NAVIGANT

ComEd Home Energy Assessment Impact Evaluation Report

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

**Presented to
ComEd**

FINAL

April 17, 2018

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ComEd Home Energy Assessment Impact Evaluation Report

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's PY9 Home Energy Assessments (HEA) 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 method. PY9 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The HEA program is an assessment and direct install program jointly implemented by ComEd and Peoples Gas and North Shore Gas (PGL/NSG) with Franklin Energy Services implementing the program in the PGL/NSG territory. The program is also jointly implemented by ComEd and Nicor Gas with CLEAResult implementing the program in the Nicor Gas territory. This report focuses solely on the electric savings from the program. Savings from natural gas measures are included in separate evaluation reports. The primary objective of this residential direct install program was to secure energy savings through direct installation of low-cost efficiency measures such as: water efficient showerheads and faucet aerators, pipe insulation, programmable thermostats, reprogramming programmable thermostats, co-pay smart thermostats, advanced power strips (APS), compact florescent lamps (CFLs), and LEDs at eligible single-family residences.

The secondary objective of this program was to function as the "gateway" for homeowners to participate in other residential programs. HEA performs a brief assessment of the major retrofit opportunities (e.g., furnace, boiler, air conditioning, insulation, and air sealing) and brings heightened awareness to the homeowners about efficiency programs offered by ComEd, Peoples Gas, North Shore Gas, and Nicor Gas.

In PY9, the program had 23,278 participants, performed 23,907 unique projects, performed 23,736 assessments and installed 664,112 measures as shown in the following table and graph.

Table 2-1. PY9 Volumetric Findings Detail

Participation	Franklin Energy in PGL NSG Territory	CLEAResult in Nicor Gas Territory	Program Overall
Participants*	12,801	10,482	23,278
Unique Projects†	13,262	10,645	23,907
Assessments	13,194	10,542	23,736
Total Measures	383,688	280,424	664,112
Number of Units/Project	28.9	26.3	27.8
Direct Install Measures (non-CFLs or LEDs)	22,010	10,755	32,765
CFL Installations	56,165	33,269	89,434
LED Installations	305,513	236,400	541,913
Programmable Thermostats	2,663	1,044	3,707
Reprogramming Thermostats/Thermostat Education	2,654	931	3,585
Smart Thermostats	1,076	1,032	2,108
Bathroom Faucet Aerator	133	357	490
Kitchen Faucet Aerator	56	101	157
Pipe Insulation	262	396	658
Showerheads	171	409	580
APS – Tier 1	6,828	2,518	9,346
APS – Tier 2	8,167	3,967	12,134

* Participants are defined as unique ComEd account numbers
† Unique Projects are defined as unique Project ID's
Source: ComEd tracking data and Navigant team analysis.

Figure 2-1 shows measure installations by type.

Figure 2-1. Distribution of Measures Installed by Type
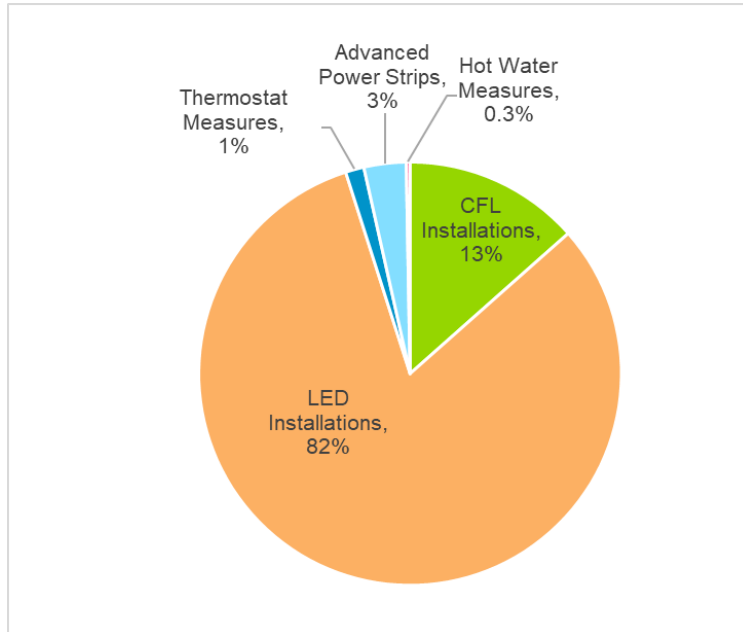
Source: Evaluation Analysis

3. PROGRAM SAVINGS

Table 3-1 summarizes the incremental energy and demand savings the HEA Program achieved in PY9.

Table 3-1. PY9 Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	30,797,725	NA	4,284
Program Gross Realization Rate	100%	NA	84%
Verified Gross Savings	30,688,042	31,337	3,581
Program Net-to-Gross Ratio (NTGR)	Varies	Varies	Varies
Verified Net Savings	25,223,277	25,316	2,983

Source: ComEd tracking data and Navigant team analysis.

4. PROGRAM SAVINGS BY MEASURE

The following tables show energy savings, demand savings, and coincidence peak demand savings by measure group. In PY9, the program included 12 measures with savings. LED and CFL installations had 21 individual measures with distinct baseline fixtures, retrofit fixtures, and installation locations. LED installations contributed most of the savings at 77 percent, followed by APS Tier 1 and Tier 2 combined at 11 percent, and CFL installations at eight percent.

Table 4-1. PY9 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)†
Lighting	CFL Installations	2,321,762	100%	2,316,461	0.80	1,853,169	NA	NA	4
Lighting	LED Installations	23,706,616	100%	23,648,986	0.80	18,919,189	NA	NA	11
HVAC	Programmable Thermostats	270,826	90%	244,440	0.90	219,996	10	50%	5
HVAC	Reprogramming Thermostats	165,324	93%	153,637	0.90	138,273	5	40%	2
HVAC	Thermostat Education	88,948	91%	80,806	0.90	72,726	5	40%	2
HVAC	Smart Thermostats	496,428	99%	491,696	NA‡	491,696	NA	NA	10
Hot Water	Bathroom Faucet Aerator	7,965	118%	9,359	0.80	7,487	NA	NA	9
Hot Water	Kitchen Faucet Aerator	20,520	90%	18,480	0.80	14,784	NA	NA	9
Hot Water	Pipe Insulation	17,856	87%	15,617	0.80	12,494	NA	NA	15
Hot Water	Showerheads	190,240	104%	197,782	0.80	158,226	NA	NA	10
Electronics	APS - Tier 1	962,741	100%	962,638	0.95	914,506	NA	NA	4
Electronics	APS - Tier 2	2,548,500	100%	2,548,140	0.95	2,420,733	NA	NA	7
	Total§	30,797,725	100%	30,688,042	Varies	25,223,277			

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site 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.
§ Values may not add due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-2. PY9 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)
Lighting	CFL Installations	NA*	NA	3,051	0.80	2,440
Lighting	LED Installations	NA	NA	25,387	0.80	20,309
HVAC	Programmable Thermostats	NA	NA	NA	0.90	NA
HVAC	Reprogramming Thermostats	NA	NA	0	0.90	0
HVAC	Thermostat Education	NA	NA	0	0.90	0
HVAC	Smart Thermostats	NA	NA	695	NA‡	695
Hot Water	Bathroom Faucet Aerator	NA	NA	554	0.80	443
Hot Water	Kitchen Faucet Aerator	NA	NA	214	0.80	171
Hot Water	Pipe Insulation	NA	NA	2	0.80	1
Hot Water	Showerheads	NA	NA	718	0.80	574
Electronics	APS - Tier 1	NA	NA	135	0.95	128
Electronics	APS - Tier 2	NA	NA	582	0.95	553
	Total§	NA	NA	31,337	Varies	25,316

*Implementation contractors did not report ex ante gross demand reduction.
†A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
‡ The IL TRM algorithm calculates net savings for smart thermostats.
§ Values may not add due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-3. PY9 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)
Lighting	CFL Installations	228	99%	226	0.80	181
Lighting	LED Installations	2,562	101%	2,581	0.80	2,065
HVAC	Programmable Thermostats	691	NA	NA	0.90	NA
HVAC	Reprogramming Thermostats	0	NA	0	0.90	0
HVAC	Thermostat Education	0	NA	0	0.90	0
HVAC	Smart Thermostats	199	81%	162	NA†	162
Hot Water	Bathroom Faucet Aerator	12	98%	12	0.80	10
Hot Water	Kitchen Faucet Aerator	5	98%	5	0.80	4
Hot Water	Pipe Insulation	2	86%	2	0.80	1
Hot Water	Showerheads	17	115%	20	0.80	16
Electronics	APS - Tier 1	108	100%	108	0.95	103
Electronics	APS - Tier 2	460	101%	465	0.95	442
	Total‡	4,284	84%	3,581	Varies	2,983

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

5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

5.1 Impact Parameter Estimates

Table 5-1 summarizes the parameters and references used in the verified gross and net savings calculations. Navigant calculated savings for each measure following algorithms defined by the Illinois TRM version 5.0 which can be found in Appendix 1.

Table 5-1. Verified Gross Savings Parameters

Research Category	Ex Ante and Verified Gross Savings (kWh/unit)	Deemed or Evaluated?	Source
Quantity	Varies	Evaluated	Program Tracking Data
NTGR	Varies		IL SAG Consensus*
CFL Installations	Varies		IL TRM v5.0 - Section 5.5†
LED Installations	Varies		IL TRM v5.0 - Section 5.5†
Programmable Thermostats	Varies		IL TRM v5.0 - Section 5.3.11†
Reprogramming Thermostats/Thermostat Education	Varies		IL TRM v5.0 - Section 5.3.11†
Smart Thermostats	Varies	Deemed	IL TRM v5.0 - Section 5.3.16†
Bathroom Faucet Aerator	Varies		IL TRM v5.0 - Section 5.4.4†
Kitchen Faucet Aerator	Varies		IL TRM v5.0 - Section 5.4.4†
Pipe Insulation	Varies		IL TRM v5.0 - Section 5.4.1†
Showerheads	Varies		IL TRM v5.0 - Section 5.4.5†
APS – Tier 1	103		IL TRM v5.0 - Section 5.2.1†
APS – Tier 2	210		IL TRM v5.0 - Section 5.2.2†

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

5.2 Other Impact Findings and Recommendations

The following provides insight into key program findings and recommendations.

Program Participation

Finding 1. In PY9, the program had 23,278 participants, performed 23,907 unique projects, performed 23,736 assessments and installed 664,112 measures. Navigant found that 586 participants who had assessments (2 percent of the assessments) did not have any of the recommended direct install measures installed in their home.

Recommendation 1. Navigant recommends interviewing participants in CY2018 to better understand the reasons why some request the assessment but do not follow through with installing measures to better understand customers' decision-making and decrease the number of home with assessments but no installed measures. In addition, Navigant recommends that the interview include questions about the participants' participation in other ComEd programs as well as other energy reduction steps they may have taken following the assessments.

Tracking System Review

Finding 2. The TRM does not give a concrete definition to distinguish single-family homes from smaller multi-family homes such as duplex, tri-plex, quadplex and households when selecting TRM assumptions for several measures. In the tracking database's measure description, the implementers included identifiers for home types such as two-unit, condo, and triplex. However, the implementers applied single-family input parameters to all home types. To increase the accuracy of the savings associated with these measures, Navigant applied multi-family parameters to home types defined as multi-family, as detailed in Table 7-1[1]. This home type discrepancy affected savings for CFL installations, LED installations,

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[1] Per email from Navigant to ComEd "RE: Navigant Request: Res Building Types", 1/29/2018.

programmable thermostats, re-programming thermostats, thermostat education, smart thermostats, aerators, and showerheads.

Recommendation 2. Navigant recommends the implementers follow the Energy Information Administration (EIA)'s definition of single-family and multi-family homes for building types[2]. In 2015, the EIA defined single-detached, single-family and duplex as single-family and two-unit, condo, triplex, quadplex, and five or more units as multi-family.

Verified Gross Impacts and Realization Rate

Finding 3. The PY9 HEA program achieved 30,688,042 kWh of verified gross energy savings. The overall gross program realization rate for energy savings is 100 percent. Although the overall program realization rate is 100 percent, there was some variability in realization rates at the measure level. Recommendations three through 11 summarize the recommendations at the measure level from Appendix 2. Impact Analysis Detail.

Recommendation 3. Navigant recommends the implementers verify that the coincidence factors (CF) for LED candelabra bulbs match the install locations to prevent the use of interior CF values for bulbs installed in exterior locations.
Note: The program resolved this discrepancy mid-PY9.

Recommendation 4. Navigant recommends the implementers update their tracking data savings for LED 15W bulbs to accurately represent the retrofit wattage as 15W instead of 19W.
Note: The program resolved this discrepancy mid-PY9.

Recommendation 5. Navigant recommends the implementers use 40W as the baseline for LED 5W Globe bulbs 350 lumens, which is consistent with the TRM.

Recommendation 6. Navigant recommends the implementer cap thermostat savings at one per single family home when multiple thermostats are installed at different dates.

Recommendation 7. Navigant recommends the implementers do not claim peak demand savings for programmable thermostats. Guidelines in the IL TRM state that summer coincident peak demand savings are not applicable due to there being no savings from cooling during the summer peak period.

Recommendation 8. Navigant recommends the implementers ensure that the baseline shown in the measure name and in the "Baseline" field are consistent for smart thermostat installations to avoid calculating baseline energy using an incorrect baseline thermostat.

Recommendation 9. Navigant recommends the implementer ensure that cooling system information shown in the "Cooling_System_Type" field of the tracking data is consistent with the requirements for smart thermostat installations to avoid miscalculation of smart thermostat coincident peak demand savings.

Recommendation 10. Navigant recommends both implementers use CF_{PJM} to calculate smart thermostat peak demand savings to support ComEd's PJM compliance requirements.

Recommendation 11. Navigant recommends the implementers make sure that R_new values for "Pipe Insulation – Electric" measures are recorded as 3.8 and not 38.

Finding 4. The PY9 HEA program achieved 31,337 kW of verified gross demand reduction and 3,581 kW of verified gross peak demand reduction. We cannot calculate the gross program realization rate for demand savings as the implementers did not track gross demand reduction. The gross program realization rate for peak demand savings is 84 percent. The reason for this discrepancy is because the implementers claimed peak demand savings for programmable thermostats where the evaluation did not, using the guidelines in the IL TRM for this measure. See Recommendation 7 above.

Verified Net Impacts

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[2] https://www.eia.gov/consumption/residential/terminology.php#s

Finding 5. The evaluation used varying deemed net-to-gross (NTG) values depending on the measure to calculate verified net savings of 25,223,277 kWh, verified net demand reduction of 25,316 kW and verified net peak demand reduction of 2,983 kW. In PY9, the HEA program exceeded its net savings forecast of 24,490 MWh by 733 MWh.

6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

Navigant calculated verified gross and net savings using the following algorithms as defined by the IL TRM v5.0 in PY9.

6.1 CFL and LED Replacement

Verified Gross Annual kWh Savings = Program Bulb Quantity $*$ ΔWatts/1000 $*$ ISR $*$ HOU $*$ WHF_{energy}

Where:
- ΔWatts = Difference between Baseline Wattage and Efficient (LED) Wattage, Evaluated
- HOU = Annual Hours of Use, Deemed
- WHF_{energy} = Energy Waste Heat Factor, Deemed

Verified Gross Annual kW Savings = Program Bulb Quantity $*$ ΔWatts/1000
Verified Gross Annual Peak kW Savings = Gross Annual kW Savings $*$ Peak Load Coincidence Factor $*$ WHF_{demand}

Where:
- Peak Load Coincidence Factor is calculated as the percentage of program bulbs turned on during peak hours (weekdays from 1 to 5 p.m.) throughout the summer.
- WHF_{demand} = Demand Waste Heat Factor

6.2 Low Flow Faucet Aerators

Verified Gross Annual kWh Savings = ((GPM_{base} $*$ L_{base} – GPM_{low} $*$ L_{low}) $*$ Household $*$ 365.25 $*$ DF / FPH) $*$ $EPG_{electric}$ $*$ISR

Where:

- GPM_{base} = Average baseline flowrate, Gallons per minute, Deemed
- L_{base} = Average baseline daily faucet use per capita, Deemed
- GPM_{low} = Average low flowrate, Gallons per minute, Deemed
- L_{low} = Average baseline daily faucet use per capita, Deemed
- Household = Average number of people per household, Deemed
- 365.25 = Number of days per year
- DF = Drain Factor, Deemed
- FPH = Faucets per household, Deemed
- $EPG_{electric}$ = Energy per gallon of water used supplied by electric water heater, Deemed
- ISR = In Service Rate, Deemed

Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU
Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU $*$ CF

6.3 Low Flow Showerheads

Verified Gross Annual kWh Savings = $((GPM_{base} * L_{base} - GPM_{low} * L_{low}) *$ Household $*$ SPCD $* 365.25$ SPH$) * EPG_{electric} *$ISR

Where:
- SPCD = Showers per capita per day, Deemed
- SPH = Showers per household, Deemed

Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU
Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU * CF

6.4 Advanced Power Strips

Tier 1:

Verified Gross Annual kWh savings = Deemed Energy Savings Per Unit
Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU
Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU * CF

Tier 2:

Verified Gross Annual kWh savings = Energy Reduction Percentage (ERP) * Baseline Energy * ISR
Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU
Verified Gross Annual Peak kW Savings = Gross Annual Energy Savings / HOU * CF

6.5 Programmable Thermostats, Reprogramming Thermostats, Thermostat Education

Verified Gross Annual kWh Savings = Electric Heating Consumption * Heating Reduction * HF * ISR + (ΔTherms $* F_e * 29.3$)

Where:
- Heating Reduction = Assumed percentage reduction in total household heating energy consumption due to programmable thermostat, Deemed
- HF = Household Factor, Deemed
- ISR = In Service Rate, Deemed
- F_e = Furnace fan energy consumption as a percentage of annual fuel consumption, Deemed
- 29.3 = kWh per therm conversion
- ΔTherms is calculated as follows

ΔTherms = %Fossil Heat * Gas Heating Consumption * Heating Reduction * HF * ISR

6.6 Water Heater Pipe Insulation

Verified Gross Annual kWh Savings = $((1/R_{exist} = 1/R_{new}) *$ Length of Insulation $*$ Circumference of Pipe $* \Delta T * 8,766) /$ (Water Heater Efficiency $* 3,413$)

Where:
- R_{exist} = Existing pipe thermal resistance, Deemed

- R_{new} = Total pipe thermal resistance after adding insulation, claimed based on pipe insulation used
- ΔT = Temperature difference between the water in the pipe and the surrounding air, Deemed
- 3,413 = Conversion from BTU to kWh

6.7 Deemed Values

Navigant calculated verified gross direct install savings for the PY9 HEA program using algorithms, assumptions, and input parameters defined in the Illinois TRM v5.0. Table 6-1 shows the deemed input values used in these algorithms and calculations

Table 6-1. TRM Deemed Savings Input Parameters Used in Ex Post Analysis

Verified Gross and Net Input Parameters	Value	Data Source
CFL In-Service Rate (ISR)	0.969	IL TRM v5.0, Section 5.5.1
CFL HOU (Interior / Exterior)	793 / 2,475	IL TRM v5.0, Section 5.5.1
CFL WHF$_{energy}$ (SF Interior / MF Interior / Exterior)	1.06 / 1.04 / 1.00	IL TRM v5.0, Section 5.5.1
CFL WHF$_{demand}$ (SF Interior / MF Interior / Exterior)	1.11 / 1.07 / 1.00	IL TRM v5.0, Section 5.5.1
CFL CF	0.074	IL TRM v5.0, Section 5.5.1
LED ISR	0.969	IL TRM v5.0, Section 5.5.8
LED HOU (Interior / Exterior)	759 / 2,475	IL TRM v5.0, Section 5.5.8
LED WHF$_{energy}$ (SF Interior / MF Interior / Exterior)	1.06 / 1.04 / 1.00	IL TRM v5.0, Section 5.5.8
LED WHF$_{demand}$ (SF Interior / MF Interior / Exterior)	1.11 / 1.07 / 1.00	IL TRM v5.0, Section 5.5.8
LED CF	0.071	IL TRM v5.0, Section 5.5.8
Faucet Aerator GPM$_{base}$	1.39	IL TRM v5.0, Section 5.4.4
Faucet Aerator L$_{base}$ (Kitchen / Bathroom)	4.5 / 1.6	IL TRM v5.0, Section 5.4.4
Faucet Aerator GPM$_{low}$	0.94	IL TRM v5.0, Section 5.4.4
Faucet Aerator L$_{low}$ (Kitchen / Bathroom)	4.5 / 1.6	IL TRM v5.0, Section 5.4.4
Faucet Aerator Household (Single Family / Multi Family)	2.56 / 2.1	IL TRM v5.0, Section 5.4.4
Faucet Aerator DF (Kitchen / Bathroom)	0.75 / 0.90	IL TRM v5.0, Section 5.4.4
Faucet Aerator FPH (Kitchen / SF Bath / MF Bath)	1 / 2.83 / 1.5	IL TRM v5.0, Section 5.4.4
Faucet Aerator EPG$_{electric}$ (Kitchen / Bath)	0.0969 / 0.0795	IL TRM v5.0, Section 5.4.4
Faucet Aerator ISR (SF / MF Kitchen / MF Bath)	0.95 / 0.91 / 0.95	IL TRM v5.0, Section 5.4.4
Faucet Aerator HOU (SF K / SF B / MF K / MF B)	94 / 14 / 77 / 22	IL TRM v5.0, Section 5.4.4
Faucet Aerator CF	0.022	IL TRM v5.0, Section 5.4.4
Shower GPM$_{base}$	2.67	IL TRM v5.0, Section 5.4.5
Shower L$_{base}$	7.8	IL TRM v5.0, Section 5.4.5
Shower GPM$_{low}$	1.5	IL TRM v5.0, Section 5.4.5
Shower L$_{low}$	7.8	IL TRM v5.0, Section 5.4.5
Shower Household (Single Family / Multi Family)	2.56 / 2.1	IL TRM v5.0, Section 5.4.5
Shower SPCD	0.6	IL TRM v5.0, Section 5.4.5
SPH (Single Family / Multi Family)	1.79 / 1.3	IL TRM v5.0, Section 5.4.5
Shower EPG$_{electric}$	0.117	IL TRM v5.0, Section 5.4.5
Shower ISR (SF / MF)	0.98 / 0.95	IL TRM v5.0, Section 5.4.5
Shower HOU (SF / MF)	302 / 248	IL TRM v5.0, Section 5.4.5
Shower CF	0.0278	IL TRM v5.0, Section 5.4.5
Advanced Power Strip Energy Savings (Tier 1)	103	IL TRM v5.0, Section 5.2.1
Advanced Power Strip Energy ERP	0.5	IL TRM v5.0, Section 5.2.2
Advanced Power Strip Baseline Energy	600	IL TRM v5.0, Section 5.2.2
Advanced Power Strip ISR	0.7	IL TRM v5.0, Section 5.2.2
Advanced Power Strip CF	0.80	IL TRM v5.0, Section 5.2.1/5.2.2

Verified Gross and Net Input Parameters	Value	Data Source
Advanced Power Strip HOU (Tier 1 / Tier 2)	7129 / 4380	IL TRM v5.0, Section 5.2.1/5.2.2
Programmable Thermostat Electric Heating Consumption (Electric Resistance / Heat Pump / Gas)	20,771 / 12,218 / 0	IL TRM v5.0, Section 5.3.11
Programmable Thermostat Gas Heating Consumption [Therms] (Electric Resistance / Heat Pump / Gas)	0 / 0 / 1,005	IL TRM v5.0, Section 5.3.11
Programmable Thermostat Heating Reduction	0.062	IL TRM v5.0, Section 5.3.11
Programmable Thermostat HF (Single Family / Multi Family)	1 / 0.65	IL TRM v5.0, Section 5.3.11
Programmable Thermostat ISR	1	IL TRM v5.0, Section 5.3.11
Programmable Thermostat F_e	0.0314	IL TRM v5.0, Section 5.3.11
DHW R_{exist}	1	IL TRM v5.0, Section 5.4.1
DHW R_{new}	2.8 / 3.8	IL TRM v5.0, Section 5.4.1
DHW ΔT	60	IL TRM v5.0, Section 5.4.1
DHW ηDHW	.98	IL TRM v5.0, Section 5.4.1
DHW Circumference of Pipe	0.196	IL TRM v5.0, Section 5.4.1

6.8 Smart Thermostats

The savings for smart, or "advanced," thermostats were calculated using deemed savings values based on application type and heating fuel that were discussed and agreed upon prior to this program year. The calculations done by Navigant used the algorithms presented below from the Illinois TRM v5.0, Section 5.3.16. Navigant also used population data specific to the HEA participants to more accurately represent the target population.

Verified Gross Annual kWh Savings = Electric Heating Consumption * Heating Reduction * HF * ISR + (ΔTherms * F_e * 29.3)

Where:
- Heating Reduction = Assumed percentage reduction in total household heating energy consumption due to programmable thermostat, Deemed
- HF = Household Factor, Deemed
- ISR = In Service Rate, Deemed
- F_e = Furnace fan energy consumption as a percentage of annual fuel consumption, Deemed
- 29.3 = kWh per therm conversion

The deemed input parameters for smart thermostats are summarized in the table below.

Table 6-2. Deemed Savings Input Parameters and Sources

Verified Gross and Net Input Parameters	Value	Data Source
Smart Thermostat Electric Heating Consumption (Electric Resistance / Heat Pump / Gas)	20,771 / 12,218 / 0	IL TRM v5.0, Section 5.3.16
Smart Thermostat Heating Reduction (Manual Baseline / Programmable BL / Unknown BL)	0.088 / 0.056 / 0.074	IL TRM v5.0, Section 5.3.16
Smart Thermostat HF (Single Family / Multi Family)	1 / 0.65	IL TRM v5.0, Section 5.3.16
Smart Thermostat ISR	1	IL TRM v5.0, Section 5.3.16
Smart Thermostat F_e	0.0314	IL TRM v5.0, Section 5.3.16

7. APPENDIX 2. IMPACT ANALYSIS DETAIL

This Appendix provides more detail on the impact analysis. The recommendations presented in this appendix are the same as those presented in Section 5. They are repeated here so they can be reviewed in context with the expanded discussion of the issue.

7.1 Home Type Definition

The TRM does not give a concrete definition to distinguish single family from smaller multi-family buildings such as duplex, tri-plex, quadplex and households when selecting TRM assumptions on several measures. Navigant defined building types for this program[3] differently compared to the implementers, which reflects a change from how we analyzed the impacts in the PY9 Wave 1 memo. For this report, Navigant used nationally-recognized definitions in the EIA 2015 Residential Energy Consumption Survey[4].

The EIA single-family home definition is: "A housing unit either detached from or attached to another housing unit that typically provides living space for one household or family. Housing units that are connected side-by-side by a wall that extends ground to roof are considered single-family attached units (i.e., a townhouse, row house, or duplex.) A mobile home is not classified as a single-family home."

The EIA multi-family home definition is: "A self-contained housing unit that occupies only part of a multi-family residential building that has two or more housing units. Apartments may be owned by an owner/occupier or rented by tenants. This category includes condominium apartments (i.e. individually owned apartments), basement apartments, or other residential structures where units are stacked vertically. Housing units that are connected side-by-side by a wall that extends ground to roof are considered single-family attached units (i.e., a townhouse, row house, or duplex.) RECS categorizes apartments into those that are in buildings with two to four units—this category also includes houses originally intended for occupancy by one household (or for some other use) that have since been converted to separate dwellings for two to four households—and that are buildings with five or more units."

The following table details how each building type was categorized for the HEA program in PY9.

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[3] Per email from Navigant to ComEd "RE: Navigant Request: Res Building Types", 1/29/2018.
[4] https://www.eia.gov/consumption/residential/terminology.php#s

Table 7-1. Home Type Definition

Identified Building Types	Implementers' Treatment	Navigant's Treatment
Two-Unit	SF	MF
Condo	SF	MF
Duplex	SF	SF
Five or More Units	SF	MF
Quadplex	SF	MF
Single-Detached	SF	SF
Single-Family	SF	SF
Triplex	SF	MF

Source: ComEd tracking data and Navigant analysis

The discrepancy between the implementers' treatment and Navigant's treatment of home types affected savings for CFL installations, LED installations, programmable thermostats, re-programming thermostats, thermostat education, and smart thermostats, aerators, and showerheads. For CFL installations, re-programming thermostats, aerators, and showerheads, the home type discrepancy is the sole reason for deviation of the verified gross realization rate from 100 percent.

> **Recommendation 2**. Navigant recommends the implementers follow the EIA's definition of single family and multi-family homes for building types. In 2015, the EIA defined single-detached, single-family and duplex as single-family and two-unit, condo, triplex, quadplex, and five or more units as multi-family.

7.2 CFL Installations

CFL Installations have a realization rate of 100 percent and represent eight percent of overall energy savings. Table 7-2 shows the results from analysis of individual CFL measures.

Table 7-2. CFL Measure Impact Detail

Research Category	Measures Installed	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTGR	Verified Net Savings (kWh)
CFL 13W	70,909	1,731,181	100%	1,727,521	0.80	1,382,016
CFL 18W	7,465	212,764	100%	212,185	0.80	169,748
CFL 23W	8,370	333,987	100%	333,041	0.80	266,433
CFL 9W	2,690	43,830	100%	43,714	0.80	34,971

Source: ComEd tracking data and Navigant team analysis.

7.3 LED Installations

LED Installations have a realization rate of 100 percent and represent 77 percent of overall energy savings.

Table 7-3 shows the results from analysis of individual LED measures.

Table 7-3. LED Measure Impact Detail

Research Category	Measures Installed	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTGR	Verified Net Savings (kWh)
LED - 19W PAR38	985	238,568	100%	238,592	0.80	190,874
LED - BR30	42,089	2,106,567	100%	2,111,312	0.80	1,689,049
LED - Globe	31,951	955,238	100%	952,187	0.80	761,749
LED 11W	8,115	344,271	100%	343,952	0.80	275,161
LED 15W	13,302	1,687,038	103%	1,729,523	0.80	1,383,619
LED 16W	1,671	93,259	100%	93,225	0.80	74,580
LED 17W	1,560	230,716	100%	230,702	0.80	184,562
LED 5.5W	5,581	110,613	100%	110,471	0.80	88,377
LED 5W	10,407	273,687	87%	238,614	0.80	190,891
LED 6.5W	3,016	116,026	100%	115,836	0.80	92,669
LED 6W	52,411	1,480,711	101%	1,488,807	0.80	1,191,045
LED 8W	125,289	6,361,832	100%	6,349,719	0.80	5,079,775
LED 9W	101,092	3,055,854	100%	3,051,004	0.80	2,440,803
LED A-Line 13W	4,482	332,770	100%	332,787	0.80	266,230
LED A-Line 7W	972	24,019	100%	23,973	0.80	19,179
LED Candelabra	124,006	5,726,053	99%	5,670,657	0.80	4,536,525
LED Track Light	14,984	569,394	100%	567,625	0.80	454,100

Source: ComEd tracking data and Navigant team analysis.

Navigant observed that while calculating the ex post savings for exterior LED candelabra bulbs that the calculator used a CF of 0.121 for interior installations instead of the 0.273 deemed by the IL TRM v5.0.

> **Recommendation 3**. Navigant recommends the implementers verify that the CF for LED candelabra bulbs match the install locations to prevent the use of interior CF values for bulbs installed in exterior locations. Note: The program resolved this discrepancy mid-PY9.

Navigant observed that while calculating the ex post savings for LED 15W that Franklin has been installing 15W LED bulbs instead of 19W bulbs in the ex ante calculation as in previous years. Franklin has noted the change and increase in savings but has not yet update the calculator or tracking savings to reflect the change in retrofit wattage.

> **Recommendation 4.** Navigant recommends the implementers update their tracking data savings for LED 15W bulbs to accurately represent the retrofit wattage as 15W instead of 19W. Note: The program resolved this discrepancy mid-PY9.

Navigant observed while calculating the ex post savings for exterior LED 5W Globe bulbs that the calculator lists the baseline as a 50/50 blend of 60W and 40W. Navigant reviewed the specification for the installed 5W Globe bulb and found the lumens to be 350. The IL TRM deems 40W as the baseline wattage for Globe bulbs 350-749 lumens, and Navigant calculated verified savings using 40W as the baseline wattage.

> **Recommendation 5.** Navigant recommends the implementers use 40W as the baseline for LED 5W Globe bulbs 350 lumens, which is consistent with the TRM.

All other differences between reported ex ante gross savings and verified gross savings were due to the home type discrepancy.

7.4 All Thermostats

In Section 5.3.11 Programmable Thermostats and Section 5.3.16 Advanced Thermostats, the IL TRM indicates that "installation of multiple programmable thermostats per home does not accrue additional savings." Navigant and the implementer capped savings for thermostats to reflect one installation per project for single-family homes and the number of units for multi-family buildings (i.e., duplexes were capped at two measures; triplexes at three measures; and quadplexes were capped at four measures) for smart thermostats, programmable thermostats, re-programming thermostats, and thermostat education. However, Navigant found instances of multiple records with different project IDs that show two thermostats installed at different dates in the same home, resulting in double counting of ex ante savings. The quantity of programmable thermostats that resulted in verified savings was 3,707, which was 74 less than the reported quantity of 3,781. The quantity of thermostat education measures that resulted in verified savings was 931, 44 less than the reported quantity of 975. The quantity of smart thermostats that resulted in verified savings was 2,108, 113 less than the reported quantity of 2,221, and the quantity of re-programmed thermostats that resulted in verified savings was 2,654, 28 less than the reported quantity of 2,682

> **Recommendation 6.** Navigant recommends the implementer cap thermostat savings at one per single family home when multiple thermostats are installed at different dates.

7.5 Programmable Thermostats

Programmable thermostats have a realization rate of 91 percent and represent one percent of overall energy savings. The implementers reported ex ante kW savings for programmable thermostats, but Navigant did not verify any demand savings. Section 5.3.11 of the IL TRM states that summer coincident peak demand savings are not applicable due to there being no savings from cooling during the summer peak period. Additional data would be required to calculate non-peak demand savings. For these reasons the verified gross peak demand savings and realization rate is NA and the peak demand realization rate is NA. This discrepancy in programmable thermostat peak demand savings was the reason why the peak demand realization rate for the HEA program in PY9 is 83 percent.

> **Recommendation 7.** Navigant recommends the implementers do not claim peak demand savings for programmable thermostats. Guidelines in the IL TRM state that summer coincident peak demand savings are not applicable due to there being no savings from cooling during the summer peak period.

7.6 Smart Thermostats

Smart thermostats have a realization rate of 96 percent and represent one percent of overall energy savings.

Navigant observed that there were inconsistencies between the baseline information in the "Existing Thermostat Type" field and the "Measure_Name" field of the tracking data. For instance, despite being named "Gas Tstat - Smart Stat ($150) Baseline Manual NSG/ComEd SF PY6/9" the "Baseline" field stated that the "Existing Thermostat Type" was "Programmable". The implementer informed Navigant that

secondary home characteristics are less accurate and measure name should take precedence. Navigant used information in the measure name to determine baselines as well as the "Existing Thermostat Type" field if no baseline was included in the measure name. In some cases, no baseline information was included in the measure name and the "Existing Thermostat Type" field indicated that the baseline was "Smart". Since the IL TRM does not deem any values for these cases of "Smart" baseline, the existing thermostat type was considered "unknown".

> **Recommendation 8.** Navigant recommends the implementers ensure that the baseline shown in the measure name and in the "Baseline" field are consistent for smart thermostat installations to avoid calculating baseline energy using an incorrect baseline thermostat.

In less than four percent of projects, the "Cooling_System_Type" field showed that the home had something other than central air conditioning or lacked central air conditioning. The IL TRM instructs that projects without central air conditioning cannot claim smart thermostat coincident peak demand savings. Navigant considered all smart thermostat projects to have central air conditioning as the program guidelines require homes to have central air conditioning to be eligible for smart thermostats.

> **Recommendation 9.** Navigant recommends the implementer ensure that cooling system information shown in the "Cooling_System_Type" field is consistent with the requirements for smart thermostat installations to avoid miscalculation of smart thermostat coincident peak demand savings.

Navigant further observed that while CLEAResult used the CF_{PJM} to calculate the ex ante peak demand savings, Franklin Energy used the CF_{SSP}. Navigant used the CF_{PJM} value to calculate the ex post peak demand savings to support ComEd's PJM compliance requirements, resulting in a gross peak demand realization rate of 78 percent.

> **Recommendation 10.** Navigant recommends both implementers use CF_{PJM} to calculate smart thermostat peak demand savings to support ComEd's PJM compliance requirements.

7.7 Pipe Insulation

Pipe insulation has a realization rate of 87 percent and represents 0.05 percent of overall energy savings. The low realization rate is attributed to measures labeled "Pipe Insulation – Electric" with R_new = 3.8 according to the implementer's calculator. The realization rate of these measures is 81 percent. Navigant noted that verified savings matched ex ante savings if R_new was inputted as 38. It is possible that the implementer's calculator accidentally inserted the period in the wrong place, turning R_new = 3.8 to R_new = 38.

> **Recommendation 11.** Navigant recommends the implementers make sure that R_new values for "Pipe Insulation – Electric" measures are recorded as 3.8 and not 38.

8. APPENDIX 3. TOTAL RESOURCE COST DETAIL

Table 8-1, below, shows the Total Resource Cost (TRC) variable table, which only includes cost-effectiveness analysis inputs available at the time of finalizing the PY9 HEA 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. EUL information in this table is subject to change and is not final.

Table 8-1. 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)
Lighting	CFL Installations	Each	89,434	4	2,321,762	228	2,316,461	226
Lighting	LED Installations - Track and Recessed	Each	93,281	15	5,550,470	612	5,594,069	618
Lighting	LED Installations - All Other	Each	448,632	10	18,156,146	1,950	18,054,917	1,963
HVAC	Programmable Thermostats	Each	3,707	5	270,826	691	244,440	NA
HVAC	Reprogramming Thermostats	Each	2,654	2	165,324	0	153,637	0
HVAC	Thermostat Education	Each	931	2	88,948	0	80,806	0
HVAC	Smart Thermostats	Each	2,108	10	496,428	199	491,696	162
Hot Water	Bathroom Faucet Aerator	Each	490	9	7,965	12	9,359	12
Hot Water	Kitchen Faucet Aerator	Each	157	9	20,520	5	18,480	5
Hot Water	Pipe Insulation	Linear Feet	658	15	17,856	2	15,617	2
Hot Water	Showerheads	Each	580	10	190,240	17	197,782	20
Electronics	APS - Tier 1	Each	9,346	4	962,741	108	962,638	108
Electronics	APS - Tier 2	Each	12,134	7	2,548,500	460	2,548,140	465

Source: ComEd tracking data and Navigant team analysis.