NAVIGANT

ComEd CY2018 Seasonal Savings Cooling Season Impact Evaluation Report

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

Presented to
ComEd

DRAFT

March 13, 2019

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ComEd CY2018 Seasonal Savings Cooling Season Impact Evaluation Report

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1. INTRODUCTION

This report presents the results of the summer cooling season impact evaluation of ComEd's CY2018 Seasonal Savings (SS) Program. It presents a summary of the energy and demand impacts for the total program, broken out by measure type. The appendix presents the impact analysis methodology. CY2018 covers January 1, 2018 through December 31, 2018. Deployment of the SS Program for the CY2018 cooling season began on June 22, 2018 and our evaluation assessed savings through September 30, 2018.

2. PROGRAM DESCRIPTION

The SS Program is designed to make small adjustments to participant's scheduled thermostat setpoints over a 3-week period (i.e., tune-up period) while maintaining customer comfort. On average, SS adjusts scheduled setpoints up by 1°F during the cooling season, with the biggest temperature adjustments taking place when customers are asleep (e.g., the middle of the night) or during regular absences.[1]

Google, the program implementer, implemented the SS Program in 2018 using a randomized encouragement design (RED)[2] for Nest thermostats new to ComEd's electric service since the PY9 SS cooling season deployment.[3] The RED splits customers into two groups: the intent-to-treat (ITT) group, where thermostats are randomly selected to receive the option to join the program offering, and the control group, where the remaining thermostats are assigned to not receive the program offering. Customers in the ITT group self-select whether they actually join the program or not. In addition to the thermostats newly added to the program in CY2018, the thermostats from the PY9 deployment that remained in ComEd's service area into CY2018 maintained their randomized groups. The PY9 ITT group was randomly split into a Double Year ITT group who were offered the program for a second time in CY2018 and a Persistence group who were not offered the program in CY2018. All groups are described in Table 2-1 below.

Table 2-1. CY2018 Cooling Season SS Groups

Study Group	Description
Single Year ITT	Randomly selected from devices that were not part of any SS group in PY9. Were offered SS for the first time during the CY2018 cooling season.
Single Year Control	Randomly selected from devices that were not part of any SS group in PY9. Were not offered SS during the CY2018 cooling season.
Double Year ITT	Randomly selected from devices in PY9 SS ITT group. Were offered SS for a second time during the CY2018 cooling season.
Double Year Control	The control group from PY9. Were again not offered SS during the CY2018 cooling season.
Persistence	Randomly selected from devices in PY9 SS ITT group. Were not offered SS during the CY2018 cooling season.

Source: Navigant

[1] For additional information see: https://nest.com/support/article/What-is-Seasonal-Savings.

[2] In this design, some customers are offered the program (i.e., encouraged to join) and others are not. The encouraged (or intent-to-treat) group customers then decide whether or not to opt-in to the program. See Navigant's PY9 report for a complete description of the SS RED design.
Navigant. 2018. *ComEd Seasonal Savings Impact Evaluation Report*. Presented to ComEd. <http://ilsagfiles.org/SAG_files/Evaluation_Documents/ComEd/ComEd_EPY9_Evaluation_Reports_Final/ComEd_PY9_Nest_Seasonal_Savings_Impact_Evaluation_Report_2018-06-28_Final.pdf>

[3] Navigant's PY9 cooling season analysis estimated savings during the summer of 2017.

ComEd can only claim savings for the Single and Double Year ITT groups as these groups had the program deployed in CY2018.[4] Navigant also estimated savings for the Persistence group to examine how savings persist into a second year after treatment (since this group was treated in PY9 but not in CY2018). Note that when customers who were treated in 2017 switch their thermostats back into cooling mode in 2018, their thermostats start on the optimized schedule from 2017. The Persistence group remains on this schedule (unless they manually change it), while the Double Year ITT group who opt into the program for a second time in CY2018 have their schedules further adjusted (i.e., to even higher setpoints).

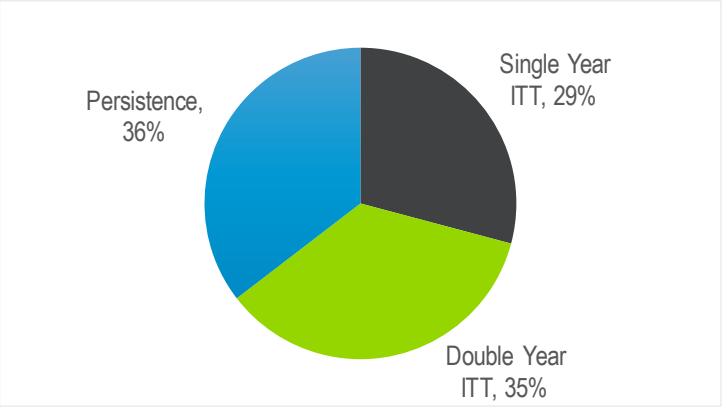
The program had 71,252 ITT (across the Single and Double Year groups) and 39,091 Persistence devices in the cooling season of CY2018 and distributed three measures as shown in the following table and graph. The device counts in Table 2-2 reflect the raw participation data Navigant received from the implementer. Savings could only be claimed for Nest thermostats that were in a ComEd majority zip code[5] with telemetry data available during the study period. In total, savings were claimed for 67,898 valid ITT devices (across the Single and Double Year groups). See Table 7-1 for a complete count of devices dropped during data cleaning, counts of devices used in the analysis, the total valid devices used to calculate savings, and the conditions for savings eligibility.

Table 2-2. CY2018 Volumetric Findings Detail

Category	Device Counts	Percentage
Nests in electric service area	146,960	–
Nests in Control group	36,617	25% of Nests
Nests in Single Year Control group	32,163	88% of Control
Nests in Double Year Control group	4,454	12% of Control
Nests in ITT group	71,252	48% of Nests
Nests in Single Year ITT group	32,162	45% of ITT
Nests in Double Year ITT group	39,090	55% of ITT
Nests in Persistence group	39,091	27% of Nests

Source: ComEd tracking data and Navigant team analysis.

Figure 2-1. Number of Measures Installed by Type



Source: ComEd tracking data and Navigant team analysis.

[4] The Persistence group was not offered any program in CY2018. Since the measure currently has a one-year effective useful life (EUL) their savings cannot be claimed for the second year after treatment.
[5] Navigant used a cut-off of at least 95% of households in a zip code having ComEd electric service for this requirement. This removed approximately 3.5% of devices.

3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the SS Program achieved in CY2018. Navigant did not estimate gas savings for this evaluation. Navigant estimated demand savings for June 22 through August 31 from 2-6 pm during non-holiday weekdays.[6] The tables below reflects these savings as Peak Demand Savings, although they do not exactly match the peak demand definition in the Illinois Technical Reference Manual (IL TRM). This is not an issue, as ComEd will not bid this program into the PJM market. In addition, this analysis estimated net savings and no further net-to-gross (NTG) adjustment was necessary. Navigant did not receive an estimate of ex ante savings for this program, so there is no gross realization rate.

Table 3-1. CY2018 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Summer Peak Demand Savings (kW)
Electricity			
Ex Ante Gross Savings	NA	NA	NA
Program Gross Realization Rate	NA	NA	NA
Verified Gross Savings	NA	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA	NA
Verified Net Savings	3,035,416	NA	3,328
Converted from Gas*			
Ex Ante Gross Savings	NA	NA	NA
Program Gross Realization Rate	NA	NA	NA
Verified Gross Savings	NA	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA	NA
Verified Net Savings	NA	NA	NA
Total Electric Plus Gas			
Ex Ante Gross Savings	NA	NA	NA
Program Gross Realization Rate	NA	NA	NA
Verified Gross Savings	NA	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA	NA
Verified Net Savings	3,035,416	NA	3,328

* Gas savings were not estimated for this program.
NA = Not applicable
Note: The coincident Summer Peak period for this program is defined as 2:00-6:00 PM Central Prevailing Time on non-holiday weekdays, June 22 through August 31, 2018.
Source: Program implementer data and Navigant team analysis.

4. Cumulative Persisting Annual Savings

The measure-specific and total ex ante gross savings for the SS Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2018 are shown in the following tables and figure. The total electric CPAS across all measures is 3,035,416 kWh. Navigant did not estimate gas savings for

[6] Navigant chose to use this definition of peak demand savings as it coincides with when the optimization algorithms definition.

this program as it was out of scope for this evaluation.[7] Therefore, electric and total CPAS are the same. Additionally, this type of analysis estimates net savings and no further NTG adjustment is necessary. Because of this, there is no NTG ratio and no gross savings estimate.

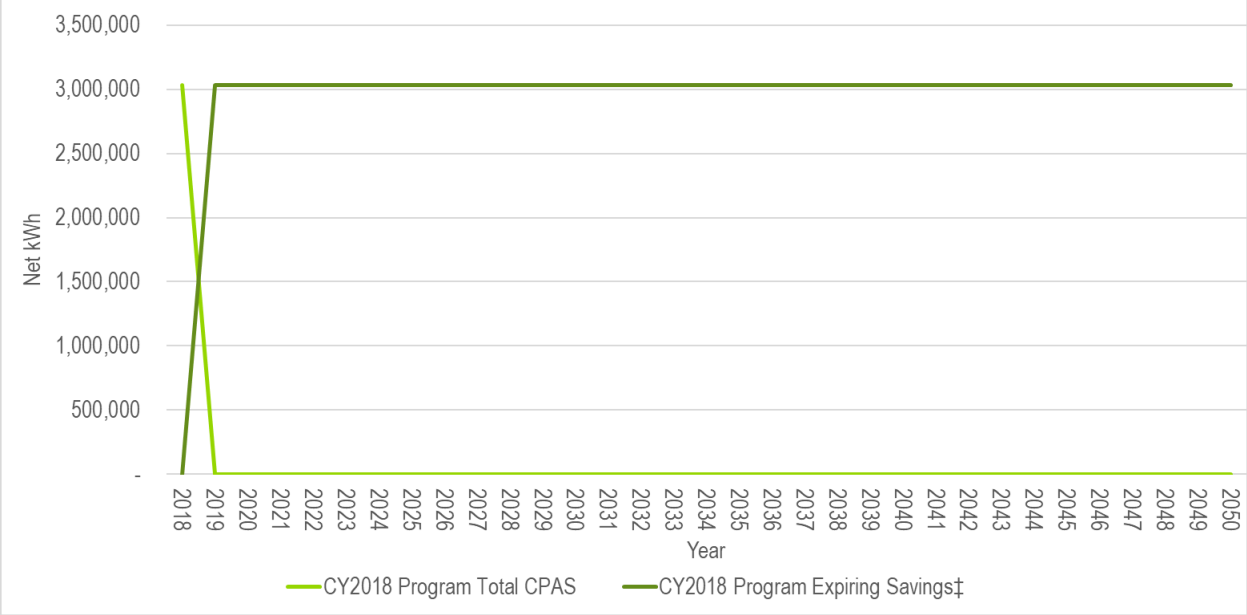
[7] Gas savings are not expected for the cooling season.

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

End Use Type	Research Category	EUL	CY2018 Verified Gross Savings	NTG*	Lifetime Net Savings†	Verified Net kWh Savings 2018	2019	2020	2021	2022	2023	2024	2025
HVAC	Single Year ITT	1.0	NA	NA	988,363	988,363							
HVAC	Double Year ITT	1.0	NA	NA	2,047,052	2,047,052							
CY2018 Program Total Electric CPAS			**NA**		**3,035,416**	**3,035,416**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CY2018 Program Expiring Electric Savings‡							**3,035,416**	**3,035,416**	**3,035,416**	**3,035,416**	**3,035,416**	**3,035,416**	**3,035,416**

Note: The green highlighted cell shows program total first year electric savings.
* The RED used for this evaluation produces net savings and as such the NTG ratio is not applicable.
† Lifetime savings are the sum of CPAS savings through the EUL.
‡ Expiring savings are equal to CPAS Yn-1 - CPAS Yn + Expiring Savings Yn-1
NA = Not applicable.
Source: Navigant analysis

Figure 4-1. Cumulative Persisting Annual Savings



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

5. Program Savings by Measure

The program includes two measures: Single Year ITT and Double Year ITT thermostat optimization (see Table 2-1 for group definitions). As shown in Table 5-1, the Double Year ITT measure contributed over double the savings from the First Year ITT measure; per thermostat the Double Year ITT group achieved savings of 2.66% of cooling season load, compared to 1.55% for the Single Year ITT group. Table 5-2 shows the peak demand savings by measure, where the Double Year ITT group again outperformed the Single Year ITT group. Appendix 2. Impact Analysis Detail provides more detailed information on savings estimates, including average per device savings, for each measure.

Table 5-1. CY2018 Energy Savings by Measure – Electric

End Use Type	Research Category	Ex Ante Gross Savings (kWh)*	Verified Gross Realization Rate*	Verified Gross Savings (kWh)*	NTG*	Verified Net Savings (kWh)	Effective Useful Life
HVAC	Single Year ITT	NA	NA	NA	NA	988,363	1.0
HVAC	Double Year ITT	NA	NA	NA	NA	2,047,052	1.0
	Total	**NA**	**NA**	**NA**	**NA**	**3,035,416**	**1.0**

* The RED used for this evaluation produces net savings and as such the NTG ratio and gross savings values are not applicable.
NA = Not applicable
Source: Program implementer data and Navigant team analysis.

Table 5-2. CY2018 Summer 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)*	NTG*	Verified Net Peak Demand Reduction (kW)
HVAC	Single Year ITT	NA	NA	NA	NA	1,090
HVAC	Double Year ITT	NA	NA	NA	NA	2,238
	Total	**NA**	**NA**	**NA**	**NA**	**3,328**

* The RED used for this evaluation produces net savings and as such the NTG ratio and gross savings values are not applicable.
NA = Not applicable
Source: Program implementer data and Navigant team analysis.

6. Impact Analysis Findings and Recommendations

6.1 Impact Parameter Estimates

The SS Program does not have relevant impact parameters.

6.2 Other Impact Findings and Recommendations

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

Finding 1. Total CY2018 cooling season electric savings from the SS Program was 3,035,416 kWh. Of this 988,363 kWh came from Single Year ITT (offered the program for the first time in CY2018), and 2,047,052 kWh came from the Double Year ITT (offered the program for the second year in a row in CY2018).

Finding 2. Just over two-thirds of eligible ITT devices opted into the SS Program (69% and 67% from the Single and Double Year ITT groups, respectively). Of those that enrolled, 90% signed up for SS within the first week of the program being offered (35,056). Since the Double Year ITT group had similar opt-in rates to the Single Year ITT group it suggests customers were accepting of a second year of adjustments to their thermostat schedules. Navigant will discuss with ComEd focusing future process evaluation on customer satisfaction and comfort with multiple years of setpoint changes to ensure the customer experience is not being compromised to achieve additional years of savings.

Finding 3. The cooling setpoint point schedules for both the Single and Double Year ITT thermostats were adjusted upward an average of 0.4°F compared to their respective control groups during the program period, with the largest setpoint adjustments taking place during the middle of the day. These setpoint adjustments resulted in cooling runtime reductions of approximately five and nine minutes per day for the Single and Double Year ITT groups, respectively.

Finding 4. Savings for Single Year ITT were 1.55% of cooling load. In PY9, the savings for the Standard measure (akin to the CY2018 offering) were 2.60% of cooling load. The drop in savings for customers offered the program for the first time between PY9 and CY2018 could have come from the higher temperatures in 2018 (August in particular was hotter). Another possibility is that the drop occurred because the CY2018 group were newer Nest thermostat

adopters (they did not have a Nest thermostat installed in PY9). There is evidence that these newer adopters had less efficient baseline schedules for the SS algorithm to adjust; in PY9 the Standard group had an average pre-period setpoint of 74.1°F versus 73.6°F for the Single Year ITT group in the CY2018 pre-period. Navigant will continue custom evaluation of thermostat optimization programs as there is not yet sufficient data on the differences in savings for different weather conditions and customer types to create an IL TRM measure.

Finding 5. The Double Year ITT group had savings of 2.66% of cooling load; this is almost the same as the savings the Standard measure achieved in PY9 (2.60%)[8] and considerably (and statistically) higher than the Single Year ITT group in CY2018 (1.55%). CY2018 is the second consecutive year that these devices received the program offer and the continued savings suggests that the further setpoint adjustment (since devices stayed on the optimized schedule from PY9 when they switched to cooling mode in 2018) drove additional savings. If 100% of the savings from PY9 persisted for these customers, they have reduced their cooling load by a total of approximately 5.26% compared to their pre-SS (i.e., 2016) baseline.

Recommendation 1. ComEd and the program implementer should consider offering thermostat optimization to the same customers in multiple years to maximize program savings. This should be paired with process research to ensure customer comfort levels are not being unduly affected.

Finding 6. The Persistence group had savings of 1.46% of cooling load. This was about half the savings achieved by the Standard measure in PY9 (2.60%), and similar to the first year savings of the Single Year ITT group (1.55%). The continuation of savings into a second year after the program offering occurred suggests that this program has a measure life of longer than one year. It is unclear how much of the drop in savings (from 2.60% in PY9 to 1.46% in CY2018) is due to differences in the weather versus decay in the savings across years. Navigant will write a workpaper for IL TRM version 8.0 recommending a multi-year measure life be included in the Effective Useful Life for Custom Measure Guidelines section of the IL TRM.[9]

Recommendation 2. For future research on persistence, the program implementer should provide data that can be linked across program years so that the evaluation team can run models for persistence that include pre-period data from before the initial SS offering.

7. Appendix 1. Impact Analysis Methodology

Navigant explored the data and estimated savings using the following group pairings, where the control group was randomly assigned compared to each ITT or persistence group:

- Single Year ITT to Single Year Control
- Double Year ITT to Double Year Control
- Persistence to Double Year Control

Some comparisons across groups and across years are also worth noting. Comparing the Single Year ITT estimate to the PY9 savings[10] allows us to see how first-year savings differ in different years. Comparing the Double Year ITT savings to PY9 and the Single Year ITT group allows us to see whether additional savings can be captured by deploying the program for a second consecutive year. Finally, comparing the persistence group to PY9 and the Single Year ITT group allows us to see how savings from one year of treatment persist into a second year without treatment.

[8] All the Double Year ITT devices were also offered the Standard measure in PY9.
[9] See Attachment B to Volume 4 of Version 7.0 of the IL TRM.
[10] The CY2018 program for the Single Year ITT group is equivalent to the Standard measure from PY9.

7.1 Exploratory Analysis

The purpose of the exploratory analysis is to use thermostat telemetry data to:

- Analyze setpoint schedules, thermostat runtime, and daily energy consumption from May 1 through September 30, 2018 to assess whether the impact of thermostat optimization was evident in the data
- Compare data between ITT and Persistence devices versus control devices

7.2 Impact Analysis

The purpose of the impact analysis is to estimate the energy savings and peak demand[11] savings from the program. The savings estimate for the ITT groups represents an unbiased estimate of the effect of CY2018 encouragement on energy use, while the savings estimate for the Persistence group represents an estimate of the persisting effect of the PY9 program intervention on energy use.

Navigant relied exclusively on thermostat telemetry data to estimate impacts by converting thermostat runtime[12] to power. Runtime data could not be linked to customer accounts due to data privacy concerns. The conversion from runtime to power was based on the following equation, taken from the advanced thermostats measure in the IL TRM.[13]

Equation 7-1. Runtime to Power Conversion

$$kW = \frac{runtime * \frac{Btu}{hr} * \frac{1}{1000} * \frac{1}{EER}}{1000}$$

Where:

runtime	is the percentage of time the thermostat was running during each 15-minute interval
$\frac{BTU}{hr}$	is the size of the AC unit, assumed to be 33,600 based on the IL TRM
EER	is the cooling equipment's energy efficiency ratio, assumed to be 8.16 based on the IL TRM

7.2.1 Linear Fixed Effects Regression Model

Navigant used separate linear fixed effects regression models to estimate savings for the Single Year ITT,[14] Double Year ITT,[15] and Persistence[16] measure groups. The model estimates savings for all devices in the ITT groups, whether or not they actually enrolled in the program in the CY2018 cooling season.

[11] Peak demand is defined as 2 p.m.-6 p.m. on non-holiday weekdays in the post period (i.e., after the treatment is applied) through August 31, 2018.
[12] Navigant included device-days that had at least 86 out of 96 possible 15-minute intervals of runtime in a day. Navigant scaled runtime up for these partially complete days in order to maintain sufficient data for the analysis. Ninety-three percent of device-days met this criterion, and runtime was scaled up based on the number of missing 15-minute intervals specific to each device-day.
[13] Advanced thermostats are measure 5.3.16 in Version 6.0, Volume 4 of the IL TRM.
[14] This group is compared to the Single Year Control group.
[15] This group is compared to the Double Year Control group.
[16] This group is compared to the Double Year Control group.

Navigant prefers this model over one that would estimate savings only for treated devices because it produces an unbiased estimate of savings.[17] Formally, the model is specified below in Equation 7-2.

Equation 7-2. Linear Fixed Effects Regression Model

$$EDU_{it} = \alpha_i + \gamma_m + \beta_1 Post_t + \beta_2 (Post_t \cdot Treat_i) + \varepsilon_{it}$$

Where:

EDU_{it}	is estimated daily usage in kWh by device *i* on day *t*
α_i	is a device-specific fixed effect for device *i*; this picks up all device-specific characteristics that do not change through time, like household square footage
γ_m	is a time-specific fixed effect for month *m;* this picks up temporal differences across months, like weather and daylight hours
$Post_t$	is a binary variable taking a value of 1 when *t* is in the post period (June 22, 2018 or later) and 0 otherwise
$Post_t \cdot Treat_i$	is a binary variable taking a value of 1 when device *i* is in the ITT group and day *t* is after the start of the SS Program (June 22, 2018 or later)
ε_{it}	is the cluster-robust error term for device *i* during day *t;* cluster-robust errors account for heteroskedasticity and autocorrelation at the device level

The coefficient β_1 is the estimate of average daily kWh energy savings from being offered the program, regardless of enrollment status.

Navigant used a similar model specification to estimate peak demand savings, where the unit of analysis is usage during the peak demand period (2-6 pm on non-holiday weekdays through August 31) rather than daily energy consumption. This model also included additional explanatory variables to control for local hourly weather and day of week.

To calculate total program savings, Navigant multiplied average daily energy savings per device by the total number of post-program deployment days for eligible ITT devices. Similarly, to calculate total demand savings, Navigant multiplied average per device demand savings by the number of valid devices with data between June 22 and August 31, 2018.

7.3 Data Cleaning & Device Validity

For the purposes of the analysis, Navigant devised and performed steps to clean and remove data deemed unsuitable. Table 7-1 details the steps taken that removed whole devices, the number of devices dropped in each category, and the total raw, remaining, and valid devices for each group. After cleaning, approximately 95% of the devices in each group were included in Navigant's analysis.

Devices were deemed ineligible for savings (or "invalid") if they met any of the following criteria:

- Appeared in the device tracking data but had no available telemetry data
- Had a zip code outside the ComEd majority zip codes
- Had no zip code in the data (meaning Navigant could not verify the location of the device)
- Did not have data within the evaluation period of the cooling season study (May 1 through Sept 30, 2018)

[17] An estimate of savings for just the treated devices may underestimate total program savings if the devices that are offered the program but choose not to opt-in produce any savings just from being offered the program. Additionally, since some devices randomly sorted into the ITT group do not actually qualify for the program, these devices are unable to opt-in and could bias the savings estimate.

Table 7-1. Data Cleaning: Devices Dropped

Category	Single Year Control		Single Year ITT		Double Year Control		Double Year ITT		Persistence	
	Devices	%	Devices	%	Devices	%	Devices	%	Devices	%
Raw device count	**32,163**	**-**	**32,162**	**-**	**4,454**	**-**	**39,090**	**-**	**39,091**	**-**
No telemetry data*†	810	*2.5%*	799	*2.5%*	135	*3.0%*	1,328	*3.4%*	1,270	*3.2%*
Zip code outside ComEd majority zip codes*	764	*2.4%*	721	*2.2%*	61	*1.4%*	522	*1.3%*	552	*1.4%*
No actual zip code provided and proxy zip code not in a ComEd majority zip code*	6	*<0.1%*	8	*<0.1%*	0	–	3	*<0.1%*	3	*<0.1%*
No data between 5/1/2018 and 9/30/2018*	1	*<0.1%*	2	*<0.1%*	1	*<0.1%*	2	*<0.1%*	0	–
Valid device count ‡	**30,582**	***95.1%***	**30,632**	***95.2%***	**4,257**	***95.6%***	**37,235**	***95.3%***	**37,266**	***95.3%***
15-minute intervals missing cooling runtime information§	29	*0.1%*	30	*0.1%*	5	*0.1%*	48	*0.1%*	61	*0.2%*
Devices with no days containing runtime for 86 or more 15-minute intervals	33	*0.1%*	42	*0.1%*	3	*0.1%*	41	*0.1%*	59	*0.2%*
Analysis device count ‖	**30,520**	***94.9%***	**30,560**	***95.0%***	**4,249**	***95.4%***	**37,146**	***95.0%***	**37,146**	***95.0%***

* Devices dropped in these steps are considered invalid and are not used in calculating final savings.
† Telemetry data intervals for these devices were not included in the data Navigant received from the implementer.
‡ Devices used to calculate season total energy savings.
§ These steps removed entire customers when all observations for that customer were removed for the described reason.
‖ Devices used to calculate per device average daily energy savings values within the regression framework.
Source: Navigant analysis of implementer thermostat telemetry data.

Within each ITT group, customers could choose whether or not to opt-in to the program. Those who opted-in received the thermostat optimization and those who chose not to opt-in received nothing beyond the initial offer to join the program. Out of the eligible devices, 69% of Single Year ITT devices and 67% of Double Year ITT devices opted into the program, and actually got the SS treatment, in CY2018.

7.4 Cooling Season Weather

The average temperature and cooling degree days in Illinois for 2017 and 2018 are compared to the 1981-2010 normal in Table 7-2. The average monthly temperatures were all above the 1981-2010 normal, with the exception of August 2018.

Table 7-2. Cooling Season Weather: Illinois

		May*	June	July	August	September	October*
Average Temperature	2017	-	73	75	72	70	58
	2018	66	71	75	75	68	-
	1981-2010 normal	59.1	68.9	74.0	72.4	64.6	52.5
	Departure (2018)	+6.9	+2.1	+1.0	+0.6	+3.4	-
Cooling Degree Days (base 65°F)	2017	-	230	307	214	179	29
	2018	166	217	330	329	176	-
	1981-2010 normal	60	165	283	238	92	11
	Departure (2018)	+106	+52	+47	+91	+84	-

* The CY2018 used data from May through September 2018, whereas the PY9 analysis used data from June through mid-October 2017.
Source: Midwest Regional Climate Center

8. Appendix 2. Impact Analysis Detail

This section presents the details of our exploratory and impact analysis findings.

8.1 Exploratory Analysis

This section presents the findings from the exploratory analysis of the thermostat telemetry data. Table 8-1 provides the average daily scheduled cooling setpoint and average daily cooling runtime for each study group before (Pre-Period) and after (Program Period) the CY2018 cooling season deployment. Average daily cooling setpoints relative to control increased by 0.4°F for both the Single and Double Year ITT groups. The average cooling runtime relative to control decreased by nine minutes for Double Year ITT and five minutes for Single Year ITT. Table 8-1 provides these differences in the SS Effect column.

Table 8-1. Summary of Exploratory Analysis, Averages

Period	Group	May 1 – Jun 21 Pre-Period	Jun 22 – Sep 30 Program Period	Δ*	SS Effect †
Avg Daily Outdoor Temp (°F)		67.6	73.1	5.5	NA
Avg Daily Scheduled Cooling Setpoints (°F)	Single Year Control	73.6	73.7	0.1	**NA**
	Single Year ITT	73.6	74.1	0.5	**0.4**
	Double Year Control	74.2	74.3	0.1	**NA**
	Double Year ITT	74.3	74.8	0.5	**0.4**
	Persistence	74.4	74.4	0.0	**-0.1**
Avg Daily Cooling Runtime (minutes)	Single Year Control	186	315	129	**NA**
	Single Year ITT	186	310	124	**-5**
	Double Year Control	176	311	135	**NA**
	Double Year ITT	178	304	126	**-9**
	Persistence	177	307	130	**-5**

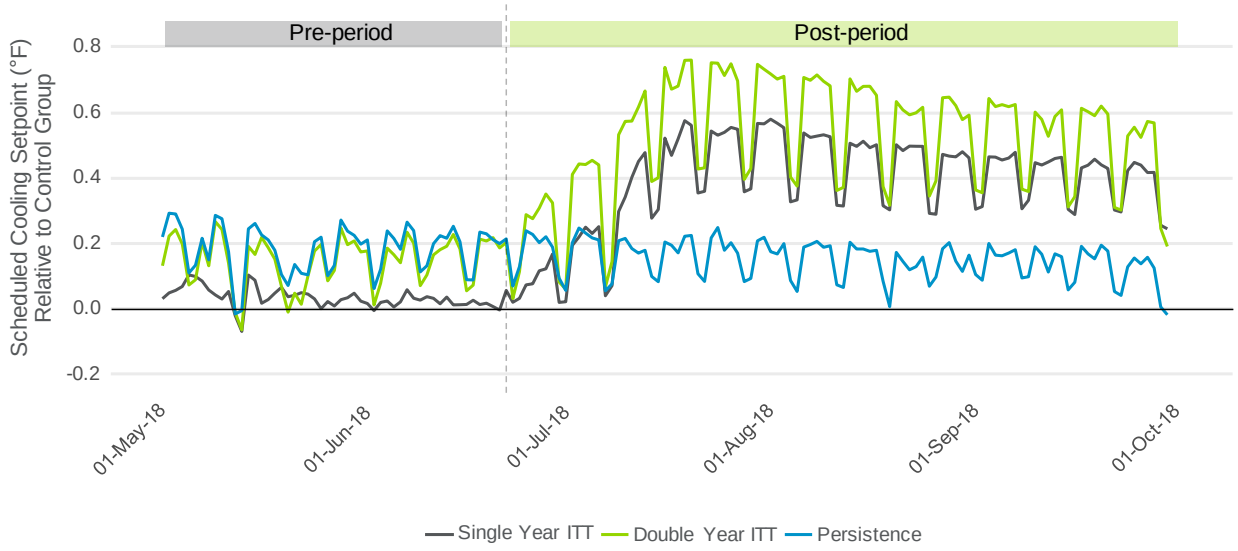
* The Δ is the difference between the program period and the pre-period.
† The SS effect is the difference between the Δ for the ITT and the control group. These values are per-period averages and do not directly reflect program impacts.
NA = Not applicable
Source: Navigant analysis of implementer thermostat telemetry data and National Oceanic and Atmospheric Administration (NOAA) temperature data.

8.1.1 Setpoint Comparisons

Figure 8-1 presents the average daily scheduled setpoints relative to the appropriate control group (represented by the x-axis) for the Single Year ITT, Double Year ITT and Persistence groups.

- **Pre-program period:** Average daily scheduled setpoints during the pre-period were similar between the Double Year ITT and Persistence groups, with an average difference of approximately 0.2°F from the Double Year Controls. These differences are expected in 2018 data, since these groups were initially randomized in 2017. The difference between Single Year ITT and control is close to zero during this period as expected, since this group was randomized in 2018.
- **Program period:** The difference in average daily scheduled setpoints from control increased for both the Single and Double Year ITT groups during the program period. The difference in average daily scheduled setpoints from control remained approximately constant for the Persistence group. These results are expected as the implementer did not offer SS to the Persistence group during the program period while they did offer it to the Single and Double Year ITT groups. This result provides evidence that the program had the intended effect of adjusting scheduled setpoints. Additionally, the setpoint schedules for the Persistence group remain above the Double Year Control group, suggesting persistence of savings from the PY9 deployment.

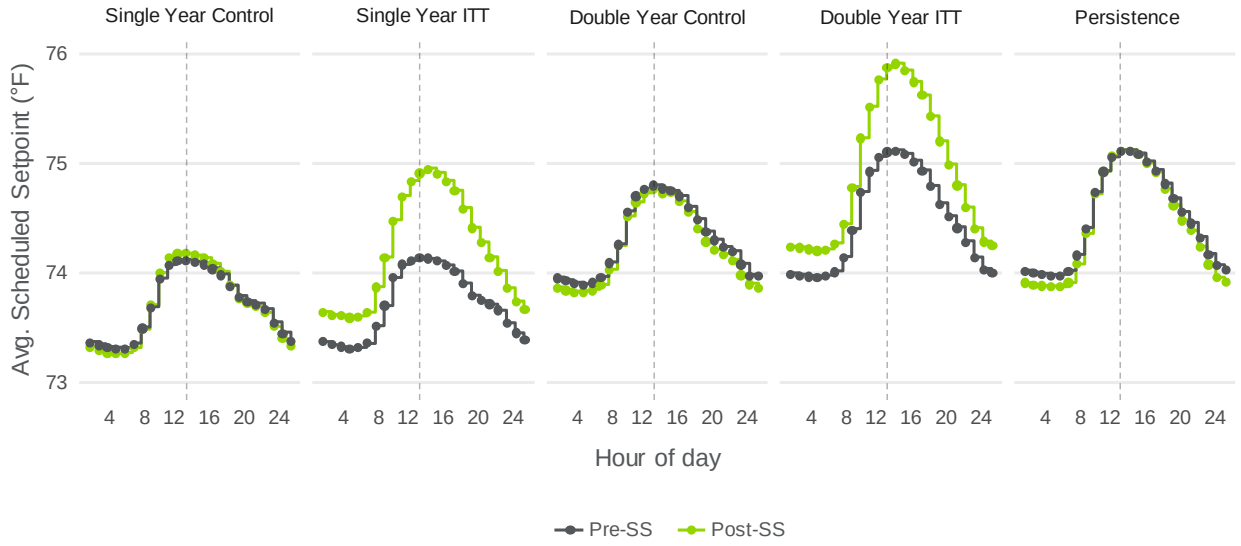
Figure 8-1. Average Daily Scheduled Setpoints Comparison: Treated & Untreated vs. Control



Source: Navigant analysis of implementer thermostat telemetry data.

Figure 8-2 presents a comparison of average hourly scheduled setpoints based on the weeks of June 15–21, 2018 (the week preceding CY2018 deployment) and July 14–20, 2018 (three weeks after CY2018 deployment) for each group. In comparison to their respective control groups, overall average scheduled setpoints increased for Single and Double Year ITT devices. Changes in setpoint for the Persistence group are comparable to those of the control group and do not show signs of changing between the two selected comparison weeks; this is as expected since this group is not receiving treatment in CY2018. Note that the shape and magnitude of setpoint schedules for the Double Year ITT and Persistence groups look identical in the week prior SS deployment; this is as expected since customers from PY9 were randomly split between these groups.

Figure 8-2. Mean Hourly Setpoint Comparison, Before and After SS



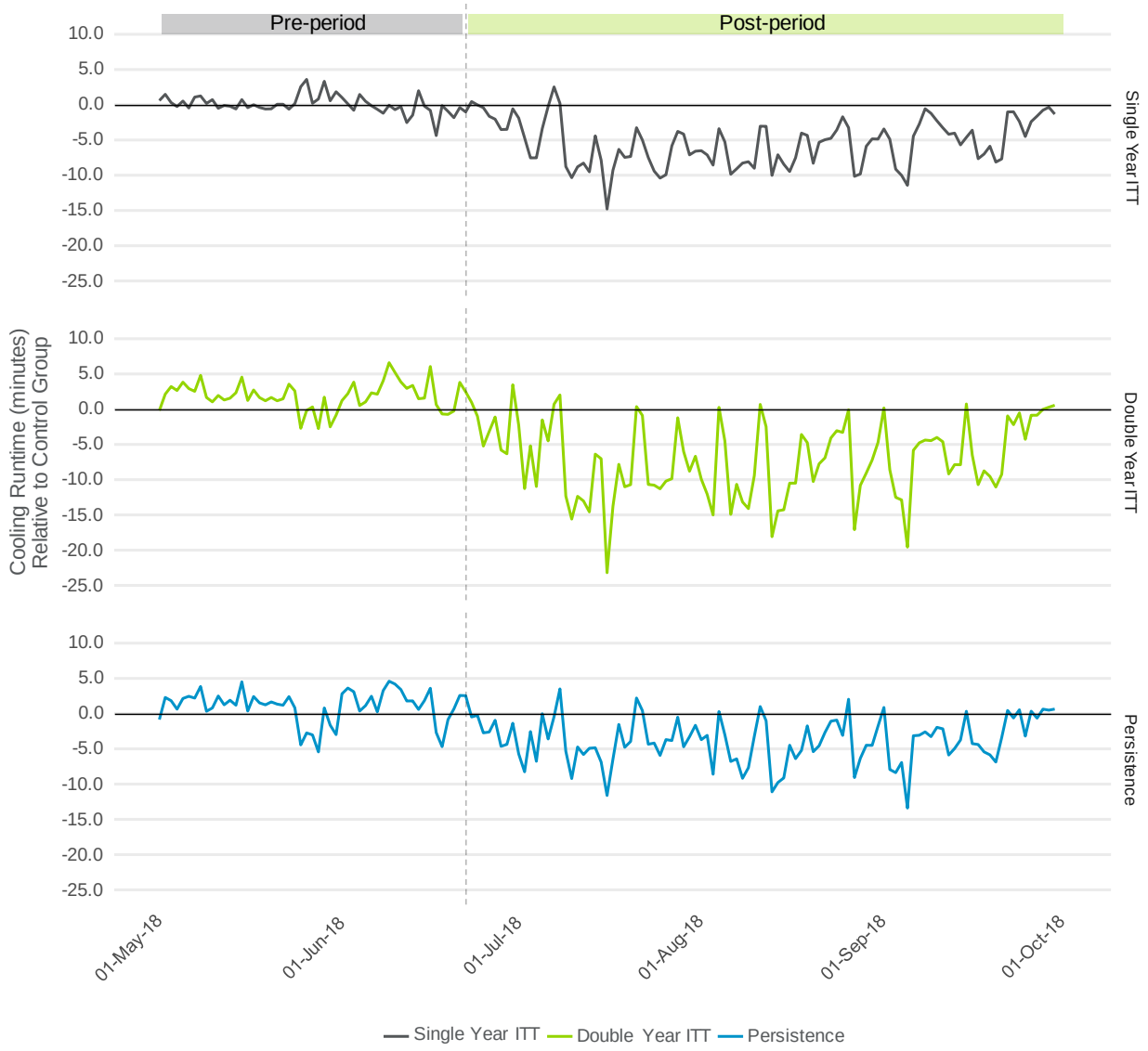
Source: Navigant analysis of implementer thermostat telemetry data.

8.1.2 Runtime Comparisons

Similar to the exploratory analysis of average scheduled setpoints, this section presents findings from the exploratory analysis of average daily thermostat cooling runtime. Unlike scheduled cooling setpoint, the cooling runtime had direct correlation with outdoor temperature. The average outdoor temperatures during the pre-program and program periods were 67.6°F and 73.1°F, respectively (see Table 8-1). Figure 8-3 presents a comparison of average daily runtime for the Single Year ITT, Double Year ITT, and Persistence groups relative to the appropriate control group (represented by the x-axis).

- **Pre-program period:** There was a small difference in average daily runtime during the pre-period between the Double Year ITT and Persistence groups and their relevant control groups. These differences are not statistically significant but are noticeably larger than the difference between the Single Year ITT group and control. This is expected as the Double Year ITT and Persistence groups were randomized compared to the control group in 2017.
- **Program period:** During the program period, average daily runtime compared to control decreased for all groups, and the decrease was largest for the Double Year ITT group. This result provides evidence that there was less cooling taking place for all three groups relative to control as a result of the program.

Figure 8-3. Average Daily Runtime Comparison: ITT Groups vs. Controls



Source: Navigant analysis of implementer thermostat telemetry data.

8.2 Impact Analysis

This section presents the findings from the energy and peak demand impact analysis for the Single Year ITT, Double Year ITT, and Persistence measures, summarized in Table 8-2. The ITT measures resulted in total energy savings of 3,035,416 kWh from June 22 to September 30, 2018, and total peak demand savings of 3,328 kW between June 22 and August 31, 2018. The Persistence group generated savings of 1,119,730 kWh and 1,008 kW.

Table 8-2. SS Summary from June 22 to September 30, 2018

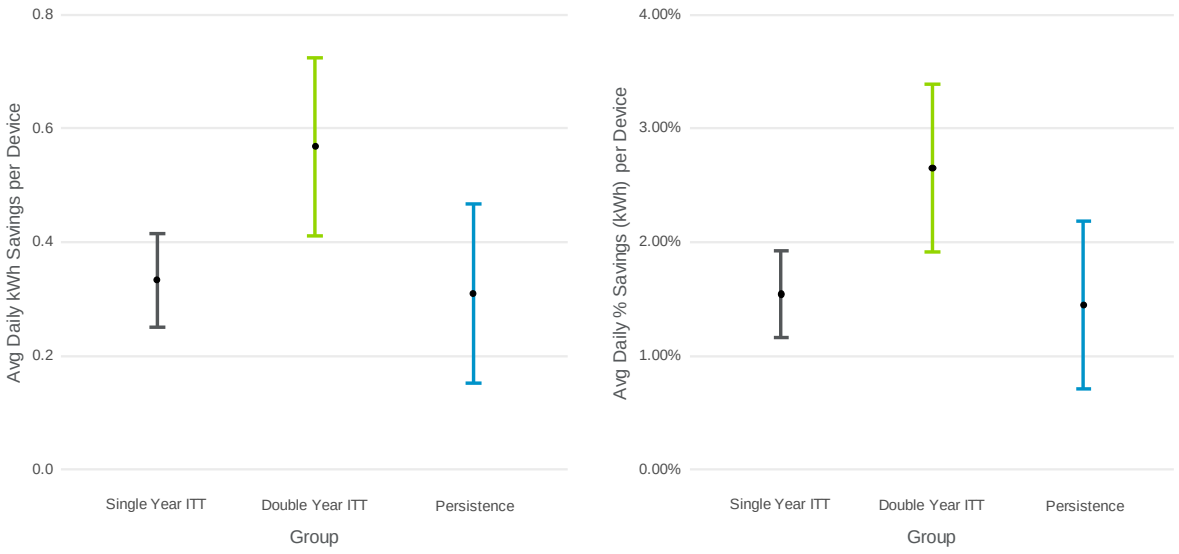
Statistic	Single Year ITT*	Double Year ITT*	Persistence
Number of thermostats in analysis control group	30,520	4,249	4,249
Number of thermostats in analysis ITT/persistence group	30,560	37,146	37,146
Number of valid thermostats in ITT/persistence group	30,632	37,235	37,266
Average daily energy savings (% of cooling load)	1.55% ± 0.38%	2.66% ± 0.73%	1.46% ± 0.74%
Average daily energy savings per device (kWh)	0.33 ± 0.08***	0.57 ± 0.16***	0.31 ± 0.16**
Average total energy savings per device (kWh) †	32.27	54.98	30.05
Total energy savings (kWh) ‡	988,363	2,047,052	1,119,730
Average demand savings (% of cooling load)	2.41% ± 0.47%	4.14% ± 0.91%	1.87% ± 0.91%
Average demand savings per device (kW) §	0.036 ± 0.007***	0.061 ± 0.013***	0.028 ± 0.013***
Total average demand savings (kW) ‖	1,090	2,238	1,008

Note: The first offer date occurred on June 22, 2018. The measure persisted while HVAC systems were in cooling mode. The impact evaluation relied on data through September 30, 2018. The demand evaluation relied on data through August 31, 2018
Significance levels: *** p < 0.001, ** p < 0.01; range indicates 90% confidence interval.
* ITT includes all devices randomly assigned to be offered the SS deployment in the CY2018 cooling season.
† Total savings per device is calculated as average daily savings per device times the number of days post SS enrollment.
‡ Total savings is calculated as average total energy savings per device times the number of valid devices.
§ Average demand savings are calculated for 2p.m. to 6p.m. on non-holiday weekdays from June 22 through August 31, 2018.
|| Not all valid devices achieved demand savings. Only devices that had available data between June 22 and August 31, 2018 were included in the total average demand savings estimate.
Source: Navigant analysis.

8.2.1 Energy Impacts

Figure 8-4 presents the estimate of average daily energy savings in absolute and percentage terms for the Single Year ITT, Double Year ITT, and Persistence groups. Navigant estimated average daily per device energy savings of 0.33 kWh (1.55% of cooling load) for the Single Year ITT group, 0.57 kWh (2.66% of cooling load) for the Double Year ITT group, and 0.31 kWh (1.46% of cooling load) for the Persistence group.

Figure 8-4. Average Daily Savings per Device

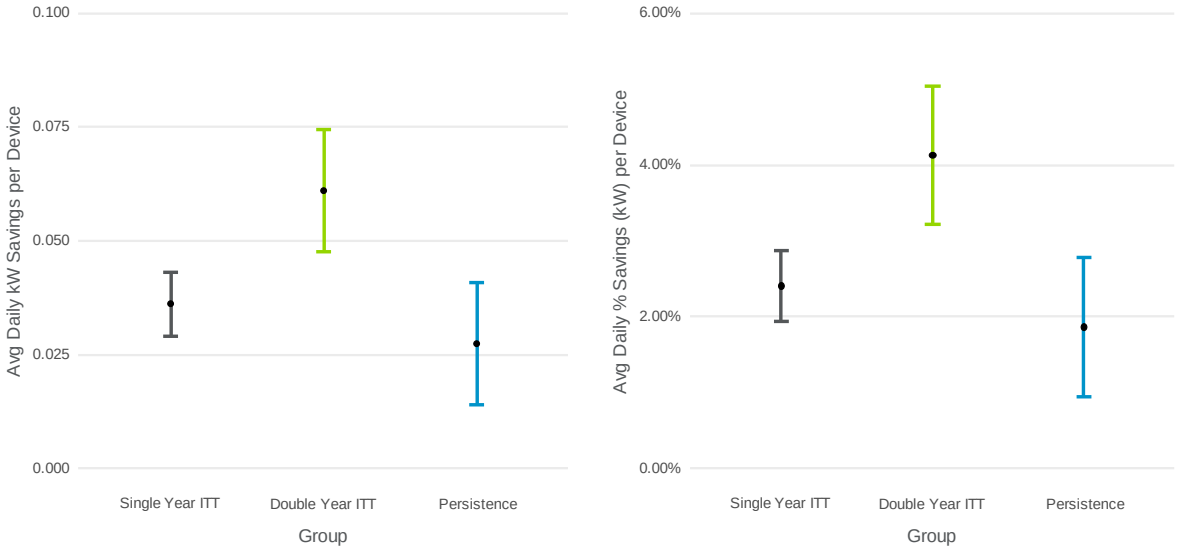


Source: Navigant analysis

8.2.2 Peak Demand Impacts

Navigant estimated peak demand impacts from 2 pm to 6 pm on program period non-holiday, weekdays from June 22 through August 31, 2018. Figure 8-5 presents the estimate of average peak demand savings in absolute and percentage terms for the Single Year ITT, Double Year ITT, and Persistence groups. Navigant estimated average peak demand savings to be 0.036 kW (2.41%) per device for the Single Year ITT group, 0.061 kW (4.14%) per device for the Double Year ITT group and 0.028 kW (1.87%) per device for the Persistence group.

Figure 8-5. Average Peak Demand Savings per Device



Source: Navigant analysis.

9. Appendix 3. Total Resource Cost Detail

Table 9-1, below, shows the Total Resource Cost (TRC) table. It includes only the cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to evaluation later.

Table 9-1. 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	Single Year ITT	Device	30,632	1.0	NA	NA	988,363	1,090
HVAC	Double Year ITT	Device	37,235	1.0	NA	NA	2,047,052	2,238

* Due to the design of the program, this evaluation inherently estimates net savings and that is what is listed here.
Source: Navigant analysis of implement thermostat telemetry data.