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# ComEd Seasonal Savings Impact Evaluation Report

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

**Presented to**
**ComEd**

**DRAFT**

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# ComEd Seasonal Savings Impact Evaluation Report

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# 1. INTRODUCTION

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

# 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, scheduled setpoints are adjusted up by 1.5°F during the cooling season, with the biggest temperature adjustments taking place when customers are typically away from home (e.g., the middle of weekdays).[1] The Peak Aware Seasonal Savings algorithm is a variation on the standard Seasonal Savings that is designed to minimize loads during the peak period of interest. To achieve this goal while also maintaining customer energy savings, schedule changes immediately before the peak are minimized so that more efficient set points can be used during peak while minimizing potential comfort issues. ComEd selected 2-6pm CT as their daily peak period for the summer (June, July, and August) of 2017.

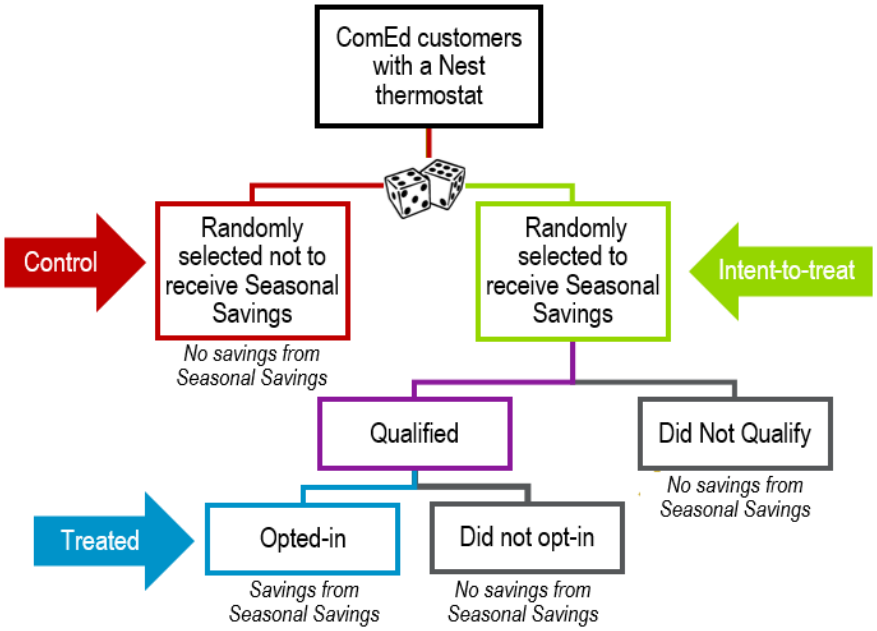
Nest, the program implementer, implemented the SS Program in 2017 using a randomized encouragement design (RED), in which all customers in ComEd's service territory with a Nest thermostat are randomly assigned into one of two groups. These two groups are the intent to treat (ITT) group, where participants are randomly assigned to receive the program offering, and the control group, where participants are randomly assigned to *not* receive the program offering. For this study, the ITT group was randomly divided between the base SS Program and the Peak Aware variation.

Some customers in the control and ITT group (i.e., randomly assigned to receive the program offering) may not qualify to participate in the program. Qualification requirements include: (1) Nest thermostat installed and connected to Wi-Fi, (2) thermostat set to cooling mode, and (3) a programmed setpoint schedule. All eligible customers are provided the program offering on the thermostat itself and through Nest's mobile app. Some portion of customers will opt in and enroll in the program, while others will not. The group of customers that opt in is referred to as the treated group. Thermostats that were part of the ITT group but that did not qualify or did not opt-in are part of the untreated group.

Refer to Figure 2-1 for an illustration of the RED design for the SS Program.

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

**Figure 2-1. Illustration of RED**




*Source: Navigant*

The program had 59,344 participants in PY9 and distributed two measures (Standard and Peak Aware treatment) as shown in the following table and graph. The device counts in Table 2-1 reflect the raw participation data Navigant received from Nest. Savings could only be claimed for devices that were in a zip code primarily made up of ComEd households[2] with thermostat telemetry data in 2017. In total, savings were claimed for 56,166 participants (50,499 Standard; 5,667 Peak Aware). See Section 6.3 for a complete listing of devices dropped, counts of devices used in the analysis, and total valid devices used to calculate savings.

**Table 2-1. PY9 Volumetric Findings Detail**

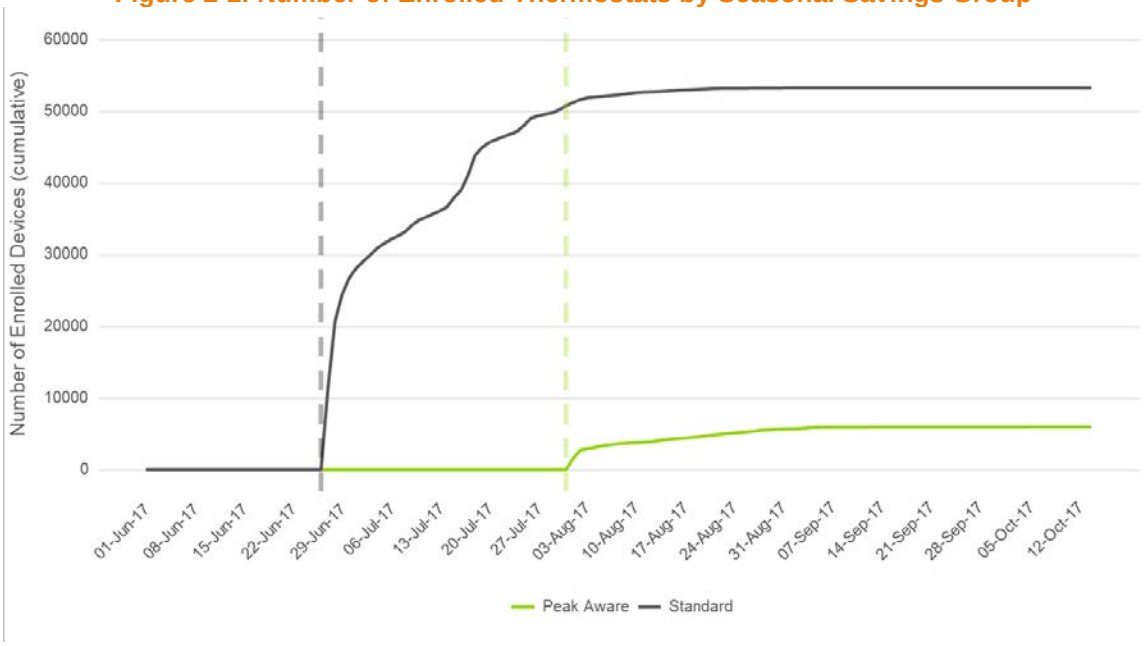
| Category | Device Counts | Percentage |
|---|---|---|
| Nests in electric service area | 101,433 | – |
| Nests in control group | 4,997 | 5% of Nests |
| Nests in Standard ITT group | 86,447 | 85% of Nests |
| Nests enrolled in SS (treated group) | 53,344 | 62% of ITT |
| Nests in untreated group | 33,103 | 38% of ITT |
| Nests that did not qualify | 14,538 | 17% of ITT |
| Nests that did not opt in | 18,565 | 21% of ITT |
| Nests in Peak Aware ITT group | 9,999 | 10% of Nests |
| Nests enrolled in SS (treated group) | 6,000 | 60% of ITT |
| Nests in untreated group | 3,999 | 40% of ITT |
| Nests that did not qualify | 1,786 | 18% of ITT |
| Nests that did not opt in | 2,213 | 22% of ITT |

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

[2] 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 1.5% of devices.

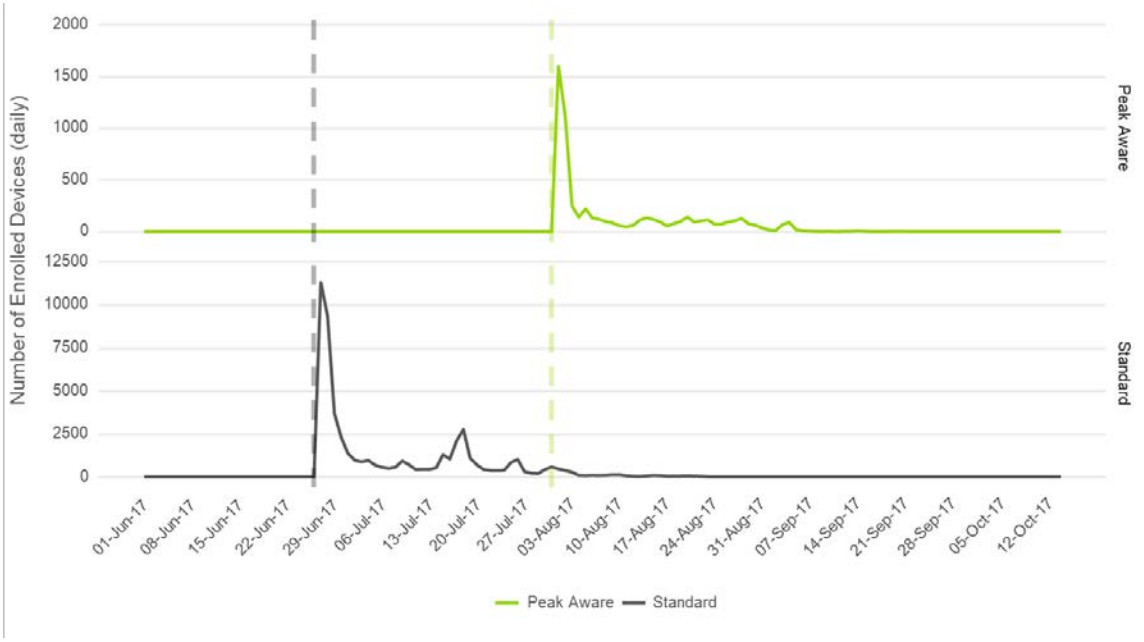
Figure 2-2 shows the number of thermostats enrolled in each measure over the course of the study period. The Standard measure rolled out first (June 27) and the Peak Aware measure rolled out later (August 1). In total, the Standard measure enrolled 53,344 thermostats and the Peak Aware measure enrolled 6,000 thermostats. Figure 2-3 presents the number of devices enrolling over time each day. Within the first week of each program offering, 56% percent of devices (29,894) enrolled in the Standard measure and 60% percent of devices (3,577) enrolled in the Peak Aware measure.

**Figure 2-2. Number of Enrolled Thermostats by Seasonal Savings Group**




*Source: Navigant analysis of customer enrollment data.*

**Figure 2-3. Number of Thermostats Enrolling per day**




*Source: Navigant analysis of customer enrollment data.*

## 3. Program Savings

Table 3-1 summarizes the incremental energy and demand savings the SS Program achieved in PY9. Demand savings were estimated for July and August from 2-6 pm. These savings are reflected as Peak Demand Savings in the tables below, although they do not exactly match the peak demand definition in the Illinois Technical Reference Manual (IL TRM). This is not a large issue since this program will not bid savings into the PJM market. In addition, this type of analysis estimates net savings and no further net-to-gross (NTG) adjustment is necessary. Because of this, there is neither an ex ante estimate of gross savings nor a gross realization rate. Navigant did not receive an estimate of ex ante savings for this program.

**Table 3-1. PY9 Total Annual Incremental Savings**

| Savings Category | Energy Savings (kWh) | Demand Savings (kW) | Peak Demand Savings (kW) |
|---|---|---|---|
| Ex Ante Gross Savings | N/A | N/A | N/A |
| Program Gross Realization Rate | N/A | N/A | N/A |
| Verified Gross Savings | N/A | N/A | N/A |
| Program Net-to-Gross Ratio (NTGR) | N/A | N/A | N/A |
| Verified Net Savings | 3,521,806 | N/A | 5,247 |

*Source: Navigant analysis of Nest thermostat telemetry data.*

## 4. Program Savings by Measure

The program includes two measures (Standard and Peak Aware) as shown in the following tables. As shown in Table 4-1, the Standard measure contributed the most energy savings (94% of the total), in particular due to the size of the participant pool. Table 4-2 shows the peak demand savings by measure, the Standard measure made up 72% of the total savings.[3] As expected, this indicates that the Peak Aware measure contributed a larger portion of the demand savings compared to the Standard measure. Although total savings were higher for the Standard measure (due to the sample size and the fact that that measure began earlier in the summer), the energy and demand savings per device were higher for the Peak Aware measure. More information, including per device savings for each measure, are shown in Section 7.

**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) † |
|---|---|---|---|---|---|---|---|---|---|
| Thermostat | Standard | N/A | N/A | N/A | N/A | 3,299,578 | N/A | N/A | 1 |
| Thermostat | Peak Aware | N/A | N/A | N/A | N/A | 222,228 | N/A | N/A | 1 |
| | Total | N/A | N/A | N/A | N/A | 3,521,806 | N/A | N/A | 1 |

* This type of analysis estimates net savings and thus has no net-to-gross ratio (NTGR).
† Navigant is using an Effective Useful Life (EUL) of 1 year. The optimization is applied for 1 year at a time and there is currently no evidence of persistence. Navigant could pursue future research to refine this estimate.
*Source: Navigant analysis of Nest thermostat telemetry data*

[3] Total demand savings were not estimated for this measure as it does not bid into PJM.

**Table 4-2. 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 Net Peak Demand Reduction (kW) † |
|---|---|---|---|---|---|---|
| Thermostat | Standard | N/A | N/A | N/A | N/A | 3,945 |
| Thermostat | Peak Aware | N/A | N/A | N/A | N/A | 1,302 |
| | Total | N/A | N/A | N/A | N/A | 5,247 |

* This type of analysis estimates net savings and thus has no NTGR.
† Peak demand reduction was calculated as total demand reduction between 2-6pm for June through August 2017.
*Source: Navigant analysis of Nest thermostat telemetry data.*

## 5. Impact Analysis Findings and Recommendations

The SS Program does not have relevant impact parameter estimates. Total PY9 verified savings were 3,521,806 kWh and total PY9 peak demand savings were 5,247 kW. Navigant's evaluation of the SS Program in Illinois found it was successful in testing the technical feasibility of thermostat optimization and in customer acceptance of the offering. The evaluation of this program shows promise for thermostat optimization, though important questions remain regarding incremental savings from future deployments, persistence of savings, and expected savings from a full season deployment.

**Finding 1.** Just under two-thirds of eligible devices opted in to their respective program variations—62% for the Standard measure and 60% for the Peak Aware measure.

**Finding 2**. The setpoint point schedules for the treated thermostats were adjusted upward by 0.7°F during the program period, on average—0.7°F for the Standard measure and 0.8°F for the Peak Aware measure. The largest setpoint adjustments took place during the middle of the weekdays (up to 1.0°F), when customers were least likely to be at home. These setpoint adjustments result in cooling runtime reductions of approximately 10 minutes. The average impact of the SS Program on cooling runtime for SS participants was 10.5 minutes—10.6 minutes for the Standard measure and 10.0 minutes for Peak Aware measure.

**Finding 3.** The average energy savings per treated thermostat from late June/mid-July through October 14 was 71.7 kWh (or 4.5% of cooling load) for the Standard measure and 43.5 kWh (or 5.1% of cooling load) for the Peak Aware measure.[4]

**Finding 4.** The average peak demand savings per treated thermostat from late June/mid-July through August 31 was 0.091 kW (or 7.1%) for Standard Seasonal Savings and 0.314 kW (or 28.2%) for Peak Aware Seasonal Savings.

**Recommendation 1.** The summer SS Program should be evaluated an additional year before being considered for inclusion in the IL TRM to assess how customers respond to two summers of schedule adjustments, understand whether customers leave the SS Program during hot weather, and seek to ascertain a relationship between savings and weather.

[4] Since Peak Aware began over 1 month after Standard began, average energy savings over the entire summer are lower. However, Peak Aware savings are more intense in the post-period, thus the savings as a percentage of cooling load is higher.

# 6. Appendix 1. Impact Analysis Methodology

## 6.1 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 June 1 through October 14, 2017 to assess whether the impact of thermostat optimization was evident in the data
- Compare data across several groups, including: ITT versus control, and treated versus untreated versus control
- Describe whether there are differences between weekdays and weekends and hour of the day with regards to cooling setpoint and runtime

## 6.2 Impact analysis

The purpose of the impact analysis is to estimate the energy savings and peak demand savings from thermostat optimization for both the treated and ITT groups.[5,6] Navigant relied exclusively on thermostat telemetry data to estimate impacts after converting thermostat runtime to power as the 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 from the advanced thermostats measure in the IL TRM.[7]

**Equation 1. Runtime to Power Conversion**

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

Where:

$\frac{BTU}{hr}$ 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

### *6.2.1 Linear Fixed Effects Regression Model*

Navigant uses a linear fixed effects (or difference-in-differences) regression model to estimate savings associated with devices that were randomly assigned to receive the program offering (ITT devices). Thus, this model is estimating savings for all devices in the ITT group, whether or not they actually enrolled in the program. Formally, the model is specified in Equation 2.

**Equation 2. Linear Fixed Effects Regression Model**

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

Where:

[5] 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, 2017.
[6] The savings estimate for the ITT group represents an unbiased estimate of the effect of encouragement on energy use while the savings estimate for the treated group represents an unbiased estimate of the effect of the program intervention on energy use.
[7] Advanced thermostats are measure 5.3.16 in version 6 of the IL TRM.

| | |
|---|---|
| $ADU_{it}$ | is estimated daily consumption of kWh by device *i* on day *t* |
| $\alpha_i$ | is a customer-specific fixed effect for device *i*; this picks up all customer-specific characteristics that do not change through time, like household square footage |
| $\gamma_t$ | is a time-specific fixed effect for day *t;* 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 27 for Standard and August 1 for Peak Aware) 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 27 for Standard and August 1 for Peak Aware) |
| $\varepsilon_{it}$ | is the cluster-robust error term for device *i* during day *t;* cluster-robust errors account for heteroskedasticity and autocorrelation at the household level |

The coefficient $\beta_1$ is the estimate of average daily kWh energy savings due to the being offered the program.

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) rather than daily energy consumption. Additional explanatory variables were included, controlling for hourly weather and day of week.

To calculate total program savings resulting from treatment, Navigant multiplied average daily energy savings by the number of program days (post tune-up) and the number of participating devices. Similarly, to calculate total demand savings, Navigant multiplied average hourly demand savings by the number of participating devices.

### 6.2.2 Two-Stage Least Squares Instrumental Variable Model

Navigant uses a two-stage least-squares instrumental variables approach to estimate savings associated with receiving the SS algorithm (i.e., this estimates savings just for the portion of the ITT group who enrolled in the program). This approach relies on the random assignment of customers into the ITT group as an instrumental variable for the decision to participate in the program, accounting for the fact that participation is not random and depends on unobserved characteristics that may be correlated with energy consumption (i.e., participation is endogenous).

In the first stage, program participation is regressed on an indicator for whether the customer was randomly assigned to receive the program offering (ITT). This regression is used to predict the likelihood of participation. In the second stage, average daily energy consumption is regressed on the predicted likelihood of participation. Formally, the first stage model is specified in Equation 3, and the second stage model is specified in Equation 4.

**Equation 3. Two-Stage Least Squares IV Model: First Stage**

$$\widehat{Treat_i} = \alpha_i + \gamma_t + \beta_1 Post_t + \beta_2 (Post_t \cdot ITT_i) + \varepsilon_{it}$$

**Equation 4. Two-Stage Least Squares IV Model: Second Stage**

$$ADU_{it} = \alpha_i + \gamma_t + \beta_1 Post_t + \beta_2 \left(PostTune_{it} \cdot \widehat{Treat_i}\right) + \varepsilon_{it}$$

Where:

| | |
|---|---|
| $ADU_{it}$ | is estimated daily consumption of kWh by device *i* on day *t* |
| $\alpha_i$ | is a customer-specific fixed effect for device *i*; this picks up all customer-specific characteristics that do not change through time, like household square footage |

| | |
|---|---|
| $\gamma_t$ | is a time-specific fixed effect for day *t;* 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 27 for Standard and August 1 for Peak Aware) 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 27 for Standard and August 1 for Peak Aware); this is the instrument for $PostTune_{it} \cdot \widehat{Treat_i}$ in the second stage of the model |
| $PostTune_{it} \cdot \widehat{Treat_i}$ | is a binary variable taking a value of 1 when device *i* is in the treated group (opted in to the SS program) and day *t* is after the start of the SS tune-up; this variable is instrumented for $Post_t \cdot Treat_i$ |
| $\varepsilon_{it}$ | is the cluster-robust error term for device *i* during day *t;* cluster-robust errors account for heteroskedasticity and autocorrelation at the household level |

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) rather than daily energy consumption. Additional explanatory variables were included, controlling for hourly weather and day of week.

To calculate total program savings resulting from treatment, Navigant multiplied average daily energy savings by the number of program days (post tune-up) and the number of participating devices. Similarly, to calculate total demand savings, Navigant multiplied average hourly demand savings by the number of participating devices.

## 6.3 Data Cleaning & Device Validity

For the purposes of the analysis, Navigant devised and performed measures to clean and remove data deemed unsuitable. Table 6-1 details the steps taken that removed whole devices, the number of devices dropped in each category, and the total raw, remaining, valid devices for each encouragement group. As shown in Table 6-2, for the Standard measure, approximately 93% of treated and 85% of untreated devices were included in Navigant's analysis, with 95% of treated and 88% of untreated devices used in the calculation of total energy and peak demand savings for the evaluation period.

Table 6-2 and Table 6-3 further break down the device loss at the treated and untreated level for each of Standard and Peak Aware, respectively.

**Table 6-1. Device Drops, ITT and Control**

| Category | Control | | Standard ITT | | Peak Aware ITT | |
|---|---|---|---|---|---|---|
| *Raw device count totals* | 4997 | *100%* | 86447 | *100%* | 9,999 | *100%* |
| No telemetry data*† | 127 | *2.54%* | 2,008 | *2.32%* | 231 | *2.31%* |
| No 2017 telemetry data* | 209 | *4.18%* | 3,477 | *4.02%* | 372 | *3.72%* |
| No zip code* | 0 | - | 5 | *0.01%* | 0 | - |
| Not in a ComEd majority zip* | 71 | *1.42%* | 1278 | *1.48%* | 167 | *1.67%* |
| Missing structure ID | 19 | *0.38%* | 366 | *0.42%* | 44 | *0.44%* |
| Multiple structure ID | 78 | *1.56%* | 1,308 | *1.51%* | 138 | *1.38%* |
| No qualification date (treatment only) | 0 | - | 2 | *< 0.01%* | 0 | - |
| No tuneup start date (treatment only) | 0 | - | 75 | *0.09%* | 15 | *0.15%* |
| No days with sufficient interval data | 2 | *0.04%* | 67 | *0.08%* | 6 | *0.06%* |
| *Remaining devices* ‡ | 4,491 | *89.87%* | 77,861 | *90.07%* | 9,026 | *90.27%* |
| *Valid devices* § | 4,491 | *89.87%* | 79,679 | *92.17%* | 9,229 | *92.30%* |

* Devices dropped via these categories are considered invalid and are not used in calculating final savings or demand savings.
† These devices were dropped by Nest due to data quality issues before Navigant received the telemetry data.
‡ Devices used to calculate per-device values for average daily energy savings and average peak demand savings.
§ Devices used to calculate season total energy savings and peak demand savings.
*Source: Navigant analysis of Nest thermostat telemetry data.*

As shown in Table 6-2, for the Standard measure, approximately 93% of treated and 85% of untreated devices were included in Navigant's analysis, with 95% of treated and 88% of untreated devices used in the calculation of total energy and peak demand savings for the evaluation period.

**Table 6-2. ITT Device Drop Breakdown: Standard**

| Category | Treated | | Untreated | |
|---|---|---|---|---|
| *Raw device count totals* | 53,344 | *100%* | 33,103 | *100%* |
| No telemetry data*† | 730 | *1.37%* | 1,278 | *3.86%* |
| No 2017 telemetry data* | 1,221 | *2.29%* | 2,256 | *6.82%* |
| No zip code* | 4 | *0.01%* | 1 | *< 0.01%* |
| Not in a ComEd majority zip* | 890 | *1.67%* | 388 | *1.17%* |
| Missing structure ID | 160 | *0.30%* | 206 | *0.62%* |
| Multiple structure ID | 693 | *1.30%* | 615 | *1.86%* |
| No qualification date (treatment only) | 2 | *< 0.01%* | 0 | - |
| No tuneup start date (treatment only) | 75 | *0.14%* | 0 | - |
| No days with sufficient interval data | 1 | *< 0.01%* | 66 | *0.20%* |
| *Remaining devices* ‡ | 49,568 | *92.92%* | 28,293 | *85.47%* |
| *Valid devices* § | 50,499 | *94.67%* | 29,180 | *88.15%* |

* Devices dropped via these categories are considered invalid and are not used in calculating final savings or demand savings.
† These devices were dropped by Nest due to data quality issues before Navigant received the telemetry data.
‡ Devices used to calculate per-device values for average daily energy savings and average peak demand savings.
§ Devices used to calculate season total energy savings and peak demand savings.
*Source: Navigant analysis of Nest thermostat telemetry data.*

As shown in Table 6-3, for the Peak Aware measure, approximately 93% of treated and 87% of untreated devices were included in Navigant's analysis, with 94% of treated and 89% of untreated devices used in the calculation of total energy and peak demand savings for the evaluation period.

**Table 6-3. ITT Device Drop Breakdown: Peak Aware**

| Category | Treated | | Untreated | |
|---|---|---|---|---|
| *Raw device count totals* | 6,000 | *100%* | 3,999 | *100%* |
| No telemetry data*† | 81 | *1.35%* | 150 | *3.75%* |
| No 2017 telemetry data* | 129 | *2.15%* | 243 | *6.08%* |
| No zip code* | 0 | - | 0 | - |
| Not in a ComEd majority zip* | 123 | *2.05%* | 44 | *1.10%* |
| Missing structure ID | 15 | *0.25%* | 29 | *0.73%* |
| Multiple structure ID | 77 | *1.28%* | 61 | *1.53%* |
| No qualification date (treatment only) | 0 | - | 0 | - |
| No tuneup start date (treatment only) | 15 | *0.25%* | 0 | - |
| No days with sufficient interval data | 0 | - | 6 | *0.15%* |
| *Remaining devices* ‡ | 5,560 | *92.67%* | 3,466 | *86.67%* |
| *Valid devices* § | 5,667 | *94.45%* | 3,562 | *89.07%* |

* Devices dropped via these categories are considered invalid and are not used in calculating final savings or demand savings.
† These devices were dropped by Nest due to data quality issues before Navigant received the telemetry data.
‡ Devices used to calculate per-device values for average daily energy savings and average peak demand savings.
§ Devices used to calculate season total energy savings and peak demand savings.
*Source: Navigant analysis of Nest thermostat telemetry data.*

## 6.4 Summer 2017 Weather

The average temperature and cooling degree days in Illinois for 2017 are compared to the 1981-2010 normal in Table 6-4. The average monthly temperatures were all above the 1981-2010 normal, with the exception of August.

**Table 6-4. Summer 2017 Weather: Illinois**

| | | June | July | August | September | October |
|---|---|---|---|---|---|---|
| Average Temperature | 2017 | 73 | 75 | 72 | 70 | 58 |
| | 1981-2010 normal | 68.9 | 74.0 | 72.4 | 64.6 | 52.5 |
| | Departure | 4.1 | 1.0 | -0.4 | 5.4 | 5.5 |
| Cooling Degree Days (base 65°F) | 2017 | 230 | 307 | 214 | 179 | 29 |
| | 1981-2010 normal | 165 | 283 | 238 | 92 | 11 |
| | Departure | 65 | 24 | -24 | 87 | 18 |

*Source: Midwest Regional Climate Center*

# 7. Appendix 2. Impact Analysis Detail

This section presents the details of our exploratory and impact analysis findings, first for the Standard measure and then for the Peak Aware measure.

## 7.1 Exploratory Analysis – Standard

This section presents the findings from the exploratory analysis of the thermostat telemetry data for the Standard measure. Table 7-1 provides the average daily scheduled setpoint and average daily cooling runtime for the control, ITT, and treated and untreated sub-groups. The analysis compares the pre-program and program period for each group and finds that the SS program made the intended adjustments to scheduled setpoints, yielding reductions in cooling runtime.

**Table 7-1. Summary of Exploratory Analysis, Averages: Standard**

| Period | Group | Jun 1 – Jun 26 Pre-Period | Jun 27 – Oct 14 Program Period | Δ* | SS Effect † |
|---|---|---|---|---|---|
| Avg Daily Outdoor Temp (°F) | | 71.9 | 69.7 | -2.2 | N/A |
| Avg Daily Scheduled Cooling Setpoints (°F) | Control | 74.2 | 74.3 | 0.16 | N/A |
| | ITT | 74.1 | 74.7 | 0.57 | 0.42 |
| | *Treated* | *74.2* | *74.9* | *0.72* | *0.57* |
| | *Untreated* | *73.8* | *74.0* | *0.18* | *N/A* |
| Avg Daily Cooling Runtime (minutes) | Control | 293 | 234 | -59.7 | N/A |
| | ITT | 294 | 229 | -65.7 | -6.00 |
| | *Treated* | *296* | *228* | *-68.6* | *-8.94* |
| | *Untreated* | *291* | *231* | *-60.4* | *N/A* |

* 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 or treated group and the control group. These values are per-period averages do not directly reflect Seasonal Savings program impacts.
*Source: Navigant analysis of Nest thermostat telemetry data and National Oceanic and Atmospheric Administration (NOAA) temperature data.*

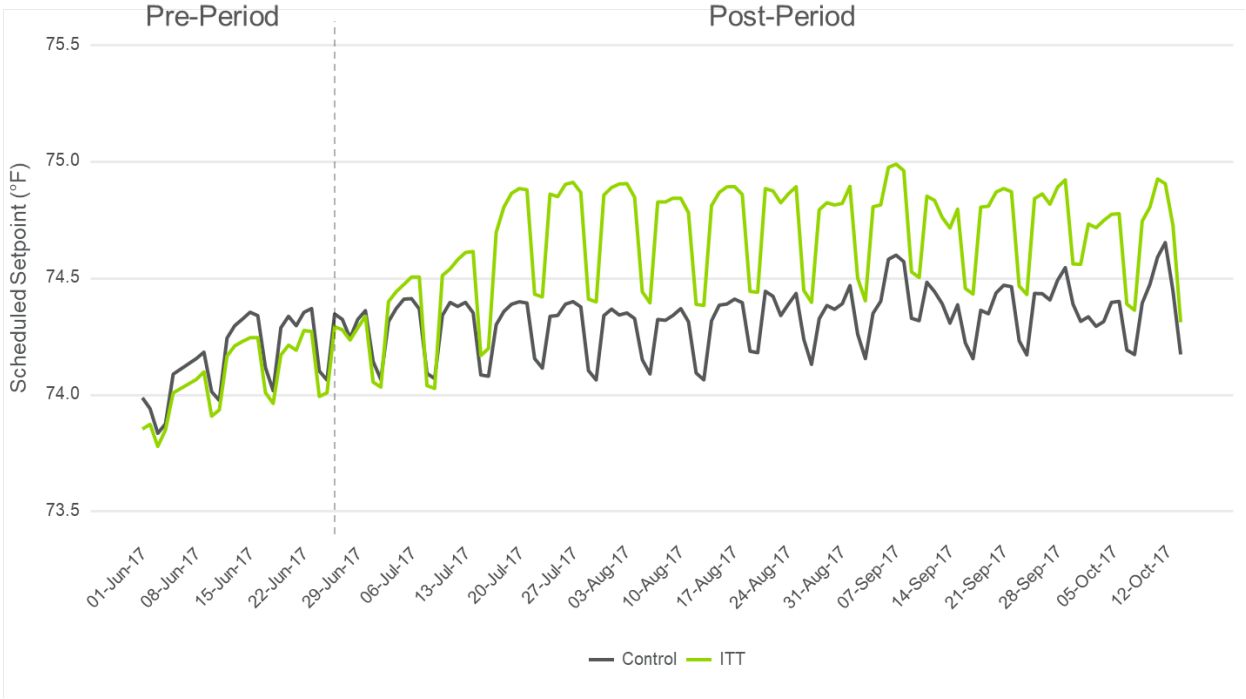
### *7.1.1 Setpoint Comparisons*

Figure 7-1 presents the average daily scheduled setpoints for the ITT and control groups. Figure 7-2 presents this information as a comparison of average daily scheduled setpoints for the ITT group relative to the control group, where the control group is represented by the centerline.

- **Pre-program period:** Average daily scheduled setpoints during the pre-period were similar between the ITT and control groups, with a difference of approximately 0.1°F on average.[8] This is the expectation of random encouragement. As a result, the ITT and control groups are expected to have average daily setpoint readings that are practically and statistically similar.
- **Program period:** The difference in average daily scheduled setpoints increased for both the ITT and control groups during the program period, but the increase was larger for the ITT group. Average daily scheduled setpoints increased by approximately 0.4°F for the ITT group relative to the control group over the entire period. This result provides evidence that the program had the intended effect of adjusting scheduled setpoints.

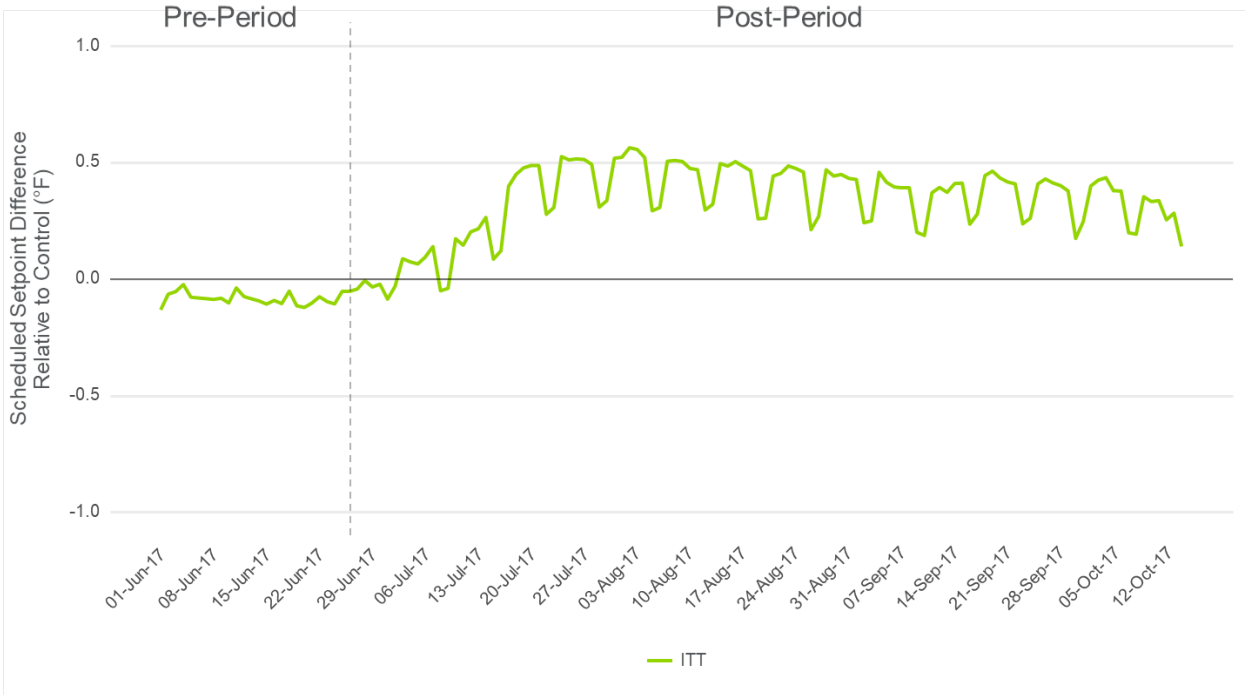
[8] This difference is not statistically significant.

**Figure 7-1. Average Daily Scheduled Setpoints: Standard**




*Source: Navigant analysis of Nest thermostat telemetry data.*

**Figure 7-2. Average Daily Scheduled Setpoint Comparison, ITT vs. Control: Standard**



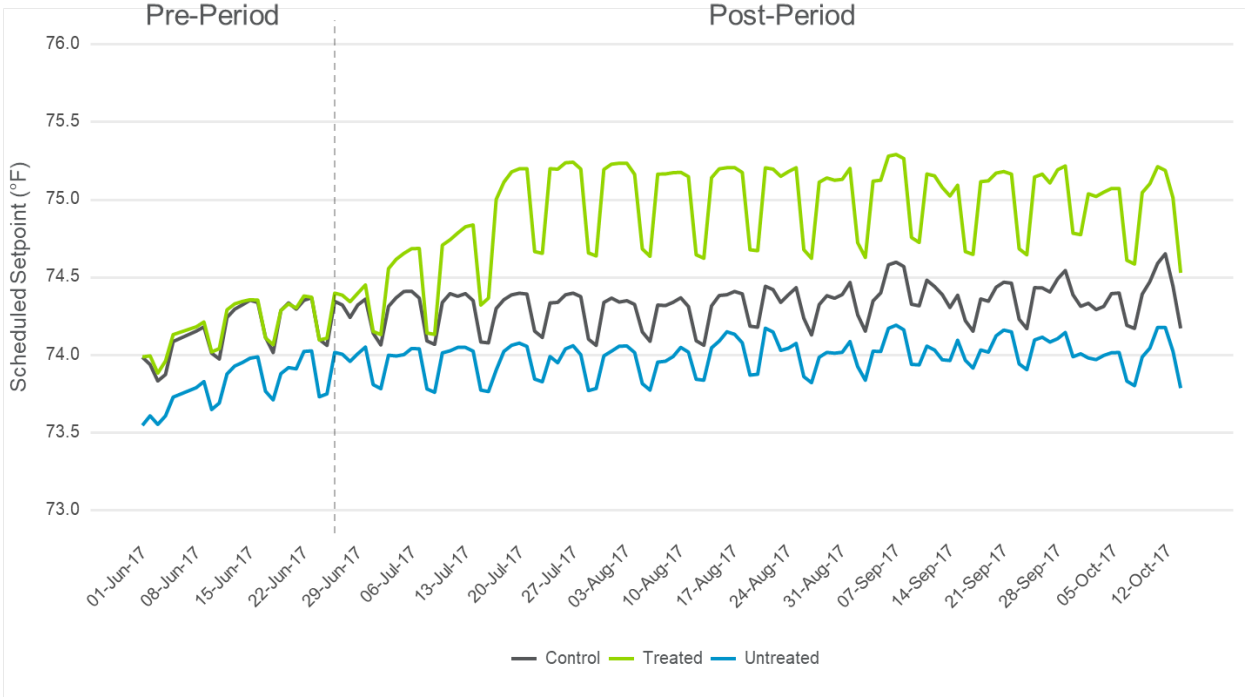

*Source: Navigant analysis of Nest thermostat telemetry data.*

Figure 7-3 and Figure 7-4 present a similar comparison as above but show the average daily scheduled setpoints for the ITT group split out by treated and untreated groups, in addition to the control group.

Figure 7-3 presents average daily scheduled setpoints, while Figure 7-4 presents this information relative to the control group, where the control group is represented by the centerline.

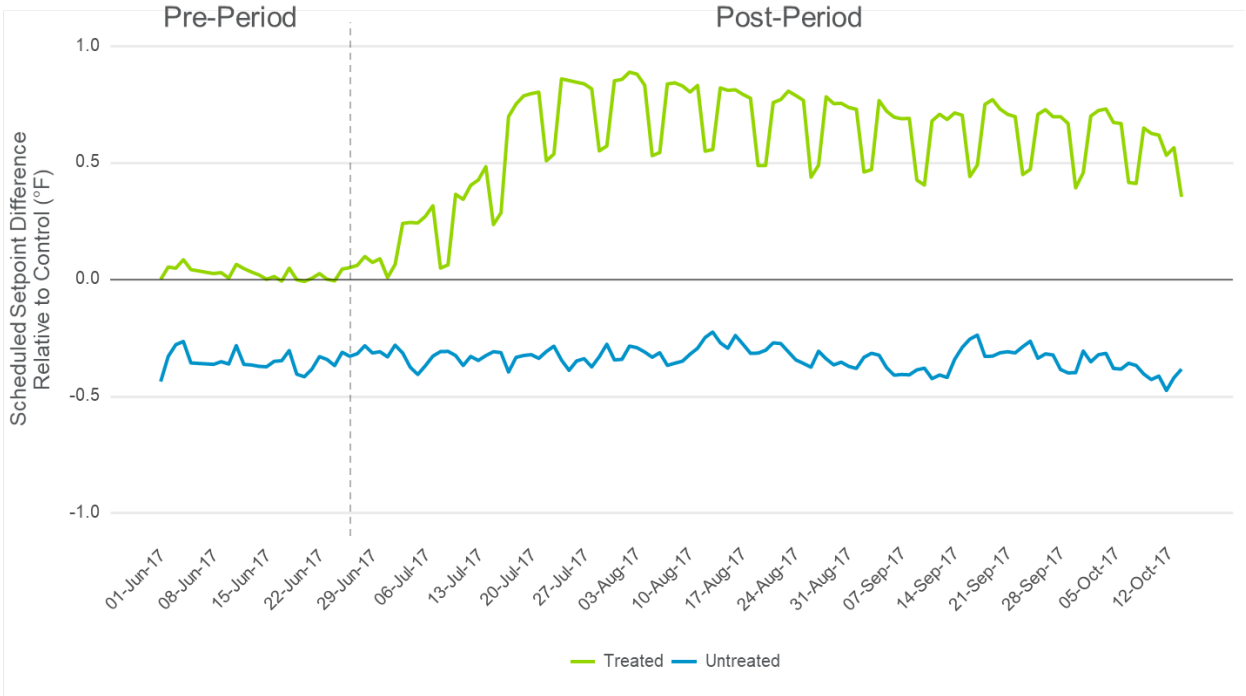
- **Pre-program period:** While the treated and control groups had similar average daily scheduled setpoints during the pre-period, the untreated group's average daily scheduled setpoint was approximately 0.38°F lower than their treated counterparts, on average. Differences between the treated and untreated groups are expected by nature of RED, as the untreated group includes customers that did not opt in and those who were not eligible to participate in the program.
- **Program period:** Average daily scheduled setpoints increased for all three groups, but the increase was largest for the treated group. Average daily scheduled setpoints increased by 0.57°F for the treated group relative to the control group during the program period, whereas it remained relatively unchanged (0.02°F) for devices that were untreated relative to the control.

**Figure 7-3. Avg. Daily Scheduled Setpoints, All Groups: Standard**




*Source: Navigant analysis of Nest thermostat telemetry data.*

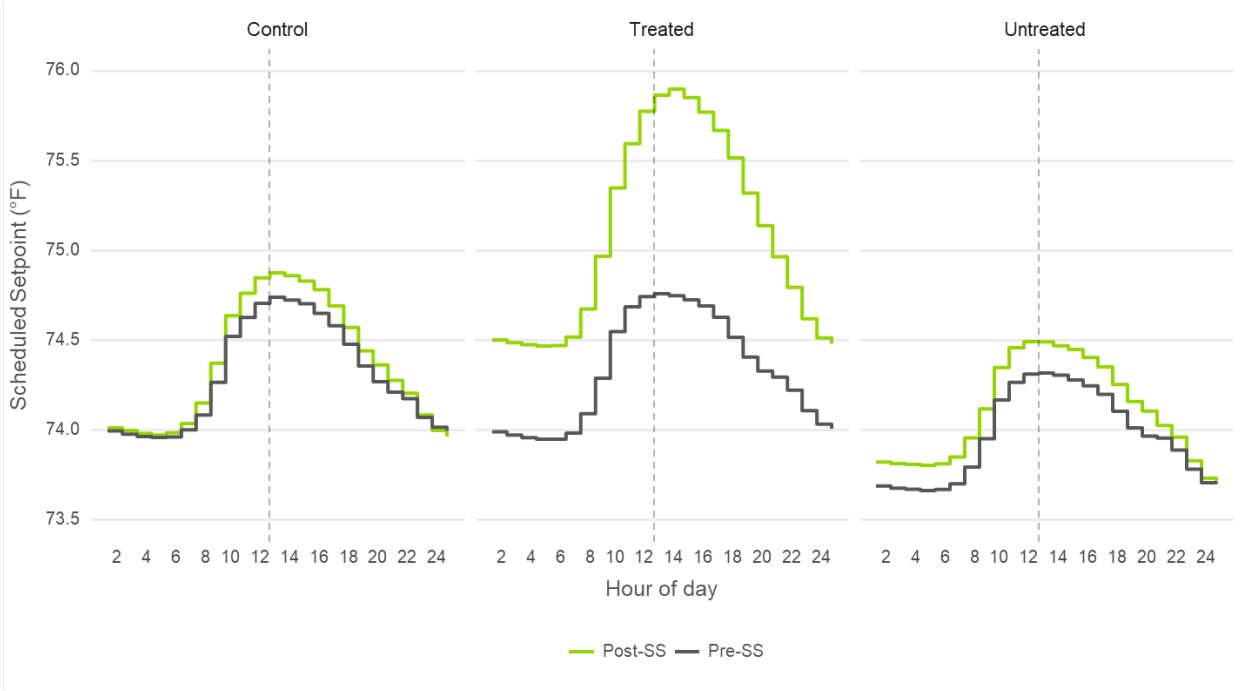
**Figure 7-4. Avg. Daily Scheduled Setpoint Comparison, Treated and Untreated vs. Control: Standard**




*Source: Navigant analysis of Nest thermostat telemetry data.*

Figure 7-5 presents a comparison of average hourly scheduled setpoints based on the weeks of June 20–26, 2017 (the week preceding enrollment) and August 22–August 28, 2017 (the week after 95% of all treated devices had enrolled) for the treated, untreated, and control groups. The differences in these values for treatment and control during these periods are further broken down in Table 7-2 by weekday, weekend, and overall differences. These comparisons further illustrate that while scheduled setpoints increased for all groups, the changes for the treated group were largest. Furthermore, the program is designed to make the largest adjustments during times when customers are away from home (e.g., weekday daytime) and smaller adjustments during times when customers are at home (e.g., weekday evenings and weekends), and this is evident in the data. In comparison to the control group, overall average scheduled setpoints increased by 0.6°F between 10 am and 6 pm for treated devices, and these changes were roughly the same for all other hours as well. On the other hand, changes in setpoint for the untreated group are comparable to those of the control group.

**Figure 7-5. Mean Hourly Setpoint Comparison, Before and After SS: Standard**




*Source: Navigant analysis of Nest thermostat telemetry data.*

**Table 7-2. Change in Scheduled Setpoints, Before and After Tune-Up: Standard***

| Day Type | Period | Treated | Control | Δ |
|---|---|---|---|---|
| Weekday | 10 am to 6 pm | 0.8°F | 0.1°F | 0.7°F |
| | Other Hours | 0.8°F | 0.1°F | 0.7°F |
| Weekend | 10 am to 6 pm | 0.6°F | 0.1°F | 0.5°F |
| | Other Hours | 0.6°F | 0.1°F | 0.5°F |
| Overall | 10 am to 6 pm | 0.7°F | 0.1°F | 0.6°F |
| | Other Hours | 0.8°F | 0.1°F | 0.7°F |

* The dates selected for before the Standard tune-up consist of the week prior to first enrollment (June 20 – June 26). The dates selected for after the Standard tune-up begins after 95% of Standard treated devices have enrolled (August 22 – August 28).
*Source: Navigant analysis of Nest thermostat telemetry data*

### *7.1.2 Runtime Comparisons*

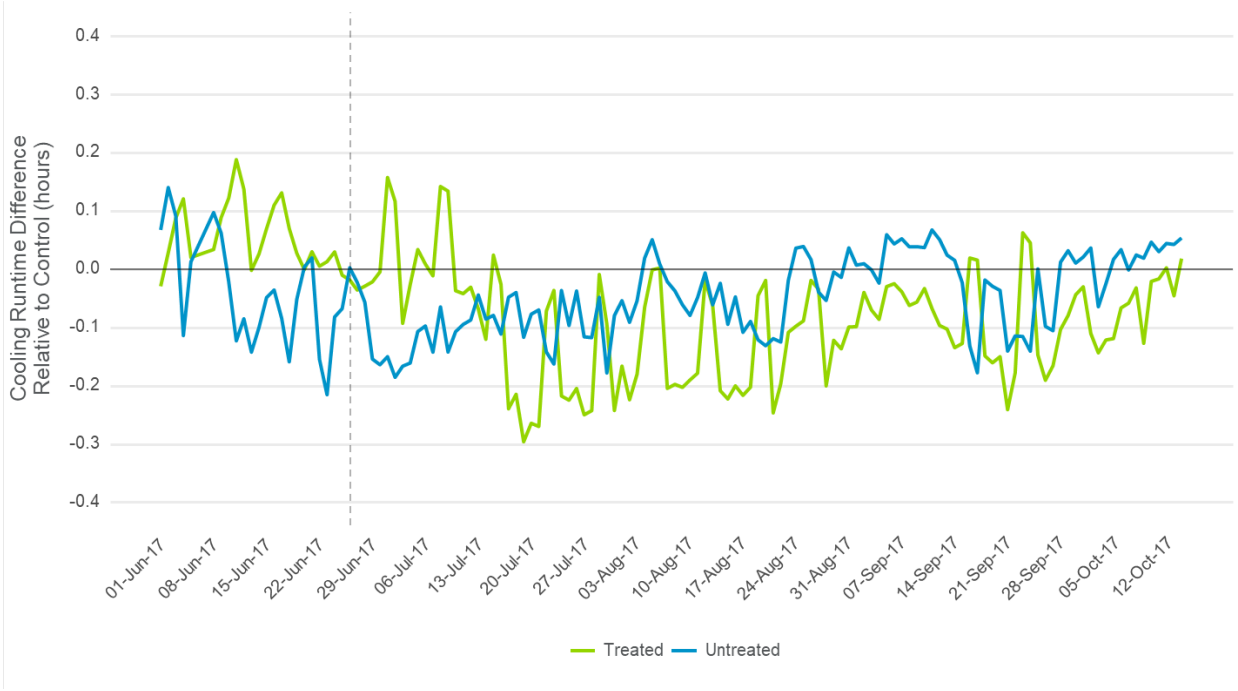
Similar to the exploratory analysis of average scheduled setpoints, this section presents findings from the exploratory analysis of average daily thermostat cooling runtime. Unlike scheduled cooling setpoint, the cooling runtime had direct correlation with outdoor temperature. The average outdoor temperatures during the pre-program and program periods were 71.9°F and 69.7°F, respectively (see Table 7-1). Figure 7-6 presents a comparison of average daily runtime for both the treated and untreated ITT groups relative to the control group, where the control group is represented by the centerline.

- **Pre-program period:** There was a small difference in average daily runtime during the pre-period between the treated or untreated sub-groups and the control group. The treated group

had 3.2 minutes more runtime than the control group, whereas the untreated group had 2.3 minutes less than the control.[9]

- **Program period:** During the program period, average daily runtime decreased for all groups, but the decrease was largest for the treated group. Average daily runtime decreased by an average of 8.9 mins during the program period for the treated group relative to the control group. This result provides evidence there was less cooling taking place for the treated group relative to the control group as a result of the program. In contrast, the untreated group saw a 0.8 minute decrease in runtime for the program period relative to the control group compared to the pre-program period.

**Figure 7-6. Average Daily Runtime Comparison, Treated and Untreated vs. Control: Standard**

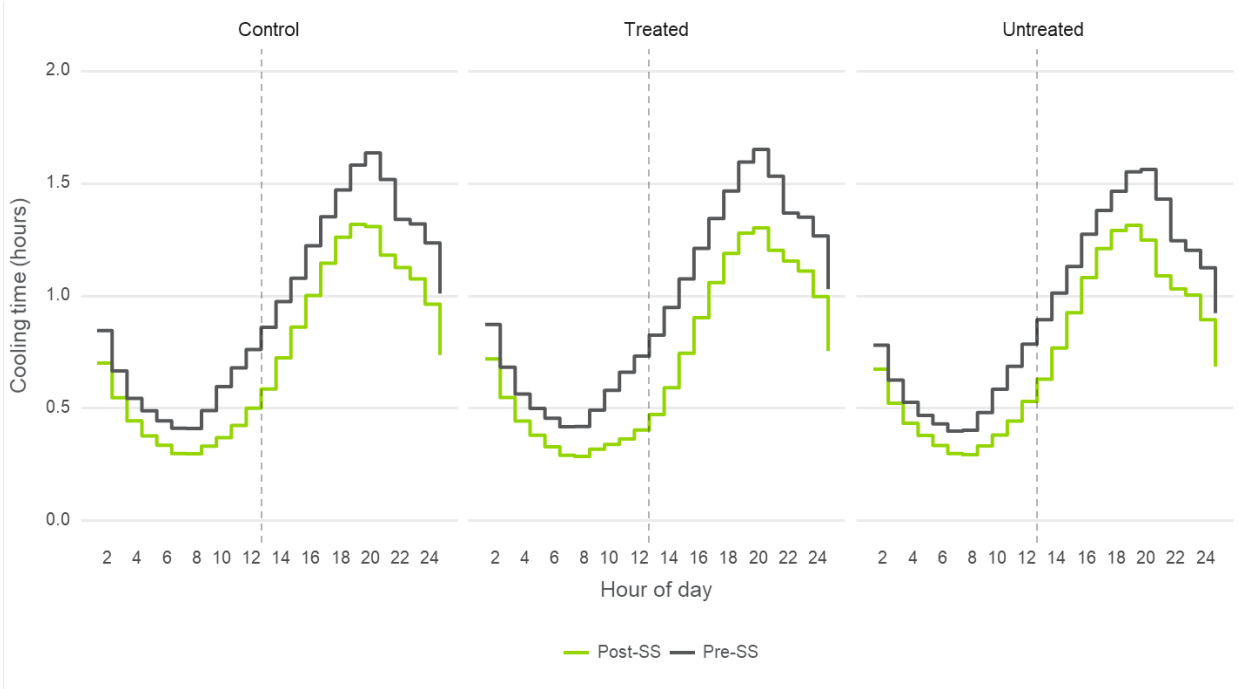



*Source: Navigant analysis of Nest thermostat telemetry data.*

Figure 7-7 presents a comparison of average hourly cooling runtime based on the weeks of June 20 – 26, 2017 (the week preceding enrollment) and August 22–August 28, 2017 (the week after 95% of all treated devices had enrolled) for the treated, untreated and control groups. The differences in these values for treatment and control during these periods are further broken down in Table 7-3 by weekday, weekend, and overall differences. These comparisons further illustrate that while cooling runtime decreased for all groups, the changes for the treated group were largest. Furthermore, the program is designed to make the largest adjustments during times when customers are away from home (e.g., weekday daytime) and smaller adjustments during times when customers are at home (e.g., weekday evenings and weekends), and this is evident in the data. In comparison to the control group, overall average cooling runtime decreased by 0.2 minutes between 10 am and 6 pm for treated devices; these changes were roughly the same for all other hours as well. On the other hand, changes in cooling runtime for the untreated group are rather comparable to those of the control group.

[9] Overall differences between ITT and control groups were not statistically significant.

**Figure 7-7. Mean Hourly Runtime Comparison, Before and After SS: Standard**




*Source: Navigant analysis of Nest thermostat telemetry data.*

**Table 7-3. Change in Runtime, Before and After Tune-Up: Standard***

| Day Type | Period | Treated | Control | Δ |
|---|---|---|---|---|
| Weekday | 10 a.m. to 6 p.m. | -1.9 min | -1.6 min | -0.3 min |
| | Other Hours | -3.1 min | -2.8 min | -0.3 min |
| Weekend | 10 a.m. to 6 p.m. | -1.8 min | -1.8 min | 0 min |
| | Other Hours | 0 min | 0.1 min | -0.1 min |
| Overall | 10 a.m. to 6 p.m. | -1.9 min | -1.7 min | -0.2 min |
| | Other Hours | -2.3 min | -2.0 min | -0.3 min |

* The dates selected for before Standard Seasonal Savings tune-up consist of the week prior to first enrollment (June 20-June 26). The dates selected for after Standard Seasonal Savings tune-up begins after 95% of Standard treated devices have enrolled (August 22–August 28).
*Source: Navigant analysis of Nest thermostat telemetry data.*

## 7.2 Impact Analysis – Standard

This section presents the findings from the energy and peak demand impact analysis for the Standard measure, summarized in Table 7-4. The Standard measure resulted in total energy savings of 3,589 MWh from June 27 to October 14, 2017, and total peak demand savings of 4,595 kW between June 27 and August 31, 2017.

**Table 7-4. SS Summary from June 27 to October 14, 2017*: Standard**

| Statistic | ITT † | Treated (Subset of ITT) † |
|---|---|---|
| Number of Nest thermostats in control group | | 4,491 |
| Number of valid Nest thermostats | 79,679 | 50,499 |
| Average energy savings (% of cooling load) | 2.6% ± 0.8% | 4.5% ± 1.4% |
| Average daily energy savings per device (kWh) | 0.42 ± 0.13 *** | 0.71 ± 0.23 *** |
| Average total energy savings per device (kWh) ‡ | 41.4 | 71.1 |
| Total energy savings (kWh) § | 3,299,578 | 3,589,249 |
| Average peak demand savings (% of cooling load) | 4.0% ± 0.8% | 7.1% ± 1.4% |
| Average peak demand savings per device (kW) ‖ | 0.050 ± 0.010 *** | 0.091 ± 0.018 *** |
| Total peak demand savings (kW) # | 3,945 | 4,595 |

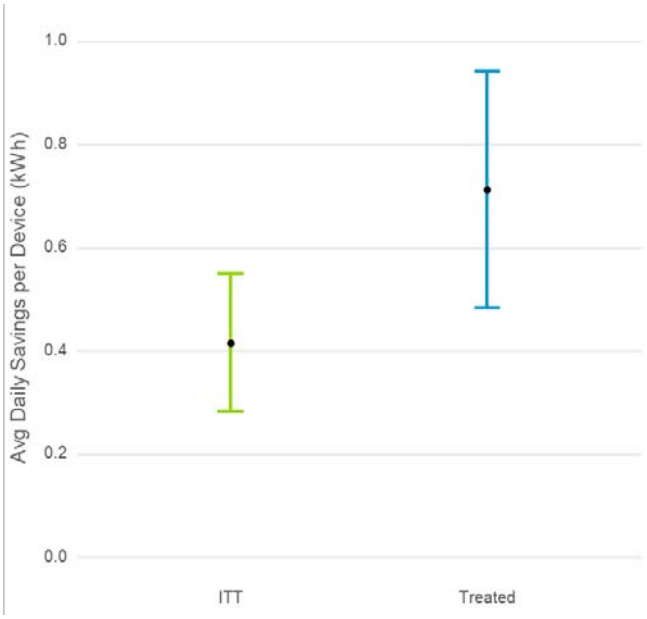
*Significance levels: *** p < 0.01, range indicates 90% confidence interval.*
** The first offer date for the Standard measure occurred on June 27, 2017. The measure persists as long as air conditioning systems are in cooling mode. This evaluation relies on data through October 14, 2017 when the majority of devices were no longer in cooling mode.*
*† ITT includes all devices randomly assigned to receive the Standard measure. Treated is a subset of ITT and includes those devices that qualified and opted into the program.*
*‡ Total savings per device is calculated as average daily savings per device x the number of days post tune-up start date.*
*§ Total savings is calculated as total energy savings per device x the number of treated/ITT devices.*
*|| Average demand savings on weekdays, non-holidays, 2 p.m. – 6 p.m., June through August.*
*# Total savings is calculated as average demand savings per device x the number of treated/ITT devices.*
*Source: Navigant analysis.*

### *7.2.1 Energy Impacts*

Figure 7-8 presents the estimate of average daily energy savings for the ITT group (including devices that opt in, do not opt in, and do not qualify) and the treated group (including only devices that opt in). Average daily energy savings is estimated to be 0.42 kWh[10] per device for the ITT group and 0.71 kWh[11] per device for the treated group. Figure 7-9 presents these results as a percentage of cooling load. Average daily energy savings are 2.6% of cooling load for the ITT group and 4.5% for the treated group.

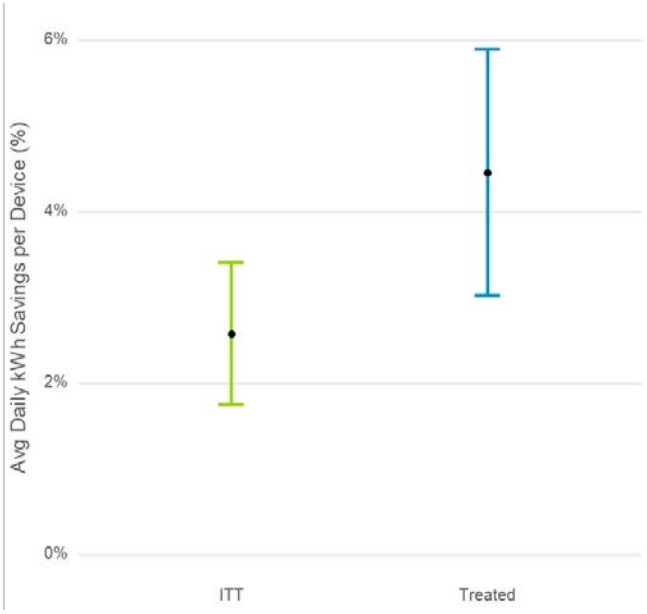
[10] The 90% confidence interval is (0.28 kWh, 0.55 kWh).
[11] The 90% confidence interval is (0.48 kWh, 0.94 kWh).

**Figure 7-8. Average Daily Savings: Standard**




*Source: Navigant analysis.*

**Figure 7-9. Average Daily Savings (as a Percentage of Cooling Load): Standard**



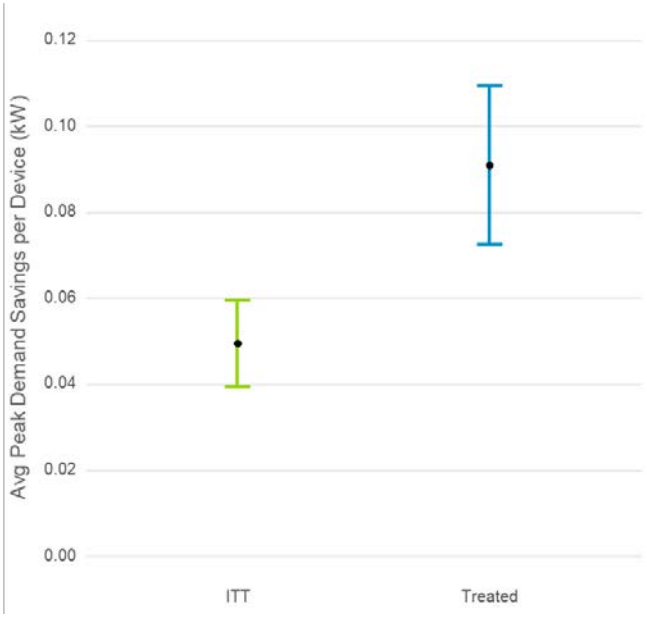

*Source: Navigant analysis*

### *7.2.2 Peak Demand Impacts*

Navigant estimated peak demand impacts from 2 pm to 6 pm on program period non-holiday, weekdays in late June through the end of August. Figure 7-10 presents the estimate of average peak demand savings for the ITT group (including devices that opt in, do not opt in, and do not qualify) and the treated

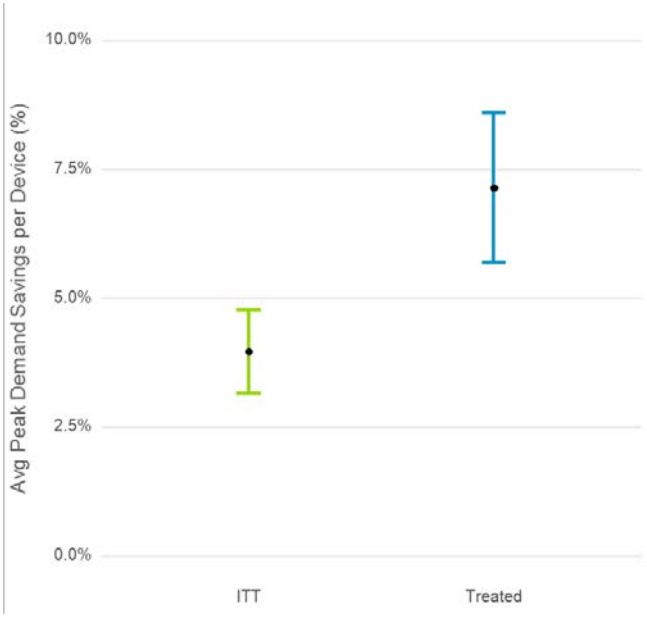
group (including only devices that opt in). Average peak demand savings is estimated to be 0.050 kW[12] per device for the ITT group and 0.091 kW[13] per device for the treated group. Figure 7-11 presents these results as a percentage of cooling load. Average peak demand savings are 4.0% of cooling load for the ITT group and 7.1% for the treated group.

**Figure 7-10. Average Peak Demand Savings: Standard**




*Source: Navigant analysis.*

**Figure 7-11. Average Peak Demand Savings (as a Percentage of Cooling Load): Standard**




*Source: Navigant analysis.*

[12] The 90% confidence interval is (0.040 kW, 0.060 kW).
[13] The 90% confidence interval is (0.073 kW, 0.109 kW).

## 7.3 Exploratory Analysis – Peak Aware

This section presents the findings from the exploratory analysis of the thermostat telemetry data for the Peak Aware measure. Table 7-5 provides the average daily scheduled setpoint and average daily cooling runtime for the control, ITT, and treated and untreated sub-groups. The analysis compares the pre-program and program period for each group and finds that the SS program made the intended adjustments to scheduled setpoints, yielding reductions in cooling runtime.

**Table 7-5. Summary of Exploratory Analysis: Peak Aware**

| Period | Group | Jun 1 – Jul 31 Pre-Period | Aug 1 – Oct 14 Program Period | Δ* | SS Impact † |
|---|---|---|---|---|---|
| Avg Daily Outdoor Temp (°F) | | 72.5 | 68.2 | -4.3 | N/A |
| Avg Daily Scheduled Cooling Setpoints (°F) | Control | 74.2 | 74.3 | 0.11 | N/A |
| | ITT | 74.2 | 74.7 | 0.52 | 0.41 |
| | *Treated* | *74.3* | *75.0* | *0.67* | *0.56* |
| | *Untreated* | *73.9* | *74.1* | *0.14* | N/A |
| Avg Daily Cooling Runtime (minutes) | Control | 311 | 191 | -120 | N/A |
| | ITT | 312 | 187 | -125 | -4.89 |
| | *Treated* | *313* | *185* | *-129* | *-8.87* |
| | *Untreated* | *309* | *191* | *-118* | N/A |

* The Δ is the difference between the program period and the pre-period.
† The SS impact is the difference between the Δ for the ITT or treated group and the control group.
*Source: Navigant analysis of Nest thermostat telemetry data and National Oceanic and Atmospheric Administration (NOAA) temperature data*

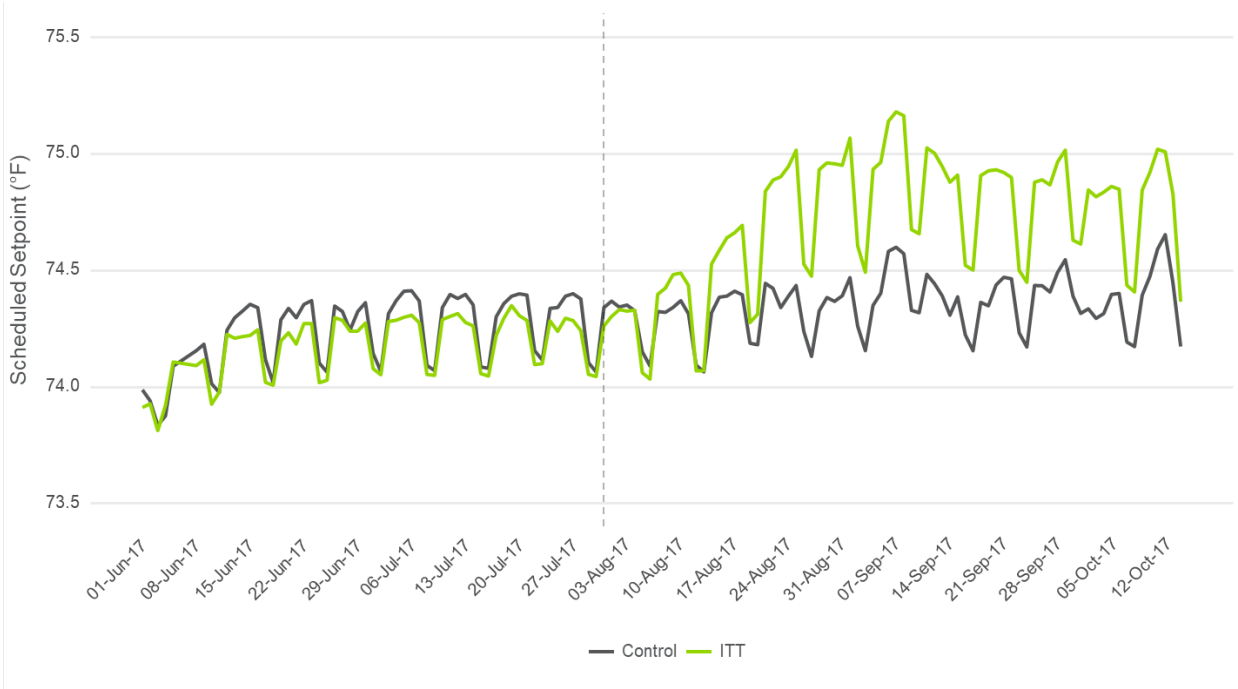
### *7.3.1 Setpoint Comparisons*

Figure 7-12 presents the average daily scheduled setpoints for the ITT and control groups. Figure 7-13 presents this information as a comparison of average daily scheduled setpoints for the ITT group relative to the control group, where the control group is represented by the centerline.

- **Pre-program period:** Average daily scheduled setpoints during the pre-period were similar between the ITT and control groups, with a difference of less than 0.1°F on average.[14] This is the expectation of random encouragement. As a result, the ITT and control groups are expected to have average daily setpoint readings that are practically and statistically similar.
- **Program period:** The difference in average daily scheduled setpoints increased for both the ITT and control groups during the program period, but the increase was larger for the ITT group. Average daily scheduled setpoints increased by approximately 0.4°F for the ITT group relative to the control group over the entire period. This result provides evidence that the program had the intended effect of adjusting scheduled setpoints.

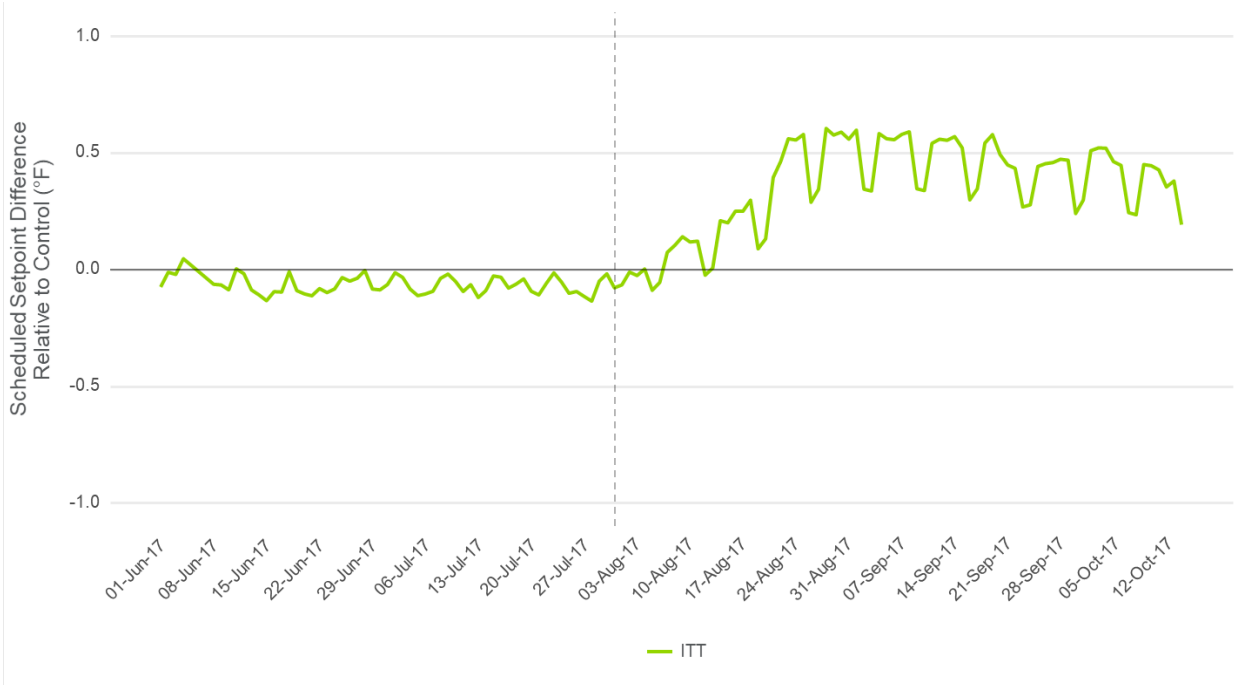
[14] This difference is not statistically significant.

**Figure 7-12. Average Daily Scheduled Setpoints: Peak Aware**




*Source: Navigant analysis of Nest thermostat telemetry data.*

**Figure 7-13. Average Daily Scheduled Setpoint Comparison, ITT vs. Control: Peak Aware**



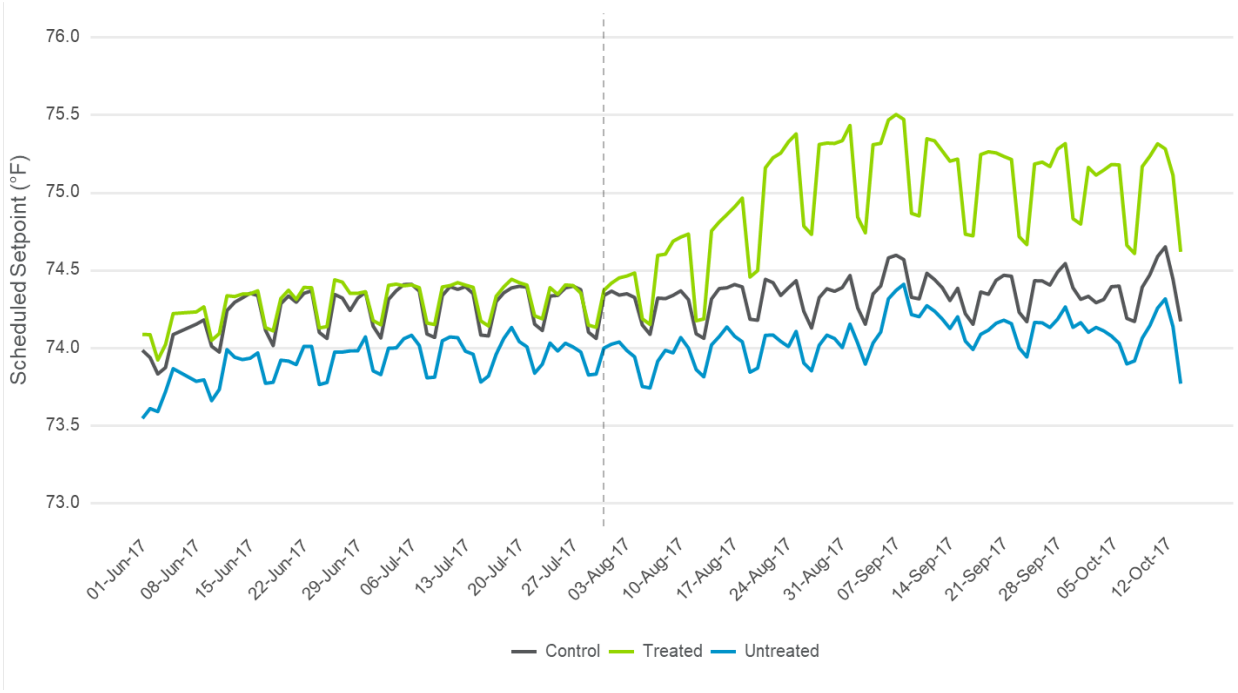

*Source: Navigant analysis of Nest thermostat telemetry data.*

Figure 7-14 and Figure 7-15 present a similar comparison as above but show the average daily scheduled setpoints for the ITT group split out by treated and untreated groups, in addition to the control

group. Figure 7-14 presents average daily scheduled setpoints, while Figure 7-15 presents this information relative to the control group, where the control group is represented by the centerline.

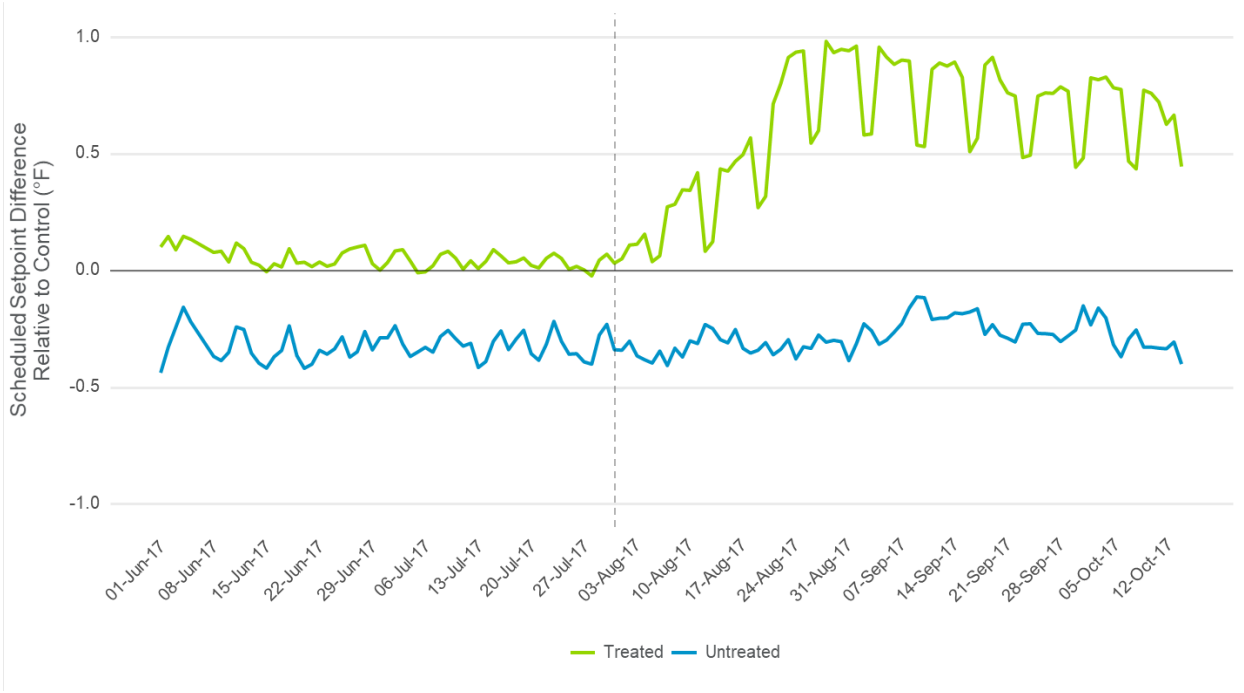
- **Pre-program period:** While the treated and control groups had similar average daily scheduled setpoints during the pre-period differing by less than 0.1°F on average, the untreated group's average daily scheduled setpoint was approximately 0.37°F lower than their treated counterparts, on average. Differences between the treated and untreated groups are expected by nature of RED, as the untreated group includes customers that did not opt in and those who were not eligible to participate in the program.
- **Program period:** Average daily scheduled setpoints increased for all three groups, but the increase was largest for the treated group. Average daily scheduled setpoints increased by 0.56°F for the treated group relative to the control group during the program period, whereas it remained relatively unchanged (0.04°F) for devices that were untreated relative to the control.

**Figure 7-14. Avg. Daily Scheduled Setpoints, All Groups: Peak Aware**




*Source: Navigant analysis of Nest thermostat telemetry data.*

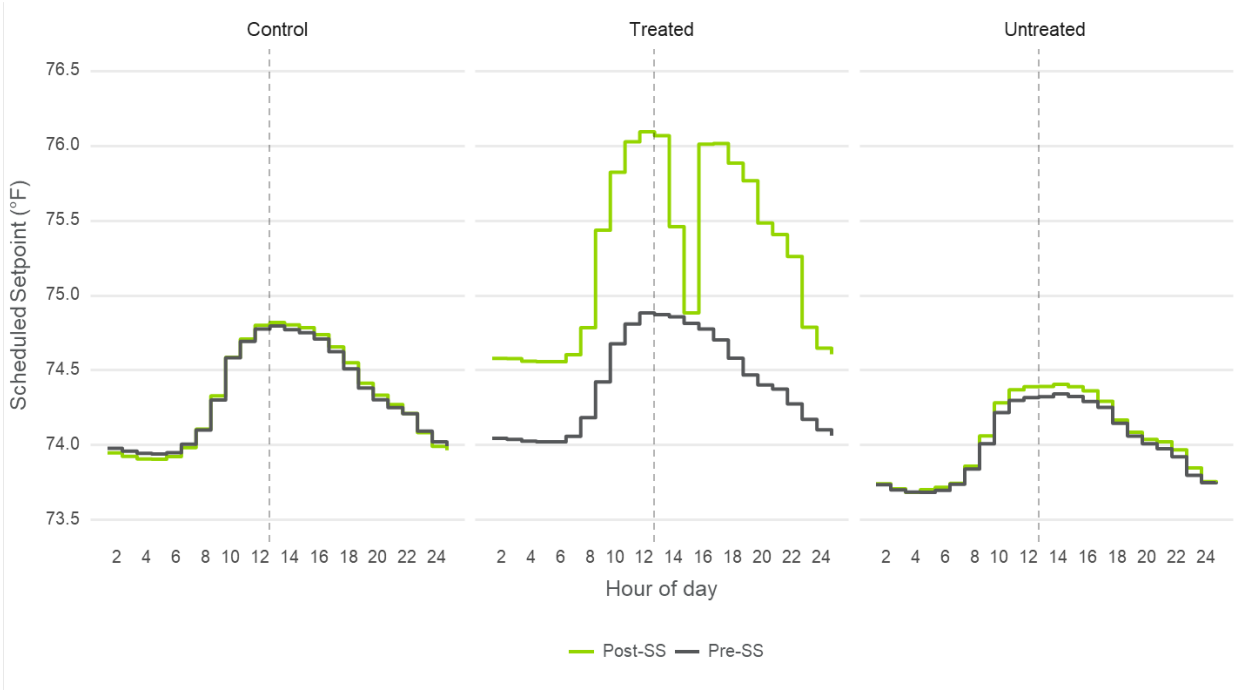
**Figure 7-15. Avg. Daily Scheduled Setpoint Comparison, Treated and Untreated vs. Control: Peak Aware**




*Source: Navigant analysis of Nest thermostat telemetry data.*

Figure 7-16 presents a comparison of average hourly scheduled setpoints based on the weeks of July 25-31, 2017 (the week preceding enrollment) and August 29-September 4, 2017 (the week after 95% of all treated devices had enrolled) for the treated, untreated and control groups. The differences in these values for treatment and control during these periods are further broken down in Table 7-6 by weekday, weekend, and overall differences, for the selected weeks. These comparisons further illustrate that while scheduled setpoints increased for all groups, the changes for the treated group were largest. Also, the treated group illustrates a significant drop in setpoint from 1-3 pm, setting up for the peak period from 2-6 pm. Furthermore, the program is designed to make the largest adjustments during times when customers are away from home (e.g., weekday daytime) and smaller adjustments during times when customers are at home (e.g., weekday evenings and weekends), and this is evident in the data. In comparison to the control group, overall average scheduled setpoints increased by 0.9°F between 10 am and 6 pm for treated devices, and approximately 0.7°F for all other hours. On the other hand, changes in setpoint for the untreated group and the control group are both comparable and negligible.

**Figure 7-16. Mean Hourly Setpoint Comparison, Before and After SS: Peak Aware**




*Source: Navigant analysis of Nest thermostat telemetry data.*

**Table 7-6. Change in Scheduled Setpoints, Before and After Tune-Up: Peak Aware***

| Day Type | Period | Treated | Control | Δ |
|---|---|---|---|---|
| Weekday | 10 am to 6 pm | 1.1°F | 0.1°F | 1.0°F |
| | Other Hours | 0.9°F | 0.1°F | 0.8°F |
| Weekend | 10 am to 6 pm | 0.7°F | 0.1°F | 0.6°F |
| | Other Hours | 0.7°F | 0.1°F | 0.6°F |
| Overall | 10 am to 6 pm | 1.0°F | 0.1°F | 0.9°F |
| | Other Hours | 0.8°F | 0.1°F | 0.7°F |

* The dates selected for before the Peak Aware tune-up consist of the week prior to first enrollment (July 25–July 31). The dates selected for after the Peak Aware tune-up begins after 95% of Peak Aware treated devices have enrolled (August 29– September 4).
*Source: Navigant analysis of Nest thermostat telemetry data.*

### *7.3.2 Thermostat Runtime Comparisons*

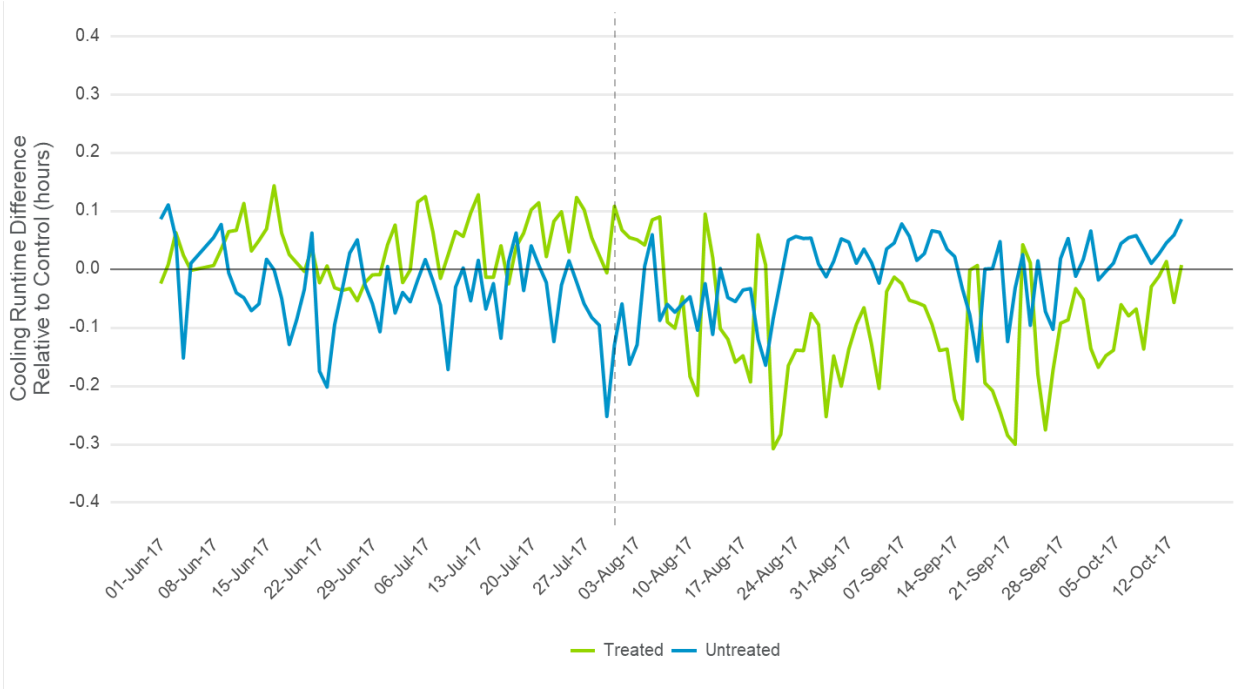
Similar to the exploratory analysis of average scheduled setpoints, this section presents findings from the exploratory analysis of average daily thermostat cooling runtime. Unlike scheduled cooling setpoint, the cooling runtime had direct correlation with outdoor temperature. The average outdoor temperatures during the pre-program and program periods were 72.5°F and 68.2°F, respectively (see Table 7-5). Figure 7-17 presents a comparison of average daily runtime for both the treated and untreated ITT groups relative to the control group, where the control group is represented by the centerline.

- **Pre-program period:** There was a small difference in average daily runtime during the pre-period between the treated or untreated sub-groups and the control group. The treated group

had 2.4 minutes more runtime than the control, whereas the untreated group had 0.3 minutes less than the control, on average.[15]

- **Program period:** During the program period, average daily runtime decreased for all groups, but the decrease was largest for the treated group. Average daily runtime decreased by an average of approximately 8.9 mins during the program period for the treated group relative to the control group. This result provides evidence there was less cooling taking place for the treated group relative to the control group as a result of the program. In contrast, the untreated group saw a 1.7 minute increase in runtime for the program period relative to the control group when compared to the pre-program period.

**Figure 7-17. Average Daily Runtime Comparison, Treated and Untreated vs. Control: Peak Aware**

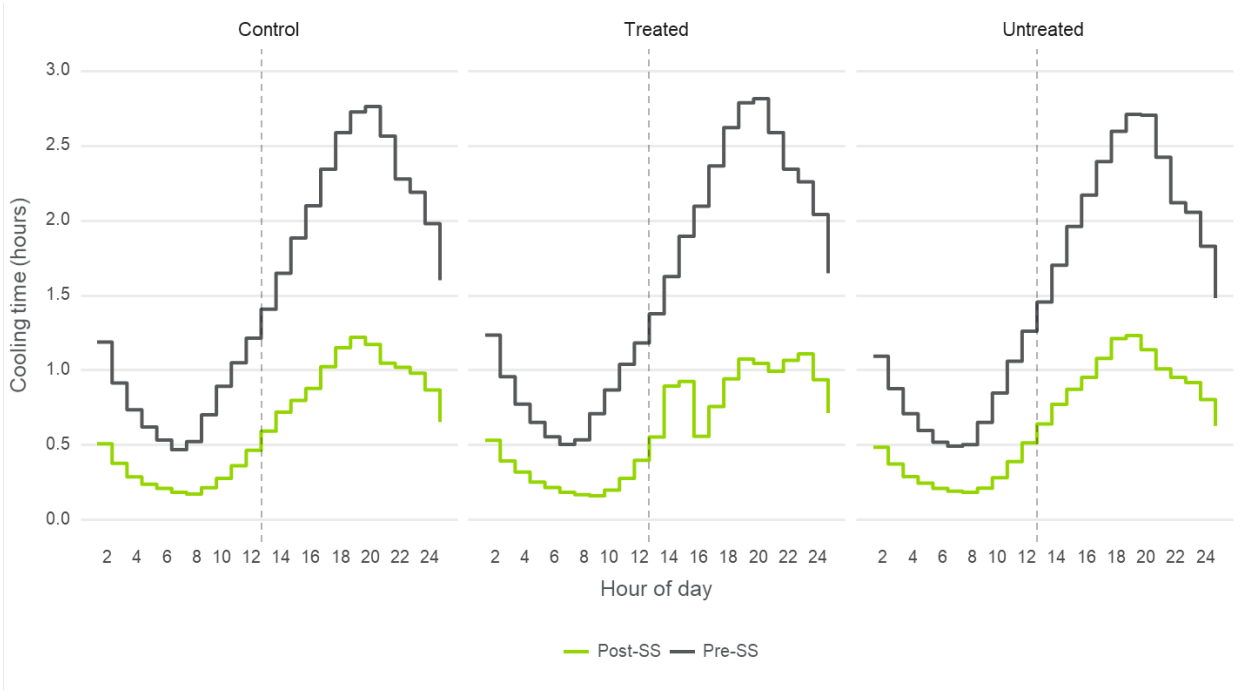



*Source: Navigant analysis of Nest thermostat telemetry data.*

Figure 7-18 presents a comparison of average hourly cooling runtime based on the weeks of July 25-31, 2017 (the week preceding enrollment) and August 29-September 4, 2017 (the week after 95% of all treated devices had enrolled) for the treated, untreated and control groups. The differences in these values for treatment and control during these periods are further broken down in Table 7-7 by weekday, weekend, and overall differences. These comparisons further illustrate that while cooling runtime decreased for all groups, the changes for the treated group were largest. Furthermore, the program is designed to make the largest adjustments during times when customers are away from home (e.g., weekday daytime) and smaller adjustments during times when customers are at home (e.g., weekday evenings and weekends), and this is evident in the data. In comparison to the control group, overall average cooling runtime decreased by 0.6 minutes between 10 am and 6 pm for treated devices, and approximately 0.2 minutes for all other hours. On the other hand, changes in cooling runtime for the untreated group and the control group are both comparable as well as negligible.

[15] Overall differences between ITT and control groups are not statistically significant.

**Figure 7-18. Mean Hourly Runtime Comparison, Before and After SS: Peak Aware**




*Source: Navigant analysis of Nest thermostat telemetry data.*

**Table 7-7. Change in Runtime, Before and After Tune-Up: Peak Aware***

| Day Type | Period | Treated | Control | Δ |
|---|---|---|---|---|
| Weekday | 10 am to 6 pm | -2.2 min | -1.6 min | -0.6 min |
| | Other Hours | -3.0 min | -2.8 min | -0.2 min |
| Weekend | 10 am to 6 pm | -1.9 min | -1.8 min | -0.1 min |
| | Other Hours | -0.2 min | 0.1 min | -0.3 min |
| Overall | 10 a.m to 6 pm | -2.3 min | -1.7 min | -0.6 min |
| | Other Hours | -2.2 min | -2.0 min | -0.2 min |

* The dates selected for before the Peak Aware tune-up consist of the week prior to first enrollment (July 25-July 31). The dates selected for after the Peak Aware tune-up begins after 95% of Peak Aware treated devices have enrolled (August 29-September 4).
*Source: Navigant analysis of Nest thermostat telemetry data.*

## 7.4 Impact Analysis – Peak Aware

This section presents the findings from the Peak Aware energy and peak demand impact analysis, summarized in Table 7-8. The Peak Aware measure resulted in total energy savings of 247 MWh from August 1 to October 14, 2017, and total peak demand savings of 1,778 kW between August 1 and August 31, 2017.

**Table 7-8. SS Summary from August 1 to October 14, 2017*: Peak Aware**

| Statistic | ITT † | Treated (Subset of ITT) † |
|---|---|---|
| Number of Nest thermostats in control group | | 4,491 |
| Number of valid Nest thermostats | 9,229 | 5,667 |
| Average energy savings (% of cooling load) | 2.8% ± 1.3% | 5.1% ± 2.5% |
| Average daily energy savings per device (kWh) | 0.36 ± 0.18 *** | 0.66 ± 0.32 *** |
| Average total energy savings per device (kWh) ‡ | 24.1 | 43.5 |
| Total energy savings (kWh) § | 222,228 | 246,517 |
| Average peak demand savings (% of cooling load) | 12.8% ± 1.1% | 28.2% ± 2.3% |
| Average peak demand savings per device (kW) ‖ | 0.141 ± 0.012 *** | 0.314 ± 0.026 *** |
| Total peak demand savings (kW) # | 1,302 | 1,778 |

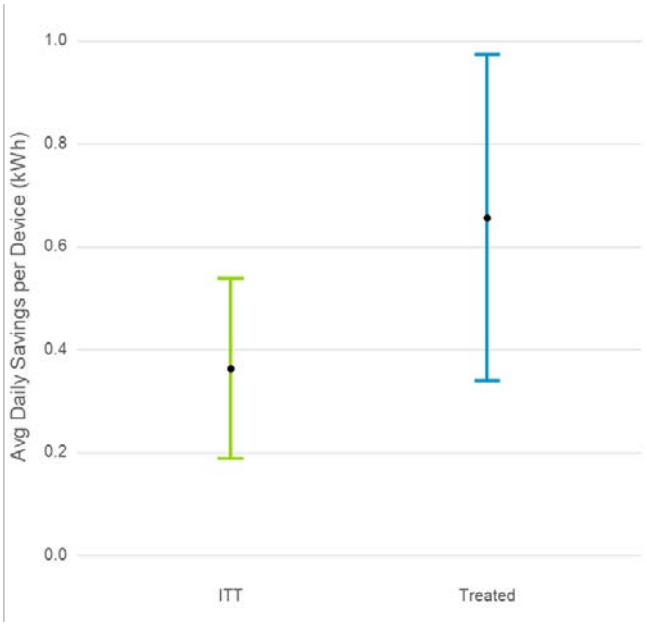
*Significance levels: *** p < 0.01, indicates 90% confidence interval.*
* The first offer date for the Peak Aware measure occurred on August 1, 2017. The measure persists as long as air conditioning systems are in cooling mode. This evaluation relies on data through October 14, 2017 when the majority of devices were no longer in cooling mode.
† ITT includes all devices randomly assigned to receive the Peak Aware measure. Treated is a subset of ITT and includes those devices that qualified and opted into the program.
‡ Total savings per device is calculated as average daily savings per device x the number of days post tune-up start date.
§ Total savings is calculated as total energy savings per device x the number of treated/ITT devices.
|| Average demand savings on weekdays, non-holidays, 2 p.m. – 6 p.m., June through August.
# Total savings is calculated as average demand savings per device x the number of treated/ITT devices.
*Source: Navigant analysis.*

### *7.4.1 Energy Impacts*

Figure 7-19 presents the estimate of average daily energy savings for the ITT group (including devices that opt in, do not opt in, and do not qualify) and the treated group (including only devices that opt in). Average daily energy savings is estimated to be 0.36 kWh[16] per device for the ITT group and 0.66 kWh[17] per device for the treated group. Figure 7-20 presents these results as a percentage of cooling load. Average daily energy savings are 2.8% of cooling load for the ITT group and 5.1% for the treated group.

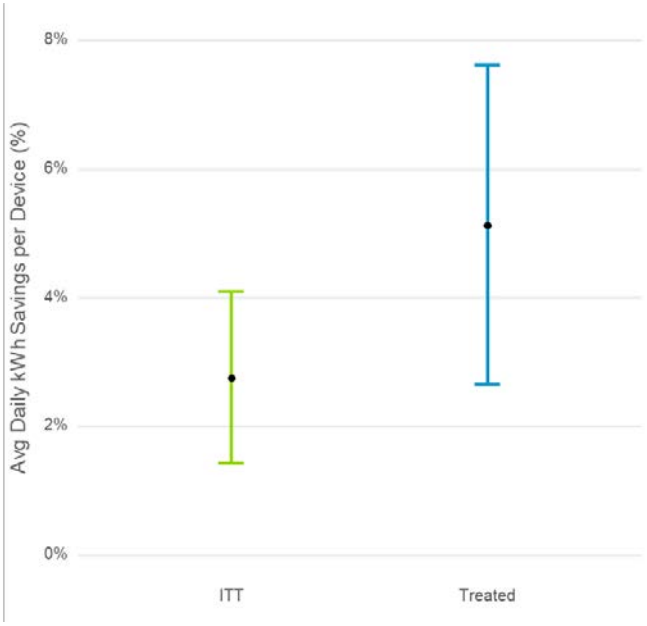
[16] The 90% confidence interval is (0.19 kWh, 0.54 kWh).
[17] The 90% confidence interval is (0.34 kWh, 0.97 kWh).

**Figure 7-19. Average Daily Savings: Peak Aware**




*Source: Navigant analysis.*

**Figure 7-20. Average Daily Savings (as a Percentage of Cooling Load): Peak Aware**



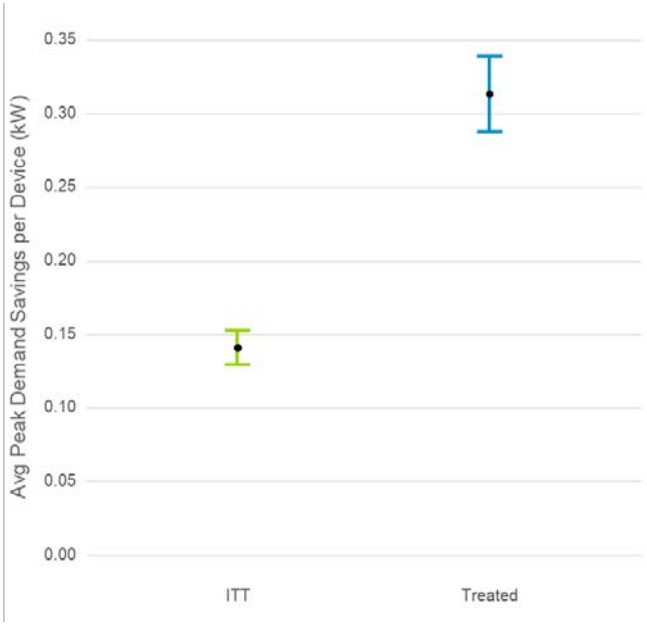

*Source: Navigant analysis.*

### *7.4.2 Peak Demand Impacts*

Navigant estimated peak demand impacts from 2 pm. to 6 pm. on program period non-holiday weekdays in August. Figure 7-21 presents the estimate of average peak demand savings for the ITT group (including devices that opt in, do not opt in, and do not qualify) and the treated group (including only

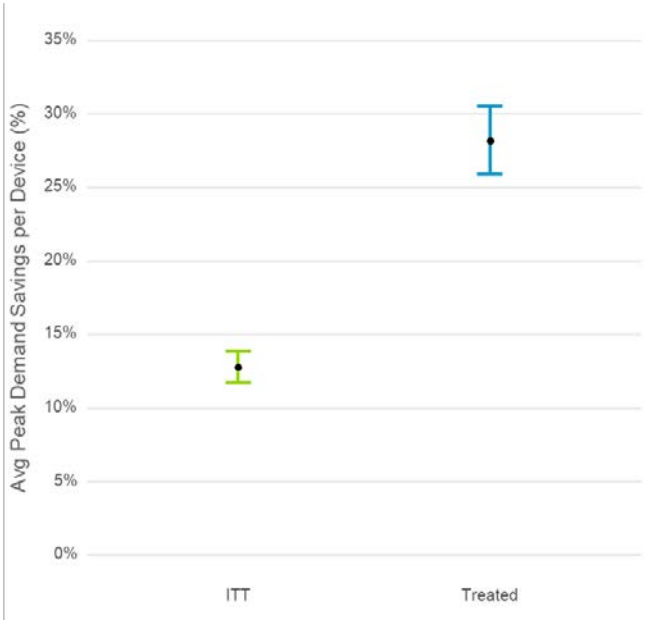
devices that opt in). Average peak demand savings is estimated to be 0.141 kW[18] per device for the ITT group and 0.314 kW[19] per device for the treated group. Figure 7-22 presents these results as a percentage of cooling load. Average peak demand savings are 12.8% of cooling load for the ITT group and 28.2% for the treated group.

**Figure 7-21. Average Peak Demand Savings: Standard**




*Source: Navigant analysis.*

**Figure 7-22. Average Peak Demand Savings (as a Percentage of Cooling Load): Peak Aware**




*Source: Navigant analysis.*

[18] The 90% confidence interval is (0.129 kW, 0.153 kW).
[19] The 90% confidence interval is (0.288 kW, 0.339 kW).

# 8. APPENDIX 3. TRC DETAIL

Table 8-1 shows the savings detail for the Total Resource Cost (TRC) cost-effectiveness analysis. This TRC variable table only includes cost-effectiveness analysis inputs available at the time of finalizing this PY9 impact 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 at a later date. Further, detail in this table (e.g., EULs) other than final PY9 savings and program data are subject to change and are not final.

**Table 8-1. TRC Detail**

| 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) |
|---|---|---|---|---|---|---|---|---|
| Thermostat | Standard | Devices | 50,499 | 1 | N/A | N/A | 3,299,578 | 3,945.00 |
| Thermostat | Peak Aware | Devices | 5,667 | 1 | N/A | N/A | 222,228 | 1,302.00 |