NAVIGANT

ComEd Heating, Cooling, and Weatherization Rebates Combined Evaluation Report

Energy Efficiency / Demand Response Plan: Plan Year 9 (PY9)

Presented to
ComEd

February 14, 2019

Prepared by:

Navigant

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ComEd Heating, Cooling, and Weatherization Rebates Combined Evaluation Report

Submitted to:

ComEd
Three Lincoln Centre
Oakbrook Terrace, IL 60181

Submitted by:

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1. INTRODUCTION

This report combines the key deliverables from the evaluation of the Heating, Cooling, and Weatherization Rebates Program for PY9. Each of these deliverables were drafted, reviewed and finalized during the course of the PY9 evaluation.

APPENDIX A. COMED HVAC WEATHERIZATION IMPACT EVALUATION REPORT 2018-05-17 FINAL

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ComEd Heating, Cooling, and Weatherization Rebates Impact Evaluation Report

Energy Efficiency / Demand Response Plan: Plan Year 9 (PY9)

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FINAL

May 17, 2018

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's PY9 Heating, Cooling (HVAC), and Weatherization (Wx) Rebates Program (HVAC Wx). The report separates the savings from the HVAC rebates and the Wx rebates to better reflect how the program has evolved into two separate programs. The report presents a summary of the energy and demand impacts for the total program and broken out by relevant measure and program structure details, also by HVAC and Wx rebates. The appendix presents the impact analysis methodology. PY9 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The Heating, Cooling, and Weatherization Rebates Program offers incentives for the installation of qualifying high efficiency equipment such as central air conditioning systems, air source heat pumps, ductless mini-split heat pumps, furnace blower motors (ECMs), heat pump water heaters, and smart thermostats. The program also offers rebates for the installation of qualifying weatherization improvements such as attic and wall insulation, and air and duct sealing.

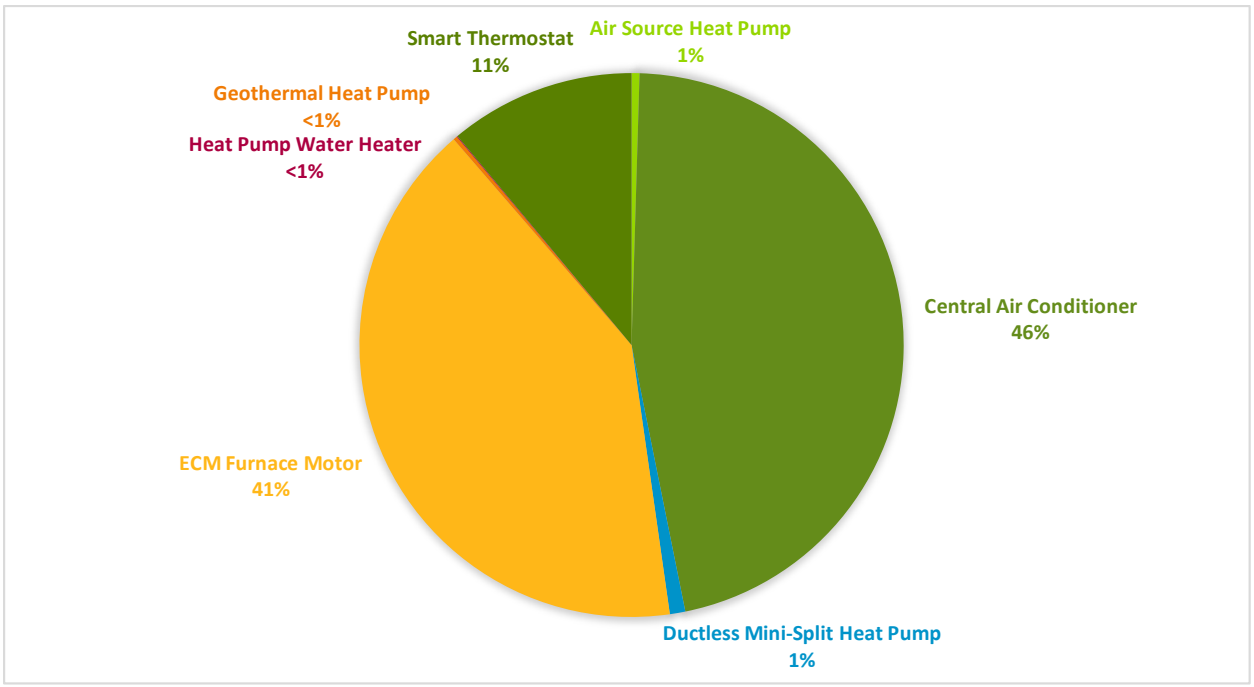
The program had 21,209 HVAC and 2,789 Wx participants in PY9 and distributed 32,825 HVAC and 5,863 Wx measures as shown in the following tables and graphs.

Table 2-1. PY9 HVAC and Wx Volumetric Findings

Participation	HVAC	Wx
Participants	21,209	2,789
Total Measures	32,825	5,863
Number of Units/Projects	22,069	2,804

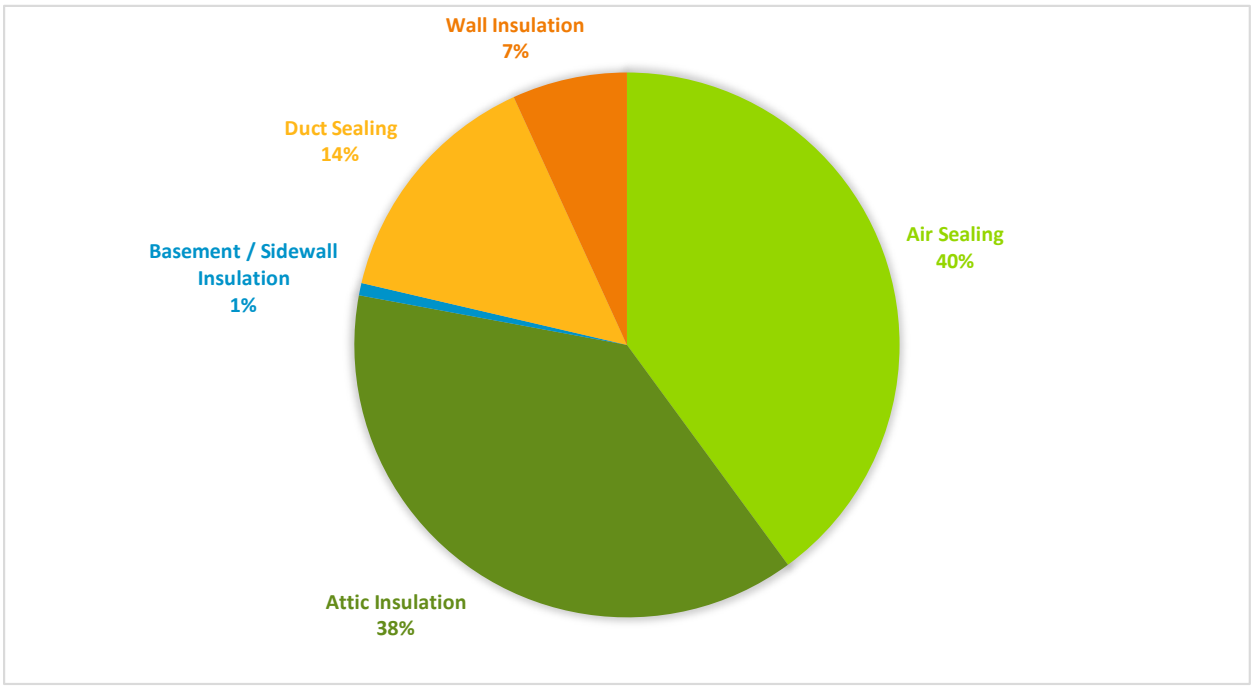
Source: ComEd tracking data and Navigant team analysis.

Figure 2-1. Distribution of HVAC Measures Installed by Type



Source: Evaluation Analysis

Figure 2-2 Distribution of Wx Measures Installed by Type



Source: Evaluation Analysis

3. Program Savings

Table 3-1 and 3-2 summarize the incremental energy and demand savings the HVAC Wx Program achieved in PY9.

Table 3-1. PY9 HVAC Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	19,822,877	NR†	7,507
Program Gross Realization Rate	99%	NA	102%
Verified Gross Savings	19,606,813	16,545	7,639
Program Net-to-Gross Ratio (NTGR)*	0.99	0.99	0.99
Verified Net Savings	19,420,792	16,391	7,565

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html. The NTGR for all program measures is 0.99 except Smart Thermostats for which a NTGR is not applicable.
† NR = Not Reported
Source: ComEd tracking data and Navigant team analysis.

Table 3-2. PY9 Weatherization Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	1,216,722	NR†	735
Program Gross Realization Rate	116%	NA	78%
Verified Gross Savings	1,410,456	1,229	573
Program Net-to-Gross Ratio (NTGR)	1.01	1.01	1.01
Verified Net Savings	1,424,560	1,241	578

*A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† NR = Not Reported
‡ Totals do not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

4. Program Savings by Measure

The program includes seven HVAC measures and five Wx measures as shown in the following tables. The Furnace Blower Motor (ECM) and the Air Sealing measures contributed the most savings to the HVAC and Wx portions of the program, respectively.

Table 4-1. PY9 HVAC Energy Savings by Measure

End Use Type	Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTGR*	Verified Net Savings (kWh)	Technical Measure Life	Persistence	Effective Useful Life (EUL)†
HVAC	Air Source Heat Pump	332,299	102%	339,563	0.99	336,168	NA	NA	18
HVAC	Central Air Conditioning	6,578,322	99%	6,525,713	0.99	6,460,456	NA	NA	18
HVAC	Ductless Heat Pumps	1,957,384	97%	1,900,953	0.99	1,881,943	NA	NA	18
HVAC	Furnace Blower Motor (ECM)	9,541,690	100%	9,541,690	0.99	9,446,273	NA	NA	20
HVAC	Ground Source Heat Pump	363,767	72%	262,365	0.99	259,742	NA	NA	25
Hot Water	Heat Pump Water Heaters	31,532	101%	31,784	0.99	31,466	NA	NA	13
HVAC	Smart Thermostats	1,017,883	99%	1,004,745	NA‡	1,004,745	NA	NA	10
	Total§	19,822,877	99%	19,606,813	0.99	19,420,792			

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† EUL is a combination of technical measure life and persistence.
‡ The IL TRM algorithm calculates net savings for smart thermostats
§ Totals may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-2. PY9 Wx Energy Savings by Measure

End Use Type	Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTGR *	Verified Net Savings (kWh)	Technical Measure Life	Persistence	Effective Useful Life (EUL)†
Weatherization	Air Sealing	638,289	129%	825,718	1.01	833,975	NA	NA	15
Weatherization	Attic Insulation	319,907	103%	328,179	1.01	331,461	NA	NA	25
Weatherization	Basement / Sidewall Insulation	5,937	122%	7,249	1.01	7,322	NA	NA	25
HVAC	Duct Sealing	214,590	100%	213,912	1.01	216,051	NA	NA	20
Weatherization	Wall Insulation	37,999	93%	35,397	1.01	35,751	NA	NA	25
	Total‡	1,216,722	116%	1,410,456	1.01	1,424,560			

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† EUL is a combination of technical measure life and persistence.
‡ Totals may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-3. PY9 HVAC Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (kW)	NTGR*	Verified Net Demand Reduction (kW)
HVAC	Air Source Heat Pump	NR†	NA	77	0.99	76
HVAC	Central Air Conditioning	NR	NA	9,039	0.99	8,949
HVAC	Ductless Heat Pumps	NR	NA	172	0.99	170
HVAC	Furnace Blower Motor (ECM)	NR	NA	5,929	0.99	5,870
HVAC	Ground Source Heat Pump	NR	NA	180	0.99	178
Hot Water	Heat Pump Water Heaters	NR	NA	13	0.99	12
HVAC	Smart Thermostats	NR	NA	1,135	NA‡	1,135
	Total§	NR	NA	16,544	0.99	16,391

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† NR = Not Reported
‡ The IL TRM algorithm calculates net savings for smart thermostats
§ Totals may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-4. PY9 Wx Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Demand Reduction (MW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (MW)	NTGR*	Verified Net Demand Reduction (MW)
Weatherization	Air Sealing	NR†	NA	880	1.01	889
Weatherization	Attic Insulation	NR	NA	277	1.01	280
Weatherization	Basement / Sidewall Insulation	NR	NA	6	1.01	6
HVAC	Duct Sealing	NR	NA	15	1.01	15
Weatherization	Wall Insulation	NR	NA	51	1.01	51
	Total‡	NR	NA	1,229	1.01	1,241

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† NR = Not Reported
‡ Totals may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-5. PY9 HVAC 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)	NTGR*	Verified Peak Net Demand Reduction (kW)
HVAC	Air Source Heat Pump	32	111%	36	0.99	36
HVAC	Central Air Conditioning	4,146	109%	4,501	0.99	4,456
HVAC	Ductless Heat Pumps	48	-22%	-11	0.99	-10
HVAC	Furnace Blower Motor (ECM)	2,768	100%	2,763	0.99	2,735
HVAC	Ground Source Heat Pump	97	87%	84	0.99	83
Hot Water	Heat Pump Water Heaters	1	101%	2	0.99	1
HVAC	Smart Thermostats	414	64%	264	NA†	264
	Total ‡	7,507	102%	7,639	0.99	7,565

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† The IL TRM algorithm calculates net savings for smart thermostats.
‡ Totals may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-6. PY9 Wx 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)	NTGR*	Verified Peak Net Demand Reduction (kW)
Weatherization	Air Sealing	560	73%	410	1.01	414
Weatherization	Attic Insulation	147	88%	129	1.01	131
Weatherization	Basement / Sidewall Insulation	2	191%	3	1.01	3
HVAC	Duct Sealing	7	98%	7	1.01	7
Weatherization	Wall Insulation	20	119%	24	1.01	24
	Total†	735	78%	573	1.01	578

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.
† Totals may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

5. Impact Analysis Findings and Recommendations

5.1 Impact Parameter Estimates

Navigant estimated verified unit savings for each program measure using impact algorithms found in the version 5 of the Illinois Technical Reference Manual[1] (TRM v5.0). Table 5-1 presents the key parameters and the references used in the verified gross and net savings calculations. Detailed breakdowns of the measure quantities and per unit savings values are provided in the Appendix 2.

[1] State of Illinois Technical Reference Manual version 5.0 from http://www.ilsag.info/technical-reference-manual.html.

Table 5-1. Verified Gross Savings Parameters

Gross Savings Input Parameters	Value	Deemed* or Evaluated?
Measure Quantities	Varies	Evaluated
Measure Type and Eligibility	Varies	Deemed
Savings Input Assumption	Varies	Deemed
Gross Savings per Unit	Varies	Deemed
Verified Realization Rate on Ex-Ante Gross Savings (Non-Lighting)	Varies	Deemed
NTGR†	Varies	Deemed

* State of Illinois Technical Reference Manual version 5.0 from http://www.ilsag.info/technical-reference-manual.html.
†Deemed values. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.x-

5.2 Other Impact Findings and Recommendations

Findings and recommendations for the PY9 HVAC and Wx Program by measure are listed below. Some of the measure-level findings by Navigant were addressed by the implementer in the PY9 Wave 1 analysis but not corrected for by the implementer in the end of year analysis. This resulted in several repeat findings and recommendations from the PY9 Wave 1 analysis.

5.2.1 Air Source Heat Pumps

Finding 1. The TRM specifies separate savings algorithms for Air Source Heat Pumps (ASHP) "time of sale" projects and "early replacement" projects. For several "early replacement" projects with high energy savings, the implementer used the "time of sale" savings algorithm. This resulted in a lower realization rate for ASHP.

Recommendation 1. Navigant recommends calculating the energy and demand savings using the proper TRM savings algorithm with regards to "time of sale" and "early replacement" ASHP projects.

Finding 2. For most of the ASHP projects with low energy realization rates, the implementer applied a "special case" approach regarding which TRM savings algorithm to apply ("time of sale" or "early replacement"). The implementer detailed the issues for these "special case" projects, presented below.

1. When a customer installs an ASHP to replace non-electric heat in an early retirement scenario, cooling savings are achieved due to efficiency gains on the cooling side; however, the customer is adding electric load for heating. Because the early retirement savings calculation considers the baseline to be the current equipment for first year savings, the gains from cooling (positive $\Delta kWh_{cooling}$) are offset by the additional load for heating (negative $\Delta kWh_{heating}$ because 1/HSPF_base = 0), resulting in overall negative first year savings for the project.

2. When a customer installs an ASHP to replace electric heating with no existing cooling in an early retirement scenario, heating savings are achieved due to efficiency gains on the heating side; however, the customer is adding electric load for cooling. Because the early retirement savings calculation considers the baseline to be the current equipment for first year savings, the gains from heating (positive $\Delta kWh_{heating}$) are offset by the additional load for cooling (negative $\Delta kWh_{cooling}$ because 1/SEER_base = 0), resulting in overall negative first year savings for the project.[2]

[2] ComEd and CLEAResult Proposed Methodology for Air Source Heat Pump Savings Calculations Memo, May 17, 2017

Navigant applied the "Time of sale" savings algorithm to these special case projects in the evaluation. However, Navigant's Wave 1 Review made a supplemental recommendation that the implementer clarify the type of *heating* unit for records where "Exisiting_HVAC_Type" is populated with "Central Air Conditioner" to help identify when to apply the "time of sale" savings algorithm.

Recommendation 2. Although the "special case" ASHP projects no longer present negative energy savings values, most of them still have low energy and demand realization rates. All "special case" situations had Central Air Conditioner as the "Existing_HVAC_Type". As stated in Finding 2, Navigant recommended that the implementer clarify the type of *heating* unit for records where "Existing_HVAC_Type" is Central Air Conditioner. The implementer did not correct this in the final set of data delivered to Navigant, and this could be a source of error for the low energy and peak demand realization rates for the "special case" projects. Navigant recommends that the implementer provide a set of these "special case" projects with associated inputs used for calculation to identify the source of the discrepancy.

5.2.2 Central Air Conditioners

Finding 3. For Central Air Conditioner (CAC) savings, the IL TRM v5.0 specifies two savings algorithms: "time of sale" and "early replacement" depending on the type of project. Navigant found multiple projects where the implementer used the "early replacement" algorithm and where there was a discrepancy with Navigant's evaluated savings. For the majority of those projects, using the "time of sale" savings algorithm resolved the discrepancy. Applying the incorrect "early replacement" savings algorithm to "time of sale" projects increased the energy and demand realization rates.

Recommendation 3. Navigant recommends applying the correct TRM savings algorithm (either "Time of Sale" or "Early Replacement") to all CAC project calculations.

5.2.3 Ductless Mini-Split Heat Pumps

Finding 4. Navigant found that Ductless Mini-Split (DMS) Heat Pump (DMSHP) projects with discrepancies for both energy and demand are due to having the value "none" for "Existing_HVAC_Type". The energy and demand savings algorithms defined by the IL TRM v5.0 for DMSHP are below:

$$\Delta kWh = \Delta kWh_{heat} + \Delta kWh_{cool}$$

$$\Delta kWh_{heat} = (Capacity_{heat} * EFLH_{heat} * (1/HSPF_{exist} - 1/HSPF_{ee})) / 1000$$

$$\Delta kWhcool = (Capacitycool* EFLHcool *(1/SEERexist - 1/SEERee)) / 1000$$

$$\Delta kW = Capacity_{cool} * (1/EER_{exist} – 1/EER_{ee})) / 1000) * CF$$

Projects with "none" for "Existing_HVAC_Type" will result in negative ΔkWh_{cool} and ΔkW values. For these projects, ΔkWh_{cool} is negative because there was no existing cooling system prior to the installation of the DMSHP. In this situation, according to the IL TRM v5.0, the $1/SEER_{exist}$ value is equal to zero. This results in a negative ΔkWh_{cool} value and thus a lower energy (ΔkWh) savings and realization rate. Similarly, the demand savings for these projects result in $1/EER_{exist}$ equal to zero according to the IL TRM v5.0, thus resulting in negative ΔkW values and negative realization rates.

Recommendation 4: Navigant recommends that the implementer account for the negative cooling energy savings as well as the negative demand savings for projects with "none" for "Existing_HVAC_Type". Regarding the $1/SEER_{exist}$ and the $1/EER_{exist}$ values, section 5.3.12 reference 400 in the IL TRM v5.0 states that "If there is no existing cooling in place but the incentive encourages installation of a new DMSHP with cooling, the added cooling load should be subtracted from any heating benefits".

5.2.4 ECM Furnace Motor

Finding 5. For several ECM Furnace Motor projects, the peak demand savings (kW) have discrepancies between the ex ante implementer and verified Navigant calculated values. This could be because the implementer used incorrect "FLH Cooling" values, or the full load hours of air conditioning to calculate some of the ECM Furnace Motor projects savings. These values are determined by the geographic location of the project and its associated "Cooling Zone". An example of this is for Rebate ID-1011178. The deemed "FLH_Cooling" value for this project is an average of the other zones in the IL TRM, equal to 629 hours. If this "FLH_Cooling" value is updated from the average (629 hours) to Climate Zone 2- Chicago ("FLH_Cooling" = 570 hours), then the realization rate is equal to 100 percent. Another example of "Cooling Zone" and resulting "FLH_cooling" error is Rebate ID-1068262. The "Cooling Zone" for this project should be 1 – Rockford (FLH_cooling = 512 hours). However, the ex ante calculation used an "FLH_Cooling" value of 470, perhaps meant to be 570, which is Cooling Zone 2 – Chicago. These errors both increased and decreased the energy savings and demand realization rates depending on which "FLH_Cooling" value was used by the implementer.

Recommendation 5. Navigant recommends that the implementer apply the correct Cooling Zone and associated FLH_cooling value to all projects.

5.2.5 Geothermal Heat Pump

Finding 6. The IL TRM v5.0 specifies that the "Existing_Heating_Type" determines Ground Source Heat Pump or Geothermal Heat Pump (GHP) Heating System Performance Factor of new replacement baseline heating systems ($HSPF_{base}$) and Heating System Performance Factor of existing heating system ($HSPF_{exist}$). End of year PY9 tracking data includes projects with "Existing_Heating_Type" of Geothermal Heat Pump, New Construction, and Gas or Propane. The IL TRM v5.0 includes $HSPF_{base}$ and $HSPF_{exist}$ deemed values only for Air Source Heat Pump and Electric Resistance existing heating systems. The IL TRM v5.0 does not specify $HSPF_{base}$ and $HSPF_{exist}$ deemed values for projects with "Existing_Heating_Type" of New Construction, Gas or Propane, or Geothermal Heat Pump. Due to the uncertainty of these values which are not deemed in the IL TRM v5.0, Navigant attempted to use reasonable values to complete the evaluation calculations. This lowered the energy and demand realization rates.

Recommendation 6. Due to the lack of deemed $HSPF_{base}$ and $HSPF_{exist}$ values for certain 'Existing_Heating_Type" selections in the IL TRM v5.0, Navigant is unsure of the values used in the implementers savings calculations. Navigant recommends that the implementer provide all $HSPF_{base}$ and $HSPF_{exist}$ values used for all "Existing_Heating_Type" selections.

Finding 7. According to the IL TRM v5.0, a Geothermal Heat Pump project's "Existing_Cooling_Type" determines savings algorithm inputs $SEER_{base}$, $SEER_{exist}$, EER_{base}, and EER_{exist}. Similar to finding 6 above, the TRM does not specify deemed values associated with certain responses to "Existing_Cooling_Type". Two of these "Existing_Cooling_Type" selections lacking associated deemed input values are Geothermal Heat Pump and New Construction. Similar to Finding 6, because of the uncertainty of these values which are not deemed in the IL TRM v5.0, Navigant attempted to use reasonable values to complete the evaluation calculations. This lowered the energy and demand realization rates.

Recommendation 7. Navigant recommends that the implementer provide all $SEER_{base}$, $SEER_{exist}$, EER_{base}, and EER_{exist} values used for all "Existing_Cooling_Type" selections for GHP projects.

5.2.6 Heat Pump Water Heaters

Finding 8. A potential source of error for Heat Pump Water Heater (HPWH) projects could be the Coefficient of Performance (COP) of electric heating system (COP_{HEAT}) value. The implementer stated in the Wave 1 Review that they use a weighted average which assumes

an 82/18 split of Electric Resistance (COP_{HEAT} = 1) and Heat Pump (COP_{HEAT} = 2.13) resulting in a weighted average COP_{HEAT} of 1.2 which they apply to all projects with electric heat. If this COP_{HEAT} values was applied by the implementer again in the end of year analysis, it lowered the realization rates for Natural Gas "Existing_HVAC_Type" projects and increased the realization rates for Electric "Existing_HVAC_Type" projects.

Recommendation 8. Navigant recommends applying a COP_{HEAT} = 0 for all HPWH projects with "Existing_HVAC_Type" of Natural Gas, and a COP_{HEAT} = 1.39 for projects with "Existing_HVAC_Type" of Electric. The COP_{HEAT} of 1.39 should be used instead of the implementers 1.2 since the IL TRM v5.0 states COP_{HEAT} of unknown electric heating systems is equal to 1.39.

5.2.7 Smart Thermostats

Finding 9. The implementer's Smart Thermostat peak demand calculations apply the Summer System Peak (SSP) coincidence factor (CF) of 0.34 to all Smart Thermostat (ST) projects. This lowered the peak demand realization rate.

Recommendation 9. Navigant recommends that the PJM CF of 0.233 should be applied to all peak demand ST calculations instead.

Finding 10. According to the implementer's calculations, Smart thermostat projects with "Existing_HVAC_Type" of Electric Resistance (no CAC) are claiming positive ex ante gross demand savings. However, the IL TRM v5.0 specifies that projects with "Existing_HVAC_Type" of Electric Resistance (no CAC) have no previous cooling system, and thus 1/EER = 0, causing no demand savings.

Recommendation 10. Navigant recommends that the implementer update 1/EER = 0 for all projects with no existing cooling system, or to provide the used 1/EER value in the ex ante calculations if it represents a reasonable estimate.

5.2.8 Air Sealing

Finding 11: For Air Sealing measures, projects implemented by CLEAResult had a realization rate of 100 percent. For projects implemented by Franklin, Navigant found a realization rate of 153 percent. Franklin used a deemed value of 0.164 kWh / CFM reduction to calculate savings for all projects, which assumes that the variables used in the calculation are constant across all projects. The tracking data provides enough information to use inputs specific to each project.

Recommendation 11: Navigant recommends that Franklin update their algorithms and use the inputs provided in the tracking data to calculate energy savings.

5.2.9 Attic Insulation

Finding 12: Attic Insulation projects implemented by CLEAResult had an overall realization rate of 100 percent; projects implemented by Franklin had an overall realization rate of 107 percent. In addition to the tracking data, Navigant also reviewed the measure builds provided by Franklin. Navigant found that five measures have electric heating and the calculator assumes natural gas heating for all other measures. These project IDs are listed in Table 5-2 below.

Table 5-2 Franklin Projects with Electric Heating

Rebate IDs
2293776
2275430
1635988
2253621
2737509

Recommendation 12: Navigant recommends that Franklin accounts for electric heating in the attic insulation calculator.

Finding 13: When reviewing the savings calculators, Navigant found that Franklin is using deemed values for the following variables: HDD, nHeat, DCC, nCool. Additionally, Franklin is using a value of 100,000 for the Btu/therm conversion instead of the deemed 100,067.

Recommendation 13: Navigant recommends that Franklin update their calculators to use the actual values provided in the tracking data instead of the deemed values for HDD, nHeat, CDD, and nCool. Additionally, Franklin should use the correct conversion factor for Btu/therm.

5.2.10 Basement Insulation

Finding 14: For Basement Insulation projects implemented by CLEAResult, the realization rate was 124 percent. Navigant was unable to isolate the source of the discrepancies causing the difference between the ex ante and verified savings estimates for basement and sidewall insulation measures. Navigant also reviewed the calculators provided by CLEAResult. Navigant found that in the ΔTherms calculation, CLEAResult is using the following algorithm:

ΔTherms = (((1/R_OLD_AG-1/(R_Added+R_Old_AG))
**L_Basement_Wall_Total*H_Basement_AG+(1-Framing_Factor)*
+(1/R_Old_BG-1/(R_Old_BG+R_Added))
**L_Basement_Wall_Total*H_basement_BG*(1-Framing_Factor))*
**24*CDD)/(nHeat*10067) *ADJbasement*

Based on the TRM v5, the algorithm should be using the variable ADJbasementHeat instead of ADJbasement in the heating calculation. This change brings the realization rate closer to 100%, but does not account for all of the difference in savings. Navigant agrees with all other calculations provided. Table 5-3 shows a sample of rebate IDs as well as their assumed calculator inputs.

Table 5-3. Sample of CLEAResult Projects and Calculator Inputs

Variable	RBT-956912	RBT-1266370	RBT-871653
L_basement_wall_total	39.25	115.625	45
H_basement_wall_Total	8	8	8
H_basement_wall_AG	2	2	2
H_basement_wall_BG	6	6	6
R_Old_AG	1	1	1
R_Old_BG	9.46	9.46	9.46
R_Added	15	15	14
HDD	3079	3079	3079
CDD	281	281	281
Framing Factor	0.00	0	0
DUA	0.75	0.75	0.75
nCool	11.5	11.5	13
nHeat	0.72	0.8	0.8
ADJbasement	0.8	0.8	0.8
ADJBasementHeat	0.6	0.6	0.6
FLHcool	568.6	570	570
Electric Reduction	1	1	1
Ex Ante kWh Savings	11.524	56.378	507.702
Realization Rate	661%	396%	16%
Verified kWh Savings	76.2	223.06	83.06

Recommendation 14: Navigant recommends that CLEAResult update their calculator so that the therms equation uses ADJBasementHeat instead of ADJBasement and conduct an engineering review Table 5-4 shows the FLH cool lookup table provided in the TRM.

*Peak kW Savings = kWh_Cooling / FLH_Cool * 0.466*

Table 5-4. FLH Cool Lookup Values

Climate Zone	FLH SF	FLH MF
1	512	467
2	570	506
3	730	663
4	1035	940
5	903	820
Average	629	564

Recommendation 15: Franklin and CLEAResult should review the values in the table above and determine if there are any differences between these values and those used in the ex ante calculations.

5.2.11 Duct Sealing

Finding 15: For projects implemented by Franklin, the realization rate was 100 percent. For projects implemented by CLEAResult, the realization rate was 97 percent. Navigant was unable to isolate the source of the discrepancies causing the difference between the ex ante and ex post savings estimates for duct sealing measures. Navigant also reviewed the calculator provided by CLEAResult and agrees with the algorithms, leading Navigant to believe it is an issue with the inputs to the calculators and not the algorithms themselves. Table 5-5 shows a sample of projects as well as their assumed inputs.

Table 5-5. Sample of CLEAResult Projects and Calculator Inputs

Variable	EA-0000634197	EA-0000522137	RBT-1310381
Distribution efficiency (DE) before	0.60	0.72	0.70
Distribution efficiency (DE) after	0.78	0.8	0.84
FLHheat	1840	1840	1840
nheat*	0.7	0.7	0.7
nheat*	2.26	2.26	2.26
Heating capacity (gas heat)	90595	90595	90595
ncool	12	12	11.5
Cooling capacity	35208	35208	35208
heating capacity (electric heat)*	35208	35208	35208
FLHcool	570.00	570.00	570.00
ηEquipment	0.72	0.83	0.83
ηSystem	0.43	0.60	0.58
Fe	3.14%	3.14%	3.14%
TRF cool	1	1	1
TRF heat	1	1	1
Ex Ante kWh Savings	1062.86	387.51	687.74
Realization Rate	92%	98%	95%
Verified kWh Savings	975.79	380.24	656.00

Recommendation 16: Navigant recommends that CLEAResult conduct an engineering review of their calculators to determine the discrepancy in calculator inputs.

5.2.12 Wall Insulation

Finding 16: For Wall Insulation projects implemented by CLEAResult, the realization rate was 100% for energy savings and 91% for demand savings. To calculate peak demand savings, Navigant is using the following algorithm.

$$Peak\ kW\ Savings = kWh\_Cooling / FLH\_Cool * 0.466$$

Where the FLH_Cool values are provided in Table 5-4.

Recommendation 17: Navigant recommends that CLEAResult review the values used for FLH_Cool and update them to those provided in the TRM.

Finding 17: For projects implemented by Franklin, the realization rate was 89 percent. Navigant also reviewed the calculator provided by Franklin. Navigant found that Franklin is using deemed values for the following variables: HDD, nHeat, DCC, nCool. Additionally, Franklin is using a value of 100,000 for the Btu/therm conversion instead of the deemed 100,067.

Recommendation 18: Navigant recommends that Franklin update their calculators to use the actual values provided in the tracking data instead of the deemed values for HDD, nHeat, CDD, and nCool. Additionally, Franklin should use the correct conversion factor for Btu/therm.

6. Appendix 1. Impact Analysis Methodology

6.1 Verified Gross Program Savings Analysis Approach

Navigant determined verified gross savings for each program measure by:

1. Reviewing the savings algorithm inputs in the measure workbook for agreement with the TRM v 5.0.
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 Navigant'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.

6.2 Verified Net Program Savings Analysis Approach

Navigant calculated verified net energy and demand (coincident peak and overall) savings by multiplying the verified gross savings estimates by a net-to-gross ratio (NTGR). In PY9, the NTGR estimates used to calculate the net verified savings were based on past evaluation research and defined by a consensus process through SAG, as documented in a spreadsheet.[3]

7. Appendix 2. Impact Analysis Detail

Navigant downloaded the final tracking data and measure workbook for the MFES PY9 impact evaluation from the ComEd Evaluation Share file site. Navigant relied on the following documents to verify the per-unit savings for each program measure:

- Final PY9 tracking database file:
  - HVAC: "HVAC_PY9_EOY_Evaluation_Data_Rev3_02162018.xlsx"
  - Wx: "Wx_PY9_EOY_Evaluation_Data_Rev0_01182018.xlsx"
- Illinois Technical Reference Manual (TRM v5.0) for deemed input parameters or secondary evaluation research to verify any custom inputs used in the ex ante calculations.

The following sections provide an outline of the differences between the ex ante and verified savings estimates for each measure by end-use. Each section contains a table that provides the quantity installed[4], ex ante and ex post values, and realization rates. Note that these values are reported in kWh, as opposed to MWh which are used for reporting in the above sections.

[3] Source ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html

[4] This quantity represents the values provided in the tracking data and are not grouped by unit as shown in Table 2-1.

7.1 Air Source Heat Pump

Air source heat pumps had a realization rate of 102 percent and accounted for two percent of HVAC energy savings and two percent of the entire HVAC Wx program energy savings. There were two project types associated with Air Source Heat Pumps, Early Retirement and Time of Sale. There was a third project type which was incorporated into the analysis and is described in depth in Section 5.2 in Finding and Recommendation 2. The high realization rate for Early Retirement projects was due to the use of incorrect Project Type for several projects in the ex ante savings calculation.

Table 7-1. Air Source Heat Pump Measure Impact Detail

Measure	Project Type	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
ASHP	Early Retirement	27	141,753	110%	155,319
ASHP	Time of Sale	86	97,678	99%	96,901
ASHP	Special Case (Forced TOS)	41	92,868	94%	87,343
ASHP	Total	154	332,299	102%	339,563

Source: ComEd tracking data and Navigant team analysis.

7.2 Central Air Conditioners

Central Air Conditioners had a realization rate of 99 percent and accounted for 33 percent of the HVAC energy savings and 31 percent of the entire HVAC Wx program energy savings. There were Time of Sale and Early Retirement CAC project types implemented in PY9. The project type determined which savings algorithm was used to calculate energy savings. The incorrect project type was applied to a small number of the projects which resulted in a lower overall realization rate.

Table 7-2. Central Air Conditioners Measure Impact Detail

Measure	Project Type	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
CAC	Early Retirement	5651	4,144,966	104%	4,319,565
CAC	Time of Sale	9581	2,433,356	91%	2,206,148
CAC	Total	15,320	6,578,322	99%	6,525,713

Source: ComEd tracking data and Navigant team analysis.

7.3 Ductless Mini-Split Heat Pumps

Ductless Mini-Split (DMS) Heat Pumps (DMSHP) had a realization rate of 97 percent and accounted for 10 percent of the HVAC energy savings and 9 percent of the entire HVAC Wx program energy savings. Two types of DMS Heat Pumps were installed for this measure, Air Source Heat Pump and Electric Resistance units. The Electric Resistance units had a higher realization rate of 98 percent compared to the Air Source Heat Pump units of 91 percent.

Table 7-3. DMS Heat Pumps Measure Impact Detail

Measure	Project Type	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
DMS	Electric Resistance	75	1,706,059	98%	1,671,440
DMS	Air Source Heat Pump	227	251,325	91%	229,513
DMS	Total	302	1,957,556	97%	1,900,953

Source: ComEd tracking data and Navigant team analysis.

7.4 ECM Furnace Motors

ECM Furnace motors had an overall realization rate of 100 percent and contributed to 48 percent of the HVAC savings and 45 percent of the entire HVAC Wx program's energy savings.

Table 7-4. ECM Furnace Motors Measure Impact Detail

Measure	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
ECM	Each	13,439	9,541,690	100%	9,541,690

Source: ComEd tracking data and Navigant team analysis.

7.5 Geothermal Heat Pump

Geothermal heat pumps had a realization rate of 72 percent and accounted for one percent of HVAC energy savings and one percent of the entire HVAC Wx program energy savings. There were two home types for GHP projects, Retrofit and New Construction. The majority of the GHP projects (78 percent) were Retrofit jobs. The retrofit projects had a low realization rate of 68 percent. These low realization rates are accounted for in Findings and Recommendations 6 and 7 in Section 5.2.

Table 7-5. Geothermal Heat Pump Measure Impact Detail

Measure	Home Type	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
GHP	Retrofit	38	314,940	68%	212,891
GHP	New Construction	11	48,827	101%	49,474
GHP	Total	49	363,767	72%	262,365

Source: ComEd tracking data and Navigant team analysis.

7.6 Heat Pump Water Heater

Heat Pump Water Heaters had a realization rate of 101 percent and accounted for 0.16 percent of HVAC energy savings and 0.15 percent of the entire HVAC Wx program energy savings.

Table 7-6. Heat Pump Water Heater Measure Impact Detail

Measure	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
HPWH	Each	16	31,532	101%	31,784

Source: ComEd tracking data and Navigant team analysis.

7.7 Smart Thermostats

Smart Thermostats had a realization rate of 99 percent and accounted for five percent of the HVAC energy savings and 5 percent of the entire HVAC Wx program energy savings. The main discrepancy found for Smart Thermostats was the use of incorrect coincidence factors (CF). Table 7-4 below shows the difference in peak demand savings between the use of PJM and SSP CF factors. The SSP CF was used in ex ante calculations, and thus resulted in a low verified gross peak realization rate when the PJM CF factor was applied.

Table 7-7. Smart Thermostats Measure Impact Detail

Measure	Coincidence Factor (CF)	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kWh)
ST	0.233 (PJM)	3,633	1,017,883	99%	1,004,745	414.292	64%	264.473
ST	0.34 (SSP)	3,633	1,017,883	99%	1,004,745	414.292	93%	385.927

Source: ComEd tracking data and Navigant team analysis.

7.8 Air Sealing

Air Sealing had a realization rate of 129 percent. Air sealing projects implemented by CLEAResult and Franklin had separate realization rates of 100 percent and 153 percent, respectively. Air sealing projects accounted for 58 percent of the Wx energy savings and four percent of the entire HVAC Wx program energy savings.

Table 7-8. Air Sealing Measure Impact Detail

Implementer	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
CLEAResult	Δ CFM	1,250,780	Varies	100%	Varies
Franklin	Δ CFM	2,143,224	0.164	153%	Varies

Source: ComEd tracking data and Navigant team analysis.

7.9 Attic Insulation

Attic Insulation had a realization rate of 103 percent. Attic Insulation projects implemented by CLEAResult and Franklin had separate realization rates of 100 percent and 107 percent, respectively. Air sealing projects accounted for 23 percent of the Wx energy savings and two percent of the entire HVAC Wx program energy savings.

Table 7-9. Attic Insulation Measure Impact Detail

Implementer	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
CLEAResult	Area	1,330,643	Varies	100%	Varies
Franklin	Area	1,125,924	Varies	107%	Varies

Source: ComEd tracking data and Navigant team analysis.

7.10 Basement Insulation

Basement or Sidewall Insulation had a realization rate of 125 percent. Basement or Sidewall Insulation projects implemented by CLEAResult and Franklin had separate realization rates of 124 percent and 126 percent, respectively. Basement Insulation accounted for 0.64 percent of the Wx energy savings and 0.043 percent of the entire HVAC Wx program energy savings.

Table 7-10. Basement or Sidewall Insulation Measure Impact Detail

Implementer	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
CLEAResult	Area	15,773	Varies	118%	Varies
Franklin	Area	4,008	Varies	126%	Varies

Source: ComEd tracking data and Navigant team analysis.

7.11 Duct Sealing

Duct Sealing had a realization rate of 100 percent. Duct Sealing projects implemented by CLEAResult and Franklin had separate realization rates of 97 percent and 100 percent, respectively. Duct Sealing accounted for 15 percent of the Wx energy savings and 1 percent of the entire HVAC Wx program energy savings.

Table 7-11. Duct Sealing Measure Impact Detail

Implementer	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
CLEAResult	Each	25	Varies	97%	Varies
Franklin	Δ CFM	298,327	0.653	100%	0.653

Source: ComEd tracking data and Navigant team analysis.

7.12 Wall Insulation

Wall insulation had a realization rate of 93 percent. Wall Insulation projects implemented by CLEAResult and Franklin had separate realization rates of 100 percent and 89 percent, respectively. The savings accounted for three percent of the Wx energy savings and 0.17 percent of the entire HVAC Wx program energy savings.

Table 7-12. Wall Insulation Measure Impact Detail

Implementer	Unit Basis	Quantity Installed	Ex Ante Gross Savings (kWh)	Verified Gross kWh Realization Rate	Verified Gross Savings (kWh)
CLEAResult	Area	69,096	Varies	100%	Varies
Franklin	Area	101,414	Varies	89%	Varies

Source: ComEd tracking data and Navigant team analysis.

8. Appendix 3. Total Resource Cost Detail

The Total Resource Cost (TRC) variable tables (Table 8-1 and Table 8-2) only include cost-effectiveness analysis inputs available at the time of finalizing the PY9 HVAC Wx impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in the tables and will be provided to evaluation later. EULs are subject to change and are not final.

Table 8-1. HVAC Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	Effective Useful Life	Ex Ante Gross Savings (kWh)	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Savings (kWh)	Verified Gross Peak Demand Reduction (kW)
HVAC	Air Source Heat Pump	Each	154	18	332,299	32	339,563	36
HVAC	Central Air Conditioning	Each	15,232	18	6,578,322	4,146	6,525,713	4,501
HVAC	Ductless Heat Pumps	Each	302	18	1,957,384	48	1,900,953	-11
HVAC	Furnace Blower Motor (ECM)	Each	13,439	20	9,541,690	2,768	9,541,690	2,763
HVAC	Ground Source Heat Pump	Each	49	25	363,767	97	262,365	84
Hot Water	Heat Pump Water Heaters	Each	16	13	31,532	1	31,784	2
HVAC	Smart Thermostats	Each	3,633	10	1,017,883	414	1,004,745	264

Table 8-2. Wx Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	Effective Useful Life	Ex Ante Gross Savings (kWh)	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Savings (kWh)	Verified Gross Peak Demand Reduction (kW)
Weatherization	Air Sealing	Each	2350	15	638,289	560	825,718	410
Weatherization	Attic Insulation	Each	2215	25	319,907	147	328,179	129
Weatherization	Basement / Sidewall Insulation	Each	50	25	5,937	2	7,249	3
HVAC	Duct Sealing	Each	848	20	214,590	7	213,912	7
Weatherization	Wall Insulation	Each	400	25	37,999	20	35,397	24

APPENDIX B. COMED HVAC REBATE PY9 SPILLOVER MEMO 2018-08-27

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To:	Vincent Gutierrez, ComEd
CC:	Jennifer Morris, ICC Staff; Randy Gunn, Jeff Erickson, Nishant Mehta
From:	Laura Agapay-Read, Peter Vigilante
Date:	August 27, 2018
Re:	Spillover Research Results from PY9 for the ComEd HVAC Rebate Program

INTRODUCTION

This memo presents our spillover research results for the PY9 ComEd Heating and Cooling (HVAC) Rebates Program using the Illinois TRM version 6.0 methodologies.[1] The evaluation team conducted spillover research in Spring 2018 with a random selection of PY9 participants.

Table 1 below provides a summary of the HVAC Rebate Program PY9 participant spillover savings research findings. Overall 100 participant telephone surveys were completed. Navigant determined a spillover rate of 0.08 for the 100 respondents. Because the random sample is representative of the population, the spillover rate is 0.08 for the population of PY9 program participants.

Table 1. Participant Spillover Results (PY9 Participants)

Program Path	Participant Spillover kWh	Participant Spillover kW	Sample (n)
HVAC Population Roll-Up	**5,160.71**	**0.34**	**100**

Source: Navigant analysis of data from a telephone survey with PY9 HVAC Rebate Program participants.

Spillover Comparison

For context, the deemed value for the 2018 HVAC Rebates Program for Participant Spillover is 0.12 for Central AC from PY7 evaluation research.

PY9 SPILLOVER RESEARCH DATA COLLECTION

The evaluation team conducted PY9 spillover research using a customer self-report approach through a telephone survey with PY9 participants from a randomized sample of 991 participants with unique account names. The survey achieved the target number of completes with 100 actual completes.

Participant Spillover Estimation

The telephone survey asked respondents if they had installed additional electricity savings measures to reduce energy consumption since participating in the Heating and Cooling Rebates Program. Navigant included questions to identify spillover candidates and estimate savings, paraphrased below:

[1] Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 6.0, Volume 4: Cross-Cutting Measures and Attachments, effective January 1st, 2018.

1. Since participating in the program, did you make additional energy efficiency improvements that were not rebated by a utility program?
2. How much influence did your participation in the program have on your making additional energy efficiency improvements?
    a. On a zero to ten scale, where zero is not at all important and ten is extremely important, how important was your participation in the Rebates program on your decision to purchase these additional electricity saving services or equipment? [Attribution Score 1.]
    b. If you had not participated in the Rebates program, how likely is that you would have purchased the additional electricity services or equipment? Please use a zero to ten scale, where zero means that you definitely would not have purchased them and ten means that you definitely would have purchased them? [Attribution Score 2.]
3. What were the details of the energy efficiency improvements (equipment, efficiency level, quantity, etc.)?

The evaluation attributed spillover to the Heating and Cooling Rebates Program if the following condition is met: the average of Attribution Score 1 and (10 minus Attribution Score 2) must exceed 5.0.

Of the 100 survey respondents, 39 respondents reported that they installed additional energy efficient equipment not incented by the program, and 32 of them indicated that participating in the program influenced them to make these additional purchases. Navigant determined that 15 out of the 32 potential spillover candidates had averaged attribution scores greater than five, and six of them installed equipment with quantifiable electricity savings. The table below lists these respondents' improvements and electricity savings:

Table 2. PY9 HVAC Rebate Spillover Research Results by Measure

End-use Measure	kWh	kW	Quantity
Windows	3,369.14	0.0008	3
Refrigerator	696.10	0.1049	1
LED Light Bulbs	341.71	0.0427	29
Clothes Washer	325.54	0.0839	2
Clothes Dryer	160.44	0.0215	1
Smart Thermostat	160.03	0.0768	1
Freezer	46.90	0.0076	1
Showerheads	41.26	0.0038	1
Dish Washer	19.60	0.0020	1
Total	**5,160.71**	**0.3441**	**40**

Source: Navigant analysis of data from a telephone survey with PY9 HVAC Rebate Program participants.

Table 3 shows the distribution of electric spillover savings among the five respondents. Over 70% of the energy savings was achieved by the installation of windows and LED lighting; the remainder was achieved by the installation of high efficiency appliances.

Table 3. PY9 HVAC Rebate Spillover Research Results by Respondent

Participant	Measure(s) Installed	Spillover kWh	Proportion of Total kWh Spillover	Spillover kW	Proportion of Total kW Spillover
Respondent 1	LEDs, Windows	1,405.84	27%	0.04	10%
Respondent 2	Windows	1,123.05	22%	0.0003	0.1%
Respondent 3	Windows	1,123.05	22%	0.0003	0.1%
Respondent 4	Dish Washer, Refrigerator, Freezer	762.60	15%	0.11	33%
Respondent 5	Clothes Washer, Clothes Dryer, LEDs, Showerheads	423.38	8%	0.07	22%
Respondent 6	Clothes Washer	162.77	3%	0.04	12%
Respondent 7	Smart Thermostat	160.03	3%	0.08	22%
Total	-	**5,160.71**	-	**0.3441**	-

Source: Navigant analysis of data from a telephone survey with PY9 HVAC Rebate Program participants.

The energy savings from these improvements amount to 8% of program savings for the 100 respondents. Because the 100 were selected as a simple random sample, their spillover savings rate is representative of the population of PY9 program participants.

Table 4. Spillover Calculations

kWh			kW		
Spillover	Ex Post	Spillover Rate	Spillover	Ex Post	Spillover Rate
5,160.7	68,176.85	**0.08**	0.34	24.58	**0.01**

Source: Navigant analysis of data from a telephone survey with PY9 HVAC Rebate Program participants and PY9 program tracking data.

APPENDIX: COMED HVAC REBATE PROGRAM NTG HISTORY

	Heating, Cooling and Weatherization Rebates
PY 10	**Heating and Cooling** NTG Central AC: 0.69 Free-Ridership Central AC: 0.43 TA Spillover (Participant) Central AC: 0.12 NTG Source for Central AC: Free-Ridership: PY8 participant self-report survey TA Spillover (Participant): PY7 SAG consensus value for CSR PY7 SAG consensus value for non-participant spillover for CSR is not applicable here because those savings are likely now captured by the new stand-alone CAC program. Navigant interviewed participating trade allies as part of the CSR evaluation and found the non-participant spillover was from ComEd customers who needed and got a new high efficiency CAC but did not need or get a new furnace, thus they did not do a "complete system replacement" and were not eligible for the incentive. The trade allies reported a substantial share of sales in high efficiency CAC that did not get an incentive because the customer did not do a CSR. We counted that as spillover. Now, however, with the Heating, Cooling, and Weatherization Program, ComEd customers can get an incentive when they replace just the CAC, and thus the NPSO we found for the old CSR program is probably being captured by the new program. NTG Smart Thermostat: NA The savings value in the IL TRM is based on regression analysis on consumption data and thus is a net savings number. NTG Air Source Heat Pump: 0.57, based upon 2013 Navigant research for Duke. NTG Ductless Mini-Split: 0.68, based upon average for 5 utilities cited in 2016 study for Wisconsin Focus on Energy. NTG ECM Furnace Motor – with Furnace Upgrade: 0.68, based upon GPY5 Navigant research for Nicor Gas NTG ECM Furnace Motor – without Furnace Upgrade: 0.80, default value NTG Geothermal Heat Pump: 0.59, based upon 2013 Ameren IL Study, Res Home Rebate Program NTG Heat Pump Water Heater: 0.76, based upon 2013 Navigant research for Duke **"2013 EM&V Report for the Home Energy Improvement Program" Duke Energy, July 2015.** http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=b94770a2-2d4a-427d-9c50-b09fd11096ed **"Ductless Mini-Split Heat Pump Market Assessment and Savings Review Report" for Wisconsin Focus on Energy, December 30, 2016. https://focusonenergy.com/sites/default/files/research/Focus%20EERD%20DMSHP%20Final%20Report_30Dec2016.pdf**

	Heating, Cooling and Weatherization Rebates
	Weatherization NTG: 1.01 Free-Ridership: 0.10 Participant Spillover: 0.11 NTG Source: Free-Ridership: PY7 SAG consensus value for the Home Energy Assessments program, which was based on participant surveys in EPY4 and EPY5 and trade ally surveys in EPY5.

Source: http://ilsagfiles.org/SAG_files/NTG/2017_NTG_Meetings/Final/ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.pdf

	Complete System Replacement (HEER)
PY1	CSR program not offered in EPY1
PY2	CSR program not offered in EPY1
PY3	CSR program not offered in EPY1
PY4	Retroactive application of NTG of 59% Free-Ridership: 41% Spillover: 0% Method: Customer self-report.
PY5	SAG consensus: Retrospective evaluation
PY6	SAG consensus: • 0.59
PY7	**NTG: 0.99** **Free Ridership: Participant 0.41; Trade ally 0.25; Average = 0.33** **(**EPY4 participant survey and EPY5 participating trade ally surveys) **Participant Spillover: 0.12** from participating trade ally survey **Nonparticipant Spillover: 0.20** from nonparticipant trade ally survey. **Ameren HVAC.** Very similar values for spillover. (0.1 and 0.22). Free-Ridership varies from 44% to 69%. The overall program NTG was calculated by averaging the EPY4 participant and the EPY5 trade ally Free-Ridership rates, and then adding the EPY4 participant spillover, and EPY5 participating trade ally and non-participating trade ally spillover, as follows: $$NTG_{Program} = 1 - \frac{(FR_{Part.} + FR_{TA})}{2} + SO_{Part.} + SO_{Part.TA} + SO_{Non-Part.TA}$$ Where NTGProgram = Program NTG FRPart. = Participant Free-Ridership FR_{TA} = Trade Ally Free-Ridership $SO_{Part.}$ = Participant Spillover SO_{PartTA} = Participating TA Spillover $SO_{Non\text{-}PartTA}$ = Non-Participating TA Spillover

Complete System Replacement (HEER)

Finding: The NTG rate found in this evaluation is 99% combining participant free ridership (0.41), trade ally free ridership (0.25), and spillover (0.12 participating trade ally and 0.20 nonparticipating trade ally).

Participating Trade Ally Free Ridership and Spillover

	Sales Weighted Free-Ridership	Sales Weighted Spillover	N
Highest Volume Trade Allies	0.21	0.12	13
Medium Volume Trade Allies	0.34	0.10	18
Lowest Volume Trade Allies	0.35	0.20	18
All Participating Trade Allies	**0.25**	**0.12**	**49**

Source: Evaluation Team analysis.

Non-Participant Trade Ally Spillover

Non-Part TA SO Savings (kWh)	Program Savings	Non-Part TA SO Rate
598,288	3,011,855	0.20

PY8	Recommendation (based upon PY7 NTG recommended values): NTG: 0.99 Free Ridership with Gas Participant: 0.41 Free Ridership with Gas TA: 0.25 TA Spillover (Participant): 0.12 TA Spillover (Non-Participant): 0.20 There was no additional NTG research conducted for EPY6. The recommended value is the same as the PY7 recommendation.
PY9	NTG: 0.99 Free-Ridership with Gas Participant: 0.41 Free-Ridership with Gas TA: 0.25 TA Spillover (Participant): 0.12 TA Spillover (Non-Participant): 0.20 NTG Source: PY7 SAG consensus value (no new research)
PY10	Program replaced in PY7 with Heating, Cooling, and Weatherization Rebates

Source: http://ilsagfiles.org/SAG_files/NTG/2017_NTG_Meetings/Final/ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.pdf