Guidehouse

ComEd Ductless Heat Pump and Building Envelope Pilot Impact Evaluation Report

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

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TABLE OF CONTENTS

1. Introduction 1
2. Program Description 1
3. Program Savings Detail 1
4. Cumulative Persisting Annual Savings 2
5. Program Savings by Measure 4
6. Impact Analysis Findings and Recommendations 5
    6.1 Impact Parameter Estimates 5
    6.2 Other Impact Findings and Recommendations 8
7. Appendix 1. Total Resource Cost Detail 9

LIST OF TABLES AND FIGURES

Figure 4-1. Cumulative Persisting Annual Savings 4
Figure 5-1. Verified Net Savings by Measure 4

Table 2-1. CY2019 Volumetric Findings Detail 1
Table 3-1. CY2019 Total Annual Incremental Electric Savings 2
Table 4-1. Cumulative Persisting Annual Savings (CPAS) – Total 3
Table 5-1. CY2019 Energy Savings by Measure – Total 5
Table 5-2. CY2019 Non-Coincident Demand Savings by Measure 5
Table 5-3. CY2019 Summer Peak Demand Savings by Measure 5
Table 6-1. Air Sealing Savings Parameters 7
Table 6-2. Attic Insulation Savings Parameters 7
Table 7-1. Total Resource Cost Savings Summary 9

ComEd Ductless Heat Pump and Building Envelope Pilot Impact Evaluation Report

1. Introduction

This report presents the results of the impact evaluation of ComEd's CY2019 Ductless Heat Pump and Building Envelope Pilot. It includes a summary of the energy and demand impacts for the total pilot 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 Ductless Heat Pump and Building Envelope Pilot (Pilot) installed free ductless mini-split heat pumps (DHP) and building envelope (BE) measures. The DHP measures for this Pilot were installed in CY2018 and Navigant's impact evaluation results are documented in the CY2018 Pilot evaluation report[1]. To evaluate performance of DHP systems in conjunction with improvements in building envelope, some of the building units that received a DHP in CY2018 also received BE improvements in the form of air sealing and attic insulation in CY2019. All the Pilot participants had electric resistance baseboard heating for their primary heating. For this Pilot, the baseboard heating remained operable in all 80 units. In 20 of the 80 units, the baseboard heat was locked out until the outdoor ambient temperature fell to 15 degrees F. Through the post installation customer education process, all 60 tenants in non- locked out units were asked to only utilize baseboard heating if they were uncomfortable.

In CY2019, the pilot program installed attic insulation and air sealing measures at one building as shown in the following table.

Table 2-1. CY2019 Volumetric Findings Detail

Participation	Quantity
Number of Buildings	1
Total Air Sealants Installed	35*
Total Attic Insulation Installed	3,404†

* Units in linear feet for three measures
† Units in ft^2 for total attic area
Source: ComEd tracking data and evaluation team analysis

3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the DHP BE Program achieved in CY2019. There are no gas savings that ComEd can claim for this program.

[1] http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_CY2018_Evaluation_Reports_Final/ComEd_DHP_and_BE_Pilot_CY2018_Impact_Evaluation_Report_2019-04-26_Final.pdf

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	11,691	NR	NR
Program Gross Realization Rate	1.08	NA	NA
Verified Gross Savings	12,593	0.15	0.11
Program Net-to-Gross Ratio (NTG)	1.00	1.00	1.00
Verified Net Savings	12,593	0.15	0.11
Converted from Gas			
Ex Ante Gross Savings	NR	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	11,691	NR	NR
Program Gross Realization Rate	1.08	NA	NA
Verified Gross Savings	12,593	0.15	0.11
Program Net-to-Gross Ratio (NTG)	1.00	1.00	1.00
Verified Net Savings	12,593	0.15	0.11

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.
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 DHP and BE Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2019. The electric CPAS across all measures installed in 2019 is 12,593 kWh (Table 4-1). Guidehouse did not evaluate gas savings for this program and as such electric CPAS is equivalent to total CPAS.

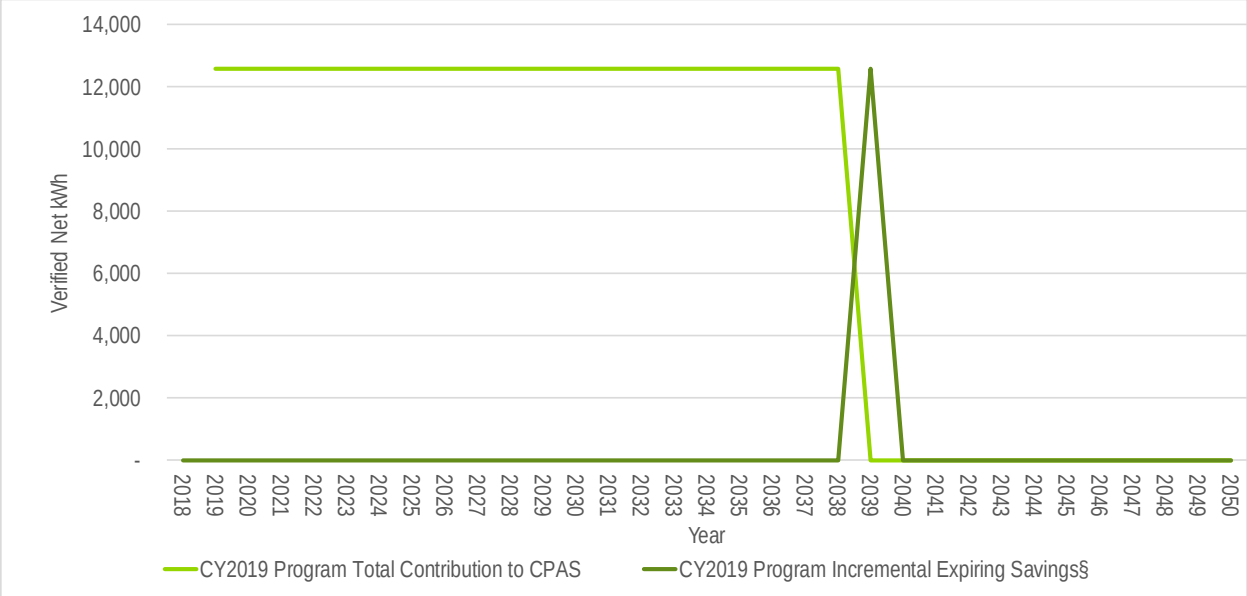
Table 4-1. Cumulative Persisting Annual Savings (CPAS) – Total

End Use Type	Research Category	EUL	CY2019 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
Shell	Air Sealing	20	10,987	1.00	219,738		10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987
Shell	Attic Insulation	20	1,606	1.00	32,123		1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606
CY2019 Program Total Electric Contribution to CPAS			12,593		251,861	-	12,593	12,593	12,593	12,593	12,593	12,593	12,593	12,593
Historic Program Total Electric Contribution to CPAS‡						316,484	316,484	316,484	316,484	316,484	316,484	302,569	302,569	302,569
Program Total Electric CPAS						316,484	329,077	329,077	329,077	329,077	329,077	315,163	315,163	315,163
CY2019 Program Incremental Expiring Electric Savings§								-	-	-	-	-	-	-
Historic Program Incremental Expiring Electric Savings‡§							-	-	-	-	-	13,914	-	-
Program Total Incremental Expiring Electric Savings§							-	-	-	-	-	13,914	-	-

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Shell	Air Sealing	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	
Shell	Attic Insulation	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	1,606	
CY2019 Program Total Electric Contribution to CPAS		12,593	12,593	12,593	12,593	12,593	12,593	12,593	12,593	12,593	12,593	12,593	12,593	-
Historic Program Total Electric Contribution to CPAS‡		302,569	302,569	302,569	302,569	302,569	302,569	302,569	302,569	302,569	-	-	-	-
Program Total Electric CPAS		315,163	315,163	315,163	315,163	315,163	315,163	315,163	315,163	315,163	12,593	12,593	12,593	-
CY2019 Program Incremental Expiring Electric Savings§		-	-	-	-	-	-	-	-	-	-	-	-	12,593
Historic Program Incremental Expiring Electric Savings‡§		-	-	-	-	-	-	-	-	-	302,569	-	-	-
Program Total Incremental Expiring Electric Savings§		-	-	-	-	-	-	-	-	-	302,569	-	-	12,593

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 two measures as shown in the following tables. The air sealing measure contributed the most savings (see Figure 5-1).

Figure 5-1. Verified Net Savings by Measure

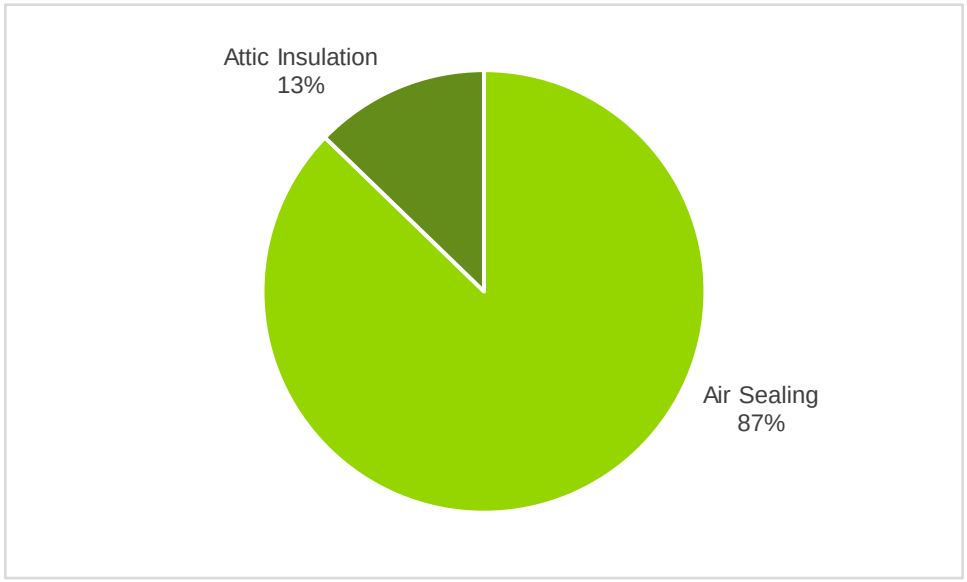


Table 5-1. CY2019 Energy Savings by Measure – Total

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)
Shell	Air Sealing	10,987	1.00	10,987	1.00	10,987	20.0
Shell	Attic Insulation	705	2.28	1,606	1.00	1,606	20.0
	Total	11,691	1.08	12,593	NA	12,593	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.
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

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)
Shell	Air Sealing	NR	NA	0.00	NA	0.00
Shell	Attic Insulation	NR	NA	0.15	NA	0.15
	Total	NR	NA	0.15	NA	0.15

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)
Shell	Air Sealing	NR	NA	0.00	NA	0.00
Shell	Attic Insulation	NR	NA	0.11	NA	0.11
	Total	NR	NA	0.11	NA	0.11

* 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

Energy and demand savings are estimated using the following formula as specified in the TRM:

Equation 6-1. Air Sealing Energy Savings

$$\text{Air Sealing Verified Gross kWh Savings} = (\Delta kWh_{gasket} * n_{gasket} + \Delta kWh_{sealing} * If_{sealing} + \Delta kWh_{WX} * If_{sealing}) * ADJ_{RxAirsealing}$$

Where:

$\Delta\ kWh_{gasket}$	= Annual energy savings from installation of air sealing gasket on an electric outlet
n_{gasket}	= Number of gaskets installed
$\Delta\ kWh_{sealing}$	= Annual energy savings from foot of caulking, sealing, or polyethylene tape
$lf_{sealing}$	= Linear feet of caulking, sealing, or polyethylene tape
$\Delta\ kWh_{WX}$	= Annual energy savings from window weatherstripping or door weatherstripping
$lf_{sealing}$	= Linear feet of window weatherstripping or door weatherstripping
$ADJ_{RxAirsealing}$	= Adjustment for air sealing savings account for prescriptive estimates overclaiming savings

Equation 6-2. Attic Insulation Energy and Demand Savings

Attic Insultation Verified Gross kWh Savings = (Heating Savings) + (Cooling Savings)
$= [((((1/R_{old} – 1/R_{attic}) * A_{attic} * (1 – Ff_{attic})) * 24 * CDD * DUA) / (1000 * \eta Cool)) * ADJ_{AtticCool}] + [((((1/R_{old} - 1/R_{attic}) * A_{attic} * (1-Ff_{attic})) * 24 * HDD) / (\eta Heat * 3412)) * ADJ_{AtticElectricHeat}]$

Verified Gross kW Savings $= (\Delta kWh_{cool} / FLH_{cooling}) * CF$

Where

CF_{PJM}	= PJM Summer Peak Coincidence Factor for DMSHP
R_{old}	= R-value of existing assembly and any existing insulation
R_{attic}	= R-value of new attic assembly
A_{attic}	= Total area of insulated attic
Ff_{attic}	= Adjustment to account for area of framing
CDD	= Cooling Degree Days
DUA	= Discretionary Use Adjustment
$\eta Cool$	= Seasonal Energy Efficiency Ratio of cooling system
$ADJ_{AtticCool}$	= Adjustment for cooling savings to account for inaccuracies in engineering algorithms
HDD	= Heating Degree Days
$nHeat$	= Efficiency of heating system
$ADJ_{AtticElectricHeat}$	= Adjustment for electric heating savings to account for inaccuracies in engineering algorithms
ΔkWh_{cool}	= Cooling savings
$FLH_{cooling}$	= Full load hours of air conditioning
CF	= Summer System Peak Coincidence Factor for Heat Pumps

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. Air Sealing Savings Parameters

Gross Savings Input Parameters	Value	Units	Deemed * or Evaluated?	Source
Quantity	35	# measures	Evaluated	ComEd Tracking Data
Annual energy savings from installation of air sealing gasket on an electric outlet	5.1	kWh/gasket	Deemed	IL TRM v7.0 – Section 5.6.1
Number of gaskets installed	Varies	# measures	Evaluated	Specifications
Annual energy savings from foot of caulking, sealing, or polyethylene tape	5.6	kWh/ft	Deemed	IL TRM v7.0 – Section 5.6.1
Linear feet of caulking, sealing, or polyethylene tape	Varies	LF	Evaluated	Specifications
Annual energy savings from window weatherstripping or door weatherstripping	6.5	kWh/ft	Deemed	IL TRM v7.0 – Section 5.6.1
Linear feet of window weatherstripping or door weatherstripping	Varies	LF	Evaluated	Specifications
Adjustment for air sealing savings account for prescriptive estimates overclaiming savings	0.8	-	Deemed	IL TRM v7.0 – Section 5.6.1

* 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 Ilinois SAG web site here: https://www.ilsag.info/ntg_2019.

Table 6-2. Attic Insulation Savings Parameters

Gross Savings Input Parameters	Value	Units	Deemed * or Evaluated?	Source
Quantity	3404	# measures	Evaluated	ComEd Tracking Data
R-value of existing assembly and any existing insulation	Varies	-	Custom	Specifications
R-value of new attic assembly	Varies	-	Custom	Specifications
Total area of insulated attic	Varies	ft^2	Custom	Specifications
Adjustment to account for area of framing	0.07	-	Deemed	TRM v7.0 – Section 5.6.5
Cooling Degree Days	820	Days	Custom	TRM v7.0 – Section 5.6.5
Discretionary Use Adjustment	0.75	-	Deemed	TRM v7.0 – Section 5.6.5
Seasonal Energy Efficiency Ratio of cooling system	26.1	kBtu/kWh	Custom	Specifications
Adjustment for cooling savings to account for inaccuracies in engineering algorithms	1.21	-	Deemed	TRM v7.0 – Section 5.6.5
Heating Degree Days	5113	Days	Custom	TRM v7.0 – Section 5.6.5

Gross Savings Input Parameters	Value	Units	Deemed * or Evaluated?	Source
Efficiency of heating system	2.86	-	Custom	Specifications
Adjustment for electric heating savings to account for inaccuracies in engineering algorithms	0.6	-	Deemed	TRM v7.0 – Section 5.6.5
Full load hours of air conditioning	467	Days	Custom	TRM v7.0 – Section 5.6.5
Summer System Peak Coincidence Factor for Heat Pumps	0.72	-	Deemed	TRM v7.0 – Section 5.6.5

* 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 IL SAG web site here: https://www.ilsag.info/ntg_2019.

6.2 Other Impact Findings and Recommendations

The evaluation team developed several recommendations based on findings from the CY2019 evaluation.

Finding 1. The ex ante energy savings for the attic insulation measure are calculated using a value framing factor value of 0.70. However, the IL TRM v7.0 algorithm deems the value to be 0.07.

Recommendation 1. Navigant recommends that the CMC should update the ex ante calculations by using the framing factor of 0.07.

Finding 2. The ex ante energy savings for the attic insulation measure are calculated using Climate Zone 2 CDD and HDD values. However, based on Navigant's analysis of the zip code of the site, Climate Zone 1 should be used for determining the CDD and Climate Zone 2 should be used for calculating determining the HDD.

Recommendation 2. Navigant recommends that CMC select the IL TRM deemed Climate Zone based on the ZIP code of the installation and update the HDD and CDD used to calculate the heating and cooling savings.

Finding 3. The ex ante calculations did not provide demand savings or summer peak demand savings.

Recommendation 2. Navigant recommends that CMC update the ex ante calculations to include demand savings and summer peak demand savings per the IL TRM v7.0 deemed values.

7. Appendix 1. Total Resource Cost Detail

Table 7-1 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 7-1. 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)
Shell	Air Sealing	Each	35	20.0	Yes	10,987	0.00	0	0	0	1.00	1.00	1.00	10,987	0.00	0	0	0
Shell	Attic Insulation	Square Feet	3,404	20.0	Yes	1,606	0.11	0	0	0	1.00	1.00	1.00	1,606	0.11	0	0	0
	Total			20.0		12,593	0	0	0	0	NA	NA	NA	12,593	0	0	0	0

NA = Not applicableNote: To avoid double counting, the verified gross kWh and net kWh used in the TRC analysis excludes secondary energy savings from water reduction measures. Table 9-1 represents the kWh savings from Table 5-1 minus those shown in Table 5-6)

* 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