71,853	71,853	71,853	71,853	71,853	71,853	71,853	71,853	71,853
HVAC	Ground Source Heat Pump - TOS	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243
HVAC	Air Source Heat Pump - ER	8,789	8,789	8,789	8,789	8,789	8,789	8,789	8,789				
HVAC	ECM Furnace Motor - Retrofit	18,079	18,079	18,079	18,079	18,079	18,079	18,079					
CY2019 Program Total Electric Contribution to CPAS		9,217,704	9,217,704	9,217,704	7,916,811	7,916,811	7,916,811	7,916,811	2,059,744	1,925,610	1,925,610	133,096	133,096
Historic Program Total Electric Contribution to CPAS‡		8,635,915	7,507,822	7,507,822	7,507,822	7,495,036	7,495,036	7,495,036	7,495,036	7,495,036	5,096,999	5,096,999	46,325
Program Total Electric CPAS		17,853,620	16,725,526	16,725,526	15,424,632	15,411,847	15,411,847	15,411,847	9,554,781	9,420,646	7,022,609	5,230,095	179,422
CY2019 Program Incremental Expiring Electric Savings§		7,033	-	-	1,300,894	-	-	-	5,857,066	134,134	-	1,792,514	-
Historic Program Incremental Expiring Electric Savings‡§		-	1,128,094	-	-	12,785	-	-	-	-	2,398,037	-	5,050,674
Program Total Incremental Expiring Electric Savings§		7,033	1,128,094	-	1,300,894	12,785	-	-	5,857,066	134,134	2,398,037	1,792,514	5,050,674

End Use Type	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
HVAC	ECM Furnace Motor - Factory Installed												
HVAC	Central Air Conditioning - TOS												
HVAC	Advanced Thermostat												
HVAC	Ductless Heat Pump - TOS												
HVAC	Central Air Conditioning - ER												
HVAC	Ductless Heat Pump - ER												
HVAC	Air Source Heat Pump - TOS												
HVAC	Ground Source Heat Pump - ER	71,853	71,853	71,853	71,853	71,853							
HVAC	Ground Source Heat Pump - TOS	61,243	61,243	61,243	61,243	61,243							
HVAC	Air Source Heat Pump - ER												
HVAC	ECM Furnace Motor - Retrofit												
CY2019 Program Total Electric Contribution to CPAS		133,096	133,096	133,096	133,096	133,096	-	-	-	-	-	-	-
Historic Program Total Electric Contribution to CPAS‡		46,325	46,325	46,325	46,325	-	-	-	-	-	-	-	-
Program Total Electric CPAS		179,422	179,422	179,422	179,422	133,096	-	-	-	-	-	-	-
CY2019 Program Incremental Expiring Electric Savings§		-	-	-	-	-	133,096	-	-	-	-	-	-
Historic Program Incremental Expiring Electric Savings‡§		-	-	-	-	46,325	-	-	-	-	-	-	-
Program Total Incremental Expiring Electric Savings§		-	-	-	-	46,325	133,096	-	-	-	-	-	-

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

Table 4-2. Cumulative Persisting Annual Savings (CPAS) – Gas

End Use Type	Research Category	EUL	CY2019 Verified Gross Savings (Therms)	NTG*	Lifetime Net Savings (Therms)†	Verified Net Therms Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
HVAC	ECM Furnace Motor - Factory Installed	15.0	-9	0.68	-88		-6	-6	-6	-6	-6	-6	-6	-6
HVAC	Central Air Conditioning - TOS	18.0		0.65										
HVAC	Advanced Thermostat	11.0	250,191	NA	2,752,104		250,191	250,191	250,191	250,191	250,191	250,191	250,191	250,191
HVAC	Ductless Heat Pump - TOS	15.0	35,864	0.68	365,815		24,388	24,388	24,388	24,388	24,388	24,388	24,388	24,388
HVAC	Central Air Conditioning - ER	18.0		0.65										
HVAC	Ductless Heat Pump - ER	15.0	142,193	0.68	1,184,118		96,691	96,691	96,691	96,691	96,691	96,691	67,108	67,108
HVAC	Air Source Heat Pump - TOS	16.0		0.57										
HVAC	Ground Source Heat Pump - ER	25.0	1,567	0.59	-14,110		924	924	924	924	924	924	924	924
HVAC	Ground Source Heat Pump - TOS	25.0		0.59										
HVAC	Air Source Heat Pump - ER	16.0		0.57										
HVAC	ECM Furnace Motor - Retrofit	15.0		0.80										
CY2019 Program Total Gas Contribution to CPAS (Therms)			429,807		4,287,840		372,189	372,189	372,189	372,189	372,189	372,189	342,605	342,605
CY2019 Program Total Gas Contribution to CPAS (kWh Equivalent)‡					125,676,581		10,908,850	10,908,850	10,908,850	10,908,850	10,908,850	10,908,850	10,041,763	10,041,763
Historic Program Total Gas Contribution to CPAS (kWh Equivalent)‡§						9,010,884	9,010,884	9,010,884	9,010,884	9,010,884	9,010,884	8,837,735	8,837,735	8,837,735
Program Total Gas CPAS (kWh Equivalent)‡						9,010,884	19,919,734	19,919,734	19,919,734	19,919,734	19,919,734	19,746,585	18,879,497	18,879,497
CY2019 Program Incremental Expiring Gas Savings (Therms)‖								-	-	-	-	-	29,583	-
CY2019 Program Incremental Expiring Gas Savings (kWh Equivalent)‡‖								-	-	-	-	-	867,088	-
Historic Program Incremental Expiring Gas Savings (kWh Equivalent)‡§‖							-	-	-	-	-	173,149	-	-
Program Total Incremental Expiring Gas Savings (kWh Equivalent)‡‖							-	-	-	-	-	173,149	867,088	-

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
HVAC	ECM Furnace Motor - Factory Installed	-6	-6	-6	-6	-6	-6	-6					
HVAC	Central Air Conditioning - TOS												
HVAC	Advanced Thermostat	250,191	250,191	250,191									
HVAC	Ductless Heat Pump - TOS	24,388	24,388	24,388	24,388	24,388	24,388	24,388					
HVAC	Central Air Conditioning - ER												
HVAC	Ductless Heat Pump - ER	67,108	67,108	67,108	67,108	67,108	67,108	67,108					
HVAC	Air Source Heat Pump - TOS												
HVAC	Ground Source Heat Pump - ER	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265	-1,265
HVAC	Ground Source Heat Pump - TOS												
HVAC	Air Source Heat Pump - ER												
HVAC	ECM Furnace Motor - Retrofit												
CY2019 Program Total Gas Contribution to CPAS (Therms)		340,416	340,416	340,416	90,225	90,225	90,225	90,225	(1,265)	(1,265)	(1,265)	(1,265)	(1,265)
CY2019 Program Total Gas Contribution to CPAS (kWh Equivalent)‡		9,977,593	9,977,593	9,977,593	2,644,487	2,644,487	2,644,487	2,644,487	(37,077)	(37,077)	(37,077)	(37,077)	(37,077)
Historic Program Total Gas Contribution to CPAS (kWh Equivalent)‡§		8,837,735	2,563,733	2,563,733	2,563,733	2,563,733	2,563,733	2,563,733	2,563,733	2,563,733	54,252	54,252	54,252
Program Total Gas CPAS (kWh Equivalent)‡		18,815,328	12,541,326	12,541,326	5,208,219	5,208,219	5,208,219	5,208,219	2,526,655	2,526,655	17,175	17,175	17,175
CY2019 Program Incremental Expiring Gas Savings (Therms)‖		2,189	-	-	250,191	-	-	-	91,490	-	-	-	-
CY2019 Program Incremental Expiring Gas Savings (kWh Equivalent)‡‖		64,169	-	-	7,333,107	-	-	-	2,681,564	-	-	-	-
Historic Program Incremental Expiring Gas Savings (kWh Equivalent)‡§‖		-	6,274,002	-	-	-	-	-	-	-	2,509,480	-	-
Program Total Incremental Expiring Gas Savings (kWh Equivalent)‡‖		64,169	6,274,002	-	7,333,107	-	-	-	2,681,564	-	2,509,480	-	-

End Use Type	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
HVAC	ECM Furnace Motor - Factory Installed												
HVAC	Central Air Conditioning - TOS												
HVAC	Advanced Thermostat												
HVAC	Ductless Heat Pump - TOS												
HVAC	Central Air Conditioning - ER												
HVAC	Ductless Heat Pump - ER												
HVAC	Air Source Heat Pump - TOS												
HVAC	Ground Source Heat Pump - ER	-1,265	-1,265	-1,265	-1,265	-1,265							
HVAC	Ground Source Heat Pump - TOS												
HVAC	Air Source Heat Pump - ER												
HVAC	ECM Furnace Motor - Retrofit												
CY2019 Program Total Gas Contribution to CPAS (Therms)		(1,265)	(1,265)	(1,265)	(1,265)	(1,265)	-	-	-	-	-	-	-
CY2019 Program Total Gas Contribution to CPAS (kWh Equivalent)‡		(37,077)	(37,077)	(37,077)	(37,077)	(37,077)	-	-	-	-	-	-	-
Historic Program Total Gas Contribution to CPAS (kWh Equivalent)‡§		54,252	54,252	54,252	54,252	-	-	-	-	-	-	-	-
Program Total Gas CPAS (kWh Equivalent)‡		17,175	17,175	17,175	17,175	(37,077)	-	-	-	-	-	-	-
CY2019 Program Incremental Expiring Gas Savings (Therms)||		-	-	-	-	-	(1,265)	-	-	-	-	-	-
CY2019 Program Incremental Expiring Gas Savings (kWh Equivalent)‡||		-	-	-	-	-	(37,077)	-	-	-	-	-	-
Historic Program Incremental Expiring Gas Savings (kWh Equivalent)‡§||		-	-	-	-	54,252	-	-	-	-	-	-	-
Program Total Incremental Expiring Gas Savings (kWh Equivalent)‡||		-	-	-	-	54,252	(37,077)	-	-	-	-	-	-

Note: The green highlighted cell shows program total first year gas savings in kWh equivalents. The gray cells are blank, indicating no values or do not contribute to calculating CPAS in CY2019.
* 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.
‡ kWh equivalent savings are calculated by multiplying therm savings by 29.31.
§ Historic savings go back to CY2018.
|| Incremental expiring savings are equal to CPAS Yn-1 - CPAS Y_n.
Source: Evaluation team analysis

Table 4-3. Cumulative Persisting Annual Savings (CPAS) – Total

End Use Type	Research Category	EUL	CY2019 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings (Including Those Converted from Gas Savings) 2018	2019	2020	2021	2022	2023	2024	2025	2026
HVAC	ECM Furnace Motor - Factory Installed	15.0	7,817,994	0.68	79,743,539		5,316,236	5,316,236	5,316,236	5,316,236	5,316,236	5,316,236	5,316,236	5,316,236
HVAC	Central Air Conditioning - TOS	18.0	2,613,561	0.65	30,578,661		1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815
HVAC	Advanced Thermostat	11.0	8,634,000	NA	94,974,005		8,634,000	8,634,000	8,634,000	8,634,000	8,634,000	8,634,000	8,634,000	8,634,000
HVAC	Ductless Heat Pump - TOS	15.0	1,599,607	0.68	16,315,996		1,087,733	1,087,733	1,087,733	1,087,733	1,087,733	1,087,733	1,087,733	1,087,733
HVAC	Central Air Conditioning - ER	18.0	531,211	0.65	3,196,115		345,287	345,287	345,287	345,287	345,287	345,287	93,699	93,699
HVAC	Ductless Heat Pump - ER	15.0	4,479,857	0.68	37,327,054		3,046,303	3,046,303	3,046,303	3,046,303	3,046,303	3,046,303	2,116,582	2,116,582
HVAC	Air Source Heat Pump - TOS	16.0	219,904	0.57	2,005,525		125,345	125,345	125,345	125,345	125,345	125,345	125,345	125,345
HVAC	Ground Source Heat Pump - ER	25.0	179,625	0.59	1,439,028		105,979	105,979	105,979	105,979	105,979	105,979	105,979	105,979
HVAC	Ground Source Heat Pump - TOS	25.0	103,801	0.59	1,531,069		61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243
HVAC	Air Source Heat Pump - ER	16.0	64,341	0.57	307,939		36,675	36,675	36,675	36,675	36,675	36,675	8,789	8,789
HVAC	ECM Furnace Motor - Retrofit	15.0	22,599	0.80	271,188		18,079	18,079	18,079	18,079	18,079	18,079	18,079	18,079
CY2019 Program Total Contribution to CPAS			26,266,502		267,690,119		20,475,695	20,475,695	20,475,695	20,475,695	20,475,695	20,475,695	19,266,500	19,266,500
Historic Program Total Contribution to CPAS‡						18,265,941	18,265,941	18,265,941	18,265,941	18,265,941	18,265,941	17,478,045	17,478,045	17,473,650
Program Total CPAS						18,265,941	38,741,636	38,741,636	38,741,636	38,741,636	38,741,636	37,953,740	36,744,546	36,740,150
CY2019 Program Incremental Expiring Savings§								-	-	-	-	-	1,209,195	-
Historic Program Incremental Expiring Savings‡§							-	-	-	-	-	787,896	-	4,395
Program Total Incremental Expiring Savings§							-	-	-	-	-	787,896	1,209,195	4,395

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
HVAC	ECM Furnace Motor - Factory Installed	5,316,236	5,316,236	5,316,236	5,316,236	5,316,236	5,316,236	5,316,236					
HVAC	Central Air Conditioning - TOS	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815	1,698,815		
HVAC	Advanced Thermostat	8,634,000	8,634,000	8,634,000									
HVAC	Ductless Heat Pump - TOS	1,087,733	1,087,733	1,087,733	1,087,733	1,087,733	1,087,733	1,087,733					
HVAC	Central Air Conditioning - ER	93,699	93,699	93,699	93,699	93,699	93,699	93,699	93,699	93,699	93,699		
HVAC	Ductless Heat Pump - ER	2,116,582	2,116,582	2,116,582	2,116,582	2,116,582	2,116,582	2,116,582					
HVAC	Air Source Heat Pump - TOS	125,345	125,345	125,345	125,345	125,345	125,345	125,345	125,345				
HVAC	Ground Source Heat Pump - ER	34,776	34,776	34,776	34,776	34,776	34,776	34,776	34,776	34,776	34,776	34,776	34,776
HVAC	Ground Source Heat Pump - TOS	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243	61,243
HVAC	Air Source Heat Pump - ER	8,789	8,789	8,789	8,789	8,789	8,789	8,789	8,789				
HVAC	ECM Furnace Motor - Retrofit	18,079	18,079	18,079	18,079	18,079	18,079	18,079					
CY2019 Program Total Contribution to CPAS		19,195,298	19,195,298	19,195,298	10,561,297	10,561,297	10,561,297	10,561,297	2,022,667	1,888,533	1,888,533	96,019	96,019
Historic Program Total Contribution to CPAS‡		17,473,650	10,071,554	10,071,554	10,071,554	10,058,769	10,058,769	10,058,769	10,058,769	10,058,769	5,151,251	5,151,251	100,578
Program Total CPAS		36,668,948	29,266,852	29,266,852	20,632,851	20,620,066	20,620,066	20,620,066	12,081,436	11,947,302	7,039,784	5,247,270	196,597
CY2019 Program Incremental Expiring Savings§		71,203	-	-	8,634,000	-	-	-	8,538,630	134,134	-	1,792,514	-
Historic Program Incremental Expiring Savings‡§		-	7,402,096	-	-	12,785	-	-	-	-	4,907,518	-	5,050,674
Program Total Incremental Expiring Savings§		71,203	7,402,096	-	8,634,000	12,785	-	-	8,538,630	134,134	4,907,518	1,792,514	5,050,674

End Use Type	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
HVAC	ECM Furnace Motor - Factory Installed												
HVAC	Central Air Conditioning - TOS												
HVAC	Advanced Thermostat												
HVAC	Ductless Heat Pump - TOS												
HVAC	Central Air Conditioning - ER												
HVAC	Ductless Heat Pump - ER												
HVAC	Air Source Heat Pump - TOS												
HVAC	Ground Source Heat Pump - ER	34,776	34,776	34,776	34,776	34,776							
HVAC	Ground Source Heat Pump - TOS	61,243	61,243	61,243	61,243	61,243							
HVAC	Air Source Heat Pump - ER												
HVAC	ECM Furnace Motor - Retrofit												
CY2019 Program Total Contribution to CPAS		96,019	96,019	96,019	96,019	96,019	-	-	-	-	-	-	-
Historic Program Total Contribution to CPAS‡		100,578	100,578	100,578	100,578	-	-	-	-	-	-	-	-
Program Total CPAS		196,597	196,597	196,597	196,597	96,019	-	-	-	-	-	-	-
CY2019 Program Incremental Expiring Savings§		-	-	-	-	-	96,019	-	-	-	-	-	-
Historic Program Incremental Expiring Savings‡§		-	-	-	-	100,578	-	-	-	-	-	-	-
Program Total Incremental Expiring Savings§		-	-	-	-	100,578	96,019	-	-	-	-	-	-

Note: The green highlighted cell shows program total first year electric savings (including direct electric savings and those converted from gas). The gray cells are blank, indicating no values or do not contribute to calculating CPAS in CY2019.

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

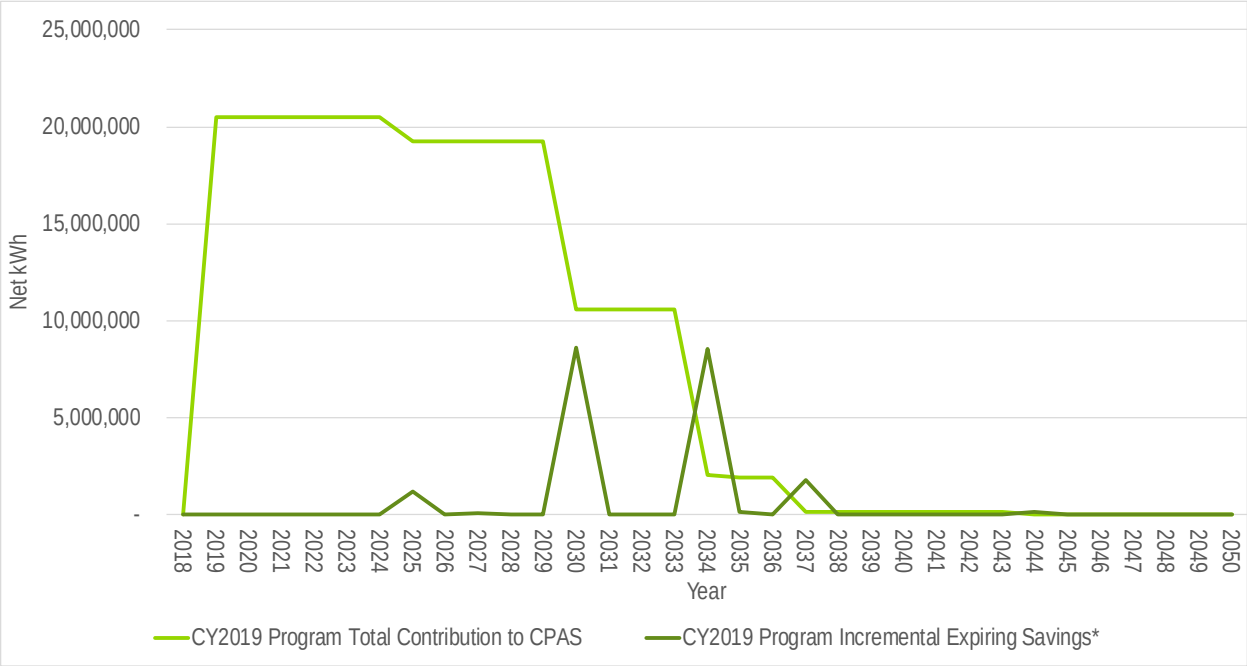
† Lifetime savings are the sum of CPAS savings through the EUL.

‡ Historic 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

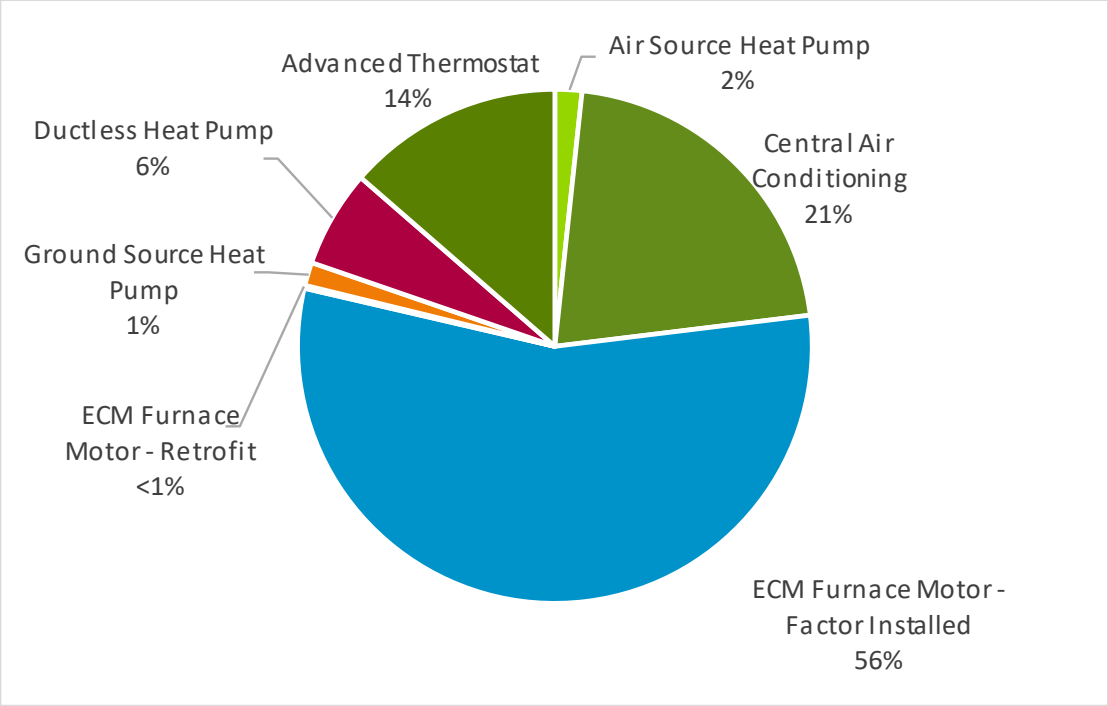


* Expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n.
Source: Evaluation team analysis

5. Program Savings by Measure

The program includes six measures as shown in the following tables. The Furnace Blower Motor (ECM) and Central Air Conditioning contributed the most savings (see Figure 5-1).

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



Source: ComEd tracking data and evaluation team analysis

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)	Effective Useful Life
HVAC	ECM Furnace Motor - Factory Installed	8,194,345	0.95	7,818,247	0.68	5,316,408	15.0
HVAC	Central Air Conditioning	3,659,084	0.86	3,144,772	0.65	2,044,102	18.0
HVAC	Advanced Thermostat	1,300,209	1.00	1,300,894	NA†	1,300,894	11.0
HVAC	Ductless Heat Pump	763,035	1.13	860,607	0.68	585,213	15.0
HVAC	Air Source Heat Pump	400,026	0.71	284,245	0.57	162,020	16.0
HVAC	Ground Source Heat Pump	194,904	1.22	237,508	0.59	140,130	25.0
HVAC	ECM Furnace Motor - Retrofit	20,712	1.09	22,599	0.80	18,079	15.0
	Total	14,532,315	0.94	13,668,872		9,566,845	

NA = Not Applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† The Illinois TRM algorithm calculates net savings for advanced thermostats.
Note: The savings in this table includes secondary electric energy (kWh) savings from water supply and wastewater treatment plants for measures claimed by ComEd.
Source: ComEd tracking data and evaluation team analysis

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

Research Category	Ex Ante Gross Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (kW)	NTG *	Verified Net Demand Reduction (kW)
ECM Furnace Motor - Factory Installed	NR	NA	1,420.32	0.68	965.82
Central Air Conditioning	NR	NA	6,355.35	0.65	4,130.98
Advanced Thermostat	NR	NA	1,511.81	NA†	1,511.81
Ductless Heat Pump	NR	NA	93.60	0.68	63.65
Air Source Heat Pump	NR	NA	-17.12	0.57	-9.76
Ground Source Heat Pump	NR	NA	103.52	0.59	61.08
ECM Furnace Motor - Retrofit	NR	NA	12.98	0.80	10.38
Total	NR		9,480.46		6,733.95

NR = Not Reported
NA = Not Applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† The Illinois TRM algorithm calculates net savings for advanced thermostats.
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)
HVAC	ECM Furnace Motor - Factory Installed	1,269.18	0.52	661.87	0.68	450.07
HVAC	Central Air Conditioning	3,622.77	0.82	2,961.59	0.65	1,925.04
HVAC	Advanced Thermostat	354.96	0.99	351.58	NA†	351.58
HVAC	Ductless Heat Pump	30.29	1.01	30.64	0.68	20.84
HVAC	Air Source Heat Pump	3.69	-2.18	-8.02	0.57	-4.57
HVAC	Ground Source Heat Pump	45.00	1.07	48.24	0.59	28.46
HVAC	ECM Furnace Motor - Retrofit	2.97	2.04	6.05	0.80	4.84
	Total	5,328.85	0.76	4,051.95		2,776.25

NA = Not Applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† The Illinois TRM algorithm calculates net savings for advanced thermostats.
Source: ComEd tracking data and evaluation team analysis

Table 5-4. CY2019 Energy Savings by Measure – Gas

End Use Type	Research Category	Ex Ante Gross Savings	Verified Gross Realization Rate	Verified Gross Savings	NTG *	Verified Net Savings	Effective Useful Life
HVAC	ECM Furnace Motor - Factory Installed	-9	1.00	-9	0.68	-6	15.0
HVAC	Central Air Conditioning	0		0	0.65	0	18.0
HVAC	Advanced Thermostat	250,754	1.00	250,191	NA‡	250,191	11.0
HVAC	Ductless Heat Pump	214,454	0.83	178,057	0.68	121,079	15.0
HVAC	Air Source Heat Pump	0		0	0.57	0	16.0
HVAC	Ground Source Heat Pump	12,003	0.13	1,567	0.59	924	25.0
HVAC	ECM Furnace Motor - Retrofit	0		0	0.80	0	15.0
	Total Therms	477,203	0.90	429,807		372,189	
	Total kWh Converted from Therms†	13,986,807	0.90	12,597,631		10,908,850	

NA = Not applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† Gas savings converted to kWh by multiplying therms * 29.31 (which is based on 100,000 Btu/therm and 3,412 Btu/kWh). Ductless Heat Pump and Ground Source Heat Pump measures produce gas savings because they are fuel switching measures.
‡ The Illinois TRM algorithm calculates net savings for advanced thermostats.
Source: ComEd tracking data and evaluation team analysis

Table 5-5. CY2019 Energy Savings by Measure – Total Combining Electricity and Gas

End Use Type	Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG *	Verified Net Savings (kWh)
HVAC	ECM Furnace Motor - Factory Installed	8,194,092	0.95	7,817,994	0.68	5,316,236
HVAC	Central Air Conditioning	3,659,084	0.86	3,144,772	0.65	2,044,102
HVAC	Advanced Thermostat	8,649,812	1.00	8,634,000	NA‡	8,634,000
HVAC	Ductless Heat Pump	7,048,693	0.86	6,079,465	0.68	4,134,036
HVAC	Air Source Heat Pump	400,026	0.71	284,245	0.57	162,020
HVAC	Ground Source Heat Pump	546,703	0.52	283,427	0.59	167,222
HVAC	ECM Furnace Motor - Retrofit	20,712	1.09	22,599	0.80	18,079
	Total†	28,519,122	0.92	26,266,502		20,475,695

* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† The total includes the electric equivalent of the total therms.
‡ The TRM algorithm calculates net savings for advanced thermostats.
Source: ComEd tracking data and evaluation team analysis

6. Impact Analysis Findings and Recommendations

6.1 Impact Parameter Estimates

Guidehouse used the savings algorithms and inputs deemed by the Illinois TRM (TRM) v7.0 and TRM v7.0 Errata, where applicable, to calculate the energy and demand savings for each measure installed as a part of the program in CY2019. The following table presents the deemed input parameter source that Guidehouse used by measure. The TRM v7.0 allows for custom or actual values to be used for some of the input parameters. Guidehouse based these values on the program tracking database when available.

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 that were not specified in the TRM. The results are shown in the following table.

Table 6-1. Savings Parameters

Gross Savings Input Parameters	Value	Units	Deemed * or Evaluated?	Source
Quantity	Varies	# measures	Evaluated	ComEd Tracking Data and Guidehouse Evaluation
NTG	Varies		Deemed	Illinois SAG Consensus
Advanced Thermostat	Varies	Each	Deemed	TRM v7.0 – Section 5.3.16
Air Source Heat Pump	Varies	Each	Deemed	TRM v7.0 – Section 5.3.01
Ductless Heat Pump	Varies	Each	Deemed	TRM v7.0 – Section 5.3.12 & TRM v7.0 Errata – Section 5.3.12
Central Air Conditioning	Varies	Each	Deemed	TRM v7.0 – Section 5.3.03
Furnace Blower Motor	Varies	Each	Deemed	TRM v7.0 – Section 5.3.05
Ground Source Heat Pump	Varies	Each	Deemed	TRM v7.0 – Section 5.3.08

* 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 and Recommendations

The evaluation team has developed several recommendations based on findings from the CY2019 evaluation listed below. Some of the measure-level findings by Guidehouse were addressed by the implementer in the CY2019 Wave 1 analysis but not corrected for by the implementer in the end of year analysis. This resulted in multiple repeat findings and recommendations from the CY2019 Wave 1 analysis.

6.2.1 Air Source Heat Pumps

Air source heat pumps (ASHP) have an electric energy realization rate of 71% and represent 1% of CY2019's verified gross energy savings. Out of the 205 ASHP projects, Guidehouse found the following discrepancies:

Finding 1: The TRM v7.0 Section 5.3.1 advises to de-rate the existing Seasonal Energy Efficiency Ratio (SEER) and Energy Effiiciency Ratio (EER) values for early replacement projects by 1% per year to account for degradation over time. Guidehouse de-rated the existing SEER and EER values, if available, based on the reported age of the existing cooling system. It is assumed that the implementer did not de-rate the existing SEER or EER efficiency values for early replacement projects.

Recommendation 1: Guidehouse recommends de-rating existing SEER and EER values for early replacement projects by 1% per year to account for degradation over time per the TRM v7.0 Section 5.3.1. Guidehouse requests that the IC report two additional fields consisting of the de-rated SEER and EER values to aid in evaluation efforts.

Finding 2: 19 ASHP projects did not have a 100% demand realization rate. This is mainly due to Guidehouse and the implementer handling the missing age of the existing cooling system differently which factors into the cooling system classification as early replacement (ER) or time of sale (TOS).

Guidehouse assigned a value of 19 years, the average age of the existing cooling system for ASHPs from EOY 2019 data, when the 'Age_Cooling_System' field was blank. According to the Illinois TRM (TRM) v7.0, savings are calculated as early replacement if the existing cooling equipment is replaced prior to the end of its useful life, among other qualifications. Guidehouse used the TRM v7.0 measure life value of 18 years for central air conditioners and 16 years for ASHPs both of which are less than the default age of 19 years. Thus, projects with a blank 'Age_Cooling_System' that received a default age of 19 years were classified as TOS.

Recommendation 2: Guidehouse recommends collecting the age of the existing cooling system whenever possible and providing the default age that they use when the existing age field, which determines TOS or ER, is missing information.

Finding 3: We found that 76 ASHP projects were missing the age of the existing heating system. This factors into the heating system classification as early replacement (ER) or time of sale (TOS). Guidehouse assigned a value of 17 years, the average age of the existing heating system for ASHPs from EOY 2019 data, when the 'Existing_Heating_System_Age' field was blank. According to the TRM v7.0, savings are calculated as early replacement if the existing heating equipment is replaced prior to the end of its useful life, among other qualifications. Guidehouse used the TRM v7.0 measure life value of 16 years for ASHPs which is less than the default age of 17 years. Thus, projects with a blank 'Existing_Heating_System_Age' that received a default age of 17 years were classified as TOS.

Recommendation 3: Guidehouse recommends collecting the age of the existing heating system whenever possible and providing the default age that they use when the existing age field, which determines TOS or ER, is missing information.

6.2.2 Central Air Conditioners

Central air conditioners (CAC) have an electric energy realization rate of 86% and represent 12% of the CY2019's verified gross energy savings. Guidehouse found the following discrepancies:

Finding 4: Guidehouse de-rated the existing SEER and EER values, if available, based on the reported age of the existing cooling system by 1% per year. It is assumed that the implementer did not de-rate the existing SEER or EER efficiency values for early replacement CAC projects as per Section 5.3.3 of the TRM v7.0.

Recommendation 4: Guidehouse recommends de-rating existing SEER and EER values for early replacement projects by 1% per year to account for degradation over time per the TRM v7.0. Guidehouse requests that the implementation contractor (IC) report two additional fields consisting of the de-rated SEER and EER values to aid in evaluation efforts.

Finding 5: Guidehouse used the de-rated existing SEER value, not the reported existing SEER, to determine the applicable baseline for projects. It is believed that the implementer used the

reported existing SEER value to determine the baseline. The existing SEER value plays a role in the basline because the TRM v7.0 states that if the SEER of the existing unit is >10 then the baseline SEER is 13 (effectively classified as TOS).

Recommendation 5: Guidehouse recommends the implementer provide clarification whether they de-rate the existing SEER value and if they use the de-rated existing SEER value in determining the baseline SEER to use when calculating savings.

Finding 6: Guidehouse calculated savings using TOS algorithms for projects when the field 'Age_Cooling_System' did not contain a value in the tracking data. Guidehouse used 19 years, the average age for existing coolings systems from 2019 EOY data, as a default value for missing values. This resulted in automatic classification of all CAC projects with missing age for the existing coolings system to be calculated as TOS. It is assumed the implementer did not assign a default age of 19 years for CAC projects with a missing age for the existing cooling system.

Recommendation 6: Guidehouse recommends collecting the age of the existing cooling system whenever possible and providing the default age that they use when the existing age field, which determines TOS or ER, is missing information.

Finding 7: Guidehouse calculated savings for four projects when the implementer calculated zero savings. The four projects are:

- EA-0005259943
- EA-0004086685
- EA-0005080514
- EA-0005698488

Recommendation 7: Guidehouse recommends the implementer calculate savings for these projects or provide additional information justifying why savings were not calculated for these projects.

Finding 8: Guidehouse found that 13% of CAC projects did not meet the EER efficient equipment requirement laid out by the TRM v7.0 Section 5.3.3 which states, "the efficient equipment is assumed to be a ducted split central air conditioning unit meeting at least the minimum ENERGY STAR efficiency level standards; 15 SEER and 12.5 EER"[2].

Recommendation 8: Guidehouse recommends the program enforce the ENERGY STAR minimum equipment requirement to actualize greater demand savings.

6.2.3 Ductless Mini-Split Heat Pumps

Ductless mini-split heat pumps (DMSHP) have an electric energy realization rate of 113% and represent 23% of CY2019's verified gross energy savings. Guidehouse also calculated verified gas savings for CY2019's DMSHP projects which resulted in a gas savings realization rate of 83%. Guidehouse found the following discrepancies:

Finding 9: There are six out of 359 DMSHP projects that did not have a 100% demand realization rate. Guidehouse calculated the six projects as early replacement for the cooling system and the implementer likely calculated them as TOS. According to the TRM v7.0, savings are calculated as ER if the existing cooling equipment is replaced prior to the end of its measure life, among other qualifications. In the case of these three projects, the existing

[2] State of Illinois Technical Reference Manual version 7.0 from http://www.ilsag.info/technical-reference-manual.html. Volume 3, Section 5.3.03, page 77.

cooling system was a central air conditioner. The TRM v7.0 lists the measure life of a CAC as 18 years. It's believed that the implementer used a measure life of a DMSHP which is 15 years. Therefore, existing central air conditioners with measure lives of 15-17 were likely calculated as TOS rather than ER by the implementer. The six projects are:

- EA-0004364644
- EA-0004613698
- EA-0004956397
- EA-0005287532
- EA-0005490965
- EA-0006037994

Recommendation 9: Guidehouse recommends using a measure life of 18 and 16 years for central air conditioning and air source heat pump systems, respectively, when determining if a project is TOS or ER.

Finding 10: 87 DMSHP projects had an existing cooling system listed as 'None'. After discussions with stakeholders, Guidehouse came to the consensus that savings would be calculated as TOS rather than ER.

Recommendation 10: Guidehouse recommends that ComEd and CLEAResult collect information for DMSHP projects to determine if a customer with no prior cooling system was planning to add cooling. Whether or not the customer was initially planning to add cooling prior to the installation of the DMSHP will determine whether the cooling portion of the project is evaluated as ER (with the cooling penalty) or as TOS (without the cooling penalty). This information is necessary to properly evaluate DMSHP projects.

Finding 11: There were 92 DMSHP projects out of 359 total projects where the electric energy realization rates were greater than 100%. Most of these projects were classified as ER and fuel switching. The algorithm for electric energy savings for ER and fuel switch projects per the TRM v7.0 is:

$$\Delta kWh = [Heating\ Savings\ from\ base\ ASHP\ to\ DMSHP] + [Cooling\ Savings]$$

It's believed CLEAResult did not calculate the portion of savings attributed to the heating savings from base ASHP to DMSHP. Some example projects where this occurred are:

- EA-0004446365
- EA-0005014395
- EA-0005262242

Recommendation 11: Guidehouse recommends CLEAResult calculate the cooling savings as well as the heating savings from base ASHP to DMSHP for ER projects that are fuel switching.

Finding 12: There were 154 DMSHP projects out of 158 total projects where the gas energy realization rates were not equal to 100%. This is likely caused for a couple of reasons:

- CLEAResult likely used a kWh to Therm conversion value of 0.0314 (1 / 29.3) when Guidehouse used a kWh to Therm conversion value of 0.10539 for the non-baseload heat rate for the RFC West region per the TRM v7.0 Section 5.3.12.
- CLEAResult likely used the measure life of a DMSHP which is 15 years when classifying if an existing heating system is at the end of its useful for ER or TOS purposes. Guidehouse used the measure life of the existing heating equipment type for this classification.

Recommendation 12: Guidehouse recommends:

- Using a kWh to Therm conversion value of 0.10539 per the TRM v7.0.
- Using the measure life of the existing heating equipment type when classifying projects as TOS or ER.

Finding 13: We found that 12 DMSHP projects had an existing cooling system listed as 'Not Applicable (New Construction)' while the heating system was not listed as 'Not Applicable (New Construction)'. Conversely, 10 DMSHP projects had an existing heating system listed as 'Not Applicable (New Construction)' while the cooling system was not listed as 'Not Applicable (New Construction)'. Table 6-2 summarizes the heating and cooling combinations when this occurs:

Table 6-2. HVAC Systems with 'Not Applicable (New Construction)

Existing_Cooling_System_Type	Existing_Heating_System_Type	Quantity
Central Air Conditioner	Not Applicable (New Construction)	2
None	Not Applicable (New Construction)	7
Not Applicable (New Construction)	Electric Resistance	5
Not Applicable (New Construction)	Natural Gas Boiler	5
Not Applicable (New Construction)	Natural Gas Furnace	2
Not Applicable (New Construction)	Not Applicable (New Construction)	29
Room Air Conditioner	Not Applicable (New Construction)	1

Recommendation 13: Guidehouse recommends that CLEAResult provide an explanation on scenarios where only the heating or cooling system is new construction and the other is not. If the heating/cooling combinations above are incorrect, Guidehouse recommends that CLEAResult ensure that either both heating and cooling systems are 'Not Applicable (New Construction)' or neither are.

Finding 14: One DMSHP project, EA-0005735844, reported positive gas savings. However, Guidehouse did not account for these gas savings because the 'Therm_Disposition' field did not indicate 'ComEd Claimed'.

Recommendation 14: Guidehouse recommends that CLEAResult confirm that ComEd intended to not claim gas savings for project EA-0005735844.

6.2.4 ECM Furnace Motor

ECM projects are split into two subcategories: factory installed and retrofit ECMs. Factory installed ECM furnace blower motors represent 56% of the total verified CY2019 net electric energy savings, and their realization rate is 95%. Retrofit ECM furnace blower motors represent <1% of the total verified CY2019 net electric energy savings, and their realization rate is 109%. Guidehouse found the following discrepancies:

Finding 15: There were 3,749 factory installed ECM projects that likely calculated ex ante electric energy and demand savings using the 'Existing or Federal Minimum Efficiency CAC'

savings values, shown in Table 6-3. Guidehouse used the 'CAC Receiving Rebate (Most Common)' savings values for factory installed ECMs. This decreased the realization rates for these projects. Conversely, there were 19 retrofit ECM projects where the implementer likely calculated electric energy and demand savings using the 'CAC Receiving Rebate (Most Common)' savings values when Guidehouse used the 'Existing or Federal Minimum Efficiency CAC' savings values. This increased realization rates for these projects.

Table 6-3. ECM Deemed Savings Values

	Region	CAC Receiving Rebate (Most Common)	Existing or Federal Minimum Efficiency CAC
kWhSavingsPerTon	Rockford	198	229
	Chicago	195	230
kWSavingsPerTon	Rockford	0.01	0.064
	Chicago	0.01	0.064

Source:TRM v7.0, Section 5.3.05

Recommendation 15: Guidehouse recommends the implementer provide the kWhSavingsPerTon and kWSavingsPerTon values used to calculate savings for retrofit and factory installed ECMs and justification for the usage of the values.

Finding 16: There were four out of 13,003 ECMs where 'ComEd Claimed' the negative therms savings. The other 12,999 ECMs had a blank 'Therms_Disposition'. Guidehouse verified the negative reported therms savings for the four projects. The projects are:

- EA-0005257190
- EA-0004475270
- EA-0003851096
- EA-0004148978

Recommendation 16: Guidehouse recommends recommends that the implementer confirm that ComEd intended to claim gas savings for the four projects.

6.2.5 Geothermal Heat Pump

Geothermal heat pumps (GHP) have an electric energy realization rate of 122% and represent 1% of the CY2019's verified gross energy savings. Guidehouse also calculated verified gas savings for CY2019's GSHP projects which resulted in a gas savings realization rate of 13%. Of the 36 projects Guidehouse found the following discrepancies:

Finding 17: Guidehouse used the default age of 17 years, the average age for the 'Age_Cooling_System' field for GHPs from 2019 EOY data, as a default value for missing values. Similarly, Guidehouse used the default age of 16 years, the average age for the 'Existing_Heating_System_Age' field for GHPs from 2019 EOY data, as a default value for missing values.This factored into the classification of projects as ER or TOS.

Recommendation 17: Guidehouse recommends collecting the age of the existing systems whenever possible and providing their process of handling missing existing system age values which factors into the determination of a project as ER or TOS.

Finding 18: There were 32 projects out of 36 projects where the 'Existing_Water_Heating_System_Fuel' was recorded as 'Unknown'. Guidehouse did not

attribute gas or electric DHW savings to these projects because the gas fuel type was unknown.

Recommendation 18: Guidehouse recommends that the water heating system fuel type be reported as either gas or electric to accurately reflect the project baseline.

Finding 19: There were 12 projects out of 36 projects where the demand realization rate was not 100%. It's believed that CLEAResult used 13.4 for the EERbase when Guidehouse used a value of 11.8 when the existing cooling equipment was an ASHP and 11 for all other existing cooling equipment types. These default values are provided in TRM v7.0.

Recommendation 19: Guidehouse recommends using an EERbase of 11.8 when the existing cooling equipment is an ASHP, GSHP, or New Construction, and 11 for all other existing cooling equipment types as per TRM v7.0.

Finding 20: There were 9 projects out of 36 that were fuel switching and classified as ER. The algorithm for electric energy savings for ER and fuel switch projects per the TRM v7.0 is:

$$\Delta kWh = [Cooling\ Savings] + [Heating\ Savings\ from\ base\ ASHP\ to\ GSHP] + [DHW\ Savings]$$

It's believed CLEAResult did not calculate the portion of savings attributed to the heating savings from base ASHP to GSHP. Some example projects where this occurred are:

- RBT-2174460
- RBT-2203135
- RBT-2201501

Recommendation 20: Guidehouse recommends CLEAResult calculate the cooling savings as well as the heating savings from base ASHP to GSHP for ER projects that are fuel switching as per TRM v7.0 Section 5.3.8.

Finding 21: There were three projects where it's believed CLEAResult did not account for electric DHW savings. Both of these projects indicated that the "Existing_Water_Heating_System_Fuel" was electric in the tracking data. These projects are:

- RBT-2205052
- RBT-2270339
- RBT-2203081

Recommendation 21: Guidehouse recommends accounting for the electric DHW savings when the existing water heating system fuel is electric.

Finding 22: All 10 projects that claimed gas savings had non-100% realization rates. This is likely caused by a couple reasons:

- CLEAResult likely used a kWh to Therm conversion value of 0.0314 (1 / 29.3), when Guidehouse used a kWh to Therm conversion value of 0.10539 valid for the non-baseload heat rate for the RFC West region per the TRM v7.0 Section 5.3.8.
- CLEAResult likely calculated the therm savings using (COPPL * 3.412) rather than $HSPF_{ASHP}$ as the efficiency of the new equipment. (COPPL * 3.412) is to be used when the measure is supported by a gas utility only. $HSPF_{ASHP}$ is to be used when the measure is supported by a gas and electric utility as per TRM v7.0 Section 5.3.8.

Recommendation 22: Guidehouse recommends:

- Using a kWh to Therm conversion value of 0.10539 per the TRM v7.0.
- Using $HSPF_{ASHP}$ rather than (COPPL * 3.412) as the efficiency of the new equipment to calculate gas savings.

6.2.6 Smart Thermostats

Smart thermostats (ST) have an electric energy realization rate of 100%, peak demand realization rate of 99%, and a gas energy realization rate of 97% and represent 33% of CY2019's verified gross energy savings. Guidehouse found the following discrepancies:

Finding 23: A possible cause for the discrepancy in demand savings is that Guidehouse calculates the existing EER of the cooling system based on the reported existing SEER value. The implementer likely uses the default EER value of 7.5 for all smart thermostat measures. Per the TRM v7.0 Section 5.3.16, when SEER is available the existing EER is calculated as:

$$EER = (-0.02 * SEER_{exist}{}^{2}) + (1.12 * SEER_{exist})$$

Recommendation 23: Guidehouse recommends the implementer calculate the existing EER value using the reported existing SEER value when available.

Finding 24: There were 115 ST projects out of 4,347 projects that had a blank field for 'Therms_Disposition' but had positive gas savings. Guidehouse did not claim these savings.

Recommendation 24: Guidehouse recommends the implementer clarify if the 115 ST projects intended to not claim gas savings.

Finding 25: Guidehouse found eight accounts that claimed savings for two thermostats. Thermostat savings for a household are capped at one thermostat per the TRM v7.0 Section 5.3.16. Residences that received multiple thermostats through the program do not receive additional savings for each additional thermostat. Below are 6 projects grouped into pairs because they are located at the same household:

- EA-0005764526 and EA-0005764663
- EA-0004209921 and EA-0005254156
- EA-0005230857 and EA-0005417357

Recommendation 25: Guidehouse recommends that the implementer only claim savings for one thermostat per household.

Finding 26: CLEAResult likely applied a default SEER value of 9.3 for all projects, possibly causing electric energy realization rates to be greater than 100% for 265 projects. Guidehouse used the reported SEER value, per the guidance of the TRM v7.0.

Recommendation 26: Guidehouse recommends that the implementer use reported existing SEER values, if available, before using default values.

Finding 27: There were 32 projects installed in multi-family homes that indicated a 'New_System_Capacity_Cooling' value of 21,840 Btu/hour in the tracking data. It's believed that CLEAResult calculated savings using the default value for the cooling capacity of a

multi-family home which is 28,000 Btu/hour rather than the value recorded in the tracking data.

Recommendation 27: Guidehouse recommends that the implementer use reported cooling capacity values, if available, before using default values.

7. Appendix 1. Impact Analysis Methodology

7.1 Verified Gross Program Savings Analysis Approach

Guidehouse determined verified gross savings for each program measure by:

1. Reviewing the savings algorithm inputs in the measure workbook for agreement with the TRM v7.0 and TRM v7.0 Errata, where applicable.
2. Validating that the savings algorithm was applied correctly.
3. Cross-checking per-unit savings values in the tracking data with the verified values in the measure workbook or in Guidehouse's calculations if the workbook did not agree with the TRM.
4. Multiplying the verified per-unit savings value by the quantity reported in the tracking data.

7.2 Verified Net Program Savings Analysis Approach

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

8. Appendix 2. Impact Analysis Detail

Guidehouse downloaded the final tracking data and measure workbook for the CY2019 impact evaluation from the ComEd Evaluation Share file site. Guidehouse relied on the following documents to verify the per-unit savings for each program measure:

- Final CY2019 tracking database files:
  - HVAC: "HVC_CY2019_EOY_Data_Rev2_01242020.xlsx"
  - Geothermal Heat Pumps: "GEO_CY2019_EOY_Data_Rev0_01122020.xlsx"
- Illinois Technical Reference Manual (TRM v7.0) for deemed input parameters or secondary evaluation research to verify any custom inputs used in the ex ante calculations.

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 Cost Effectiveness Savings (kWh)||	Gross Cost Effectiveness Savings (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 Cost Effectiveness Savings (kWh)||	Net Cost Effectiveness Savings (therms)||
HVAC	ECM Furnace Motor - Factory Installed	Each	12,970	15.0	No	7,818,247	661.87	-9	0	0	0.68	0.68	0.68	5,316,408	450.07	-6	0	0
HVAC	Central Air Conditioning - TOS	Each	8,975	18.0	No	2,613,561	2,494.13	0	0	0	0.65	0.65	0.65	1,698,815	1,621.19	0	0	0
HVAC	Advanced Thermostat	Each	4,339	11.0	No	1,300,894	351.58	250,191	0	0	NA	NA	NA	1,300,894	351.58	250,191	0	0
HVAC	Ductless Heat Pump - TOS‡	Each	200	15.0	No	548,426	7.33	35,864	-120,425	53,420	0.68	0.68	0.68	372,930	4.99	24,388	-81,889	36,326
HVAC	Central Air Conditioning - ER	Each	469	18.0†	Yes	531,211	467.46	0	0	0	0.65	0.65	0.65	345,287	303.85	0	0	0
HVAC	Ductless Heat Pump - ER‡	Each	159	15.0†	Yes	312,181	23.31	142,193	-367,689	153,087	0.68	0.68	0.68	212,283	15.85	96,691	-250,029	104,099
HVAC	Air Source Heat Pump - TOS	Each	169	16.0	No	219,904	-11.49	0	0	0	0.57	0.57	0.57	125,345	-6.55	0	0	0
HVAC	Ground Source Heat Pump - ER‡	Each	18	25.0†	Yes	133,706	32.06	1,567	-63,910	1,091	0.59	0.59	0.59	78,887	18.92	924	-37,707	644
HVAC	Ground Source Heat Pump - TOS‡	Each	18	25.0	No	103,801	16.18	0	0	0	0.59	0.59	0.59	61,243	9.55	0	0	0
HVAC	Air Source Heat Pump - ER	Each	36	16.0†	Yes	64,341	3.47	0	0	0	0.57	0.57	0.57	36,675	1.98	0	0	0
HVAC	ECM Furnace Motor - Retrofit	Each	33	15.0	No	22,599	6.05	0	0	0	0.80	0.80	0.80	18,079	4.84	0	0	0
	Total		27,386	15.5		13,668,872	4,051.95	429,807	-552,025	207,598				9,566,845	2,776.25	372,189	-369,625	141,068

* Early Replacement (ER) measures are flagged as YES, otherwise a NO is indicated in the column.

† The savings for this measure varies over time. See the CPAS tables (Table 4-1 to Table 4-3).

‡ The savings shown for this measure are calculated using the alternative formula shown in the TRM for calculating savings from fuel switching measures for the TRC analysis.

§ The TRM algorithm calculates net savings for advanced thermostats.

|| The gross and net cost effectiveness savings (kWh and therms) in the table above are calculated for fuel switching measures per TRM v6.0 section "Cost Effectiveness Screening and

Source: ComEd tracking data and evaluation team analysis