



ComEd Ductless Heat Pump and Building Envelope Pilot Impact Evaluation Report

Energy Efficiency / Demand Response Plan:
Program Year 2018 (CY2018)
(1/1/2018-12/31/2018)

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's CY2018 Ductless Heat Pump (DHP) and Building Envelope (BE) Pilot Program. It presents a summary of the energy and demand impacts for the total program and broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology. CY2018 covers January 1, 2018 through December 31, 2018.

2. PROGRAM DESCRIPTION

The DHP and BE Pilot Program installed free ductless mini-split heat pumps (DHP) installations in multifamily building units to evaluate the performance and feasibility of the DHP technology in cold weather climates. The pilot program installed DHPs in income eligible buildings, some of which will also receive building envelope improvements in CY2019, to evaluate program overlap and performance of DHP systems in conjunction with improvements in building envelope. All the participants had electric resistance baseboard heating for their primary heating. For this pilot program, the baseboard heating remained in the units to operate as supplemental heating in case the DHP systems were unable to meet customers' heating needs. The baseboard heating was controlled to turn on only when the DHP systems were unable to maintain the required indoor temperature levels.

CMC Energy Services (CMC), the implementation contractor (IC), will perform electric submetering on each DHP system to monitor daily energy consumption during the heating and cooling seasons. In CY2019, CMC will conduct an engineering analysis of the DHP systems and the overall performance of the pilot program, which Navigant will review, based on the energy consumption data collected through CY2019.

In CY2018, the pilot program installed 87 DHP systems in six buildings as shown in the following table.

Table 2-1. CY2018 Volumetric Findings Detail

Participation	
Number of Buildings	6
Total DHP Systems Installed	87

Source: ComEd tracking data and Navigant team analysis.

3. PROGRAM SAVINGS DETAIL

Table 3-1 summarizes the incremental energy and demand savings the DHP and BE Pilot Program achieved in CY2018. There are no gas savings that ComEd can claim for this program.

Table 3-1. CY2018 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Summer Peak Demand Savings (kW)
Electricity			
Ex Ante Gross Savings	312,698	NR	15.79
Program Gross Realization Rate	1.01	NA	1.01
Verified Gross Savings	316,484	56.94	15.94
Program Net-to-Gross Ratio (NTG)	1.00	1.00	1.00
Verified Net Savings	316,484	56.94	15.94
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	312,698	NR	15.79
Program Gross Realization Rate	1.01	NA	1.01
Verified Gross Savings	316,484	56.94	15.94
Program Net-to-Gross Ratio (NTG)	1.00	1.00	1.00
Verified Net Savings	316,484	56.94	15.94

Note: The coincident Summer Peak period is defined as 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, June through August.

NR = Not reported

NA = Not applicable

Source: ComEd tracking data and Navigant team analysis.

4. CUMULATIVE PERSISTING ANNUAL SAVINGS

The measure-specific and total ex ante gross savings for the DHP and BE Pilot Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2018 are shown in the following tables and figure. The total CPAS across all participants is 316,484 kWh. The program did not have any CPAS equivalent of gas savings.

Since all the installations were early replacements, Navigant also applied the baseline adjustment after the first six years of the installation, starting 2024, as deemed by the IL TRM v6.0.

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

End Use Type	Research Category	EUL	CY2018		Verified Net kWh Savings									
			Verified Gross Savings	NTG*	Lifetime Net Savings†	2018	2019	2020	2021	2022	2023	2024	2025	2026
HVAC	Ductless Heat Pumps	18	316,484	1.00	5,529,735	316,484	316,484	316,484	316,484	316,484	316,484	302,569	302,569	302,569
CY2018 Program Total Electric CPAS			316,484		5,529,735	316,484	316,484	316,484	316,484	316,484	316,484	302,569	302,569	302,569
CY2018 Program Expiring Electric Savings‡							-	-	-	-	-	13,914	13,914	13,914

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
HVAC	Ductless Heat Pumps	302,569	302,569	302,569	302,569	302,569	302,569	302,569	302,569	302,569			
CY2018 Program Total Electric CPAS		302,569	302,569	302,569	302,569	302,569	302,569	302,569	302,569	302,569	-	-	-
CY2018 Program Expiring Electric Saving		13,914	13,914	13,914	13,914	13,914	13,914	13,914	13,914	13,914	316,484	316,484	316,484

Note: The green highlighted cell shows program total first year electric savings.

* A deemed value. Source: ComEd_CY2018_Pilot_Programs_NTG_Memo_Final_2019-04-11.pdf, which is to be found on the IL SAG web site here:

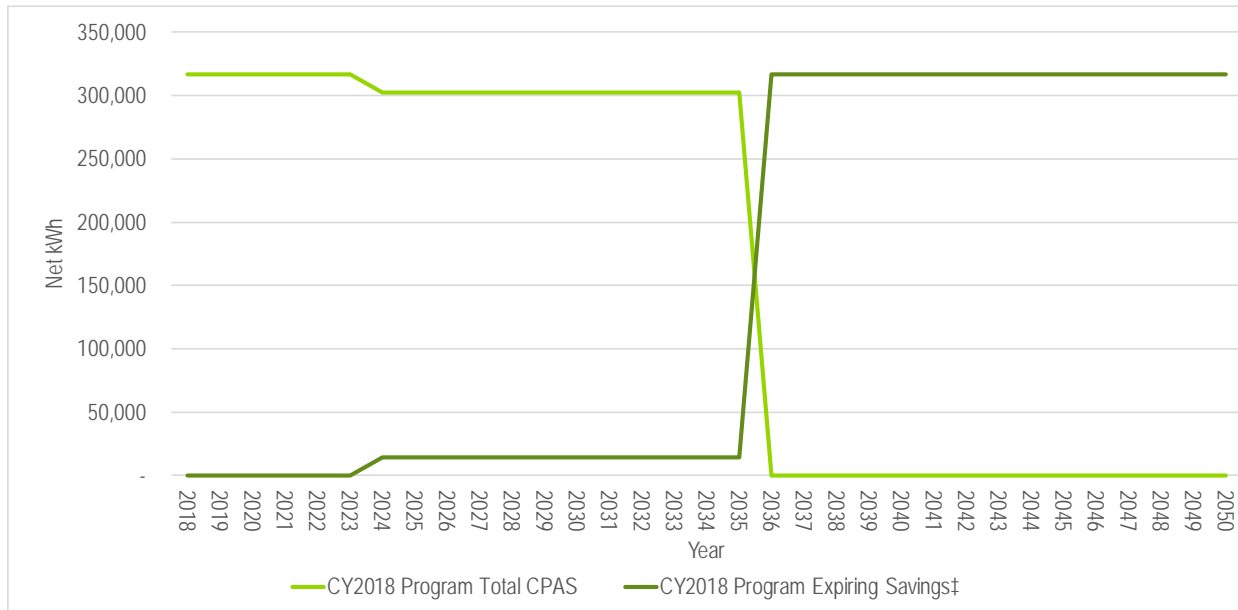
http://ilsagfiles.org/SAG_files/NTG/2018_NTG_Meetings/ComEd_CY2018_Pilot_Programs_NTG_Memo_Final_2019-04-11.pdf.

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

‡ Expiring savings are equal to CPAS Yn-1 - CPAS Yn + Expiring Savings Yn-1.

Source: Navigant analysis

Figure 4-1. Cumulative Persisting Annual Savings



‡ Expiring savings are equal to CPAS Yn-1 - CPAS Yn + Expiring Savings Yn-1.
 Source: Navigant analysis

5. PROGRAM SAVINGS BY MEASURE

The pilot program only includes DHP systems in CY2018 and the verified energy and demand savings for them can be found in Table 3-1. The building envelope improvement measures will be installed in CY2019.

6. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

6.1 Impact Parameter Estimates

Table 6-1 show the inputs used to calculate the verified energy and demand savings for the DHP measure along with details about the source of each input. The lifetime energy savings are estimated by multiplying the verified savings by the effective useful life for each measure.

Table 6-1. Ductless Heat Pump Savings Parameters

Gross Savings Input Parameters	Value	Units	Deemed * or Evaluated?	Source
Quantity	87	# measures	Evaluated	ComEd Tracking Data
Elect _{heat}	1	-	Deemed	IL TRM v6.0 – Section 5.3.12
Capacity _{heat}	Varies	Btu/hr	Custom	Specifications
EFLH _{heat}	Varies	Hours	Deemed	IL TRM v6.0 – Section 5.3.12
HSPF _{Base}	3.410	kBtu/kWh	Deemed	IL TRM v6.0 – Section 5.3.12
HSPF _{Exist}	3.412	kBtu/kWh	Custom	Specifications
HSPF _{EE}	Varies	kBtu/kWh	Custom	Specifications
Capacity _{cool}	Varies	Btu/hr	Custom	Specifications
SEER _{Base}	13	-	Deemed	IL TRM v6.0 – Section 5.3.12
SEER _{EE}	Varies	-	Custom	Specifications
SEER _{Exist}	Varies	-	Custom	Specifications
EFLH _{cool}	Varies	Hours	Deemed	IL TRM v6.0 – Section 5.3.12
EER _{Base}	11	-	Deemed	IL TRM v6.0 – Section 5.3.12
EER _{Exist}	Varies	-	Custom	Specifications
EER _{EE}	Varies	-	Custom	Specifications
CF _{PJM}	0.28	-	Deemed	IL TRM v6.0 – Section 5.3.12

* State of Illinois Technical Reference Manual version 6.0 from <http://www.ilsag.info/technical-reference-manual.html>.
 Source: ComEd tracking data and Navigant team analysis.

6.2 Other Impact Findings and Recommendations

The evaluation team has developed several recommendations based on findings from the CY2018 evaluation, as follows:

Finding 1. The ex ante energy savings for the first six years of the DHP installations are calculated using energy efficiency ratio (EER) of the existing cooling unit while the IL TRM v6.0 algorithm calculates the savings using the seasonal energy efficiency ratio (SEER) value of the existing cooling unit instead.

Recommendation 1. Navigant recommends that the IC should convert the EER of the existing cooling unit to SEER using the equation specified in the IL TRM v6.0, $EER_{Exist} = (-0.02 * SEER_{Exist}) + (1.12 * SEER_{Exist})$ and use the SEER value to calculate the energy savings.
 Note: The IC updated their ex ante savings calculations after Navigant finalized the analysis.

Finding 2. The ex ante energy and demand savings are calculated using the cooling capacity of the baseline cooling unit (if that information is available). However, the IL TRM v6.0 algorithm deems using the cooling capacity of the replacement unit.

Recommendation 2. Navigant recommends that the IC should update the ex ante calculations to use the cooling capacity of the replacement unit.
 Note: The IC updated their ex ante savings calculations after Navigant finalized the analysis.

Finding 3. Climate Zone 2 heating and cooling Equivalent Full Load Hours (EFLH) are being used to calculate ex ante energy savings.

Recommendation 3. Navigant recommends that the IC should select the IL TRM deemed Climate Zone based on the Zip code of the installation and updating the heating and cooling EFLH accordingly.

7. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

Energy and demand savings are estimated using the following formula as specified in the section 5.3.12 of the IL TRM v6.0:

Equation 1. Energy and Demand Savings for Remaining Life of Existing Unit (First 6 Years)

$$\begin{aligned} \text{Verified Gross kWh Savings} &= (\text{Heating Savings}) + (\text{Cooling Savings}) \\ &= [(\text{Elect}_{\text{heat}} * \text{Capacity}_{\text{heat}} * \text{EFLH}_{\text{heat}} * (1/\text{HSPF}_{\text{Exist}} - 1/\text{HSPF}_{\text{EE}})) / 1000] + \\ &\quad [(\text{Capacity}_{\text{cool}} * \text{EFLH}_{\text{cool}} * (1/\text{SEER}_{\text{Exist}} - 1/\text{SEER}_{\text{EE}})) / 1000] \end{aligned}$$

$$\text{Verified Gross kW Savings} = (\text{Capacity}_{\text{cool}} * (1/\text{EER}_{\text{Exist}} - 1/\text{EER}_{\text{EE}})) / 1000 * \text{CF}$$

Equation 2. Energy and Demand Savings for Remaining Measure Life (Next 12 Years)

$$\begin{aligned} \text{Verified Gross kWh Savings} &= (\text{Heating Savings}) + (\text{Cooling Savings}) \\ &= [(\text{Elect}_{\text{heat}} * \text{Capacity}_{\text{heat}} * \text{EFLH}_{\text{heat}} * (1/\text{HSPF}_{\text{Base}} - 1/\text{HSPF}_{\text{EE}})) / 1000] + \\ &\quad [(\text{Capacity}_{\text{cool}} * \text{EFLH}_{\text{cool}} * (1/\text{SEER}_{\text{Base}} - 1/\text{SEER}_{\text{EE}})) / 1000] \end{aligned}$$

$$\text{Verified Gross kW Savings} = (\text{Capacity}_{\text{cool}} * (1/\text{EER}_{\text{Base}} - 1/\text{EER}_{\text{EE}})) / 1000 * \text{CF}$$

Where:

$\text{Elect}_{\text{heat}}$	= 1 if existing building is electrically heated and 0 if not
$\text{Capacity}_{\text{heat}}$	= Heating capacity of the ductless heat pump unit in Btu/hr
$\text{EFLH}_{\text{heat}}$	= Equivalent Full Load Hours for heating.
$\text{HSPF}_{\text{Base}}$	= Heating System Performance Factor of new replacement baseline heating system (kBtu/kWh)
$\text{HSPF}_{\text{Exist}}$	= HSPF rating of existing equipment (kbtu/kwh)
HSPF_{EE}	= HSPF rating of new equipment (kbtu/kwh)
$\text{Capacity}_{\text{cool}}$	= the cooling capacity of the ductless heat pump unit in Btu/hr
$\text{SEER}_{\text{Base}}$	= SEER Efficiency of new replacement baseline unit
SEER_{EE}	= SEER rating of new equipment (kbtu/kwh)
$\text{SEER}_{\text{Exist}}$	= SEER rating of existing equipment (kbtu/kwh)
$\text{EFLH}_{\text{cool}}$	= Equivalent Full Load Hours for cooling. Depends on location
EER_{Base}	= EER Efficiency of new replacement unit
$\text{EER}_{\text{Exist}}$	= Energy Efficiency Ratio of existing cooling system (kBtu/hr / kW)
EER_{EE}	= Energy Efficiency Ratio of new DMSHP (kBtu/hr / kW)
CF_{PJM}	= PJM Summer Peak Coincidence Factor for DMSHP

8. APPENDIX 2. TOTAL RESOURCE COST DETAIL

Table 8-1, below, shows the Total Resource Cost (TRC) table. It includes only the 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 evaluation later.

Table 8-1. Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	Effective Useful Life	Verified Gross Savings (kWh)	Verified Gross Peak Demand Reduction (kW)	NTG	Verified Net Savings (kWh)	Verified Net Peak Demand Reduction (kW)
HVAC	Ductless Heat Pumps*	Each	87	18.0	316,484	15.94	1	316,484	15.94

* The baseline for this early replacement measure changes after 6 years. See CPAS table in Section 4
 Source: ComEd tracking data and Navigant team analysis.