NAVIGANT

ComEd CLEAResult Schools Direct Install IPA Program Impact Evaluation Report

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

Presented to
ComEd

FINAL

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ComEd CLEAResult Schools Direct Install IPA Program Impact Evaluation Report

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's Program Year 9 (PY9) CLEAResult Schools Direct Install IPA Program. It presents a summary of the energy and demand impacts for the total program and broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology. PY9 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The CLEAResult Schools Direct Install IPA Program aids small private educational facilities[1] to implement energy efficiency measures. CLEAResult is the program implementer and eligible measures include LED exit signs, LED lamps, low-flow devices (aerators, showerheads and pre-rinse spray valves), programmable thermostats, occupancy sensors and vending machine controllers.

The program had 116 participants in PY9 and installed 1,895 units of 18 unique measures, as shown in the following table and graph. The 18 unique measures have been categorized into four end-use categories: lighting, refrigeration, thermostats and water heating.

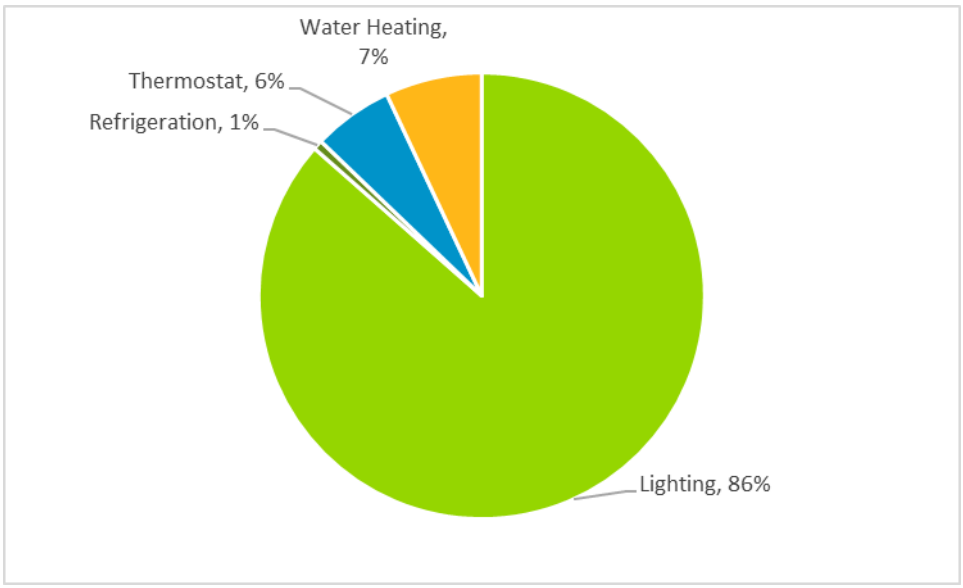
Table 2-1. PY9 Volumetric Findings Detail

Participation	PY9
Participants	116
Total Measures	1,895
Number of Units/Projects	16
Lighting Measures	1,639
Refrigeration Measures	13
Thermostat Measures	110
Water Heating Measures	133

Source: ComEd tracking data and Navigant team analysis.

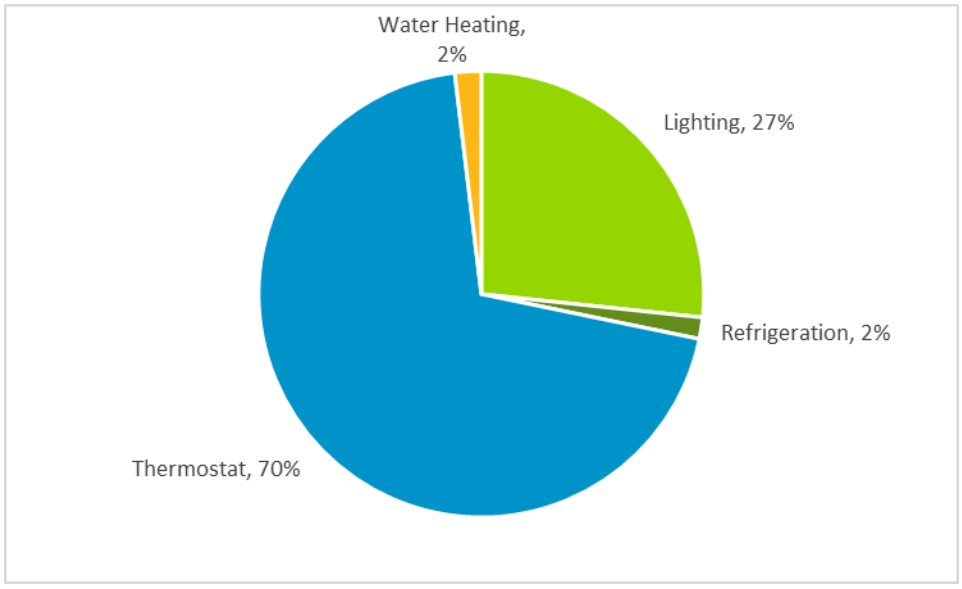
[1] "Small commercial and industrial" customers are defined as customers with peak demands of 100 kW or less.

Figure 2-1. Installations by Measure Type



Source: Evaluation Analysis

Figure 2-2. Program Savings by Measure Type



Source: Evaluation Analysis

3. Program Savings

Table 3-1 summarizes the incremental energy and demand savings the CLEAResult Schools Direct Install IPA Program achieved in PY9. The 122 percent realization rate on energy savings is due to an increase in verified savings for the programmable thermostat measure and updated measure savings based on actual building types.

Table 3-1. PY9 Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	1,105,022	NR	268
Program Gross Realization Rate	122%	NA	98%
Verified Gross Savings	1,352,207	607	261
Program Net-to-Gross Ratio (NTGR)	0.95	0.95	0.95
Verified Net Savings	1,284,596	576	248

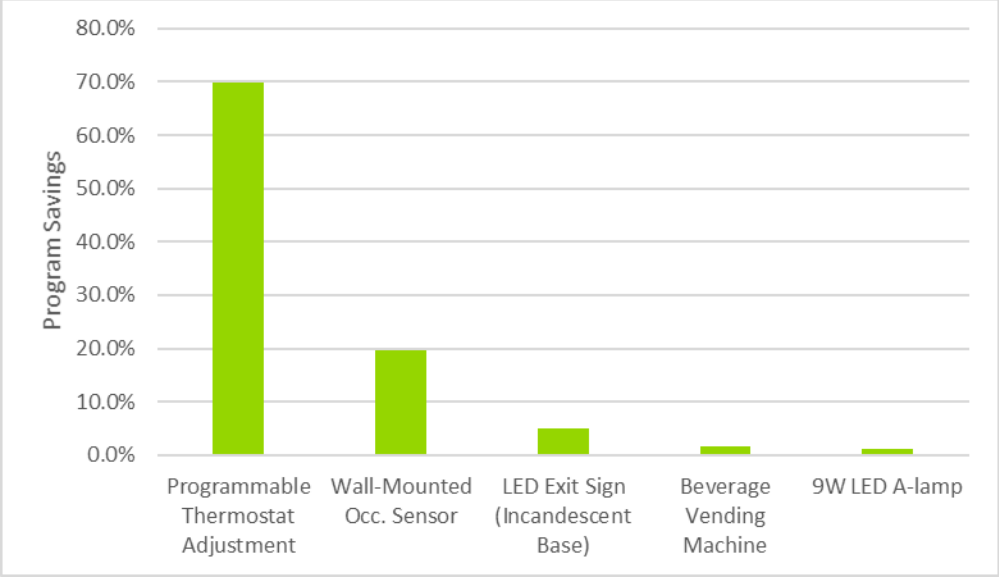
NR = not reported
Source: ComEd tracking data and Navigant team analysis.

In addition to energy and demand savings, certain measures in the program also generate water savings. The ComEd CLEAResult Schools Direct Install IPA program generated 65,488 gallons of annual verified water savings. The details of the water savings are provided in Table 4-4.

4. Program Savings by Measure

The program includes 18 unique measures as shown in the following table. The programmable thermostat adjustments and wall-mounted occupancy sensors are the most impactful measures and account for 90 percent of the program savings.

Figure 4-1. Top Five Measures by Total Savings



Source: ComEd tracking data and Navigant team analysis.

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	13.5W LED BR30 Directional	3,191	106%	3,386	0.95	3,217	NA	NA	14.6
Lighting	13W LED A-lamp	1,883	118%	2,230	0.95	2,118	NA	NA	9.5
Lighting	7.5W LED A-lamp	959	121%	1,157	0.95	1,099	NA	NA	9.4
Lighting	8W LED BR30 Directional	282	138%	391	0.95	371	NA	NA	8.1
Lighting	8W LED Globe Lamp	2,191	119%	2,610	0.95	2,479	NA	NA	9.8
Lighting	9W LED A-lamp	16,767	92%	15,459	0.95	14,686	NA	NA	12.3
Lighting	CFL Lamp (15W or Less)	72	138%	99	0.95	94	NA	NA	3.2
Lighting	CFL Lamp (21W or Greater)	364	117%	427	0.95	406	NA	NA	3.3
Lighting	LED Exit Sign (Fluorescent Base)	369	101%	372	0.95	354	NA	NA	16.0
Lighting	LED Exit Sign (Incandescent Base)	67,691	98%	66,566	0.95	63,238	NA	NA	16.0
Lighting	Occupancy Sensor (Remote Mounted)	2,646	84%	2,230	0.95	2,118	NA	NA	8.0
Lighting	Occupancy Sensor (Wall Mounted)	298,694	89%	265,715	0.95	252,429	NA	NA	8.0
Refrigeration	Vending Machine Controls (Refrigerated Beverage Machine)	20,968	100%	20,968	0.95	19,920	NA	NA	5.0
HVAC	Programmable Thermostat Adjustment	668,276	141%	944,714	0.95	897,478	8.0	25%	2.0
Water Heating	Low Flow Aerator - Bath	5,355	146%	7,797	0.95	7,407	NA	NA	9.0
Water Heating	Low Flow Aerator - Kitchen	4,828	157%	7,600	0.95	7,220	NA	NA	9.0
Water Heating	Low Flow Showerhead	2,177	100%	2,177	0.95	2,068	NA	NA	10.0
Water Heating	Pre-Rinse Spray Valve	8,309	100%	8,309	0.95	7,893	NA	NA	5.0
	Total§	1,105,022	122%	1,352,207	0.95	1,284,596	NA	NA	4.2

* 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 expected measure life of a programmable thermostat is assumed to be 8 years based upon equipment life only. For the purposes of claiming savings" for thermostat replacement and adjustments, persistence factors are provided. State of Illinois Technical Reference Manual, version 5.0

‡ EUL is a combination of technical measure life and persistence.

§ Numbers may not sum exactly 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	13.5W LED BR30 Directional	NR	NA	2	0.95	2
Lighting	13W LED A-lamp	NR	NA	1	0.95	1
Lighting	7.5W LED A-lamp	NR	NA	1	0.95	0.5
Lighting	8W LED BR30 Directional	NR	NA	0.1	0.95	0.1
Lighting	8W LED Globe Lamp	NR	NA	1	0.95	1
Lighting	9W LED A-lamp	NR	NA	9	0.95	9
Lighting	CFL Lamp (15W or Less)	NR	NA	0.0	0.95	0.0
Lighting	CFL Lamp (21W or Greater)	NR	NA	0.2	0.95	0.2
Lighting	LED Exit Sign (Fluorescent Base)	NR	NA	0.1	0.95	0.0
Lighting	LED Exit Sign (Incandescent Base)	NR	NA	9	0.95	8
Lighting	Occupancy Sensor (Remote Mounted)	NR	NA	2	0.95	1
Lighting	Occupancy Sensor (Wall Mounted)	NR	NA	225	0.95	214
Refrigeration	Vending Machine Controls(Refrigerated	NR	NA	0.0	0.95	0.0
HVAC	Programmable Thermostat Adjustment	NR	NA	0.0	0.95	0.0
Water Heating	Low Flow Aerator - Bath	NR	NA	183	0.95	174
Water Heating	Low Flow Aerator - Kitchen	NR	NA	165	0.95	156
Water Heating	Low Flow Showerhead	NR	NA	10	0.95	9
Water Heating	Pre-Rinse Spray Valve	NR	NA	0.0	0.95	0.0
	Total†	NR	NA	607	0.95	576

NR = not reported
* 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.
† Numbers may not sum exactly 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	13.5W LED BR30 Directional	1	107%	1	0.95	1
Lighting	13W LED A-lamp	1	102%	1	0.95	1
Lighting	7.5W LED A-lamp	0.3	107%	0.4	0.95	0.3
Lighting	8W LED BR30 Directional	0.1	113%	0.1	0.95	0.1
Lighting	8W LED Globe Lamp	1	104%	1	0.95	1
Lighting	9W LED A-lamp	6	88%	5	0.95	5
Lighting	CFL Lamp (15W or Less)	0.0	113%	0.0	0.95	0.0
Lighting	CFL Lamp (21W or Greater)	0.1	101%	0.1	0.95	0.1
Lighting	LED Exit Sign (Fluorescent Base)	0.0	105%	0.0	0.95	0.0
Lighting	LED Exit Sign (Incandescent Base)	8	107%	9	0.95	8
Lighting	Occupancy Sensor (Remote Mounted)	2	113%	2	0.95	2
Lighting	Occupancy Sensor (Wall Mounted)	245	96%	236	0.95	224
Refrigeration	Vending Machine Controls (Refrigerated Beverage Machine)	0.0	NA	0.0	0.95	0.0
HVAC	Programmable Thermostat Adjustment	0.0	NA	0.0	0.95	0.0
Water Heating	Low Flow Aerator - Bath	2	164%	3	0.95	3
Water Heating	Low Flow Aerator - Kitchen	2	145%	2	0.95	2
Water Heating	Low Flow Showerhead	0.3	106%	0.3	0.95	0.3
Water Heating	Pre-Rinse Spray Valve	0.0	NA	0.0	0.95	0.0
	Total†	268	98%	261	0.95	248

* 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.
† Numbers may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 4-4. PY9 Water Savings by Measure

Measure	Water Savings (gal/yr)
Low Flow Aerator - Bath	657
Low Flow Aerator - Kitchen	486
Low Flow Showerhead	17,171
Pre-Rinse Spray Valve	47,174
Total	65,488

Source: ComEd tracking data and Navigant team analysis.

5. Impact Analysis Findings and Recommendations

5.1 Impact Parameter Estimates

Energy and demand savings are estimated using the following algorithms from the IL TRM v5.0. The measure-specific parameters are detailed in Appendix 6.

Table 5-1. Verified Gross Savings Parameters

Gross Savings Input Parameters	Deemed* or Evaluated?
Quantity	Deemed
Measure Type and Eligibility	Deemed
Gross Savings per Unit, Sampled Deemed Measures	Deemed
Verified Realization Rate on Ex Ante Gross Savings (Lighting)	Deemed
Verified Realization Rate on Ex Ante Gross Savings (Non-Lighting)	Deemed

* State of Illinois Technical Reference Manual version 2.0 from http://www.ilsag.info/technical-reference-manual.html.

5.2 Other Impact Findings and Recommendations

The program's energy realization rate of 122 percent is primarily due to an increase in verified savings for the programmable thermostat measure. This, and all other findings are detailed below.

Finding 1. The deemed savings for programmable thermostat adjustment were not correctly documented in the tracking system. Using the algorithms and assumptions agreed outlined in Section 6.4, the verified energy savings is 8,588 kWh, or 140 percent of the ex ante value.
Recommendation 1. Navigant recommends correcting this value in the tracking data.

Finding 2. The ex ante savings assumes the Elementary School building type for all projects. Navigant used an additional level of building type information included in the tracking database,[2] which when combined with online research, yielded additional school building types to refine the project with a more targeted savings estimate. Navigant's analysis incorporated the adjusted building types in verifying the savings for this program.
Recommendation 2. Navigant recommends that the implementer collect building type information and use parameter assumptions from TRM based on different building types to estimate savings.

Finding 3. The ex ante gross demand savings for all measures do not match for the verified demand savings. In an effort to determine the cause of this discrepancy, Navigant verified the peak demand savings using the Elementary Schools as the assumed building type and found that all measures still did not match the ex ante peak demand savings. The reasons for this discrepancy could not be determined, however a measure-level correlation was found.

[2] The tracking data classifies the building types as Childcare, Elementary, High School, K-12, Other and Preschool.

Table 5-2. Demand Savings Realization Rate for Elementary School Building Type

Measure Type	Demand Realization Rate (using Elementary School)
Lighting Measures	105%
Low Flow Showerhead	106%
Low Flow Aerator - Bath	138%
Low Flow Aerator - Kitchen	139%

Source: ComEd tracking data and Navigant team analysis.

Recommendation 3. Navigant recommends correcting the deemed savings used in the tracking data.

Finding 4. The ex ante energy savings for measures MC-2415762 and MC-2480514 do not match the verified savings. The reasons for this discrepancy could not be determined.
Recommendation 4. Navigant recommends correcting these values in the tracking data.

Finding 5. The tracking system included peak demand reduction but did not include non-peak demand savings.
Recommendation 5. Include ex ante non-peak demand savings calculations in the tracking system.

6. Appendix 1. Impact Analysis Methodology

The energy and demand savings were estimated using Illinois TRM v5.0. The Illinois TRM deems most input parameters for lighting measures and are provided below.

Table 6-1. IL TRM v5.0 Lighting Algorithm Input Values

Building Type	Fixture Annual Operating Hours	Screw-Based Lamp Annual Operating hours	Waste Heat Cooling Energy (WHF_e)	Waste Heat Cooling Demand (WHF_d)	Coincidence Factor
Childcare/Pre-School	2,860	2,860	1.17	1.29	0.72
College	3,395	2,588	1.06	1.39	0.63
Elementary School	3,038	2,118	1.17	1.29	0.72
High School	3,038	2,327	1.18	1.39	0.72
Office - Low Rise	2,698	3,088	1.11	1.31	0.52
Religious Building	2,085	1,664	1.12	1.37	0.48

6.1 LED Lamps[3]

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1000} * Hours * WHF_e * ISR$$

$$\Delta kW = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * WHF_d * CF$$

Where:

$Watts_{Base}$ = *Input wattage of existing or baseline system*

[3] Identical algorithms in IL TRM v5.0, 4.5.4 LED Bulbs and Fixtures; 4.5.3 High Performance and Reduced Wattage T8 Fixtures and Lamps

$Watts_{EE}$ = Input wattage of proposed system
Hours = Annual hours of operation
WHF_e = Waste heat factor for energy
ISR = In service rate
WHF_d = Waste heat factor for demand
CF = Summer peak coincidence factor

Table 6-2. LED Lamps Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
Varies (see Table 6-3)	$Watts_{Base}$	*Assumed (Table 6-3)*	Deemed
Varies (see Table 6-3)	$Watts_{EE}$	*Actual*	Deemed
See Table 6-1	Hours	*IL TRM v5.0, 4.5.3-4*	Deemed
See Table 6-1	WHF_e	*IL TRM v5.0, 4.5.3-4*	Deemed
1.0	ISR	*IL TRM v5.0, 4.5.3-4*	Deemed
See Table 6-1	WHF_d	*IL TRM v5.0, 4.5.3-4*	Deemed
See Table 6-1	CF	*IL TRM v5.0, 4.5.3-4*	Deemed

Table 6-3. LED Lamps Baseline and Installed Wattages

Installed Measure	$Watts_{Base}$	$Watts_{EE}$
7.5W LED A-lamp	29	7.5
9W LED A-lamp	43	9
13W LED A-lamp	53	13
8W LED BR30 Directional Lamp	65	8
13.5 LED BR30 Directional Lamp	65	13.5
7W LED PAR20 Directional Lamp	50	7
10W LED PAR20 Directional Lamp	75	10
4.7W LED Candelabra Lamp	40	4.7
7.5 LED Candelabra Lamp	50	7.5
8W LED Globe Lamp	60	8

6.2 Compact Fluorescent Lamps (CFL)[4]

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1000} * Hours * WHF_e * ISR$$

$$\Delta kW = \frac{Watts_{Base} - Watts_{EE}}{1{,}000} * ISR * WHF_d * CF$$

Where:

$Watts_{Base}$ = Input wattage of existing or baseline system
$Watts_{EE}$ = Input wattage of proposed system
Hours = Shower length in minutes with baseline showerhead
WHF_e = Waste heat factor for energy
ISR = In Service Rate
WHF_d = Waste heat factor for demand
CF = Summer peak coincidence factor

[4] IL TRM v5.0, 4.5.1 Commercial ENERGY STAR Compact Fluorescent Lamp (CFL)

Table 6-4. CFL Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
43 (Lamps 15W or less) 53 (Lamps 16-20W) 72 (Lamps 21W or greater)	$Watts_{Base}$	*Assumed*	Deemed
14 (Lamps 15W or less) 19 (Lamps 16-20W) 23 (Lamps 21W or greater)	$Watts_{EE}$	*Actual*	Deemed
See Table 6-1	Hours	*IL TRM v5.0, 4.5.3-4*	Deemed
See Table 6-1	WHF_e	*IL TRM v5.0, 4.5.3-4*	Deemed
1.0	ISR	*IL TRM v5.0, 4.5.3-4*	Deemed
See Table 6-1	WHF_d	*IL TRM v5.0, 4.5.3-4*	Deemed
See Table 6-1	CF	*IL TRM v5.0, 4.5.3-4*	Deemed

6.3 Occupancy Sensors[5]

$$\Delta kWh = kW_{Controlled} * Hours * ESF * WHF_e$$

$$\Delta kW = kW_{Controlled} * WHF_d * (CF_{baseline} - CF_{OS})$$

Where:

$kW_{Controlled}$ = *Amount of water saved*
Hours = *Specific mass of water, lb/gal*
ESF = *Specific heat of water, Btu/lb-°F*
WHF_e = *Water heater outlet temperature, °F*
WHF_d = *Inlet water temperature, °F*
$CF_{baseline}$ = *Efficiency of electric water heater*
CF_{OS} = *Btu/kWh conversion factor*

[5] IL TRM v5.0, 4.5.10 Occupancy Sensor Lighting Controls

Table 6-5. Occupancy Sensors Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
0.305 (wall-mounted sensor) 0.517 (remote-mounted sensor) 0.180 (fixture-mounted sensor)	$kW_{Controlled}$	*IL TRM v5.0, 4.5.10*	Deemed
See Table 6-1	Hours	*IL TRM v5.0, 4.5.10*	Deemed
24%	ESF	*IL TRM v5.0, 4.5.10*	Deemed
See Table 6-1	WHF_e	*IL TRM v5.0, 4.5.10*	Deemed
See Table 6-1	WHF_d	*IL TRM v5.0, 4.5.10*	Deemed
See Table 6-1	$CF_{baseline}$	*IL TRM v5.0, 4.5.10*	Deemed
0.15	CF_{OS}	*IL TRM v5.0, 4.5.10*	Deemed

6.4 Commercial Programmable Thermostat Adjustment[6]

$$\Delta kWh = [Baseline\ Usage - Proposed\ Usage] * Capacity$$

$$\Delta kW = 0$$

Assembly

$$\frac{kWh}{ton} = CZ + Fu * (0.83 * Tc + 0.83 * Th + 1.67 * Ws - 293.018) - 0.0922 * Tc * Th + 1.291 * Ws$$

Office – Low Rise

$$\frac{kWh}{ton} = CZ + Fu * (7.082 * Tc - 41.199 * Th + 18.734 * Ws - 3{,}288.55) + Tc * (0.205 * Ws - 34.929)$$

Religious

$$\frac{kWh}{ton} = CZ + Fu * (-1.579 * Tc - 18.14 * Th + 15.01 * Ws - 2417.74) + Tc * (0.177 * Ws - 26.412)$$

Where:

Usage	*= Per-ton energy usage, kWh/ton*
Capacity	*= Cooling system capacity, tons*
CZ	*= Climate zone coefficient*
Fu	*= Fan mode during unoccupied period*
Fo	*= Fan mode during occupied period*
Th	*= Degrees of heating setback, °F*
Tc	*= Degrees of cooling setback, °F*
Ws	*= Weekly hours thermostat is in occupied mode*

[6] IL TRM v5.0, 4.4.25 Small Commercial Thermostat Adjustments

Table 6-6. Programmable Thermostat Adjustment Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
3.3	Capacity	*Assumed*[7]	Deemed
911.366 (Assembly) 5,047.662 (Office-Low Rise) 4,197.117 (Religious Facility)	CZ	*IL TRM v5.0, 4.4.25*	Deemed
0 (baseline condition) 1 (proposed condition)	Fu	*Assumed*[7]	Deemed
Continuous	Fo	*Assumed*[7]	Deemed
10	Th	*Assumed*[7]	Deemed
10	Tc	*Assumed*[7]	Deemed
98 (Assembly) 55 (Office-Low Rise) 133 (Religious Facility)	Ws	*IL TRM v5.0, 4.4.25*	Deemed

Table 6-7. Building Weighting for Programmable Thermostat Adjustment[7]

Building Type	Weighting Factor
Assembly	0.67%
Office - Low Rise	89.47%
Religious Facility	9.86%

6.5 Advanced Power Strips[8]

$$\Delta kWh_{5-Plug} = 56.5$$

$$\Delta kWh_{7-Plug} = 103$$

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

Where:

Hours = *Annual number of of hours which the standby loads are turned off by the advanced power strip*
CF = *Summer peak coincidence factor*

Table 6-8. Advanced Power Strip Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
7,129	Hours	*IL TRM v5.0, 5.2.1*	Deemed
0.8	CF	*IL TRM v5.0, 5.2.1*	Deemed

[7] The 3.3-ton capacity assumption and building weighting factors were agreed upon during a meeting between ComEd, CLEAResult and Navigant on August 8, 2017.
[8] IL TRM v5.0, 5.2.1 Advanced Power Strip – Tier 1

6.6 Vending Machine Controllers[9]

$$\Delta kWh = \frac{Watts_{base}}{1{,}000} * Hours * ESF$$

$$\Delta kW = 0$$

Where:

$Watts_{Base}$ = Connected wattage of controlled equipment
Hours = Operating hours of connected equipment
ESF = Energy savings factor

Table 6-9. Vending Machine Controller Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
400 (Refrigerated beverage vending machine) 85 (Non-refrigerated snack vending machine) 460 (Glass front refrigerated coolers)	$Watts_{Base}$	*IL TRM v5.0, 4.6.2*	Deemed
8,766	Hours	*IL TRM v5.0, 4.6.2*	Deemed
46% (Refrigerated beverage vending machine) 46% (Non-refrigerated snack vending machine) 30% (Glass front refrigerated coolers)	ESF	*IL TRM v5.0, 4.6.2*	Deemed

6.7 Low Flow Showerheads[10]

$$\Delta kWh = \left((GPM_{base} * L_{base} - GPM_{low} * L_{low}) * NPSD * 365.25\right) * EPG_{electric} * ISR$$

$$EPG_{electric} = \frac{8.33 * 1.0\ (ShowerTemp - SupplyTemp)}{RE_{electric} * 3412}$$

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

$$Hours = \left((GPM_{base} * L_{base}) * NPSD * 365.25\right) * \frac{0.773}{GPH}$$

[9] IL TRM v5.0, 4.6.2 Beverage and Snack Machine Controls
[10] IL TRM v5.0, 4.3.3 Low Flow Showerheads

Where:

%ElectricDHW = *Proportion of water heating supplied by electric fuel*
GPM_{base} = *Flow rate of the baseline showerhead*
L_{base} = *Shower length in minutes with baseline showerhead*
GPM_{low} = *As-used flow rate of the low-flow showerhead*
L_{low} = *Shower length in minutes with low-flow showerhead*
NPSD = *Average number of people per household*
365.25 = *Days per year, on average*
$EPG_{electric}$ = *Energy per gallon of hot water supplied by electric fuel*
ISR = *In service rate*
8.33 = *Density of water, lbs/gal*
1.0 = *Specific heat of water, Btu/lb-°F*
ShowerTemp = *Temperature of shower water, °F*
SupplyTemp = *Temperature of water entering water heater, °F*
$RE_{electric}$ = *Recovery efficiency of electric water heater*
3,412 = *Btu/kWh conversion factor*
Hours = *Annual electric DHW recovery hours for showerhead use*
CF = *Summer peak coincidence factor*
GPH = *Gallons per hour recovery of electric water heater*

Table 6-10. Low Flow Showerhead Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
100%	%ElectricDHW	*IL TRM v5.0, 4.3.3*	Deemed
2.67	GPM_{base}	*IL TRM v5.0, 4.3.3*	Deemed
8.20	L_{base}	*IL TRM v5.0, 4.3.3*	Deemed
1.5	GPM_{low}	*IL TRM v5.0, 4.3.3*	Deemed
8.20	L_{low}	*IL TRM v5.0, 4.3.3*	Deemed
1	NPSD	*IL TRM v5.0, 4.3.3*	Deemed
0.127	$EPG_{electric}$	*IL TRM v5.0, 4.3.3*	Deemed
0.98	ISR	*IL TRM v5.0, 4.3.3*	Deemed
105	ShowerTemp	*IL TRM v5.0, 4.3.3*	Deemed
54.1	SupplyTemp	*IL TRM v5.0, 4.3.3*	Deemed
98%	$RE_{electric}$	*IL TRM v5.0, 4.3.3*	Deemed
225	Hours	*IL TRM v5.0, 4.3.3*	Deemed
0.0278	CF	*IL TRM v5.0, 4.3.3*	Deemed
27.51	GPH	*IL TRM v5.0, 4.3.3*	Deemed

6.8 Low Flow Aerators[11]

$$\Delta kWh = \%ElectricDHW * \left(\frac{GPM_{base} - GPM_{low}}{GPM_{base}}\right) * Usage * EPG_{electric} * ISR$$

$$EPG_{electric} = \frac{8.33 * 1.0\ (WaterTemp - SupplyTemp)}{RE_{electric} * 3412}$$

$$\Delta kW = \frac{\Delta kWh}{Hours} * CF$$

[11] IL TRM v5.0, 4.3.2 Low Flow Aerators

$$Hours = \frac{Usage * 0.545}{GPH}$$

Where:

%ElectricDHW = *Proportion of water heating supplied by electric fuel*
GPM_{base} = *Average flow rate of the baseline aerator*
GPM_{low} = *Average flow rate of the low flow aerator*
Usage = *Estimated usage of mixed water, gal/yr*
$EPG_{electric}$ = *Energy per gallon of hot water supplied by electric fuel*
ISR = *In service rate*
$EPG_{electric}$ = *Energy per gallon of hot water supplied by electric fuel*
ISR = *In service rate*
8.33 = *Density of water, lbs/gal*
1.0 = *Specific heat of water, Btu/lb-°F*
WaterTemp = *Assumed temperature of mixed water, °F*
SupplyTemp = *Temperature of water entering water heater, °F*
$RE_{electric}$ = *Recovery efficiency of electric water heater*
3,412 = *Btu/kWh conversion factor*
Hours = *Annual electric DHW recovery hours for showerhead use*
CF = *Summer peak coincidence factor*
GPH = *Gallons per hour recovery of electric water heater*

Table 6-11. Low Flow Aerator Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
100%	%ElectricDHW	*IL TRM v5.0, 4.3.2*	Deemed
1.39	GPM_{base}	*IL TRM v5.0, 4.3.2*	Deemed
0.94	GPM_{low}	*IL TRM v5.0, 4.3.2*	Deemed
1	NPSD	*IL TRM v5.0, 4.3.2*	Deemed
0.0795 (bath) 0.0969 (kitchen)	$EPG_{electric}$	*IL TRM v5.0, 4.3.2*	Deemed
0.95	ISR	*IL TRM v5.0, 4.3.2*	Deemed
86 (bath) 93 (kitchen)	ShowerTemp	*IL TRM v5.0, 4.3.2*	Deemed
54.1	SupplyTemp	*IL TRM v5.0, 4.3.2*	Deemed
98%	$RE_{electric}$	*IL TRM v5.0, 4.3.2*	Deemed
Varies by Building Type	Hours	*IL TRM v5.0, 4.3.2*	Deemed
Varies by Building Type	CF	*IL TRM v5.0, 4.3.2*	Deemed
56	GPH	*IL TRM v5.0, 4.3.2*	Deemed

6.9 Pre-Rinse Spray Valve[12]

$$\Delta kWh = \Delta Gallons * 8.33 * 1 * (T_{out} - T_{in}) * \frac{\frac{1}{EFF_{Elec}}}{3{,}413} * FLAG$$

$$\Delta Gallons = \left(FLO_{base} - FLO_{eff}\right) * 60 * Hours_{day} * Days_{year}$$

$$\Delta kW = 0$$

[12] IL TRM v5.0, 4.2.11 High Efficiency Pre-Rinse Spray Valve

Where:

ΔGallons	*= Amount of water saved*
8.33	*= Specific mass of water, lb/gal*
1	*= Specific heat of water, Btu/lb-°F*
T_{out}	*= Water heater outlet temperature, °F*
T_{in}	*= Inlet water temperature, °F*
EFF_{Elec}	*= Efficiency of electric water heater*
3,413	*= Btu/kWh conversion factor*
FLAG	*= 1 if electric, 0 if gas*
FLO_{base}	*= Flow rate of baseline spray valve, gpm*
FLO_{eff}	*= Flow rate of installed spray valve, gpm*
60	*= minutes/hour conversion factor*
$Hours_{day}$	*= Hours per day of pre-rinse spray valve operation*
$Days_{year}$	*= Days per year of pre-rinse spray valve operation*

Table 6-12. Pre-Rinse Spray Valve Custom and Deemed Values

Value	Variable	Source	Deemed/ Custom
47,174	ΔGallons	*IL TRM v5.0, 4.2.11*	Deemed
124.1	T_{out}	*IL TRM v5.0, 4.2.11*	Deemed
54.1	T_{in}	*IL TRM v5.0, 4.2.11*	Deemed
97%	EFF_{Elec}	*IL TRM v5.0, 4.2.11*	Deemed
1	FLAG	*IL TRM v5.0, 4.2.11*	Deemed
1.90	FLO_{base}	*IL TRM v5.0, 4.2.11*	Deemed
1.06	FLO_{eff}	*IL TRM v5.0, 4.2.11*	Deemed
3	$Hours_{day}$	*IL TRM v5.0, 4.2.11*	Deemed
312	$Days_{year}$	*IL TRM v5.0, 4.2.11*	Deemed

7. Appendix 2. Impact Analysis Detail

The Childcare/Pre-School building type provides approximately half of the of the program's verified net energy and non-peak demand savings.

Table 7-1. PY9 Energy Savings by Building Type

Building Type	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTGR*	Verified Net Savings (kWh)
Childcare/Pre-School	486,131	133%	647,115	0.95	614,760
Elementary School	364,151	127%	462,199	0.95	439,089
High School	38,672	103%	39,851	0.95	37,858
Office - Low Rise	102,824	111%	114,633	0.95	108,901
Religious Building	113,245	78%	88,409	0.95	83,988
Total†	1,105,022	122%	1,352,207	0.95	1,284,596

* 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.
† Numbers may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 7-2. PY9 Non-Peak Demand Savings by Building Type

Building Type	Ex Ante Gross Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (kW)	NTGR*	Verified Net Demand Reduction (kW)
Childcare/Pre-School	NR	NA	296	0.95	282
Elementary School	NR	NA	155	0.95	147
High School	NR	NA	40	0.95	38
Office - Low Rise	NR	NA	72	0.95	68
Religious Building	NR	NA	44	0.95	42
Total†	NR	NA	607	0.95	576

NR = not reported
* 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.
† Numbers may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

Table 7-3. PY9 Peak Demand Savings by Building Type

Building Type	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kW)	NTGR*	Verified Peak Net Demand Reduction (kW)
Childcare/Pre-School	65	97%	63	0.95	60
Elementary School	81	105%	85	0.95	81
High School	22	105%	23	0.95	22
Office - Low Rise	42	115%	49	0.95	46
Religious Building	57	72%	41	0.95	39
Total†	268	98%	261	0.95	248

* 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.
† Numbers may not sum exactly due to rounding.
Source: ComEd tracking data and Navigant team analysis.

8. Appendix 3. Total Resource Cost Detail

Table 8-1, the Total Resource Cost (TRC) variable table, only includes cost-effectiveness analysis inputs available at the time of finalizing the PY9 CLEAResult Schools DI 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. EULs are subject to change and are 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)
HVAC	Programmable Thermostat Adjustment	Thermostat	110	2.0	668,276	0.0	944,714	0.0
Lighting	Occupancy Sensor (Wall Mounted)	Sensor	1,145	8.0	298,694	244.6	265,715	235.9
Lighting	LED Exit Sign (Incandescent Base)	Fixture	200	16.0	67,691	8	66,566	9
Refrigeration	Vending Machine Controls (Refrigerated Beverage Machine)	Machine	13	5.0	20,968	0	20,968	0
Lighting	9W LED A-lamp	Lamp	199	12.3	16,767	6.0	15,459	5.3
Water Heating	Pre-Rinse Spray Valve	PRSV	1	5.0	8,309	0.0	8,309	0.0
Water Heating	Low Flow Aerator - Bath	Aerator	73	9.0	5,355	1.7	7,797	2.8
Water Heating	Low Flow Aerator - Kitchen	Aerator	54	9.0	4,828	1.5	7,600	2.2
Lighting	13.5W LED BR30 Directional	Lamp	25	14.6	3,191	1.1	3,386	1.2
Lighting	Occupancy Sensor (Remote Mounted)	Sensor	6	8.0	2,646	2	2,230	2
Lighting	8W LED Globe Lamp	Lamp	17	9.8	2,191	1	2,610	1
Water Heating	Low Flow Showerhead	Showerhead	5	10.0	2,177	0.3	2,177	0.3
Lighting	13W LED A-lamp	Lamp	19	9.5	1,883	1	2,230	1
Lighting	7.5W LED A-lamp	Lamp	18	9.4	959	0	1,157	0
Lighting	LED Exit Sign (Fluorescent Base)	Fixture	4	16.0	369	0	372	0
Lighting	CFL Lamp (21W or Greater)	Lamp	3	3.3	364	0	427	0
Lighting	8W LED BR30 Directional	Lamp	2	8.1	282	0.1	391	0.1
Lighting	CFL Lamp (15W or Less)	Lamp	1	3.2	72	0	99	0