NAVIGANT

ComEd Elementary Energy Education Impact Evaluation Report

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

**Presented to
ComEd**

DRAFT

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ComEd Elementary Energy Education Impact Evaluation Report

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's PY9 Elementary Energy Education (EEE) program. It presents a summary of the electric energy and demand impacts for the total program and a detailed breakdown by measure. The appendix presents the impact analysis methodology. PY9 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

ComEd offered this program jointly with Nicor Gas, Peoples Gas, and North Shore Gas. The EEE program is implemented by Resource Action Programs (RAP) and is branded "Super Savers." In PY9, the program targeted fifth grade students in public and private schools that are customers of ComEd and Nicor Gas, Peoples Gas, or North Shore Gas. Schools received an invitation to participate and register to receive program materials; alternatively, schools could register on the program website to join a waiting list if the program was fully-enrolled when they registered. Schools that had previously participated in the program were also invited to participate again. The program used a "teacher-lead instruction" program model where the teacher could choose to teach the curriculum over five or ten days and focus on one kit measure per day. After the lesson, students took home a kit that included water conservation measures; instruments to measure water and ambient temperature, as well as water flow rates; LEDs; CFLs; shower timers; and a student survey form where participants reported details of their family's participation. Students and teachers were incentivized to return the student survey forms with a $50 mini-grant for each class that completed and returned 80 percent of the forms. RAP based the program's savings on the installation rate of implemented measures reported in the student survey form against the number of kits that were reported taken home.

The EEE program's primary focus is to produce electricity and natural gas savings in the residential sector by motivating students and their families to reduce energy consumption for water heating and lighting in their home. A secondary goal of the program is to reduce residential use of water. Additionally, the EEE program aims to increase participation in other ComEd, Nicor Gas, Peoples Gas and North Shore Gas energy efficiency programs via cross-marketing and increased customer awareness of energy efficiency issues.

The program had a total of 41,862 participants in PY9 and distributed a total of 376,758 measures as shown in the following table and graph.

Table 2-1. PY9 Volumetric Findings Detail

Participation	Total PY9 Count
Number of Measures Per Kit	9
Total Number of Kits Distributed	41,862
Number of Showerheads Distributed	41,862
Number of Kitchen Aerators Distributed	41,862
Number of Bathroom Aerators Distributed	83,724
Number of CFLs Distributed	25,844
Number of LEDs Distributed	99,742
Number of Water Heater Temperature Setbacks	41,862
Number of Shower Timers Distributed	41,862
Total Number of Measures Distributed	376,758

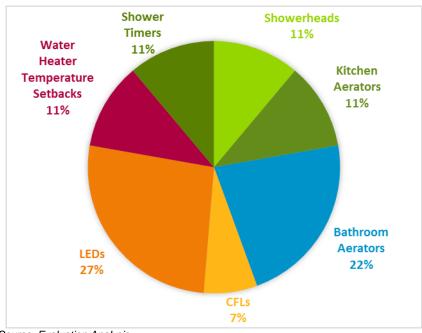*Source: ComEd tracking data and Navigant team analysis.*

Figure 2-1. Measure Distribution by Type

Source: Evaluation Analysis

3. PROGRAM SAVINGS

Table 3-1 summarizes the total incremental energy, demand and peak demand savings in PY9 of the EEE Program. The natural gas savings achieved through the program will be presented in the gas utilities' impact evaluation reports.

Table 3-1. PY9 Total Annual Incremental Savings

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Peak Demand Savings (MW)
Ex Ante Gross Savings	6,079	NR*	0.702
Program Gross Realization Rate	101%	NA	89%
Verified Gross Savings	6,161	20.721	0.627
Program Net-to-Gross Ratio (NTGR)	1.00	1.00	1.00
Verified Net Savings	6,161	20.721	0.627

Source: ComEd tracking data and Navigant team analysis.
*Not Reported

4. PROGRAM SAVINGS BY MEASURE

Table 4-1, Table 4-2, and Table 4-3 below show the total PY9 energy, demand and peak demand savings for all measures respectively. The measures are further sub-divided by the building type in which they were installed. Showerheads and LEDs contributed the most savings, accounting for 45 and 25 percent of the total program savings respectively.

Table 4-1. PY9 Energy Savings by Measure

End Use Type	Research Category	Ex Ante Gross Savings (MWh)	Verified Gross Realization Rate	Verified Gross Savings (MWh)	NTGR *	Verified Net Savings (MWh)	Technical Measure Life	Persistence	Effective Useful Life (EUL)†
Hot Water	Showerhead (1.5 GPM) - Single Family	1,397	100%	1,397	1.00	1,397			10
Hot Water	Showerhead (1.5 GPM) - Multi Family	1,367	100%	1,367	1.00	1,367			10
Hot Water	Kitchen Aerator (1.5 GPM) - Single Family	574	100%	574	1.00	574			9
Hot Water	Kitchen Aerator (1.5 GPM) - Multi Family	431	100%	431	1.00	431			9
Hot Water	Bathroom Aerator (1.0 GPM) Installed one - Single Family	49	100%	49	1.00	49			9
Hot Water	Bathroom Aerator (1.0 GPM) Installed one - Multi Family	71	100%	71	1.00	71			9
Hot Water	Bathroom Aerator (1.0 GPM) Installed Both - Single Family	58	100%	58	1.00	58			9
Hot Water	Bathroom Aerator (1.0 GPM) Installed Both - Multi Family	61	100%	61	1.00	61			9
Lighting	13-watt CFL 1 - Single Family	227	100%	227	1.00	227			4
Lighting	13-watt CFL 1 - Multi Family	143	100%	143	1.00	143			4
Lighting	9.0-watt LED 1 - Single Family	191	100%	191	1.00	191	26		10
Lighting	9.0-watt LED 1 - Multi Family	103	100%	103	1.00	103	26		10
Lighting	9.0-watt LED 2 - Single Family	420	100%	420	1.00	420	26		10
Lighting	9.0-watt LED 2 - Multi Family	240	100%	240	1.00	240	26		10
Lighting	9.0-watt LED 3 - Single Family	377	100%	377	1.00	377	26		10
Lighting	9.0-watt LED 3 - Multi Family	211	100%	211	1.00	211	26		10
Hot Water	Water Heater Temperature SetBack Electric (Single and Mult	58	128%	74	1.00	74			2
Hot Water	Shower Timer Install - Single Family	83	157%	130	1.00	130			2
Hot Water	Shower Timer Install - Multi Family	18	197%	35	1.00	35			2
	Total	6,079	101%	6,161	1.00	6,161			

Source: ComEd tracking data and Navigant team analysis.
* 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.

Table 4-2. PY9 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)
Hot Water	Showerhead (1.5 GPM) - Single Family	NR†	NA	2.752	1.00	2.752
Hot Water	Showerhead (1.5 GPM) - Multi Family	NR	NA	2.658	1.00	2.658
Hot Water	Kitchen Aerator (1.5 GPM) - Single Family	NR	NA	3.206	1.00	3.206
Hot Water	Kitchen Aerator (1.5 GPM) - Multi Family	NR	NA	2.378	1.00	2.378
Hot Water	Bathroom Aerator (1.0 GPM) Installed one - Single Family	NR	NA	1.817	1.00	1.817
Hot Water	Bathroom Aerator (1.0 GPM) Installed one - Multi Family	NR	NA	1.377	1.00	1.377
Hot Water	Bathroom Aerator (1.0 GPM) Installed Both - Single Family	NR	NA	2.165	1.00	2.165
Hot Water	Bathroom Aerator (1.0 GPM) Installed Both - Multi Family	NR	NA	1.192	1.00	1.192
Lighting	13-watt CFL 1 - Single Family	NR	NA	0.313	1.00	0.313
Lighting	13-watt CFL 1 - Multi Family	NR	NA	0.194	1.00	0.194
Lighting	9.0-watt LED 1 - Single Family	NR	NA	0.263	1.00	0.263
Lighting	9.0-watt LED 1 - Multi Family	NR	NA	0.140	1.00	0.140
Lighting	9.0-watt LED 2 - Single Family	NR	NA	0.580	1.00	0.580
Lighting	9.0-watt LED 2 - Multi Family	NR	NA	0.326	1.00	0.326
Lighting	9.0-watt LED 3 - Single Family	NR	NA	0.520	1.00	0.520
Lighting	9.0-watt LED 3 - Multi Family	NR	NA	0.286	1.00	0.286
Hot Water	Water Heater Temperature SetBack Electric (Single and Multi	NR	NA	0.008	1.00	0.008
Hot Water	Shower Timer Install - Single Family	NR	NA	0.482	1.00	0.482
Hot Water	Shower Timer Install - Multi Family	NR	NA	0.064	1.00	0.064
	Total	NR	NA	20.721	1.00	20.721

Source: ComEd tracking data and Navigant team analysis.

† 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.

Table 4-3. PY9 Peak Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Peak Demand Reduction (MW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (MW)	NTGR*	Verified Peak Net Demand Reduction (MW)
Hot Water	Showerhead (1.5 GPM) - Single Family	0.077	100%	0.077	1.00	0.077
Hot Water	Showerhead (1.5 GPM) - Multi Family	0.074	100%	0.074	1.00	0.074
Hot Water	Kitchen Aerator (1.5 GPM) - Single Family	0.071	100%	0.071	1.00	0.071
Hot Water	Kitchen Aerator (1.5 GPM) - Multi Family	0.052	100%	0.052	1.00	0.052
Hot Water	Bathroom Aerator (1.0 GPM) Installed one - Single Family	0.037	108%	0.040	1.00	0.040
Hot Water	Bathroom Aerator (1.0 GPM) Installed one - Multi Family	0.043	70%	0.030	1.00	0.030
Hot Water	Bathroom Aerator (1.0 GPM) Installed Both - Single Family	0.044	109%	0.048	1.00	0.048
Hot Water	Bathroom Aerator (1.0 GPM) Installed Both - Multi Family	0.036	73%	0.026	1.00	0.026
Lighting	13-watt CFL 1 - Single Family	0.022	100%	0.022	1.00	0.022
Lighting	13-watt CFL 1 - Multi Family	0.014	100%	0.014	1.00	0.014
Lighting	9.0-watt LED 1 - Single Family	0.019	100%	0.019	1.00	0.019
Lighting	9.0-watt LED 1 - Multi Family	0.010	100%	0.010	1.00	0.010
Lighting	9.0-watt LED 2 - Single Family	0.041	100%	0.041	1.00	0.041
Lighting	9.0-watt LED 2 - Multi Family	0.023	100%	0.023	1.00	0.023
Lighting	9.0-watt LED 3 - Single Family	0.037	100%	0.037	1.00	0.037
Lighting	9.0-watt LED 3 - Multi Family	0.020	100%	0.020	1.00	0.020
Hot Water	Water Heater Temperature SetBack Electric (Single and Mul	0.007	128%	0.008	1.00	0.008
Hot Water	Shower Timer Install - Single Family	0.063	21%	0.013	1.00	0.013
Hot Water	Shower Timer Install - Multi Family	0.013	13%	0.002	1.00	0.002
	Total	0.702	89%	0.627	1.00	0.627

Source: ComEd tracking data and Navigant team analysis.
* 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.

5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

5.1 Impact Parameter Estimates

Navigant's analysis of the ComEd PY9 EEE Kits program resulted in a verified energy and peak demand savings of 6,161 MWh and 0.627 MW respectively. The verified gross realization rate for energy and peak demand savings are 101% and 89% respectively.

The impact evaluation of the program was done in two waves, Wave 1 was comprised of kits distributed during fall 2016 to spring 2017 and Wave 2 was comprised of kits distributed during fall 2017. The CFL bulb included in Wave 1 was replaced by an LED in Wave 2. The discrepancy between the ex post and ex ante peak demand savings stated in the first paragraph is due to issues highlighted in Section 5.2 (Findings 1, 3, 5, 6 and 7). Most of the discrepancies were resolved in the Wave 2 analysis. The realization rates reported above are for the whole program year.

Navigant used the student survey results for each wave to calculate the custom inputs to the savings algorithms deemed by the IL TRM. Table 5-1 summarizes the parameters and references the evaluation 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. Impact Analysis Methodology. Appendix 2. Impact Analysis Detail, shows the input parameters used by RAP and Navigant to calculate verified energy and peak demand savings for Wave 1 and Wave 2.

The following table details all the custom and deemed inputs used for calculating the energy and demand savings for each measure as well as their source.

Table 5-1. Verified Gross Savings Parameters

Measure	Custom* Input Parameters	Deemed† Input Parameters	Deemed† Input Data Source
LEDs	WattsEE, ISR, %SF_MF, quantity	WattsBase, Hours, WHFe, WHFd, CF	IL TRM v5.0 Section 5.5.8
CFLs	WattsEE, ISR, %SF_MF, quantity	WattsBase, Hours, WHFe, WHFd, CF	IL TRM v5.0 Section 5.5.1
Low Flow Faucet Aerators	%ElectricDHW, Household, ISR, Hours, %SF_MF, quantity	GPM_base, L_base, GPM_low, L_low, 365.25, DF, FPH, EPG_electric, CF	IL TRM v5.0 Section 5.4.4
Low Flow Showerheads	%ElectricDHW, GPM_low, Household, ISR, %SF_MF, quantity, Hours	GPM_base, L_base, L_low, SPCD, 365.25, SPH, EPG_electric, CF	IL TRM v5.0 Section 5.4.5
Water Heater Temperature Setback	Tpre, Tpost, ISR, %ElectricDHW, quantity	U, A, Hours, 3412, RE_electric, CF	IL TRM v5.0 Section 5.4.6
Shower Timer	%Electric DHW, GPM, L_timer, Household, UsageFactor, %SF_MF, quantity, Hours	L_base, Days/yr, SPCD, CF, EPG_Electric	IL TRM v6.0 Section 5.4.9

* Based on the student survey data provided by RAP
†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

PY9 impact findings and recommendations for measures included in the EEE kit are listed below.

5.2.1 Bathroom and Kitchen Low Flow Faucet Aerators

Finding 1. The "Hours" values used while calculating the Wave 1 ex ante kW savings for both "Bathroom Aerator – Installed 1" and "Bathroom Aerator – Installed both" were not correct. FPH (Faucets Per Household) of 2.4689 was used in calculating the Hours value instead of the 2.83 and 1.5 deemed for single-family and multi-family homes, respectively. This lead to a discrepancy between the total PY9 verified peak demand savings and the corresponding ex ante value for this measure.

Recommendation 1. Navigant recommends calculating the "Hours" for "Bathroom Aerator – Installed 1" and "Bathroom Aerator – Installed 2" using the correct FPH values. Note: The program resolved this discrepancy in Wave 2.

5.2.2 Water Heater Temperature Setback

Finding 2. Since surface area and capacity of the water storage tanks are not tracked in the student survey responses, Navigant assumed these values to be 24.99 ft^2 and 50 gallons respectively according to the IL TRM v5.0.

Finding 3. Since the IL TRM v5.0 discourages setting the hot water setpoints below 120 degrees, Navigant set a minimum threshold for the hot water setpoint prior to adjustment (T_{pre}) and the hot water setpoint after adjustment (T_{post}) at 120 degrees. Navigant assigned any responses lower

than 120 degrees a value of 120 degrees. This led to a discrepancy between the total PY9 verified energy and peak demand savings and the corresponding ex ante values for this measure.

Recommendation 2. Navigant recommends capping T_{pre} and T_{post} at 120 degrees.
Note: The program resolved this discrepancy in Wave 2.

Finding 4. Some respondents reported increasing the hot water setpoint after receiving the kit. Navigant did not include these respondents in the water heater temperature setback calculations.

5.2.3 Shower Timer

Finding 5. Navigant observed that the showerhead flowrate (GPM), Usage Factor, and Hours of Use (HOU) values used in the Wave 1 ex ante calculations are incorrect. This led to a discrepancy between the total PY9 verified energy and peak demand savings and the corresponding ex ante values for this measure.

Recommendation 3. Revise the GPM, Usage Factor and HOU values using Equation 1, Equation 2 and Equation 3 shown below. The inputs to these equations should be calculated using the student survey results.
Note: The program did not resolve this discrepancy in Wave 2.

Finding 6. Navigant observed that the program's Wave 1 ex-ante calculations did not use a multiplier for the percentage split between single family and multi-family residences (%SF_MF) in the population while calculating the total ex ante kWh and kW savings for the whole population. Without the multiplier, the ex ante calculations assume that all the residences in the population are both multi-family and single family, therefore overestimating the energy savings by double counting buildings.

Recommendation 4. Navigant recommends using the correct Wave 1 and Wave 2 percentage of single and multi-family residences for the shower timer measure.
Note: The program did not resolve this discrepancy in Wave 2.

Finding 7. RAP assumed that the per unit verified energy and demand savings for the shower timers included in Wave 1 kits and the shower timers included in the Wave 2 kits are the same for both waves. However, since the custom inputs to the energy savings algorithms change from Wave 1 to Wave 2 based on the student survey responses, the per unit verified energy and demand savings change from Wave 1 to Wave 2. Additionally, RAP also double counted the %Electric DHW value while calculating the Wave 2 energy and demand savings for the measure.

Recommendation 5. Navigant recommends the program use the Wave 2 student survey results to calculate the custom inputs for Wave 2 savings values.

Finding 8. According to the student survey results almost 60 percent of the participants start the shower timer when they get into the shower. This causes a reduction in the savings potential of this measure.

Recommendation 6. If not being done already, Navigant recommends the training material emphasize instructing the participants to start the shower timer when they turn ON the water instead of when they get IN the shower.

Navigant used the following parameter formulas in estimating energy and demand savings:

Equation 1. GPM calculation

*GPM = ISR Showerhead * 1.5 + (1 − ISR Showerhead) * 2.35*

Equation 2. Usage Factor calculation

*UsageFactor = (100 * Count HA7 Response 1 + 50 * Count HA7 Response 2 + 15 * Count HA7 Response 3 + 0 * Count HA7 Response 4) / (Count HA7 Response 1 + Count HA7 Response 2 + Count HA7 Response 3 + Count HA7 Response 4)*

Equation 3. Hours calculation

*Hours = ((GPM_SF * L_base) * Household_SF * SPCD * 365.25) * 0.712 / GPH*

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 LEDs and CFLs

Navigant used measure level inputs deemed by the IL TRM v5.0 along with custom input values based on the student survey results provided by RAP to calculate the ex post savings. Table 5-1 shows the source of all the inputs used. There was no change between the ex ante and the verified energy and demand savings for these measures. The verified energy and peak demand savings are highlighted in Table 4-1 and Table 4-3 respectively.

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

Equation 4. LED and CFL Savings Equation and Inputs, IL TRM v5.0 Section 5.5.8 and 5.5.1 respectively

*Verified Gross Annual kWh Savings = ((WattsBase - WattsEE) / 1000) * ISR * Hours * WHFe * %SF_MF * quantity*
*Verified Gross Annual kW Savings = ((WattsBase - WattsEE) / 1000) * ISR * WHFd * CF * %SF_MF * quantity*

Where:

WattsBase	*= Baseline wattage, based on lumens of the LED and CFL bulbs and program year installed*
WattsEE	*= Actual wattage of LED and CFL included in the kits*
ISR	*= In Service Rate, the percentage of units sent that are actually in service.*
Hours	*= Average hours of use per year*
WHFe	*= Waste heat factor for energy to account for cooling energy savings from efficient lighting*
WHFd	*= Waste heat factor for demand to account for cooling savings from efficient lighting.*
%SF_MF	*= percentage of SF or MF homes in the student survey responses*
quantity	*= total number of kits distributed in PY9*

6.2 Bathroom and Kitchen Low Flow Faucet Aerators

Navigant used measure level inputs deemed by the IL TRM v5.0 along with custom input values based on the student survey results provided by RAP to calculate the ex post savings. Table 5-1 shows the source of all the inputs used. The overall verified peak demand savings did not match the ex ante values for bathroom aerators and the reasons for the discrepancy are highlighted in the Section 5.2.1 below. The verified energy and peak demand savings are highlighted in Table 4-1 and Table 4-3 respectively. Appendix 2. Impact Analysis Detail, compares the input assumptions used by RAP and Navigant in the ex ante and ex post calculations.

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

Equation 5. Low Flow Faucet Aerators Savings Equation and Inputs, IL TRM v5.0 Section 5.4.4

Verified Gross Annual kWh Savings = %ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 *DF / FPH) * EPG_electric * ISR * %SF_MF * quantity
Verified Gross Annual kW Savings = Verified Gross Annual kWh Savings / Hours * CF * %SF_MF * quantity

Where:

%ElectricDHW	*= proportion of water heating supplied by electric resistance heating*
GPM_base	*= Average flow rate, in gallons per minute, of the baseline faucet*
GPM_low	*= Average flow rate, in gallons per minute, of the low-flow faucet aerator*
L_base	*= Average baseline daily length faucet use per capita for faucet of interest in minutes*
L_low	*= Average retrofit daily length faucet use per capita for faucet of interest in minutes*
Household	*= Average number of people per household*
365.25	*= Days per year, on average.*
DF	*= Drain Factor*
FPH	*= Faucets Per Household*
EPG_electric	*= Energy per gallon of water used by faucet supplied by electric water heater*
ISR	*= In service rate of aerator*
Hours	*= Annual electric DHW recovery hours for faucet use*
CF	*= Coincidence Factor for electric load reduction*
%SF_MF	*= percentage of SF or MF homes in the student survey responses*
quantity	*= total number of kits in PY9*

6.3 Low Flow Showerheads

Navigant used measure level inputs deemed by the IL TRM v5.0 along with custom input values based on the student survey results provided by RAP to calculate the ex post savings. Table 5-1 shows the source of all the inputs used. There was no change in the verified energy and demand savings for these measures. The verified energy and peak demand savings are highlighted in Table 4-1 and Table 4-3 respectively.

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

Equation 6. Low Flow Showerheads Savings Equation and Inputs, IL TRM v5.0 Section 5.4.5

Verified Gross Annual kWh Savings = %ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_electric * ISR * %SF_MF * quantity
Verified Gross Annual kW Savings = Verified Gross Annual kWh Savings / Hours * CF * %SF_MF * quantity

Where:

%ElectricDHW	*= proportion of water heating supplied by electric resistance heating*
GPM_base	*= Flow rate of the baseline showerhead*
GPM_low	*= As-used flow rate of the low-flow showerhead*
L_base	*= Shower length in minutes with baseline showerhead*
L_low	*= Shower length in minutes with low-flow showerhead*
Household	*= Average number of people per household*
SPCD	*= Showers Per Capita Per Day*
365.25	*= Days per year, on average.*
SPH	*= Showerheads Per Household*
EPG_electric	*= Energy per gallon of hot water supplied by electric*
ISR	*= In service rate of showerhead*
Hours	*= Annual electric DHW recovery hours for showerhead use*
CF	*= Coincidence Factor for electric load reduction*
%SF_MF	*= percentage of SF or MF homes in the student survey responses*
quantity	*= total number of kits distributed in PY9*

6.4 Water Heater Temperature Setback

Navigant used measure level inputs deemed by the IL TRM v5.0 along with custom input values based on the student survey results provided by RAP to calculate the ex post savings. Table 5-1 shows the source of all the inputs used. The overall verified peak demand savings did not match the ex ante values provided for this measure and the reasons for the discrepancy are highlighted in the Section 5.2.2 below. The verified energy and peak demand savings are highlighted in Table 4-1 and Table 4-3 respectively. Appendix 2. Impact Analysis Detail, compares the input assumptions used by RAP and Navigant in the ex ante and ex post calculations.

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

Equation 7. Water Heater Temperature Setback Savings Equation and Inputs, IL TRM v5.0 Section 5.4.6

Verified Gross Annual kWh Savings = ((U * A * (Tpre – Tpost) * Hours) / (3412 * RE_electric)) * ISR * %ElectricDHW * quantity
Verified Gross Annual kW Savings = Verified Gross Annual kWh Savings / Hours * CF * quantity

Where:

U	*= Overall heat transfer coefficient of tank (Btu/Hr-°F-ft2)*
A	*= Surface area of storage tank (square feet)*
Tpre	*= Actual hot water setpoint prior to adjustment*
Tpost	*= Actual new hot water setpoint, which may not be lower than 120 degrees*
Hours	*= Number of hours in a year*
3412	*= Conversion from Btu to kWh*
RE_electric	*= Recovery efficiency of electric hot water heater*
ISR	*= In service rate of showerhead*
%ElectricDHW	*= proportion of water heating supplied by electric resistance heating*
CF	*= Summer Peak Coincidence Factor for measure*

Quantiity = total number of kits distributed in PY9

6.5 Shower Timer

Since the shower timer is not included in the IL TRM v5.0, Navigant used the measure level inputs deemed by the IL TRM v6.0 along with custom input values based on the student survey results provided by RAP to calculate the ex post savings. Table 5-1 shows the source of all the inputs used. The overall verified peak demand savings did not match the ex ante values provided for this measure and the reasons for the discrepancy are highlighted in the Section 5.2.3 above. The verified energy and peak demand savings are highlighted in Table 4-1 and Table 4-3 respectively. Appendix 2. Impact Analysis Detail, compares the input assumptions used by RAP and Navigant in the ex ante and ex post calculations.

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

<p style="color:orange">Equation 8. Shower timer Equation and Inputs, IL TRM v6.0 Section 5.4.9</p>

Verified Gross Annual kWh Savings = (%Electric DHW * GPM * (L_base – L_timer) * Household * Days/yr * SPCD * UsageFactor * EPG_Electric) * %SF_MF * quantity
Verified Gross Annual kW Savings = Verified Gross Annual kWh Savings / Hours * CF * %SF_MF * quantity

Where:

%ElectricDHW	*= proportion of water heating supplied by electric resistance heating*
GPM	*= Flow rate of showerhead as used*
L_base	*= Number of minutes in shower without a shower timer*
L_timer	*= Number of minutes in shower after shower timer*
Household	*= Number in household using timer*
Days/yr	*= 365.25*
SPCD	*= Showers Per Capita Per Day*
UsageFactor	*= How often each participant is using shower timer*
EPG_electric	*= Energy per gallon of hot water supplied by electric*
Hours	*= Annual electric DHW recovery hours for showerhead use*
CF	*= Coincidence Factor for electric load reduction*
%SF_MF	*= percentage of SF or MF homes in the student survey responses*
quantity	*= total number of kits distributed in PY9*

7. APPENDIX 2. IMPACT ANALYSIS DETAIL

The tables below show the comparison of input assumptions used by Navigant and RAP in ex ante and ex post calculations for the measures with discrepancies between ex ante and ex post values. There were no discrepancies among input values for CFL, LED, showerhead and kitchen aerator measures.

Table 7-1. One Bathroom Aerator Installed - Custom and Deemed Values Comparison

Wave 1 Value, Navigant	Wave 1 Value, Implementer	Wave 2 Value, Navigant	Wave 2 Value, Implementer	Variable	Source	Deemed/ Custom	Discrepancy?
0.277	0.277	0.274	0.274	%ElectricDHW	Survey - HCU6	Custom	-
1.39	1.39	1.39	1.39	GPM_base	IL TRM 5.4.4	Deemed	-
0.94	0.94	0.94	0.94	GPM_low	Specifications	Deemed	-
1.6	1.6	1.6	1.6	L_base	IL TRM 5.4.4	Deemed	-
1.6	1.6	1.6	1.6	L_low	IL TRM 5.4.4	Deemed	-
365.25	365.25	365.25	365.25	days/year	IL TRM 5.4.4	Deemed	-
4.880	4.880	4.888	4.888	Household SF	Survey - HCU2	Custom	-
4.946	4.946	4.953	4.953	Household MF	Survey - HCU2	Custom	-
0.9	0.9	0.9	0.9	DF	IL TRM 5.4.4	Deemed	-
2.83	2.83	2.83	2.83	BFPH - SF	IL TRM 5.4.4	Deemed	-
1.5	1.5	1.5	1.5	BFPH - MF	IL TRM 5.4.4	Deemed	-
0.0795	0.0795	0.0795	0.0795	EPG_electric	IL TRM 5.4.4	Deemed	-
0.200	0.200	0.219	0.219	ISR SF	Survey - HA3	Custom	-
0.279	0.279	0.246	0.246	ISR MF	Survey - HA3	Custom	-
0.62	0.62	0.64	0.64	%SF	Survey - HCU1	Custom	-
0.38	0.38	0.36	0.36	%MF	Survey - HCU1	Custom	-
27	30.9	27	27	Hours - SF	IL TRM 5.4.4	Custom	Yes (Wave 1)
52	31.3	52	52	Hours - MF	IL TRM 5.4.4	Custom	Yes (Wave 1)
0.022	0.022	0.022	0.022	CF	IL TRM 5.4.4	Deemed	-

Source: ComEd tracking data and Navigant team analysis.

Table 7-2. Both Bathroom Aerators Installed - Custom and Deemed Values Comparison

Wave 1 Value, Navigant	Wave 1 Value, Implementer	Wave 2 Value, Navigant	Wave 2 Value, Implementer	Variable	Source	Deemed/ Custom	Discrepancy?
0.277	0.277	0.274	0.274	%ElectricDHW	Survey - HCU6	Custom	-
1.39	1.39	1.39	1.39	GPM_base	IL TRM 5.4.4	Deemed	-
0.94	0.94	0.94	0.94	GPM_low	Specifications	Deemed	-
1.6	1.6	1.6	1.6	L_base	IL TRM 5.4.4	Deemed	-
1.6	1.6	1.6	1.6	L_low	IL TRM 5.4.4	Deemed	-
365.25	365.25	365.25	365.25	days/year	IL TRM 5.4.4	Deemed	-
4.880	4.880	4.888	4.888	Household SF	Survey - HCU2	Custom	-
4.946	4.946	4.953	4.953	Household MF	Survey - HCU2	Custom	-
0.9	0.9	0.9	0.9	DF	IL TRM 5.4.4	Deemed	-
2.83	2.83	2.83	2.83	BFPH - SF	IL TRM 5.4.4	Deemed	-
1.5	1.5	1.5	1.5	BFPH - MF	IL TRM 5.4.4	Deemed	-
0.0795	0.0795	0.0795	0.0795	EPG_electric	IL TRM 5.4.4	Deemed	-
0.135	0.135	0.106	0.106	ISR SF	Survey - HA3	Custom	-
0.106	0.106	0.133	0.133	ISR MF	Survey - HA3	Custom	-
0.62	0.62	0.64	0.64	%SF	Survey - HCU1	Custom	-
0.38	0.38	0.36	0.36	%MF	Survey - HCU1	Custom	-
27	30.9	27	27	Hours - SF	IL TRM 5.4.4	Custom	Yes (Wave 1)
52	31.3	52	52	Hours - MF	IL TRM 5.4.4	Custom	Yes (Wave 1)
0.022	0.022	0.022	0.022	CF	IL TRM 5.4.4	Deemed	

Source: ComEd tracking data and Navigant team analysis.

Table 7-3. Water Heater Temperature Setback Custom and Deemed Values Comparison

Wave 1 Value, Navigant	Wave 1 Value, Implementer	Wave 2 Value, Navigant	Wave 2 Value, Implementer	Variable	Source	Deemed/ Custom	Discrepancy?
0.08	0.08	0.08	0.08	U	IL TRM 5.4.6	Deemed	-
24.99	24.99	24.99	24.99	A	IL TRM 5.4.6	Deemed	-
5.32	3.39	4.73	4.75	(Tpre-Tpost)	Survey - HA13and14	Custom	Yes (Both)
8766.00	8766.00	8766.00	8766.00	Hours	IL TRM 5.4.6	Deemed	-
3412.00	3412.00	3412.00	3412.00	Conversion from Btu to kWh	IL TRM 5.4.6	Deemed	-
0.98	0.98	0.98	0.98	RE_electric	IL TRM 5.4.6	Deemed	-
1.00	1.00	1.00	1.00	CF	IL TRM 5.4.6	Deemed	-
0.22	0.22	0.26	0.26	ISR	Survey - HA12	Custom	-
0.28	0.28	0.27	0.27	%ElectricDHW	Survey - HCU6	Custom	-

Source: ComEd tracking data and Navigant team analysis.

Table 7-4. Shower Timer Custom and Deemed Values Comparison

Wave 1 Value, Navigant	Wave 1 Value, Implementer	Wave 2 Value, Navigant	Wave 2 Value, Implementer	Variable	Source	Deemed/ Custom	Discrepancy?
0.28	0.28	0.27	0.28	%Electric DHW	Survey - HCU6	Custom	Yes (Wave 2)
1.93	1.92	1.93	1.93	GPM_MF	Survey - HA1	Custom	Yes (Wave 1)
2.00	1.85	1.99	2.00	GPM_SF	Survey - HA1	Custom	Yes (Both)
7.80	7.80	7.80	7.80	L_base	IL TRM 5.4.9 (v6)	Deemed	-
7.74	7.74	7.59	7.74	L_timer_MF	Survey - HA9, HA10	Custom	Yes (Wave 2)
3.19	3.19	3.21	3.19	Household_MF	Survey - HA8	Custom	Yes (Wave 2)
0.40	0.24	0.45	0.40	UsageFactor_ MF	Survey - HA7	Custom	Yes (Both)
7.52	7.52	7.52	7.52	L_timer_SF	Survey - HA9, HA10	Custom	-
2.98	2.98	3.16	2.98	Household_SF	Survey - HA8	Custom	Yes (Wave 2)
0.40	0.24	0.41	0.40	UsageFactor_ SF	Survey - HA7	Custom	Yes (Both)
0.62	1.00	0.64	0.62	%SF	Survey - HCU3	Custom	Yes (Both)
0.38	1.00	0.36	0.38	%MF	Survey - HCU4	Custom	Yes (Both)
263.61	31.30	278.72	263.61	Hours_SF	Survey - HA1, HA8	Custom	Yes (Both)
281.96	34.76	283.26	281.96	Hours_MF	Survey - HA1, HA8	Custom	Yes (Both)
0.03	0.03	0.03	0.03	CF	IL TRM 5.4.9 (v6)	Deemed	-
365.25	365.25	365.25	365.25	Days/yr	IL TRM 5.4.9 (v6)	Deemed	-
0.60	0.60	0.60	0.60	SPCD	IL TRM 5.4.9 (v6)	Deemed	-
0.12	0.12	0.12	0.12	EPG_Electric	IL TRM 5.4.9 (v6)	Deemed	-

Source: ComEd tracking data and Navigant team analysis.

8. APPENDIX 3. TRC DETAIL

[This section will be included in the second draft.]