Liberty Utilities

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August 21, 2013

Via Electronic and U.S. Mail

Debra A. Howland, Executive Director
New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

RE: DE 12-262 CORE Energy Efficiency Program Evaluation Study

Dear Ms. Howland:

Enclosed for filing, please find a program evaluation study prepared for EnergyNorth Natural Gas, Inc., d/b/a Liberty Utilities, as part of the Residential Building Practices and Demonstration Program approved in Order No. 25,462, in Docket No. DE 12-262. Liberty Utilities plans to review the highlights of the study at the CORE program quarterly meeting scheduled in September.

Thank you for your assistance with this matter. Please do not hesitate to call if you have any questions.

Sincerely,

FOR

James J. Bonner Jr.

Enclosure

Cc: Service List

WI-FI PROGRAMMABLE THERMOSTAT PILOT PROGRAM EVALUATION

July 2013

Prepared for:

Liberty Utilities

Salem, New Hampshire 03079

The Cadmus Group, Inc.

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CADMUS

Table of Contents

Executive Summary

Energy savings for residential heating are driven both by characteristics of the home and heating system as well as the behavior of the occupants. A new generation of Wi-Fi thermostats encourages energy efficient behavior by making it easy for occupants to program smart schedules and control their thermostats from home or away with a wireless connection. As part of their New Hampshire energy efficiency programming, Liberty Utilities created a Wi-Fi Thermostat Pilot Program to evaluate the impact of these thermostats on occupant behavior and natural gas energy consumption in the 2012-2013 heating season. This report presents the background, scope, methods, findings and recommendations of the Liberty Utilities Wi-Fi Thermostat Pilot Program conducted by Cadmus.

Background and Scope

Liberty Utilities created the Wi-Fi Thermostat Pilot Program for its New Hampshire residential natural gas customers to replace their existing programmable thermostats with new Wi-Fi enabled programmable thermostats. During its first year, the program installed 32 Venstar ColorTouch T5800 thermostats in 29 participant homes during fall of 2012 and analyzed participant heating consumption through the 2012-2013 heating season. Cadmus worked with Liberty Utilities to develop the pilot design, recruit participants, and collect data to conduct impact, product, and process evaluations to assess the potential for an expanded Liberty Utilities Wi-Fi thermostat program.

From October 2012 to June 2013, Cadmus worked collaboratively with the Liberty Utilities program manager to conduct the following tasks:

1. Design the pilot program and recruit participants
2. Conduct the pilot program
3. Conduct evaluations:
    - **Impact Evaluation:** Assessment of the impact of the pilot program on participant natural gas consumption.
    - **Product Evaluation:** Assessment of participant satisfaction with Venstar ColorTouch T5800
    - **Process Evaluation:** Assessment of program design, participant motivation, and participant satisfaction.

Methods

Cadmus utilized a variety of methods to cost-effectively conduct the pilot study. Table 1 summarizes the methods conducted to complete each task.

Table 1. Pilot Program Methods

Task	Method
Task 1. Design Pilot Program and Recruit Participants	
Define program objectives, choose thermostat model, and determine participant eligibility	• Conducted secondary research on existing Wi-Fi thermostat models and previous thermostat studies
Recruit Participants	• E-mailed interest indictor and eligibility survey to LU natural gas customers in New Hampshire
Task 2. Conduct Pilot Program	
Install thermostats	• Mailed thermostats and temperature loggers • 21 thermostats were self-installed, 11 thermostats were installed by program contractor
Configure Wi-Fi	• Mailed instructions and provided phone/e-mail support to program participants
Task 3. Conduct Evaluations	
Impact evaluation	• Data collection: participant surveys, online thermostat data, space temperatures, pre/post energy bills • Analysis: Billing analysis, space temperature profiles
Process evaluation	• Surveys (recruitment, mid-study, post-study)
Product evaluation	• Surveys (mid-study and post-study)

Cadmus collected data through surveys, data loggers, and the thermostat manufacturer's software services. Table 2 summarizes the data collected to support the evaluations.

Table 2. Summary of Data Collection

Data	Method or Source
Surveys	Participants reported heating system type, baseline thermostat/control information, and thermostat settings
Venstar Skyport® online data	Cadmus collected thermostat schedules and setpoints, and heating run-time data from participant Skyport® accounts
Space temperature data	Participants self-installed pre-programmed U10 space temperature loggers next to thermostats; loggers recorded at 10-min intervals
Natural gas billing data	LU program manager provided participant natural gas billing data for 2 years before thermostat installation and through spring 2013
Weather data	Cadmus used actual and Typical Meteorological Year (TMY3) weather data from National Climatic Data Center for Nashua (base temp = 65). Cadmus used the most recent 15 years of data (1991-2005) for nearby Manchester, NH.[1]

[1] There were 6,294 HDDs for the TMY3 period in Manchester, NH.

Results

At the end of the study period, Cadmus conducted a billing analysis to determine the impact of the Wi-Fi pilot program and installed thermostats on participants' annual natural gas consumption for heating. Table 3 shows that the average impact was a reduction of 69 therms per home, or 8% of the participants' baseline natural gas consumption.

Table 3. Wi-Fi Thermostat Billing Analysis Savings Summary

Number of Participants (Billing Analysis)	Normal HDD_TMY3	Savings per Participant (therms)	Savings per Thermostat (therms)	Pre Period Usage	Savings as % of Pre-Period Usage	90% Precision	Savings Lower 90% CI	Savings Upper 90% CI
23	6,294	69	66	836	8%	20%	53	80

Conclusions and Recommendations

After an analysis of gas billing data and participant survey responses, Cadmus identified the following findings and recommendations:

Impact Evaluation

- **The Wi-Fi thermostats show gas savings of approximately 8% per thermostat and per participant home in heating season.** The billing analysis savings account for "take-back" effects, but predominantly the Wi-Fi thermostat pilot participants are showing savings after installing the new thermostats.
    - **Recommendation:** To achieve more precise savings, conduct a billing analysis for a larger participant population in future years. In addition, run the study through the cooling season to measure the impact of thermostats on cooling systems.
- **Three of 23 participants (13%) increased their gas usage after installing the thermostat.** These participants may have changed their behavior and used their heating systems more. For example, some participants reported that they started turning their heat up remotely when they were on their way home in order to pre-heat their house.
    - **Recommendation:** If a full-scale Wi-Fi thermostat program is rolled out, Liberty Utilities should provide education to customers about how user behavior and thermostat scheduling impacts heating and cooling energy consumption.

Product Evaluation

- **16 of 18 participants (88%) found the installation of the thermostat to be either "very easy", "easy", or "neutral." The remaining 12% found the installation of the thermostat to be "difficult" or "very difficult."** Survey responses from participants indicate that the thermostat

installation itself was very easy, but that the installation of the C-wire (a common requirement for thermostats with Wi-Fi connections) caused the ease-of-use ratings to decline.

  - **Recommendation:** Explain to customers that the thermostat requires a 24 VAC line. One way to help them understand the need is to explain that thermostats that use batteries may not have a 24 VAC line installed.

- **No participants reported difficulty in programming their thermostat and the number of participants who program their thermostats increased (two additional people)**. Many commented that the thermostat was "user-friendly."
  - **Recommendation:** If Wi-Fi thermostats are promoted on a larger scale, the "user-friendliness" of the thermostats, along with the wireless features, should be highlighted to customers.

- **The majority of participants were willing to pay $50-$125 for a Wi-Fi thermostat both before and after the study.** When participants were asked how much money they would recommend be offered in a rebate to encourage customers to purchase a $200 Wi-Fi thermostat, 78% of participants recommended a rebate between $50 and $100.
  - **Recommendation:** Offer a rebate between $50 and $150. Although the majority of participants recommended a $100 rebate (and this is the rebate amount offered by several gas utility companies in New England), their "willingness to pay" responses indicate that many need a higher incentive offer to purchase a Wi-Fi thermostat. Depending on the percentage of customers that Liberty Utilities hopes to upgrade to Wi-Fi thermostats, a range of $50 to $150 should be considered for the rebate offering.

Process Evaluation

- **Ninety-three percent of participants found the enrollment process either "very easy" or "easy."** The remaining participants reported it to be "neither easy nor difficult." These are satisfactory ratings; however, to improve the process, the following two recommendations were made by participants:
  - Create clearer instructions for sharing Skyport® account access with Liberty Utilities.
  - Create a clearer explanation on how to determine current thermostat type.

- **Adding Liberty Utilities as a viewer of the Skyport®account so that they could collect their heating system run-time history was difficult for participants**.
  - **Recommendation:** Venstar has reported that they are developing a platform that would allow utility companies to view multiple customers' Skyport® accounts for the purpose of collecting customer information such as HVAC system run-time. Although details have not been released from Venstar, this would eliminate the need for customers to set up complicated Skyport® account settings.

Introduction and Scope

Liberty Utilities (New Hampshire) is a natural gas and electricity distribution utility serving 87,000 natural gas customers and 43,000 electricity customers in New Hampshire.[2] Liberty Utilities has a variety of energy-efficiency programs and incentives to help customers save money and reduce carbon emissions. Among the program offerings are in-home energy assessments and rebate incentives for energy-saving technologies such as efficient boilers, efficient furnaces, and programmable thermostats.

Liberty Utilities is considering offering an additional rebate for Wi-Fi thermostats for natural gas customers. Like programmable thermostats, Wi-Fi thermostats can program different temperature setpoints for different times of day. This can save customers energy by reducing heating and cooling run-times when appropriate, such as when the home is unoccupied. In addition to this feature, Wi-Fi thermostats can be controlled remotely through web-based accounts or smartphone applications. This provides the potential for increased energy savings compared to standard programmable thermostats by giving customers the ability to easily change setpoints in response to schedule changes.

The Wi-Fi Thermostat Pilot program was offered by Liberty Utilities to assess the energy impact of replacing programmable thermostats with Wi-Fi programmable thermostats for a sample of gas customers. The primary goal of the evaluation was to complete an impact evaluation to estimate the gas savings attributable to installing the selected pilot thermostat—the Venstar ColorTouch T5800 thermostat—and participating in the program. Cadmus also conducted a product evaluation and process evaluation to understand participant motivation, behavior, and program and product satisfaction. Program participants received a free Wi-Fi Venstar ColorTouch T5800 thermostat.

This evaluation report describes the tasks and methods used to conduct the pilot evaluation, and the results, conclusions, and recommendations determined through the study.

[2] http://www.libertyutilities.com. 2013.

Methods

Cadmus conducted the pilot program between October 2012 and June 2013 under three primary tasks:

1. Design pilot program and recruit participants.
2. Conduct pilot program.
3. Conduct evaluations (impact, process, and product).

Table 4 summarizes the methods conducted to complete each task.

Table 4. Summary of Study Methods

Task	Method
Task 1. Design Pilot Program and Recruit Participants	
Define program objectives, choose thermostat model, and determine participant eligibility	• Conducted secondary research on existing Wi-Fi thermostat models and previous thermostat studies
Recruit Participants	• E-mailed interest indictor and eligibility survey to LU natural gas customers
Task 2. Conduct Pilot Program	
Install thermostats	• Mailed thermostats and temperature loggers • 21 thermostats were self-installed, 11 thermostats were installed by program contractor
Configure Wi-Fi	• Mailed instructions and provided phone/e-mail support to program participants
Task 3. Conduct Evaluations	
Impact evaluation	• Data collection: participant surveys, online thermostat data, logged space temperature, pre/post billing data • Analysis: Billing analysis, space temperature profiles
Process evaluation	• Surveys (recruitment, mid-study, post-study)
Product evaluation	• Surveys (mid-study and post-study)

The evaluation team completed many tasks collaboratively with the LU program manager to facilitate early feedback and provide opportunities to modify the data collection as project objectives evolved and new areas of interest arose. The following sections describe in detail the methods the evaluation team used to conduct each task of this study.

Task 1. Design Pilot Program and Recruit Participants

Cadmus worked with the Liberty Utilities program manager to design the pilot program and recruit participants during the period from October 2012 to November 2012.

Program Design

The program design included establishing program objectives, selecting the thermostat technology, and determining of participant eligibility.

Program Goals

The primary goal of the pilot program was to assess the energy savings for Wi-Fi programmable thermostats installed in homes of Liberty Utilities natural gas customers.

The evaluation team designed the pilot study to achieve the following objectives:

- Assess the natural gas energy impact of the Wi-Fi thermostat in participant homes.
- Assess participant motivations and satisfaction with the Wi-Fi thermostat and participant process.
- Assess the participant satisfaction with selected Wi-Fi thermostat model including installation and usability.
- Conduct a study to engage LU's natural gas customers and increase awareness of the company's energy-efficiency programs.

Thermostat

Cadmus worked with the Liberty Utilities program manager to select the Wi-Fi thermostat model to use for this study. The Venstar ColorTouch Series T5800 was chosen because it was the highest rated thermostat for ease of use by Consumer Reports in October 2012.[3] It is valued at $170 for the thermostat and $64 for the Wi-Fi key.[4]

Eligibility

Cadmus worked with the Liberty Utilities program manager to determine the eligibility requirements appropriate to meet the study objectives.

To facilitate the billing analysis approach with a small participant sample, we focused on recruiting a fairly homogenous participant group with similar home and heating system characteristics. The evaluation team determined that eligible participants must meet the following criteria:

1. Be a Liberty Utilities residential natural gas customer.
2. Use natural gas as primary heating fuel.
3. Live in the home for at least two years.
4. Live in a single-family home.
5. Have no change in home occupancy in last two years.
6. Use an Apple iPhone® and/or Android® smartphone.
7. Have a programmable thermostat.

Participant Recruitment

To recruit participants for the study, Cadmus sent an e-mail notice to 3,656 Liberty Utilities natural gas customers for which an e-mail address was on file with the utility. The notice provided basic information

[3] "Thermostats: Saving Energy Can Be Easy With the Right Model." Consumer Reports. 2012.
[4] Market value from HVAC Parts Warehouse (hvacpw.com) in July 2013.

about the study and a link to an online survey through which customers could determine their eligibility. (The recruitment survey is provided in Appendix A).

The e-mail promoted the benefits of participating in the pilot program, such as the ability to:

- Monitor thermostat information, including heating system run-time and current usage.
- Receive alerts on a wireless device if the home's temperature has gone above or below pre-set limits.
- View the current weather and weather forecast on the thermostat and on a wireless device.
- Send text messages from a smartphone to the thermostat display, such as reminders to family members.

The e-mail provided instructions on how to apply for participation, and a direct link to an online prequalification survey where customers could apply to be considered for the study.

If customers completed the online survey and were eligible, Cadmus invited them to complete an additional survey to provide information for further screening of eligibility, such as utility information, household characteristics, and current thermostat wiring. Because the Venstar ColorTouch T5800 has specific wiring requirements, Cadmus looked for customers with the following wiring requirements:

- R: 24VAC Power
- W1/O/B: 1st Stage Heat
- C: 24VAC Common

Only seven interested customers had a C-wire. The remaining interested customers were still invited to participate under the condition that they have the proper wiring installed. Half of these participants were willing to install the C-wire on their own, and half had a contractor hired by Liberty Utilities install the C-wire. Cadmus notified customers of their selection to participate via e-mail and sent them a participant agreement of terms and conditions to sign and a utility data release form. Upon receipt of these documents, Cadmus mailed a thermostat, Wi-Fi key, and indoor temperature logger to each participant. Details about this equipment are outlined in Task 2.

Liberty Utilities chose a goal sample size of 30 participants, based on resource constraints and interest among customers in participating. Although 34 participants were recruited, five participants dropped out due to heating system incompatibility with the thermostat or lack of interest or time.[5]

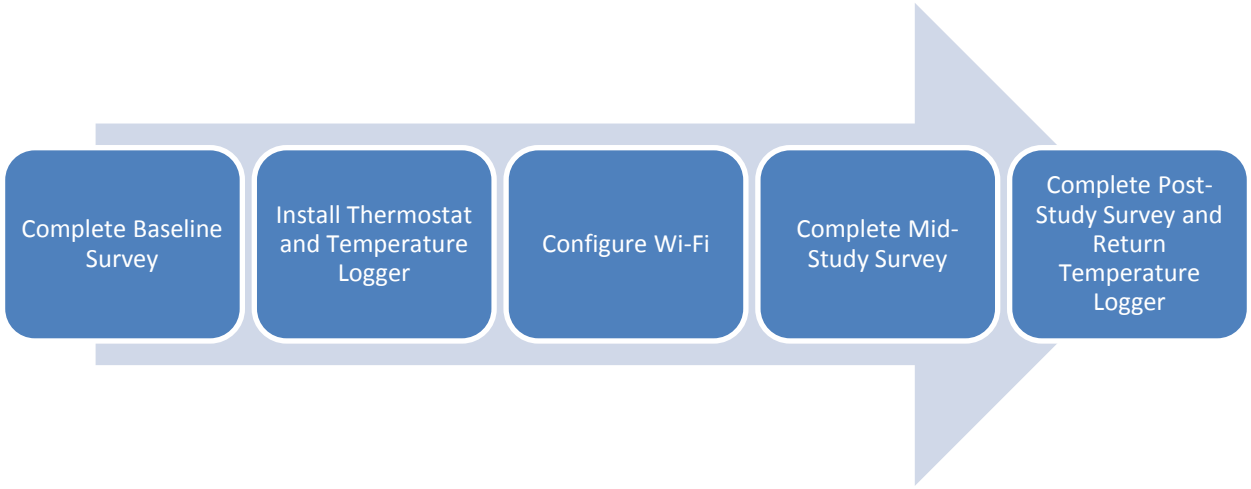
[5] Three customers dropped out due to heating system compatibility issues. One customer reported they were interested in the study but did not have time to commit this year. One customer stopped correspondence due to lack of interest in participating.

Task 2. Conduct Pilot Program

The implementation of the Liberty Utilities Wi-Fi Thermostat Pilot Program relied on a combination of participant and contractor support. Participants were required to complete four surveys: recruitment, baseline, mid-study and post-study. In addition, all participants installed their own thermostats, set up third-party access for their thermostat data, and installed indoor temperature logging equipment provided by Cadmus.

The participant process is outlined in Figure 1.

Figure 1. Pilot Participation Process



Complete Baseline Survey

Participants were required to complete the baseline survey to provide information about their thermostat control behavior and settings prior to installing the Wi-Fi thermostat. Participants completed these surveys on paper and returned them to Cadmus via e-mail or mail in October and November 2012. The complete Baseline Survey is provided in Appendix B.

Install Thermostat and Temperature Logger

Due to both budget limitations and the desire to reflect a typical thermostat purchase and installation scenario, participants were required to install their thermostat independently. The self-installation requirement provided an opportunity to evaluate the usability of the thermostat. For those participants who did not have the proper wiring or requested assistance with the installation, Liberty Utilities hired a contractor to install the wiring and thermostat and to collect program documents.

Configure Wi-Fi

In order to be controlled remotely via Skyport® account or smartphone, participants had to configure the thermostat's Wi-Fi and provide Skyport® account access to the evaluation team. To do this, participants had to insert the Wi-Fi key into the thermostat. Upon detecting the Wi-Fi key, the thermostat screen displayed prompts for participants to follow to complete Wi-Fi set-up. Steps included scanning available networks and entering the network password (if applicable).

Complete Mid-Study Survey

Participants completed a mid-study survey between February and March 2013. The purpose of this survey was to assess motivation for participating in the pilot program, to examine the ease of the installation process (particularly for those participants who installed the thermostat independently), and to collect information on how participants set up and control their thermostat.

Complete Post-Study Survey and Return Temperature Logger

At the conclusion of the study, participants were requested to complete a post-study survey online and return the temperatures logger(s). The post-study survey served to collect information on willingness to pay for the thermostat, how participants control their thermostat, and asses overall product and program satisfaction.

Participants were sent instructions on how to remove the temperature logger and a pre-paid envelope for returning the logger to Cadmus. They were allowed to keep their Wi-Fi thermostat.

Task 3. Conduct Evaluations

The analysis portion of the study consists of three evaluations: impact, product, and process. Cadmus completed the impact evaluation through an analysis of gas billing data, indoor temperature data, heating system run-time data, and a series of surveys. Analysis of these surveys was also the method by which we completed the product and process evaluations.

The methodology of the implementation and evaluations are detailed below.

Data Collection

Cadmus used multiple methods to collect data throughout the pilot program period. Table 5 summarizes the data Cadmus collected to support the evaluation tasks.

Table 5. Summary of Data Collection

Data	Method or Source
Surveys	Participants reported heating system type, baseline thermostat/control information, and thermostat settings
Venstar Skyport® online data	Cadmus collected thermostat schedules and setpoints, and heating run-time data from participant Skyport® accounts
Space temperature data	Participants self-installed U10 space temperature loggers next to thermostats; loggers recorded at 10-min intervals
Natural gas billing data	LU program manager provided participant natural gas billing data for a period 2 years before thermostat installation and through spring 2013
Weather data	Cadmus downloaded actual and Typical Meteorological Year (TMY3) weather data from National Climatic Data Center for Nashua (base temp = 65). For this billing analysis, Cadmus used the most recent 15 years of TMY3 data (1991-2005) for nearby Manchester, New Hampshire to calculate normalized HDDs and weather-normalized savings estimates.[6]

[6] There were 6,294 HDDs for the TMY3 period in Manchester, NH.

Surveys

Participants completed four surveys throughout the study: recruitment, baseline, mid-study and post-study. Cadmus developed these surveys to understand the participants' motivation for participating, behavior in operating the thermostat and satisfaction levels. We used information from these surveys for the impact, product, and process evaluations.

Table 6 outlines the timeframe and description for each of the four surveys. The complete surveys are included in the Appendices.

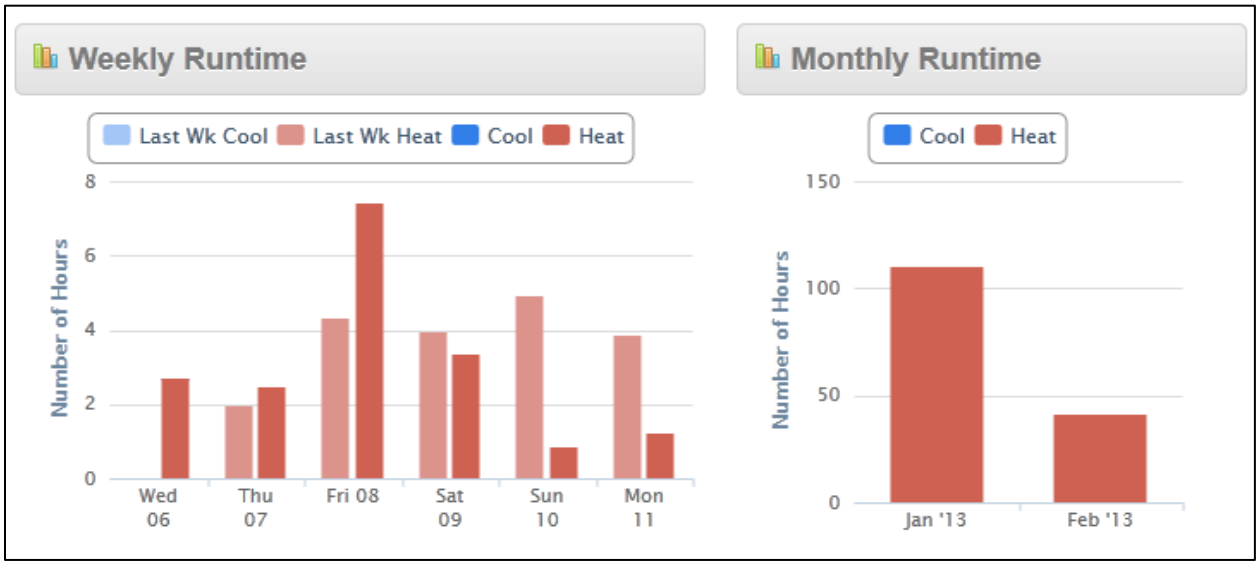
Table 6. Summary of Surveys

Survey	Timeframe	Description
Recruitment	October/November 2012	Determined eligibility and household characteristics
Baseline	November – January 2012 *(at time of tstat installation)*	Captured information on old thermostat settings and usage for comparison to new thermostat
Mid-Study	February/March 2013	Assessed motivation, implementation processes, thermostat usage, and participant satisfaction
Post-Study	May/June 2012	Similar to mid-study survey but focused on thermostat usage and participant satisfaction

Venstar Skyport® Online Data

Cadmus collected information about each participant's thermostat settings and heating system run-time through the Venstar Skyport® web-portal. With permission from participants, Cadmus accessed participants' web-based Skyport® accounts, which show the current thermostat setting, programmed schedules, and a two-week history of daily heating system run-time. Figure 2 shows screenshots of the thermostat run-time history.

Figure 2. Screenshot of HVAC System Run-time on participant Skyport® Account



Cadmus recorded the participants' programmed thermostat settings at the beginning and end of the study and compiled the run-time history of each participant throughout the study period.

Space Temperature

Cadmus mailed a pre-launched HOBO® U10 temperature logger and installation instructions to each participant. The instructions directed the participant to install the U10 next to their thermostat and to send a picture of the installation to the Cadmus project manager to confirm the installation. Figure 3 shows an example of the U10 data logger installed next to a participant's thermostat.

Figure 3. U10 Temperature Logger Installed Next to a Thermostat

The U10 data logger was pre-launched to record space temperature every ten minutes throughout the study period. At the end of the study, Cadmus provided each participant with a pre-paid envelope to return their U10 data logger(s) through the mail.

Natural Gas Billing Data

Cadmus requested participant natural gas billing data from Liberty Utilities both at the beginning of the study and at the end.

At the beginning of the study, Cadmus requested 24-months of usage data for LU's residential natural gas heating customers. Cadmus used these data to examine the typical natural gas heating consumption for LU's customers in New Hampshire and to verify eligibility of program participants.

At the end of the study, the LU program manager provided Cadmus with billing data from January 2011 through May 2013 for 28 of 29 pilot participants.[7] Cadmus used these data to conduct the billing analysis to determine the impact of the Wi-Fi thermostat installation on the participants' natural gas consumption.

[7] One participant did not have complete historical billing data available from Liberty Utilities. The remaining 28 customers had sufficient billing data.

Weather Data

Cadmus collected daily temperature weather data from the National Climatic Data Center for the Nashua weather station corresponding to the Wi-Fi pilot participants' ZIP codes. Cadmus collected both actual weather data for the dates corresponding to the collected participant billing data, as well as Typical Meteorological Year (TMY) data to represent the typical weather year. From the daily weather data, we calculated the base 65 reference temperature heating degree days (HDDs).[8]

Billing Analysis

Cadmus conducted a billing analysis to assess the impact of the Wi-Fi thermostat program on the participants' natural gas consumption. Cadmus used the heating system run-time data, indoor temperature data, and participant survey data to fine-tune the billing analysis and understand participant behavior.

Data Aggregation and Screening

Gas billing data from January 2011 through the thermostat installation date served as the pre-installation period. This included up to two pre-period years of billing data.[9] Since the pilot thermostat installations occurred between November 2012 and January 2013, post-installation billing data were available from the installation date up through May 2013.

Due to the limited post-installation data compared to the pre-installation data, we paired pre- and post-installation months for this billing analysis. By using the same months in both pre- and post-installation periods, we ensured a reasonable comparison in both periods, preventing bias that could occur if we had used mismatched months. For example, for a participant who had the Wi-Fi thermostat installed in January 2013, we included post data in our analysis from the period February 2013 through May 2013, and used the corresponding February 2012 through May 2012 and February 2011 through May 2011 billing data for our baseline analysis.[10]

The next step in our analysis was to compare the participants' billing data to the appropriate weather data. We matched each participant's monthly billing period to the associated base 65 HDDs.

We then matched the survey information to the billing data. We applied the data screening and criteria shown in Table 7. If a participant failed any of these screens, we excluded that site's data from our billing analysis.

[8] This is defined as the number of degrees below 65 Fahrenheit. For example, the base 65 HDD for a daily temperature of 50 degrees Fahrenheit is 15.

[9] Because 2011 weather was closer to the 2013 post-period weather, that year's billing data was included in the analysis as well; 2012 tended to have a milder winter than both 2011 and 2013.

[10] If a customer did not have all the paired months of billing data for 2011, we used only one year of pre-period billing data. For example, if a customer installed the thermostat in November 2012, then there was no corresponding December 2010 month, thus the paired months from the earlier pre-period could not be included and only one paired pre-year was used.

Table 7. Participant Screening for Analysis

Site-Level Screening Criterion	Participant Count	Thermostat Count
Total units included in study	29	32
Fewer than three paired months in the pre- or post- period	1	2
Remodeled home or changed thermostat zones served in post-period	2	3
Post-period occupancy changed compared to the pre-period based on survey responses	3	3
Total Units Screened Out (and removed from analysis)	**6**	**8**
Total Units Included in Analysis	**23**	**24**

Using these criteria, we screened out six of 29 participants accounting for eight thermostats. We used 23 participants in our regression modeling.

Data Modeling

To determine the gas savings, we used the fixed-effects modeling method shown below that pools monthly time-series billing data, which corrected for differences between the pre- and post-period weather, as well as for differences in the usage magnitudes between participants. The fixed-effects model normalized this usage variation across the participants by using a separate intercept for each participant with an interaction with heating degree days in the model estimation.

$$ADC_{it} = \alpha_i * AVGHDD_{it} + \beta_1 POST_{it} * AVGHDD_{it} + \varepsilon_{it}$$

Where for participant 'i' and monthly billing period 't':

ADC$_{it}$ is the average daily pre/post gas Therm consumption per billing period for each participant.

α_i is the site specific intercept term.

AVGHDD$_{it}$ is the average daily HDD (base 65) for Nashua, NH.

β_1 is the average daily Therm gas heating savings per HDD as a result of thermostat installation(s).

POST$_{it}$ is a dummy variable that is '1' in the post period and '0' otherwise.

POST$_{it}$ * AVGHDD$_{it}$, is the interaction of the POST indicator and average daily HDDs (AVGHDD$_{it}$)

ε_{it} is the regression model error term.

The model directly estimates both the pre-period usage per heating degree day for each participant and the combined thermostat savings (β_1). The inclusion of the interaction of the HDDs and the post-variable allows for the possibility of obtaining weather-normalized savings by specifically isolating only the heating Therm savings.

Evaluation Results

This section describes the results for the three evaluation tasks:

- Impact Evaluation
- Process Evaluation
- Product Evaluation

The results are based on the data collected and analyzed as described in the previous section.

Impact Evaluation

The goal of the impact evaluation was to estimate the gas savings attributable to the Wi-Fi thermostats in the pilot. The pilot participants had programmable thermostats before participating in the Wi-Fi pilot program; therefore, these savings should be seen as the difference between a standard programmable thermostat and the Wi-Fi thermostat. A total of 29 households participated in the pilot program, accounting for 32 thermostats. After data screening, 23 participants were used to estimate the gas savings.

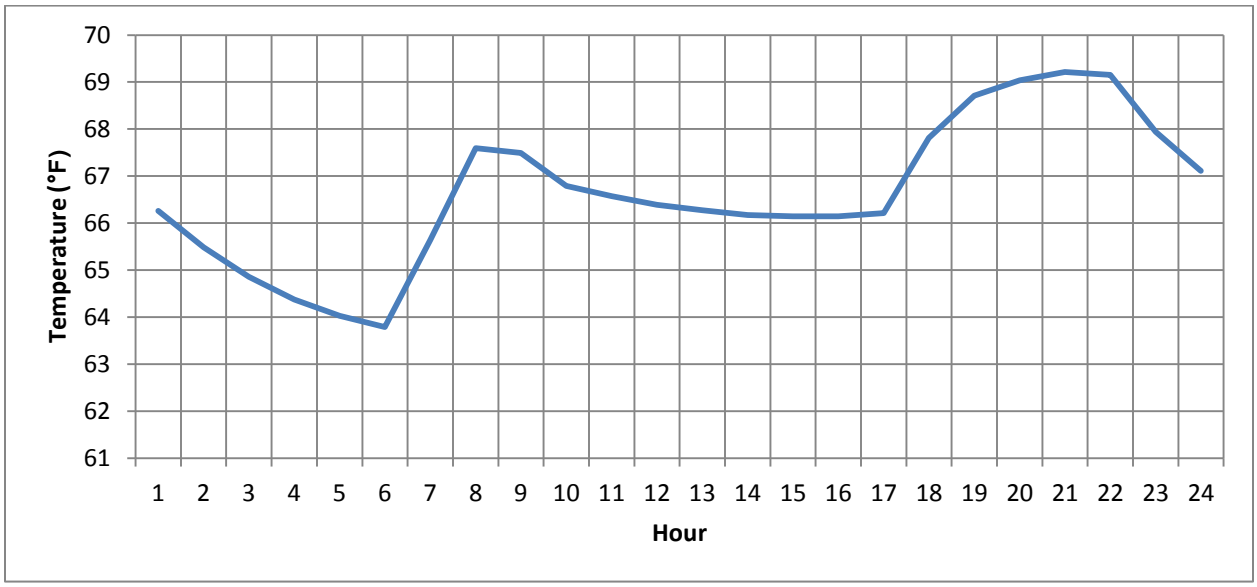
Thermostat Programming

Cadmus verified that most participants were using their new thermostats to program temperature setpoint schedules through spot-inspections of programmed schedules and analysis of the space temperature data collected throughout the study period.

Of the 29 participants, 28 had space temperature data that could be analyzed.[11] Cadmus calculated the average hourly temperature for each participant and created average hourly temperature profiles. Figure 4 shows an example 24-hour profile.

[11] One customer had not returned the temperature logger at the time of reporting.

Figure 4. Sample 24-hour Average Hourly Temperature Profile



The temperature profile demonstrates a programmed thermostat schedule with multiple setpoints and multiple setback periods. In this example, the participant has programmed the thermostat to reduce heating overnight as well as during normal working hours, an optimal strategy for energy savings.

Natural Gas Savings

The results of the billing analysis are outlined in Table 8. The analysis determined that the average savings for the pilot program participants was 69 therms per home. However, since our billing analysis sample (n=23) averaged 1.043 Wi-Fi thermostats installed per home, the savings per thermostat is 66 therms. Based on the average baseline natural gas consumption per home of 836 therms, the program realized 8% savings per home. Calculating a 90% confidence interval around the overall savings yields an estimate of 53 to 80 therms savings per thermostat.[12]

Table 8. Wi-Fi Thermostat Billing Analysis Savings Summary

Number of Participants (Billing Analysis)	Normal HDD_TMY3	Savings per Home (therms)	Savings per Thermostat (therms)	Pre Period Usage	Savings as % of Pre-Period Usage	90% Precision	Savings Lower 90% CI	Savings Upper 90% CI
23	6,294	69	66	836	8%	20%	53	80

For the regression group, the average conditioned square footage was 1,900 square feet. Of the 23 participants, 70% had a furnace, 26% had a boiler, and 4% did not know their primary heating type.

The evaluated energy savings are comparable to the results of a Wi-Fi thermostat study conducted in Massachusetts for 83 households and 123 thermostats during the 2011-2012 heating season. In the

[12] The regression output of the billing analysis is provided in Appendix D.

Massachusetts study, gas savings of 11% per thermostat for a home with one thermostat and 8% per thermostat for homes with two thermostats was observed.[13]

Savings per Participant

The percentage savings by participant ranged from -9% to 19% of pre-period usage. Three of the participants (13%) in the final model increased usage after installing the thermostat. These participants changed their behavior after installing the thermostat and used the heating system more. In the participants' survey responses, some stated that they are keeping their home more comfortable than before, demonstrating the potential "take-back" effects after installing Wi-Fi thermostats.

Before installing the Wi-Fi thermostat, 100% of participants had a standard programmable thermostat. Not all participants, however, programmed their thermostats. Two participants (7%) reported using a single setpoint throughout the heating season, six (21%) reported changing their thermostat setpoints manually, 13 (45%) reported programming their thermostat, and two (7%) did not provide baseline information.

Those participants who switched from a single setpoint throughout the season to a Wi-Fi thermostat saw the highest improvement in savings at 13% of pre-study usage—almost double the percent savings of those who previously changed their settings manually or programmed their thermostat prior to receiving the Wi-Fi thermostat. Savings by baseline group are shown in Table 9.

Table 9. Wi-Fi thermostat Billing Analysis Savings Summary by Baseline Group

Baseline Group	n	Pre Period Usage (therms)	Savings Per Participant (therms)	Savings Per Thermostat (therms)	Savings as % of pre-period usage	90% Precision	Savings Lower 90% CI	Savings Upper 90% CI	Average Conditioned Sqft
Overall	23	836	69	66	8%	20%	53	80	1,897
Single Setpoint	2	738	95	95	13%	60%	38	152	1,950
Manual	6	689	59	50	7%	49%	26	75	1,842
Programmed	13	922	73	73	8%	26%	54	92	2,083
Unknown	2	817	42	42	5%	61%	16	67	1,300
* n = number of participants included in the billing analysis									

[13] Wi-Fi Programmable Controllable Thermostat Pilot Program Evaluation. The Cadmus Group, Inc. 2012.

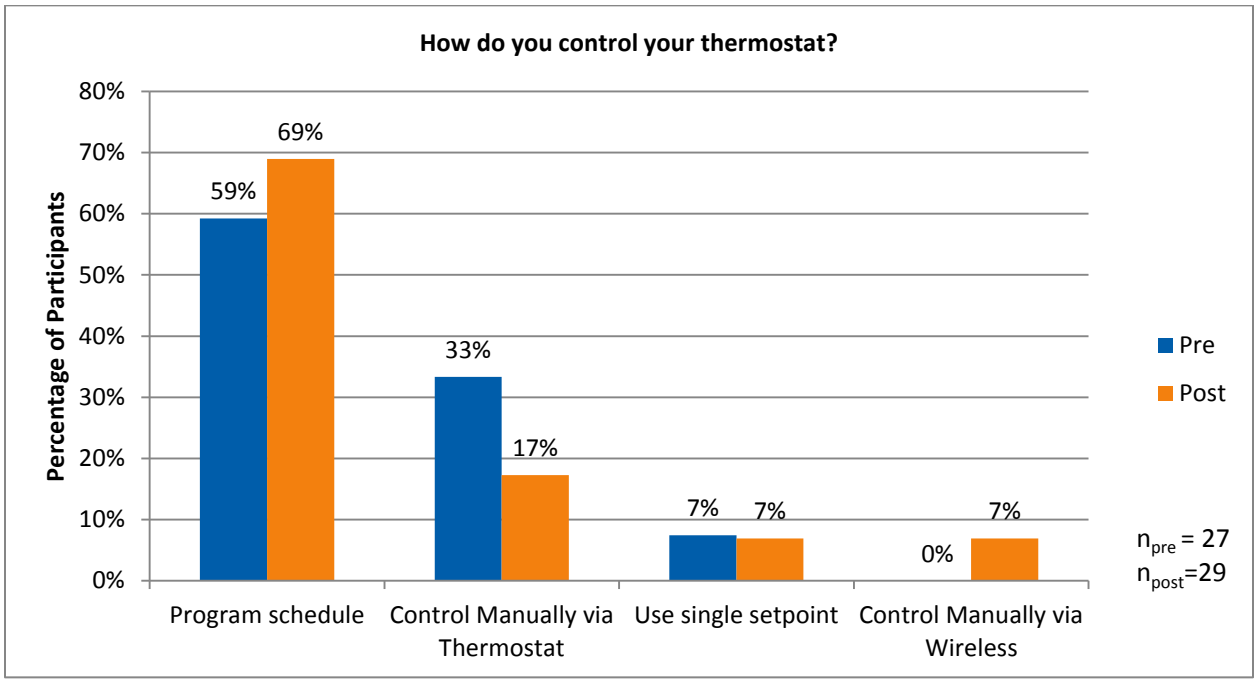
Perceived Gas Savings

Nine of 29 participants (31%) reported noticing a change in their energy bills since installing the Wi-Fi thermostat. These participants all reported noticing "lower" or "slightly lower" energy bills. No one reported noticing an increase in their energy bills.

Reported Changes in Thermostat Settings

From the pre-install to post-install period, the percentage of participants who program their thermostats increased from 59% to 69% while the percentage of people who control the temperature from the thermostat manually decreased from 33% to 17%. The number of participants who use a single setpoint throughout the season stayed the same. Seven percent of the participants began controlling their thermostat manually via wireless using the smartphone application or Skyport® website (Figure 5).[14]

Figure 5. Changes in Thermostat Control



Product Evaluation

We evaluated both the usability of the Wi-Fi thermostat set-up and its features.

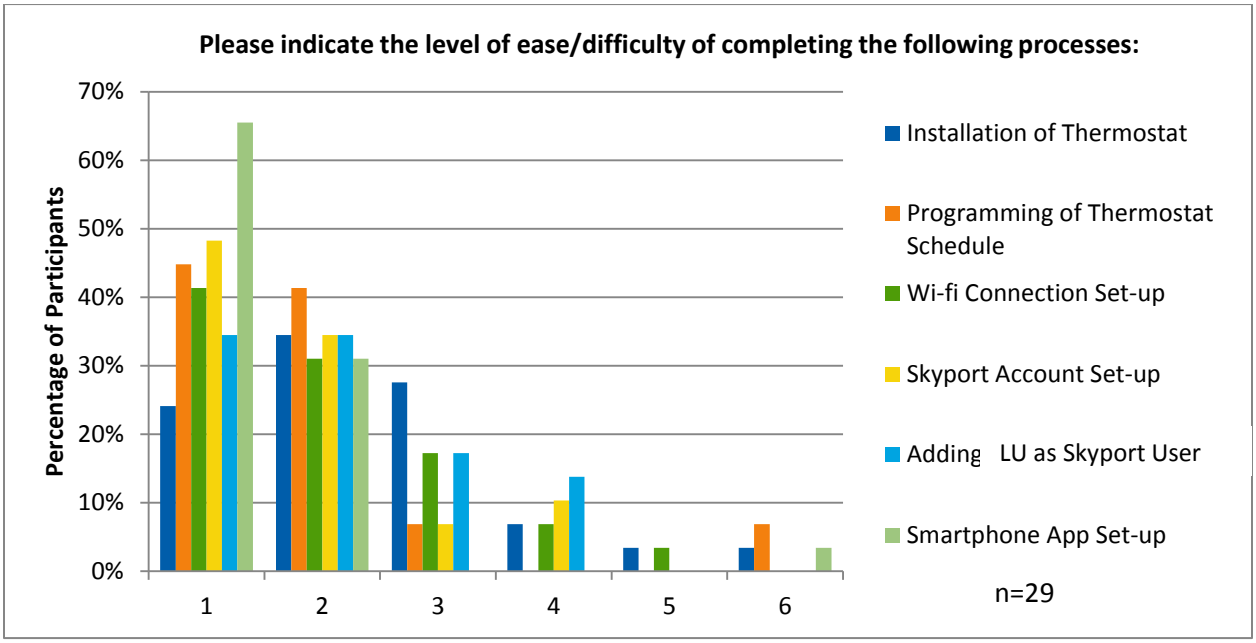
System Set-up

For system set-up, participants were asked to rate the usability, or ease of use, of the Wi-Fi thermostat (Figure 6). The following aspects were evaluated: installation, programming of thermostat schedule, Wi-Fi connection set-up, Skyport® account set-up, adding Liberty Utilities as a Skyport® account viewer, and

[14] Baseline data on thermostat settings was available for 27 of 29 participants (93%).

smartphone application set-up. An evaluation of each of these steps follows. If participants do not use the system regularly and have no basis for an opinion, they had the option to select "N/A."

Figure 6. Ease of Set-up



Installation of Thermostat

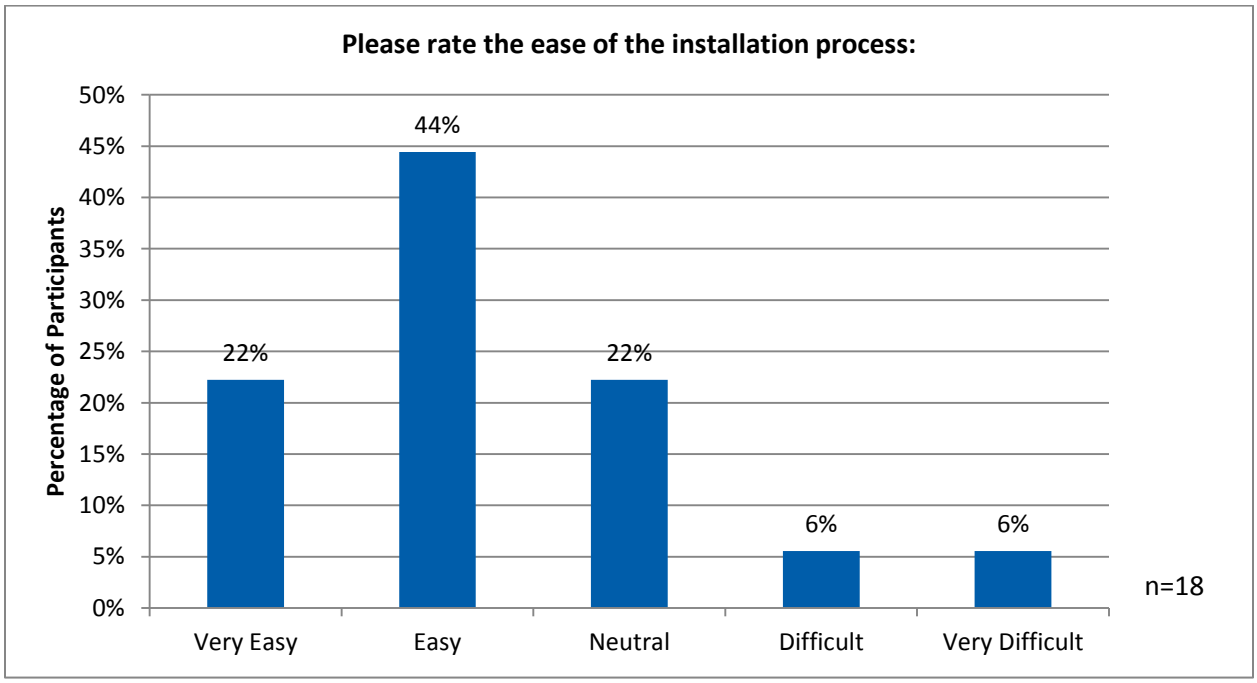
As is the case with the majority of Wi-Fi thermostats, the Venstar ColorTouch T5800 requires a 24VAC Common wire, or C-wire. This is in addition to the standard R (24VAC Power) and W1/O/B (First-Stage Heat) wiring. The C-wire supplies 24VAC so that the thermostat can run without batteries. Of 29 participants, seven (24%) already had this wire installed, 11 (38%) took the responsibility of installing the wire, and 11 (38%) had the wire (and thermostat) installed by a contractor hired by Liberty Utilities.[15]

For those participants who had a contractor install their thermostat wiring and thermostat, the average cost was $229.55. The minimum cost was $80 and the maximum cost was $320. Costs varied depending on the distance the wire had to be run from the heating system to the thermostat.

Eighteen (62%) of participants installed the thermostat on their own, without hiring a contractor. Of these participants, 66% rated the ease of the installation as either "very easy" or "easy." Twenty-percent rated it as "neutral" and 12% rated it as "difficult" or "very difficult" (Figure 7).

[15] Three customers had to drop out of the study because their HVAC systems were not compatible with the thermostat. One customer's boiler did not have a C-terminal. The two remaining customers reported that their thermostats were not receiving constant power. The HVAC contractor concluded that the boiler's low water cut off was cycling power to the thermostat and causing it to turn on and off.

Figure 7. Ease of Installation



Survey responses from participants indicate that the thermostat installation itself was very easy, but that the installation of the C-wire caused the ease-of-use ratings to decline:

- Installation of thermostat itself was simple. Adding the C-wire was the challenge. Fortunately for me, there was a spare wire in the existing cable that I just needed to connect on both ends.
- I only added "easy" to the thermostat installation because I had to make changes to add the control wire for one of the thermostats. Otherwise, the entire process was very easy.
- Installation of thermostat was easy but rewiring was more challenging.

One participant provided a suggestion for addressing this issue if the thermostat is further promoted by Liberty Utilities:

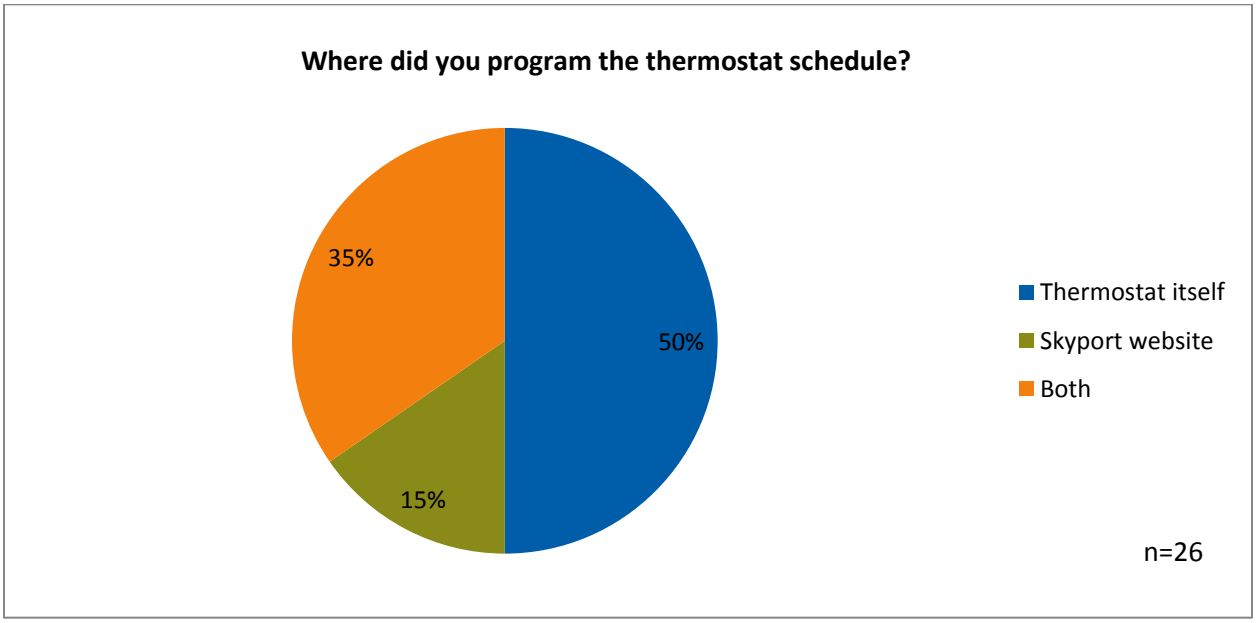
- Explain to customers that the thermostat requires a 24 VAC line. One way to help them understand the need is to explain that thermostats that use batteries or do not have any LCD/LED displays may not have a 24 VAC line installed.

Setting up the Venstar ColorTouch T5800 involved programming the thermostat schedule, setting up a Wi-Fi connection, creating a Skyport® account, sharing access to the Skyport® account with Liberty Utilities, and installing the smartphone application. An evaluation of each of these processes is outlined below.

Programming Thermostat Schedule

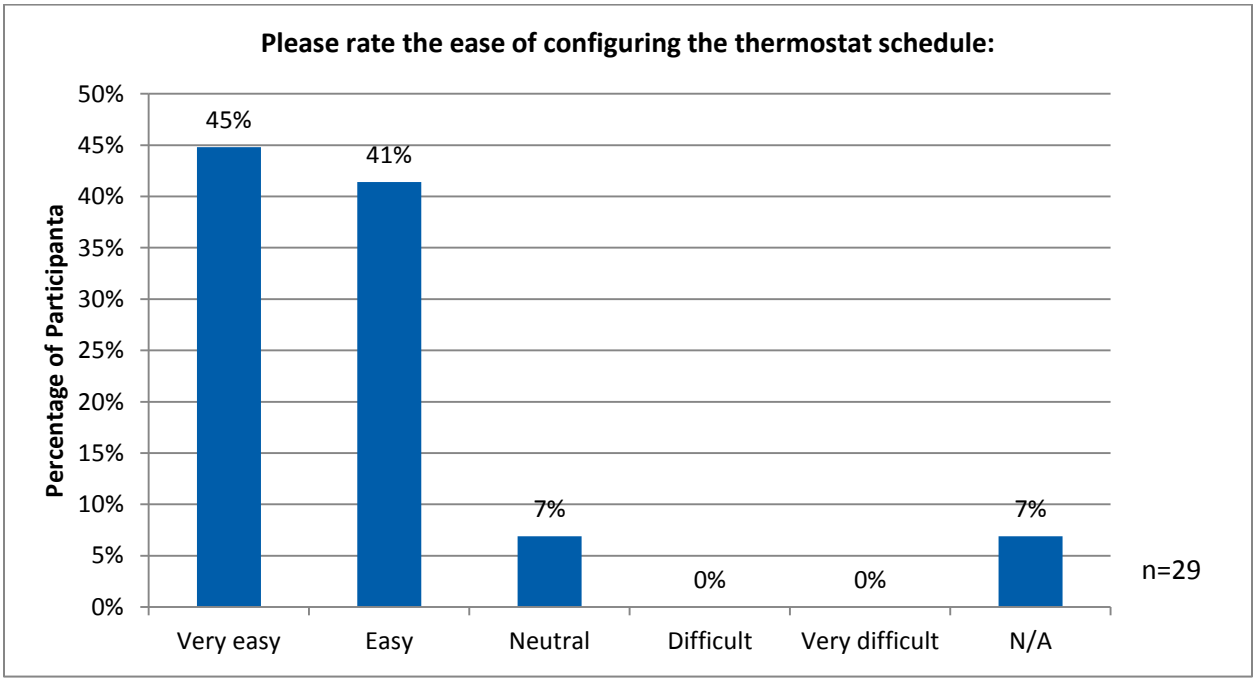
The thermostat schedule and setpoints can be programmed either at the thermostat unit or through the online Skyport® account; it cannot be programmed from the smartphone application. The majority of the participants that did program their thermostat programmed it from the thermostat itself, rather than from the Skyport® website (Figure 8).

Figure 8. Thermostat Programming Location



Eighty-six percent of participants found programming their schedule to be either "very easy" or "easy." Seven percent rated it as "neutral" and no one rated it as either "difficult" or "very difficult." Seven percent of respondents answered "N/A" because they did not set up a schedule (Figure 9).

Figure 9. Ease of Schedule Set-up



Of 29 participants, 21 (72%) reported that the new thermostat made it easier for them to set their thermostat. Participants provided the following comments about the user-friendliness of the thermostat:

- Big buttons, can configure remotely.
- Can be easily read and understood.
- Can do it by my phone when I'm not home.
- Easier to program.
- Easier to program than the programmable thermostat we replaced.
- I can set the temp from my phone or computer.
- I find it much easier to use my phone to control the thermostat.
- I used my cell phone.
- Manual settings with app.
- More intuitive. Love the touch screen.
- On the fly any time!
- The PC-enabled web interface.
- Touch screen makes it easier and very intuitive.
- Use of smartphone adds a new option.
- Very easy to set the schedule since we use the same every weekday.

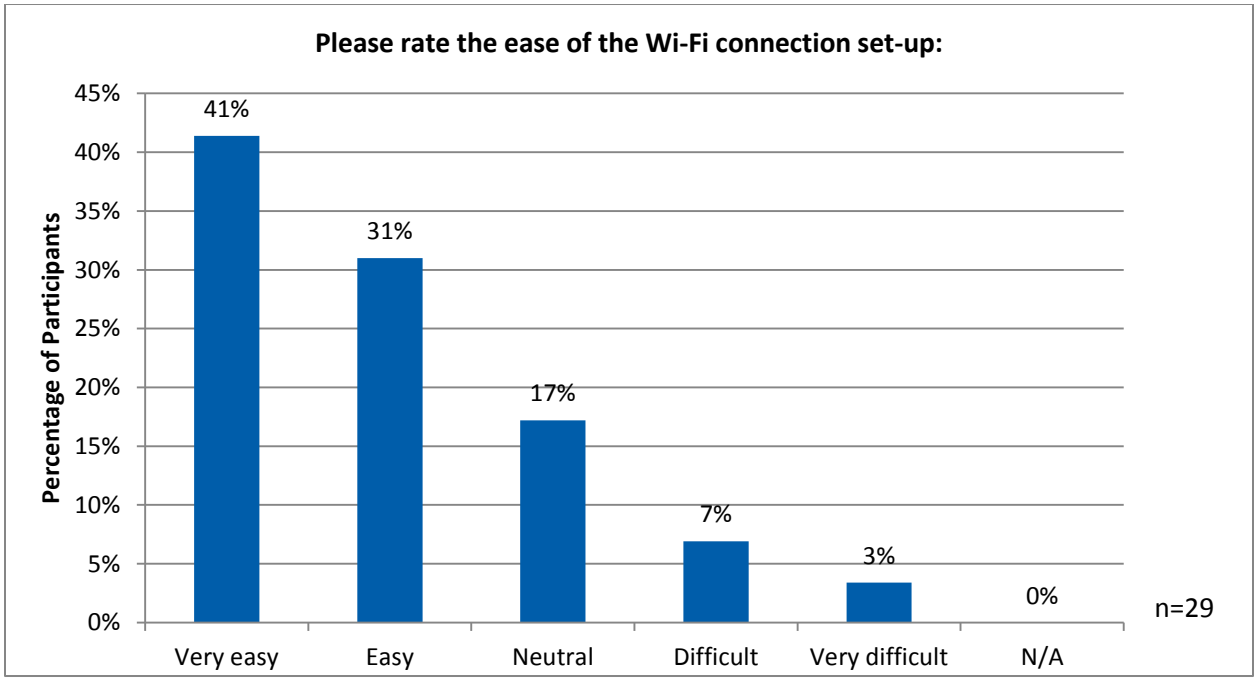
- Can do it remotely from anywhere.
- Changing as needed through my phone.
- iPhone.
- Remotely.
- The mobile app has made it easy to check the outside temp and house temperature settings when I am out of town or away for a night or two.
- Web interface makes setting it might easier, and ability to use Android phone allows setting it remotely with ease.

Wi-Fi Connection Set-up

Wi-Fi connection set-up involved plugging a Wi-Fi key into the thermostat and following a set of instructions on the thermostat. Seventy-two percent of participants found the Wi-Fi connection set-up "very easy" or "easy," 17% rated it as "neutral," and 10% rated it as either "difficult" or "very difficult" (Figure 10).

Several participants resolved their Wi-Fi connection issues by updating their thermostat's firmware. Other participants resolved the issue by purchasing a Wi-Fi booster for their router or by purchasing a new router with a stronger Wi-Fi signal.

Figure 10. Ease of Wi-Fi Set-up

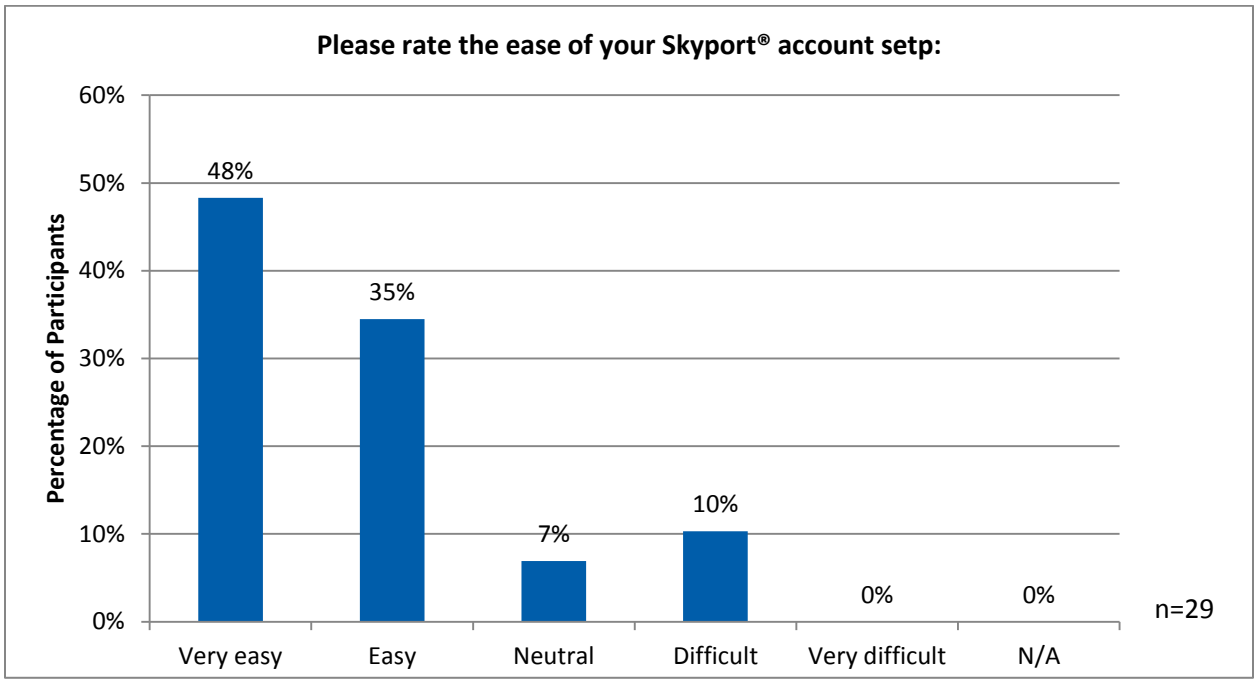


Skyport® Account Set-up

Participants created web-based Skyport® accounts that enabled them to control their thermostat online. Eighty-three percent of participants found the process to be either "very easy" or "easy," while 7% rated

it as "neutral" and 10% rated it as "difficult" (Figure 11). One person reported difficulties due to an error in the Venstar manual, which asked for password when it actually needed the Skyport® identification number.

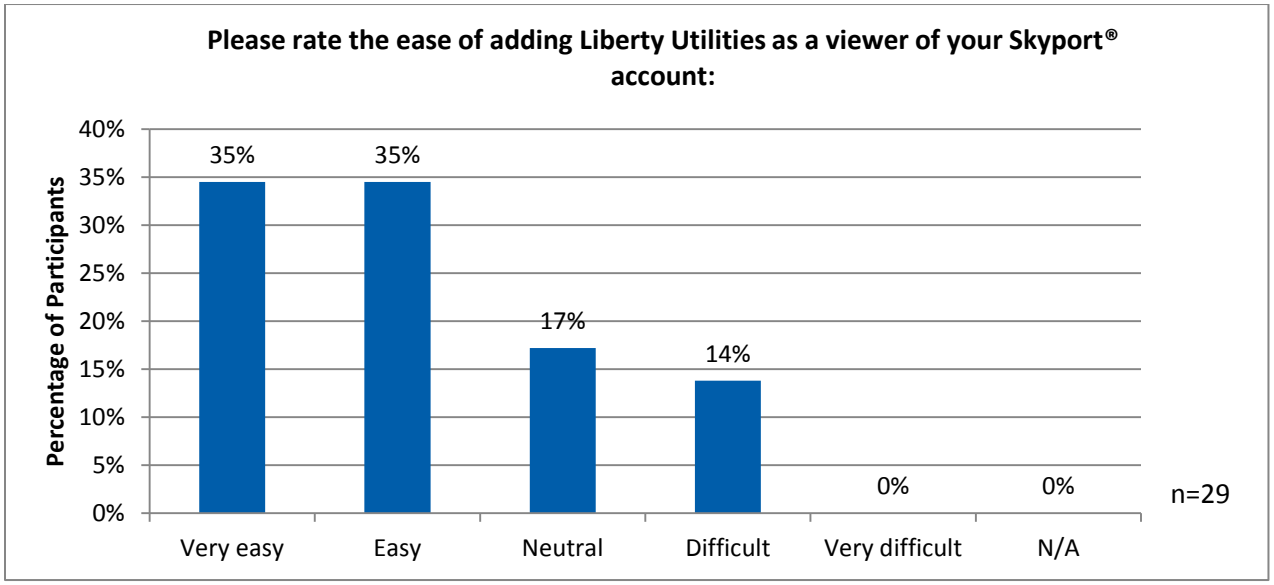
Figure 11. Ease of Skyport® Account Set-up



Adding Liberty Utilities as a Skyport® Account User

In order to collect participants' heating system run-time information, Cadmus needed to be able to access their Skyport® accounts. To do this, Cadmus asked each participant to add Cadmus as a viewer of their account. Cadmus sent each participant instructions on how to do this. Seventy percent of participants found this process to be "very easy" or "easy," 17% rated it as "neutral" and 14% rated it a "difficult" (Figure 12). Participants expressed that the instructions could have been clearer.

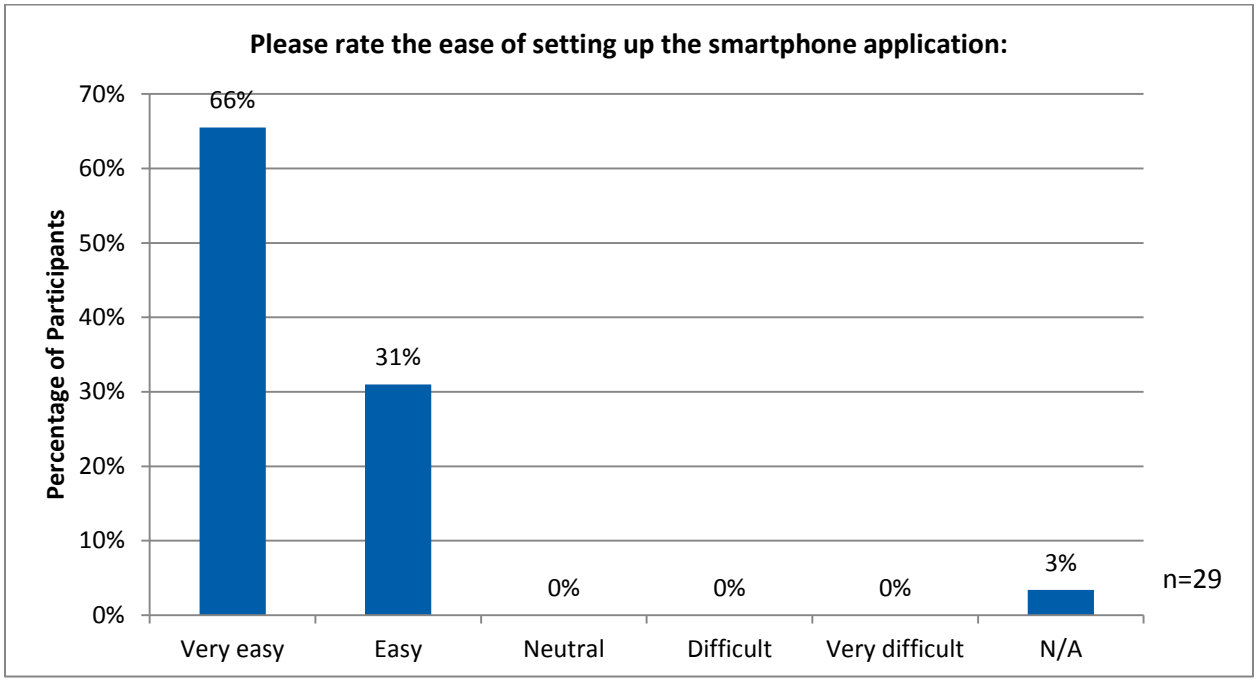
Figure 12. Ease of Adding Liberty Utilities



Smartphone Application Set-up

Participants were required to have an iPhone® or Android® smartphone in order to participate in the study so that they could install the Venstar application and control their thermostat from their smartphone. Ninety-seven percent of participants found setting up their smartphone application to be "very easy" or "easy" and 3% did not give a rating because they do not use the application (Figure 13).

Figure 13. Ease of Smartphone Application Set-up



Most people gave very positive ratings on the smartphone application:

- The app works great and allows me to keep the heat down at night (overriding program) from the office if it's going to be a late night.
- The best feature for me is the smartphone app. I love the ability to monitor and adjust temperatures from anywhere.

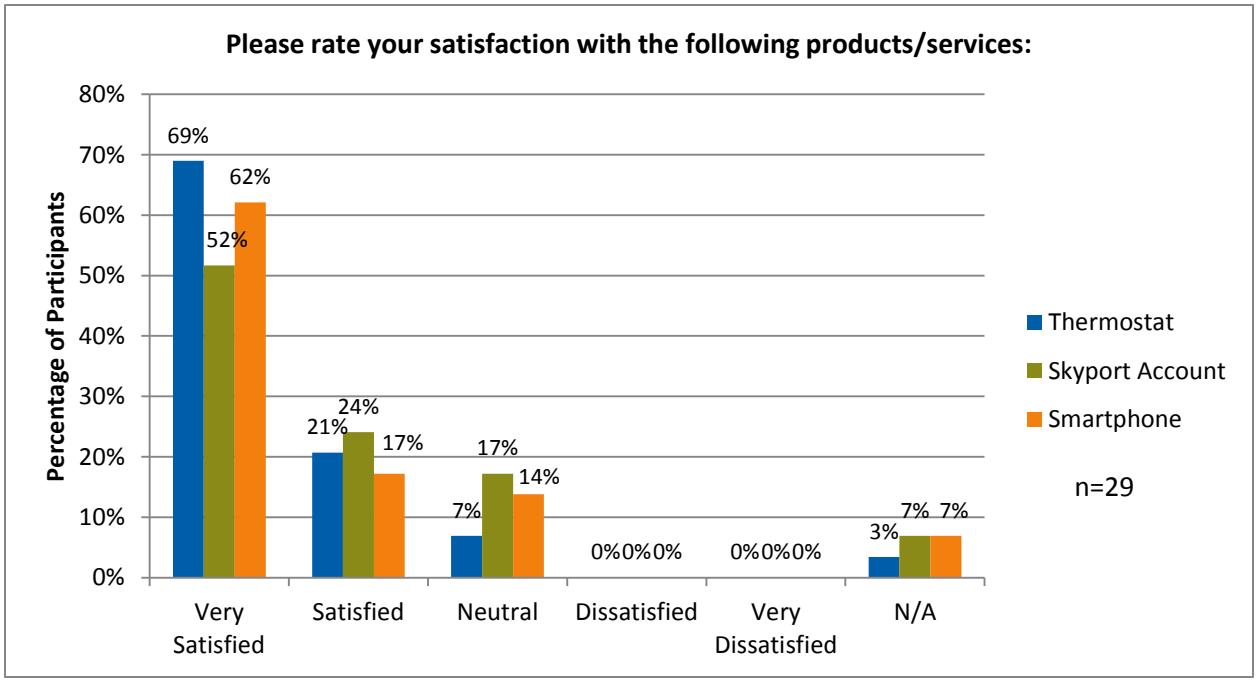
Some participant suggestions for improvements were:

- I would love the smartphone app to have more detailed reporting and scheduling like the web application. Also, it would be nice to have some sort of computer interface or API to assess the thermostat programmatically from my home network, to allow more advanced scheduling/logging.
- Occasionally the thermostat is not accessible via the smartphone app. Sometimes there is a message that the login failed, or it is inaccessible.
- I wish we could change the schedule using the smartphone app. That would make it truly wonderful!

Overall Product Satisfaction

No one gave an unsatisfactory rating for any of the three systems: thermostat, Skyport® account, or smartphone application. Participants were most satisfied with the thermostat, then the smartphone application, followed by the Skyport® website (Figure 14).

Figure 14. Product Satisfaction



Most participants gave very satisfactory ratings and found the thermostat to be very user-friendly:

- It's a great piece of equipment that has operated flawlessly since installation.
- It is a great system and very user-friendly.
- So far it has been an excellent decision to use this new product.

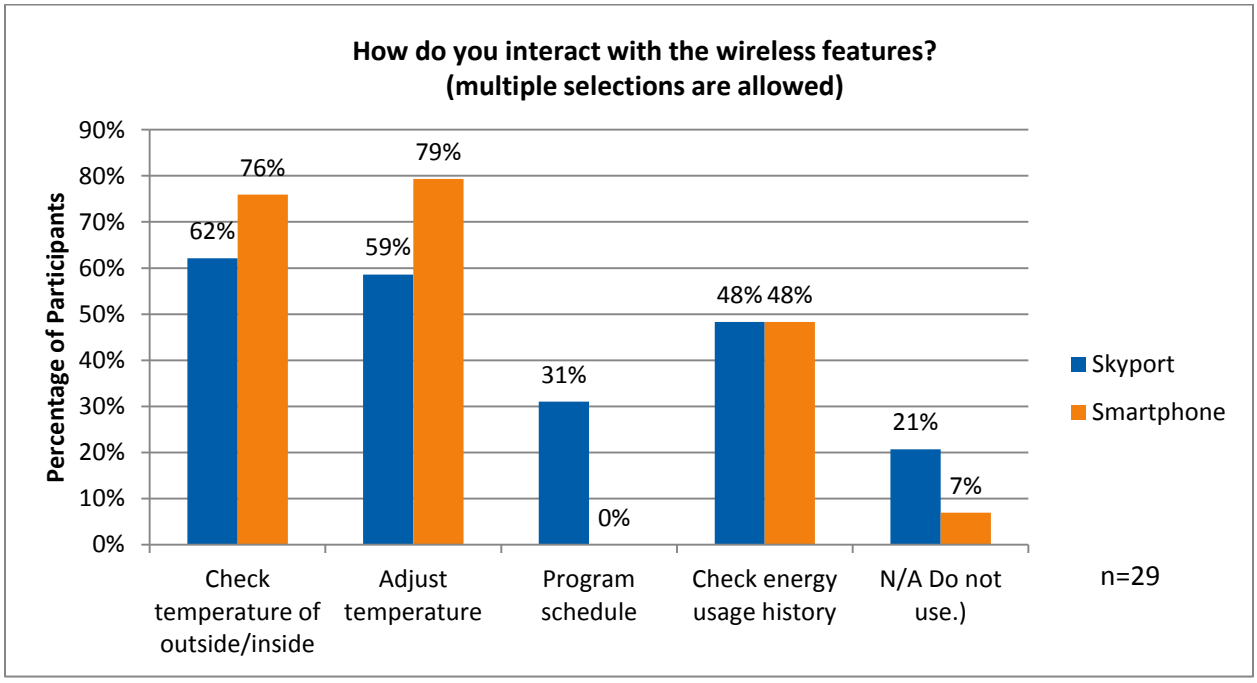
Wi-Fi Features

Many participants take advantage of their remote access to their thermostat controls and use the following features remotely:

- Check temperature of outside/inside.
- Adjust temperature.
- Program schedule.
- Check energy usage history.

Aside from programming the thermostat, which cannot be completed on the smartphone application, the smartphone application is more popular than the Skyport® account for connecting to the thermostat wirelessly.

Figure 15. Interacting With Thermostat



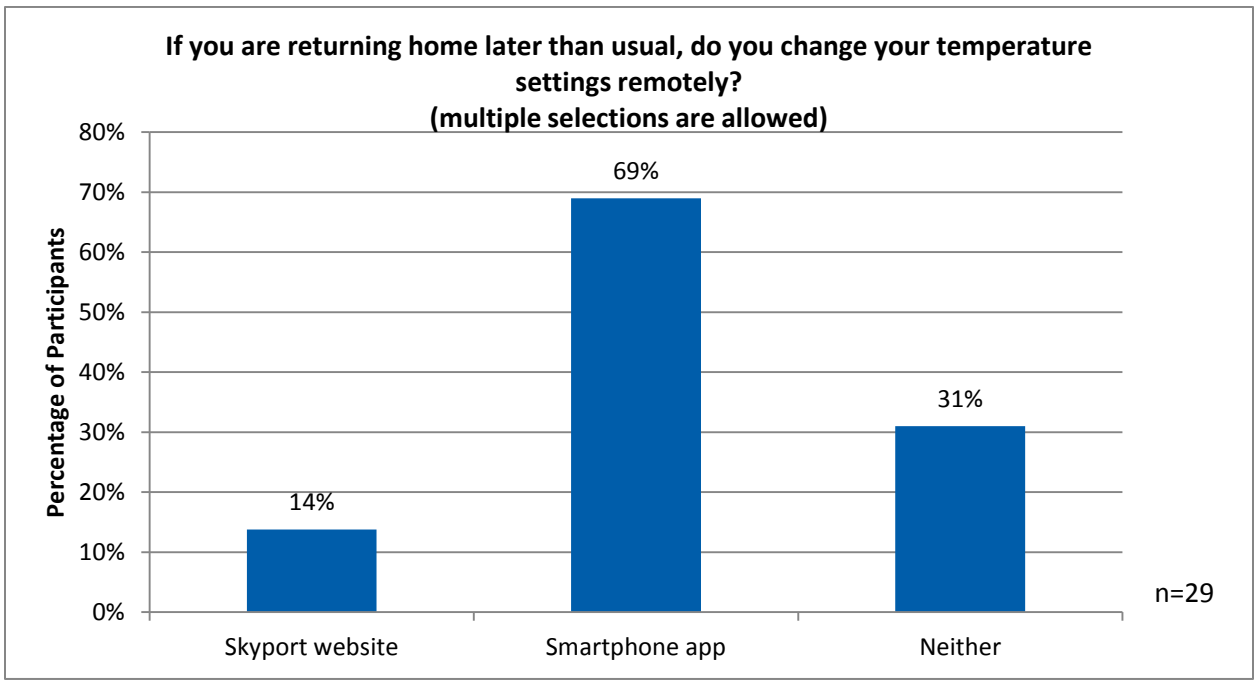
Twenty-one percent of participants do not use Skyport® and 7% of participants do not use the smartphone application (**Error! Reference source not found.**). When asked why, respondents listed the ollowing reasons:

- Do not see a need to.
- Do not remember to.

For the Skyport® accounts, several participants said they do not use it because they prefer the smartphone application.

Twenty of 29 participants (69%) adjust their temperature setting remotely with the smartphone application. Four of the smartphone application users (14% of total 29 participants) also use the Skyport® website to adjust their temperature settings (Figure 16).

Figure 16. Remote Settings Question



Overall Satisfaction of Features

Many participants enjoyed the Wi-Fi thermostat's additional features:

- I have never been able to access outside temps and energy usage through a thermostat before. I went on a weekend vacation out of town during extremely cold temps. It was extremely helpful to access current house temps and outside temps to make adjustments and ensure my house didn't get too cold. Great product.
- The thermostat is very easy to use. Programming is simple compared to my old programmable thermostat. The best feature for me is the smartphone app. I love the ability to monitor and adjust temperatures from anywhere.

Others found the features unnecessary when compared to a standard programmable thermostat:

- My old thermostat was as good as this one for most uses. Only advantage of the new one is the ability to adjust temp remotely via smartphone, but I rarely use that app.

Process Evaluation

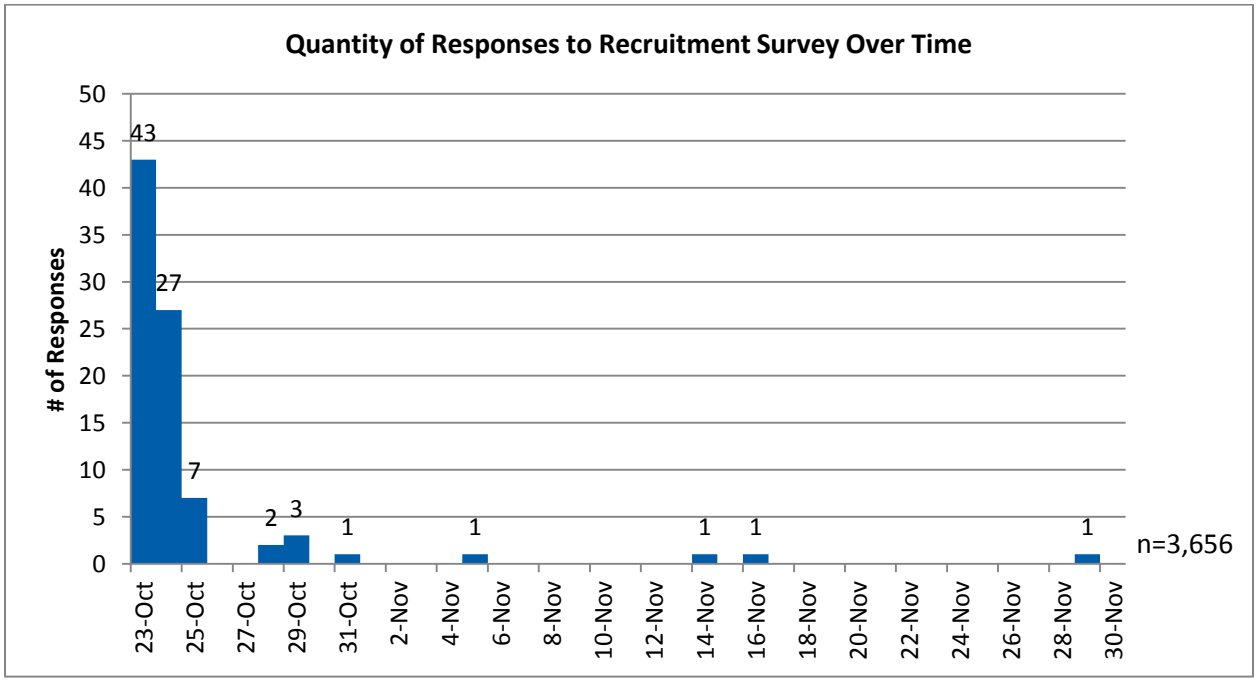
Cadmus analyzed the survey responses to conduct a process evaluation focused on the participant process, participant motivation, and participant satisfaction with the pilot program.

Recruitment Response Rate

Liberty Utilities and Cadmus recruited eligible participants to the Wi-Fi Programmable Thermostat Pilot Program through an e-mail advertisement sent to 3,656 of its gas customers in New Hampshire with the goal of recruiting 30 study participants. Of the 3,656 e-mails sent, 495 (14%) bounced back due to invalid e-mail addresses on record. Of the remaining 3,161 e-mails that were received by customers, 886 (28%) customers opened the e-mail, 799 (25%) read the e-mail, 187 (6%) clicked the link to the survey, 159 (5%) started the survey, and 93 (3%) completed the survey.

Of those 93 customers who completed the survey, most opened and read the e-mail within three days and completed the survey within one week, as shown in Figure 17.

Figure 17. Responses to LU Thermostat Recruitment Survey



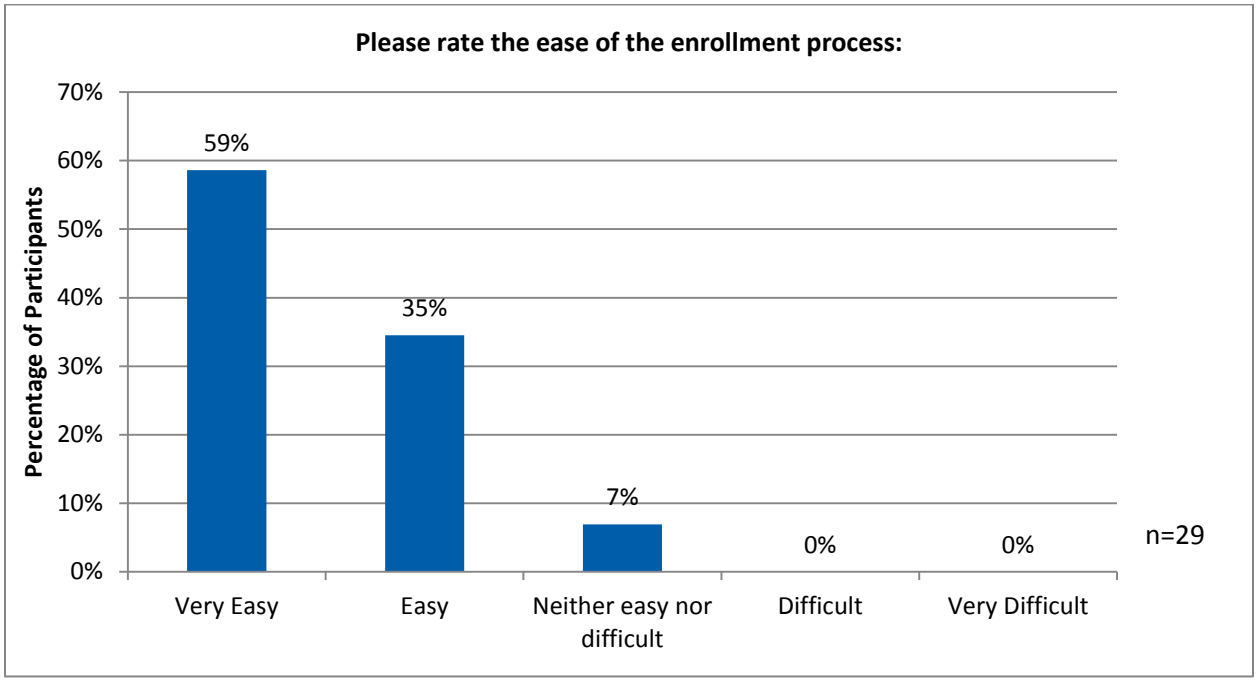
Enrollment

Participants who accepted their invitation to participate in the study were asked to sign a participant agreement of terms and conditions and to complete a baseline survey (Appendix B). Cadmus asked participants to send back their materials via e-mail or Fed-Ex with a prepaid return envelope addressed

to Cadmus. For those participants who had a contractor install their thermostat, the contractor collected hard copies of these materials and mailed to Cadmus with the labor invoices.

Overall, participants found the enrollment process to be very easy (Figure 18).

Figure 18. Ease of Enrollment



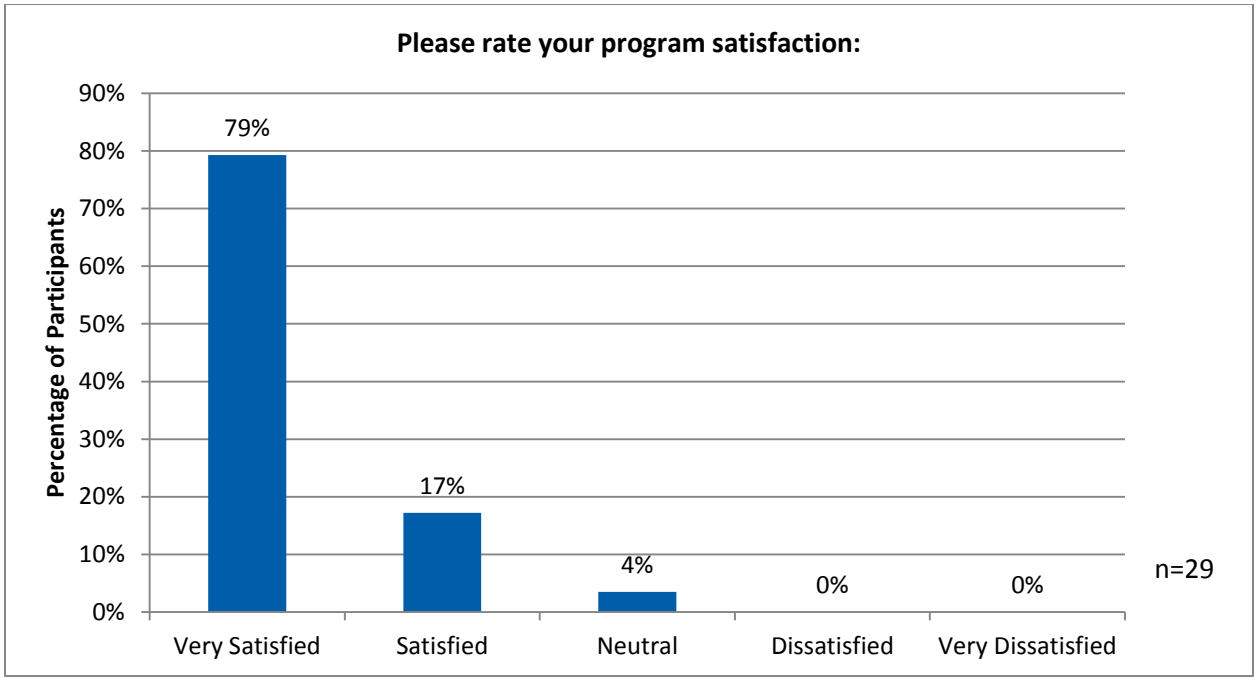
Satisfaction

Overall, 96% of participants were "very satisfied" or "satisfied" with the program (Figure 19).

Participants reported that the program was easy to participate in, non-intrusive, and not too demanding:

- Easy to sign up. Reasonable amount of paperwork. Fed-Ex envelopes were convenient.
- The entire process was easy to set up, monitor, and products worked flawlessly. Very satisfied with company and products.
- I thought it was a great idea and it was not intrusive at all.
- They were very helpful and not too demanding.

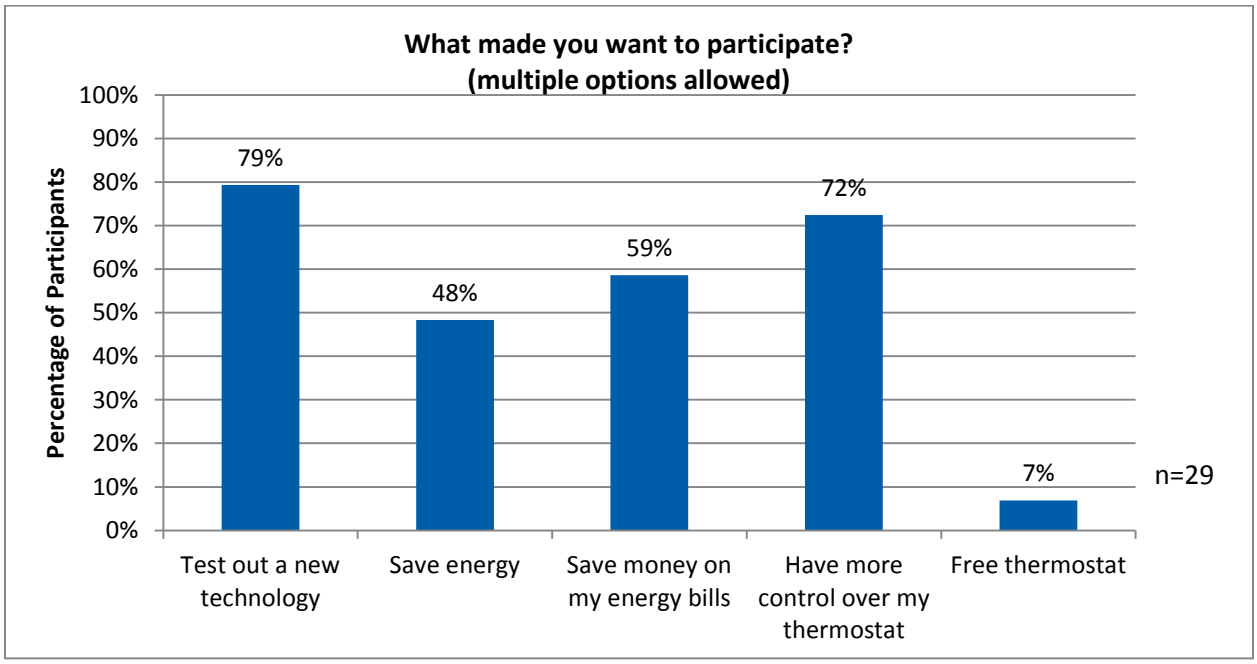
Figure 19. Program Satisfaction



Participant Motivation

When asked what made participants want to participate in the study, most participants reported being interested in testing out a new technology and having more control over their thermostat, at 79% and 72%, respectively. Saving money and energy were less popular motivators, at 59% and 48%, respectively. Two participants (7%) selected "Other" as a response. Both participants listed "free thermostat" as their motivator (Figure 20).

Figure 20. Motivation

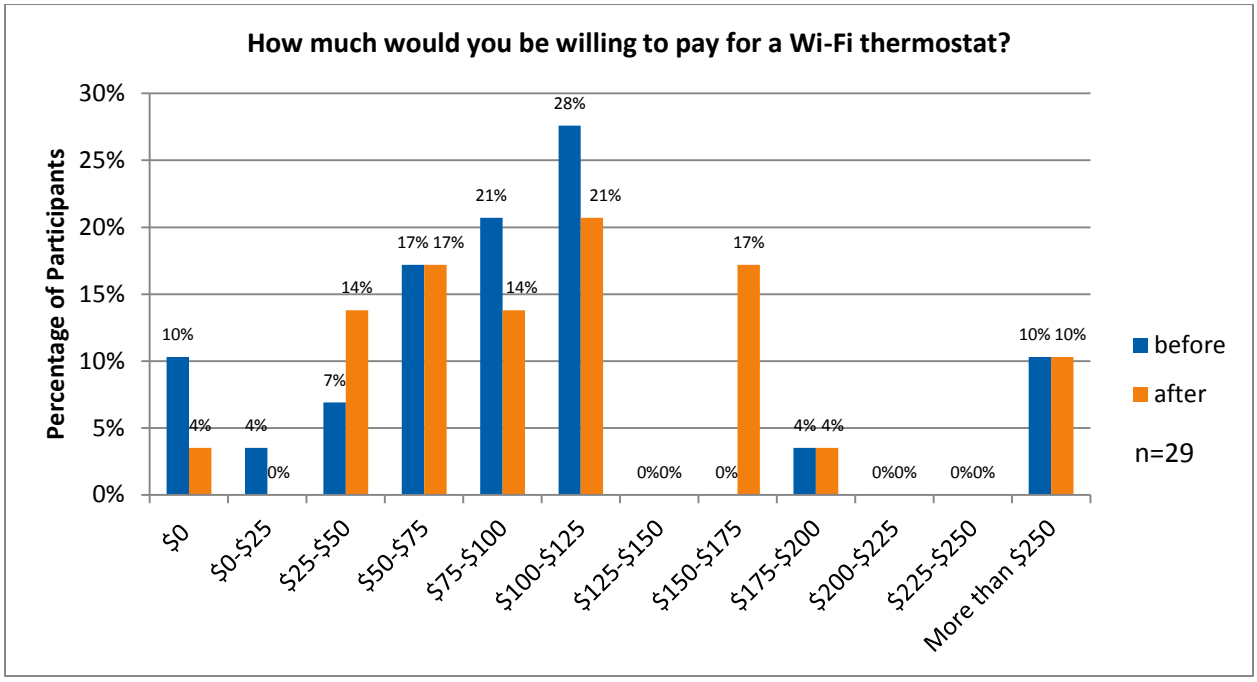


Sixty-six percent of participants (19 of 29) reported that they were not planning to purchase a new thermostat and 34% (10 of 29) said they were. Of the 10 participants who were planning to purchase a new unit, seven were planning to purchase a Wi-Fi programmable thermostat.

Willingness to Pay

Before participating in the study, most participants were willing to pay $100-$125. After the study, this remained the most popular price range that participants were willing to pay for the thermostat. On average, participants were willing to pay $40 more for the thermostat after the study than before the study (Figure 21).

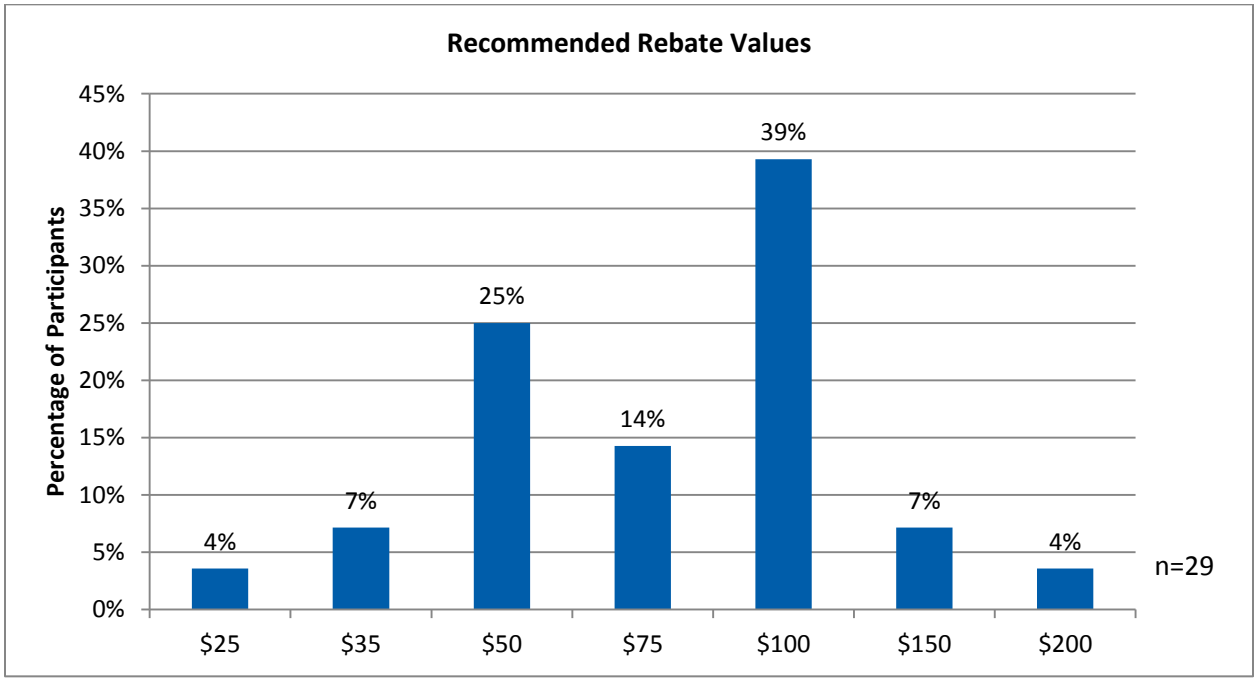
Figure 21. Willingness to Pay



Recommended Rebate Levels

When participants were asked open-endedly what dollar amount they would recommend for a rebate for a $200 Wi-Fi thermostat, 78% of participants suggested a rebate between $50 and $100. The most commonly recommended rebate amount was $100 (Figure 22).

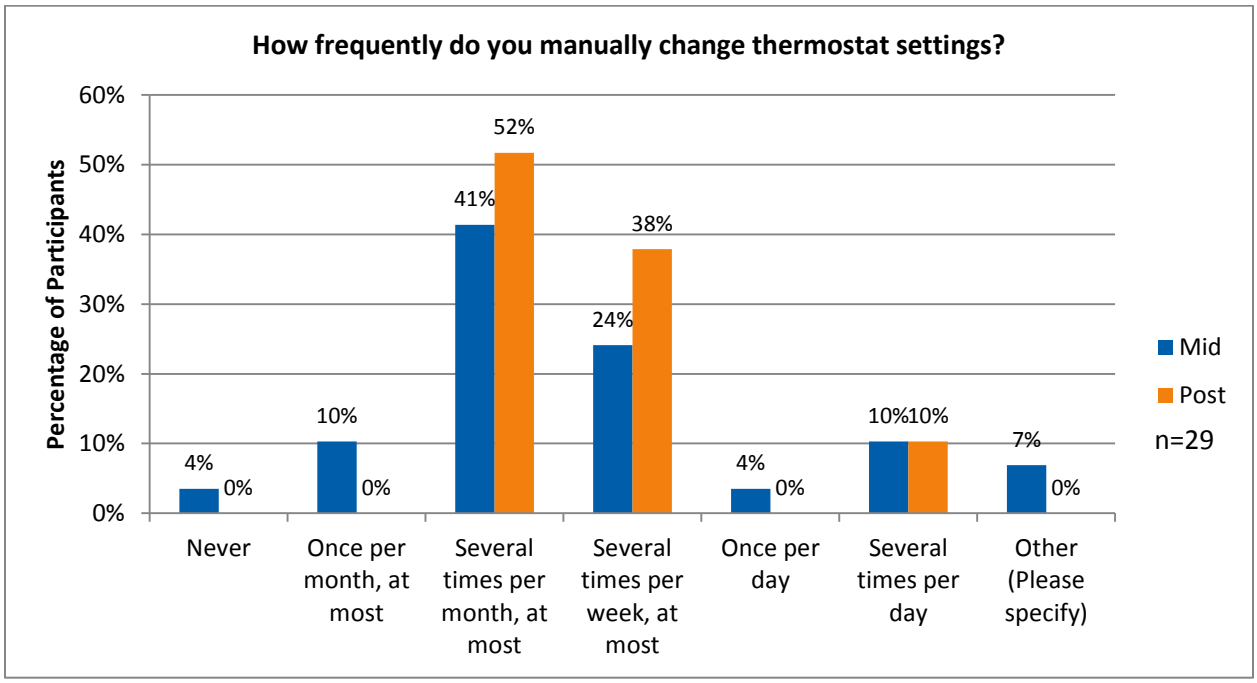
Figure 22. Rebate Recommendations



Thermostat Use

Most participants reported manually changing their thermostat settings several times per week to several times per month. From the mid-study survey to the post-study survey, the frequency that participants reported manually changing their thermostats increased (Figure 23).

Figure 23. Manual Change Frequency



"Other" responses reported in the mid-study survey include:

- Change temperature settings rarely.
- Only change when guests with different temperature preferences visit.

Behavior

Nearly one quarter (24%) of participants believe that being able to view their energy use history has impacted their behavior. Participants reported the following changes in behavior:

- Conscientious about adjusting temp when we are out and then readjusting when we are returning.
- I try to lower the temps if I happen to not be home to reduce my usage.
- Try to keep temp low to minimize energy usage as compared to prior week.
- Change temp when we are not at home.
- I would adjust to save more energy, such as at night.
- Adjust as needed.

Seventy-two percent of participants felt that the Wi-Fi capability impacted their approach to regulating their home temperature as compared to their standard programmable thermostat.

Many reported that they adjusted their settings more frequently:

- Due to the convenience, we change the settings more often.
- Easier to change the temp so it gets bumped up more often compared to prior programmable model.
- I adjusted it more often.
- It is much more convenient to make adjustments with a smart phone from anywhere.
- Manual adjustments by the day during winter to keep temp down when not home.
- Like being able to adjust the temp. when I am on my way home.
- We are more likely to turn the heat down when gone for just a few hours since we can turn it up on the way home.
- If my schedule changes, I can make changes before getting home or extend the time when it is in setback.
- I have been able to use the Wi-Fi tstat to better match my varied schedule of being at home. I can now turn the temp down lower when I am away. I can also turn it up sooner, so it is warm when I return.
- It's great to be able to turn the heat up so the house is warm when I get home from work (during really cold spells).
- It makes setting the schedule far easier, so that I'm more likely to do it. Also allows remote changes while away from home, which can be handy.
- I have used that feature from work.
- I will change it if I know no one is home. I change it from work.

Others liked the ability to monitor their home's temperature while away:

- It allows me to monitor it remotely and turn it down when we are on trips.
- Vacation mode is managed more closely.
- I check in through my mobile app to ensure the heating schedule is efficient and to make sure no kids in the house has modified the temperature settings.

One person reported that it made them more aware of their energy usage.

Thermal Comfort

Of 29 participants, 14 (48%) noticed a change in the thermal comfort if their home. Many people reported that the temperature of their home seemed more "constant," "steady," "stable," and "consistent." Two people reported a negative change in the thermal comfort of their home. These

people reported that even when they set the thermostat at the same temperatures setting they used with their old thermostat, the house felt colder.

Positive changes:

- Being able to pre-heat on very cold days outside of the normal schedule was a great advantage.
- I am able to turn the temp up when I leave work so the home is warm when I return to the house.
- I can adjust the temperature before I get home if my schedule changes.
- I use the mobile app to balance efficiency and comfort level in the house.
- More consistent temp.
- More stable.
- Steady temp works great.
- Temperature is constant.
- We can come home to the house the right temp, rather than having to wait for it to warm up.
- We turn up the temperature before arriving home.
- I can set it depending on my coming home schedule.
- Generally more comfortable, especially in the summer due to ability to control the fan independently of the heating system.

Negative changes:

- Needed to be set higher than my old one.
- When the scheduling is on, the house never seems to get up to the correct temperature which makes things feel cold.

Conclusions and Recommendations

This section describes the evaluation team's conclusions and recommendations based on analysis of the survey responses and other data collection for the pilot program evaluation.

Impact Evaluation

- **The Wi-Fi thermostats show gas savings of approximately 8% per thermostat and per participant home in heating season.** The billing analysis savings account for "take-back" effects, but predominantly the Wi-Fi thermostat pilot participants are showing savings after installing the new thermostats.
    - **Recommendation:** To achieve more precise savings, conduct a billing analysis for a larger participant population in future years. In addition, run the study through the cooling season to measure the impact of thermostats on cooling systems.

- **Three of 23 participants (13%) increased their gas usage after installing the thermostat.** These participants may have changed their behavior and used their heating systems more. For example, some participants reported that they started turning their heat up remotely when they were on their way home in order to pre-heat their house.
    - **Recommendation:** If a full-scale Wi-Fi thermostat program is rolled out, Liberty Utilities should provide education to customers about how user behavior and thermostat scheduling impacts heating and cooling energy consumption.

Product Evaluation

- **16 of 18 participants (88%) found the installation of the thermostat to be either "very easy", "easy", or "neutral." The remaining 12% found the installation of the thermostat to be "difficult" or "very difficult."** Survey responses from participants indicate that the thermostat installation itself was very easy, but that the installation of the C-wire (a common requirement for thermostats with Wi-Fi connections) caused the ease-of-use ratings to decline.
    - **Recommendation:** Explain to customers that the thermostat requires a 24 VAC line. One way to help them understand the need is to explain that thermostats that use batteries may not have a 24 VAC line installed.

- **No participants reported difficulty in programming their thermostat and the number of participants who program their thermostats increased (two additional people)**. Many commented that the thermostat was "user-friendly."
    - **Recommendation:** If Wi-Fi thermostats are promoted on a larger scale, the "user-friendliness" of the thermostats, along with the wireless features, should be highlighted to customers.

- **The majority of participants were willing to pay $50-$125 for a Wi-Fi thermostat both before and after the study.** When participants were asked how much money they would recommend be offered in a rebate to encourage customers to purchase a $200 Wi-Fi thermostat, 78% of participants recommended a rebate between $50 and $100.
    - **Recommendation:** Offer a rebate between $50 and $150. Although the majority of participants recommended a $100 rebate (and this is the rebate amount offered by several gas utility companies in New England), their "willingness to pay" responses indicate that many need a higher incentive offer to purchase a Wi-Fi thermostat. Depending on the percentage of customers that Liberty Utilities hopes to upgrade to Wi-Fi thermostats, a range of $50 to $150 should be considered for the rebate offering.

Process Evaluation

- **Ninety-three percent of participants found the enrollment process either "very easy" or "easy."** The remaining participants reported it to be "neither easy nor difficult." These are satisfactory ratings; however, to improve the process, the following two recommendations were made by participants:
    - Create clearer instructions for sharing Skyport® account access with Liberty Utilities.
    - Create a clearer explanation on how to determine current thermostat type.
- **Adding Liberty Utilities as a viewer of the Skyport®account so that they could collect their heating system run-time history was difficult for participants**.
    - **Recommendation:** Venstar has reported that they are developing a platform that would allow utility companies to view multiple customers' Skyport® accounts for the purpose of collecting customer information such as HVAC system run-time. Although details have not been released from Venstar, this would eliminate the need for customers to set up complicated Skyport® account settings.

Appendix A. Recruitment Survey

To recruit participants for the study, Cadmus sent an e-mail notice to 3,656 Liberty Utilities natural gas customers with basic information about the study and a link to an online survey where customers could self-determine their eligibility to participate in the Wi-Fi Thermostat Pilot Study.

The survey was distributed on 10/23/2012.

Thank you for your interest in the Liberty Utilities Wi-Fi Thermostat Product Evaluation Study.

Please fill out the following survey by Wednesday, October 31, 2012 in order to apply to be considered for participation in our product evaluation study and the chance to receive a Venstar ColorTouch Series T5800. Liberty Utilities will contact you in the next month if you have been selected to participate in this product evaluation study.

Please click [Next] to continue to the survey.

Eligibility

Please answer the following 7 questions to determine whether you are eligible to be considered for the Liberty Utilities Wi-Fi Thermostat Product Evaluation Study.

1) Are you a Liberty Utilities natural gas customer?*

( ) Yes

( ) No

2) Do you use natural gas for your primary heating fuel?*

( ) Yes

( ) No

3) Have you lived in your home for at least two years?*

( ) Yes

( ) No

4) Is your home a single-family home?*

( ) Yes, my home is a single-family home (1 unit per building)

( ) No, my home is a multi-family home (2 or more units per building)

5) Has the typical occupancy in your home remained the same in the last two years (e.g., no one moved in or out; no one is home during the day more or less frequently than before)?*

( ) Yes, the typical occupancy in my home has remained the same in the last two years

( ) No, the typical occupancy in my home has changed in the last two years

6) Do you regularly use an Apple iPhone® and/or Android® phone?*

( ) Yes

( ) No

7) Do you have a programmable thermostat in your home?*

( ) Yes, I have a programmable thermostat in my home.

( ) No, I have a manual thermostat in my home.

If you answered "Yes" to ALL seven questions:

If you answered "Yes" to all of questions 1 through 7, then Congratulations! You are eligible to be considered for participation in the Liberty Utility Wi-Fi Thermostat Product Evaluation Study! We invite you to continue our survey in order to finish applying for consideration. Only 100% completed surveys will be considered for this program. Please click Next at the bottom of the page to continue.

If you answered "No" to ANY of the seven questions:

If you answered "No" to any of questions 1 through 7, then you are ineligible for participation in the Wi-Fi Thermostat Product Evaluation Study. Please discontinue the survey at this time by closing the survey. Liberty Utilities appreciates your interest and time and we encourage you to stay tuned for future programs that you may be eligible for. Please take advantage of other Liberty Utilities energy efficiency programs. Please see http://libertyutilities.com/efficiency/ for other program offerings.

Participation Agreement

This thermostat study aims to examine the usability, energy impact, and customer satisfaction for the Venstar Wi-Fi Thermostat installation. If selected to participate in this study, you will receive a Venstar

Wi-Fi programmable thermostat for your home. To support the study, all participants will be required to:

1. Allow one or more in-home surveys conducted by qualified energy technicians to verify thermostat installation and collect data on your home heating system.
2. Allow access to Wi-Fi thermostat data to the study manager for a period of 1 year after installations.
3. Answer one or more surveys regarding your experience with the thermostat and program participation.

Please acknowledge that you understand the participation requirements described above by selecting "Yes." Selecting "Yes" in this interest survey is non-binding; however, if you are uncomfortable with these requirements please do not volunteer to be considered for participation in this study.*

( ) Yes, I understand the participation requirements and am comfortable with an in-home survey, allowing access to my thermostat setting information, heating and cooling system, and participating in surveys about my experience.

( ) No, I am not comfortable with the participation requirements. (If selecting this option, please exit the survey).

Utility Information

8) Please provide the last five digits of you Liberty Utilities gas account number:

_____

[ ] I do not have access to my Liberty Utilities natural gas account number at this time.

9) What is your electric company?*

( ) PSNH

( ) Unitil

( ) NH Electric Co-op

( ) Liberty Utilities (Electric)

Household Information

10) Do you own or rent your home?*

( ) Own

( ) Rent

11) How many people live in the home most of the year?*

_____

12) What is the approximate square footage of the heated area of your home?

_____

13) Have you had any energy efficiency improvements installed in your home in the past 24 months (such as new heating system, insulation, air sealing, or new windows)?*

( ) Yes

( ) No

If yes, please describe:

_____

14) Do you have plans to install any energy efficiency improvements in your home (such as new heating system, insulation, air sealing, or new windows) during the upcoming heating season?*

( ) Yes

( ) No

If yes, please describe:

_____

15) Have you participated in any natural gas energy efficiency programs in the past 24 months?*

( ) Yes

( ) No

If yes, please describe:

_____

Household Heating and Cooling

16) What type of natural gas heating system do you have?*

( ) Furnace (forced hot air)

( ) Hot water boiler (baseboard heat)

( ) Steam boiler

( ) Other/unknown

17) Have you made any changes to your home heating system or heating patterns in the last two years? (e.g., new heating system, new home insulation; changed thermostat settings)*

( ) Yes

( ) No

If yes, please describe:

_____

18) Do you use any of the following for heat?*

[ ] Electric space heater

[ ] Electric baseboard heating

[ ] Natural gas fireplace

[ ] Wood fireplace

[ ] Wood/wood pellet stove

[ ] Other

[ ] Does not apply

19) Do you have a central air conditioning system?*

( ) Yes

( ) No

20) Do you have window air conditioners?*

( ) Yes

( ) No

Wi-Fi Information

21) Does your home have a Wi-Fi network, enabling wireless access to the Internet?*

( ) Yes

( ) No

22) If you have Wi-Fi, do you know your network ID and password?*

( ) Yes

( ) No

23) Please check all of the following wireless devices that you use:*

[ ] iPhone®

[ ] Android® phone

24) Have you installed internet-based apps on your phone?*

( ) Yes

( ) No

Existing Thermostats

25) How many thermostats do you have in your home to control heat?*

_____

26) How many additional (non-heat) thermostats do you have to control air conditioning? (Enter 0 if none.)*

_____

27) How do you adjust your programmable thermostat during different times of the day?*

( ) Manually

( ) Using the programmable clock

( ) Both methods

28) Would you or a household member be comfortable installing the Wi-Fi Venstar ColorTouch thermostat in your home?*

( ) Yes

( ) No

Thank you for taking our survey.

Your response is very important to us. Liberty Utilities will contact you within a month to let you know if you have been selected to participate or not.

For more information on programs offered by Liberty Utilities, please visit http://libertyutilities.com/efficiency/

Appendix B. Baseline Survey

Participants were required to complete baseline survey to collect information on their thermostat control behavior and settings prior to installing the Wi-Fi thermostat. Participants completed these surveys on paper and returned them to Cadmus via e-mail or mail in October and November 2012.

The survey was mailed distributed to participants via e-mail.

System Configuration of Current Thermostat

1) Current thermostat make/model: _____

2) How do you control your current thermostat?

   ☐ I program my thermostat with different setpoints and schedules.

   ☐ I manually change the settings throughout the season depending on my schedule and the weather.

   ☐ I use a single setpoint throughout the season.

3) Do you leave your thermostat set at the regular schedule when leaving for extended periods of time, such as for vacation?

   ☐ Yes

   ☐ No Changes: _____

4) How do you decide what temperature to set your thermostat to?

   ☐ Based on Comfort

   ☐ Based on Utility Bill

5) What are you going to do with your thermostat, now that you are replacing it?

   _____

   _____

Please fill out the chart below to describe how you typically control your thermostat **during the heating season and using your current thermostat. (This should not be how you plan to control the new thermostat).**

		Daily Operating Schedule						
Mode	**Set temp**	**Sun**	**Mon**	**Tue**	**Wed**	**Thur**	**Fri**	**Sat**
Example 1: Home/Away								
Away	*66*	*1200-1700*	*900-1700*	*900-1700*	*900-1700*	*900-1700*	*900-1700*	*1200-1700*
Home	*72*	*Remaining*	*Remaining*	*Remaining*	*Remaining*	*Remaining*	*Remaining*	*Remaining*
Example 2: Single Setpoint								
Heating	*68*	*All*	*All*	*All*	*All*	*All*	*All*	*All*
Home								
Away								
Asleep								
Awake								

Appendix C. Mid-Study Survey

Participants completed an online mid-study survey in February and March 2013. The purpose of this survey was to assess motivation for participating, the ease of the installation process (particularly for those participants who installed the thermostat independently), and to collect information on how participants set up and control their thermostat.

Liberty Utilities

Liberty Utilities Wi-Fi Thermostat Study
Mid-Study Survey

Thank you for participating in the Liberty Utilities Wi-Fi Thermostat Study. As part of the study, we ask that you please complete this survey about your experience with the thermostat and the program. Your feedback on the Venstar ColorTouch thermostat will contribute to our product evaluation. The survey should take about 15 minutes.

Program Enrollment Process

1) Please enter your full name:*

_____

2) You received an e-mail back in October of 2012 describing the program. Thinking back to this e-mail, what about it made you want to participate? Please check all that apply.*

[ ] Test out a new technology

[ ] Save energy

[ ] Save money on my energy bills

[ ] Have more control over my thermostat

[ ] Other (Please specify below)

3) Please use the following scale to rate the enrollment process. How easy was it? Would you say:*

( ) Very Easy

( ) Easy

( ) Neither easy nor difficult

( ) Difficult

( ) Very Difficult

4) Do you have any suggestions about how to improve the enrollment process?*

( ) No

( ) Yes (Please specify below): _____

Thermostat Installation

5) Did your home require additional thermostat wiring in order to install the Venstar ColorTouch Thermostat?*

( ) Yes

( ) No (Skip to question 7)

6) If you answered Yes, who installed the Venstar thermostat wiring in your home?

( ) Myself/family member

( ) Friend

( ) Contractor (Please specify contractor name below): _____

( ) Other (Please specify below): _____

( ) N/A

7) Did you have to add a "C" wire (24 VAC Common)?

( ) Yes

( ) No

( ) Don't know

8) Who installed your Venstar thermostat?*

( ) Myself/family member

( ) Friend

( ) Contractor (Please specify contractor name below): _____

( ) Other (Please specify below): _____

9) Have you e-mailed Venstar for support since the thermostat was installed?*

( ) Yes

( ) No (Skip to next page)

10) Did you receive support from Venstar?

( ) Yes

( ) No (Skip to next page)

11) What did you receive support on from Venstar?

_____

12) Please rate the helpfulness of the support you received?

( ) Very helpful

( ) Helpful

( ) Not very helpful

( ) Not helpful at all

13) Please explain this rating:

_____

System & Wi-Fi Configuration

14) Have you programmed the thermostat's schedule for temperature and time settings?*

( ) Yes

( ) No (Skip to Question 17)

15) When did you set up the thermostat schedule?

_____

16) Have you changed the thermostat schedule since initially programming the thermostat? If yes, what did you change, and why?

( ) Yes (Please explain what you changed and why, below): _____

( ) No

17) Where did you program the thermostat schedule?

( ) Thermostat itself

( ) Skyport® website

( ) Both

18) If you have not programmed the thermostat schedule, please explain why:*

( ) Reason:: _____

( ) N/A (I have programmed the thermostat schedule).

19) Have you connected your home's central cooling system to the thermostat?*

( ) Yes

( ) No, but I intend to before summer.

( ) No, and I don't intend to.

( ) I don't have a central cooling system.

Thermostat Use

20) How do you control your Venstar ColorTouch thermostat?*

( ) I use a single temperature throughout the season.

( ) I program my thermostat with different temperatures for different days and times.

( ) I manually change the temperature settings throughout the season depending on my schedule and the weather.

( ) Other (Please specify below): _____

21) Which of the following best describes how often you manually change your thermostat settings?*

( ) Never

( ) Once per month, at most

( ) Several times per month, at most

( ) Several times per week, at most

( ) Once per day

( ) Several times per day

( ) Other (Please specify): _____

22) Do you use the vacation feature on your Venstar ColorTouch thermostat to turn down your thermostat when you will be gone for extended periods of time?*

( ) Yes, always

( ) Yes, sometimes

( ) No, but I plan to

( ) No, and I do not plan to

( ) Not aware of that functionality

( ) Other (Please specify below): _____

Skyport® Web Portal And Smartphone App Use

23) Do you ever access the thermostat settings through the web or a smartphone app (check all that apply)?*

[ ] Skyport® website

[ ] Smartphone app

[ ] No

24) How do you interact with the Skyport® website (please check all that apply)?*

[ ] Check temperature of outside/inside

[ ] Adjust temperature

[ ] Program schedule

[ ] Check energy usage history

[ ] Other (Please specify below)

[ ] N/A (I do not interact with the Skyport® website.)

25) Is there any particular reason that you do not use the Skyport® website?*

[ ] Don't know how to

[ ] Don't remember to

[ ] Don't see a need to

[ ] Other (Please specify below)

[ ] N/A (I use the Skyport® website.)

26) How do you interact with the smartphone app (please check all that apply)?*

[ ] Check temperature of outside/inside

[ ] Adjust temperature

[ ] Check energy usage history

[ ] Other (Please specify below)

[ ] N/A (I do not interact with the smartphone app.)

27) Is there any particular reason you do not use the smartphone app?*

[ ] Don't know how

[ ] Don't remember to

[ ] Don't see a need to

[ ] Other (Please specify below)

[ ] N/A (I use the smartphone app.)

28) If you check your energy usage history, has this affected how you use the thermostat?*

( ) Yes (Please explain below): _____

( ) No

29) If you are arriving home at a different time than is scheduled on the thermostat, do you ever adjust the temperature settings via the web/phone app (please check all that apply)?*

[ ] Skyport® website

[ ] Smartphone app

[ ] Neither

30) Which of the following best describes how frequently you interact with the following products/services?*

	Several times per day	Once per day	Several times per week, at most	Several times per month, at most	Once per month, at most	Never
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Website	( )	( )	( )	( )	( )	( )
Smartphone App	( )	( )	( )	( )	( )	( )

Process and Product Evaluation

31) Please indicate the level of ease/difficulty you experienced when completing the following processes:*

	Very easy	Easy	Neutral	Difficult	Very difficult	N/A
Enrollment process	( )	( )	( )	( )	( )	( )
Thermostat installation	( )	( )	( )	( )	( )	( )
Configuration of thermostat schedule	( )	( )	( )	( )	( )	( )
Wi-Fi connection set-up	( )	( )	( )	( )	( )	( )
Skyport® Account set-up	( )	( )	( )	( )	( )	( )
Adding Liberty Utilities as a user of your Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone application set-up	( )	( )	( )	( )	( )	( )

32) Please use this space to include any comments or suggestions regarding your experience with the processes listed above:

33) Please indicate the level of ease/difficulty you have experienced when using the following products/services:*

	Very easy	Easy	Neutral	Difficult	Very difficult	N/A
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone application	( )	( )	( )	( )	( )	( )

34) Please indicate your satisfaction with the features provided by the following products/services:*

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied	N/A
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone application	( )	( )	( )	( )	( )	( )

35) Please use this space to include any comments or suggestions regarding your experience and satisfaction with the products/services listed above:

Process and Product Evaluation

36) Please indicate the level of ease/difficulty you experienced when completing the following processes:*

	Very easy	Easy	Neutral	Difficult	Very Difficult	N/A
Enrollment process	( )	( )	( )	( )	( )	( )
Thermostat installation	( )	( )	( )	( )	( )	( )
Configuration of thermostat schedule	( )	( )	( )	( )	( )	( )
Wi-Fi connection set-up	( )	( )	( )	( )	( )	( )
Skyport® Account set-up	( )	( )	( )	( )	( )	( )
Adding Liberty Utilities as a user of your Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone application set-up	( )	( )	( )	( )	( )	( )

37) Please use this space to include any comments or suggestions regarding your experience with the processes listed above:

38) Please indicate the level of ease/difficulty you have experienced when using the following products/services:*

	Very easy	Easy	Neutral	Difficult	Very Difficult	N/A
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone application	( )	( )	( )	( )	( )	( )

39) Please indicate your satisfaction with the features provided by the following products/services:*

	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied	N/A
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone application	( )	( )	( )	( )	( )	( )

40) Please use this space to include any comments or suggestions regarding your experience and satisfaction with the products/services listed above:

Thank You.

Thank you for taking our survey. Your response is very important to us.

Appendix D. Post-Study Survey

At the conclusion of the study, participants were requested to complete an online post-study survey to collect information on willingness to pay for the thermostat, how participants control their thermostat, and asses overall product and program satisfaction.

The survey was distributed on 05/23/2013.

Liberty Utilities

Liberty Utilities Wi-Fi Thermostat Study
Post-Study Survey

Thank you for participating in the Liberty Utilities Wi-Fi Thermostat Study. As part of the study, we ask that you please complete this final survey about your experience with your Venstar ColorTouch thermostat and the program as a whole. Your feedback will contribute to our product evaluation and our design of future programs.

The survey should take about 15 minutes and must be completed in one session.

There are seven sections:

- Program Participation
- Thermostat Use
- Usage of Features
- Thermostat Impact
- Household Characteristics
- Product Satisfaction
- Program Satisfaction

Program Participation

1) Please enter your first and last name:*

_____

2) Before learning about the Wi-Fi Thermostat Study, were you already planning to install a new thermostat of any kind?*

( ) Yes

( ) No

3) If yes, what kind of thermostat were you planning on buying?*

( ) Manual thermostat

( ) Programmable thermostat

( ) Wi-Fi thermostat (web-enabled thermostat, such as the Venstar ColorTouch)

( ) Smart thermostat (self-learning thermostat, such as the Nest thermostat)

( ) N/A

4) If you were planning on purchasing a Wi-Fi thermostat, when do you think you would have installed it if you had not participated in the program?*

( ) Within six months

( ) Between six months and a year

( ) More than a year

( ) N/A

5) If you were planning on purchasing a new thermostat, but did not consider a Wi-Fi thermostat, why?*

( ) Hadn't heard of it before

( ) Costs too much

( ) Other: _____*

( ) N/A

6) On a scale from 0 to 10, where 0 is extremely unlikely and 10 is extremely likely, how likely is it that you would have bought a Wi-Fi thermostat without the incentive from the Liberty Utilities Wi-Fi Thermostat Pilot Program?*

( ) 0 (Extremely unlikely)

( ) 1

( ) 2

( ) 3

( ) 4

( ) 5

( ) 6

( ) 7

( ) 8

( ) 9

( ) 10 (Extremely likely)

7) Before participating in the study, how much would you have been willing to pay for a Wi-Fi thermostat?*

( ) $0

( ) $0-$25

( ) $25-$50

( ) $50-$75

( ) $75-$100

( ) $100-$125

( ) $125-$150

( ) $150-$175

( ) $175-$200

( ) $200-$225

( ) $225-$250

( ) More than $250

8) Now that you have had a chance to use the Wi-Fi thermostat, how much would you be willing to pay for a Wi-Fi thermostat?*

( ) $0

( ) $0-$25

( ) $25-$50

( ) $50-$75

( ) $75-$100

( ) $100-$125

( ) $125-$150

( ) $150-$175

( ) $175-$200

( ) $200-$225

( ) $225-$250

( ) More than $250

9) Liberty Utilities is considering offering a rebate to customers to encourage their purchase of Wi-Fi thermostats. How much money would you recommend be offered in a rebate to encourage customers to purchase a $200 Wi-Fi thermostat?*

Thermostat Use

10) Have you changed the heating/cooling schedule since initially programming the thermostat?*

( ) Yes

( ) No

11) If yes, what did you change?

_____

12) Which of the following best describes how often you manually change your thermostat settings?*

( ) Never

( ) Several times per month, at most

( ) Several times per week, at most

( ) Once per day

( ) Several times per day

( ) Other: _____

13) Have you connected your home's central cooling system to the thermostat?*

( ) Yes

( ) No, but I intend to before summer

( ) No, and I do not intend to

( ) N/A (I do not have a central cooling system.)

14) Has the Wi-Fi capability changed your approach to regulating the temperature in your home when compared to your previous thermostat?*

( ) Yes

( ) No

15) If yes, in what way?

_____

16) Has the new Wi-Fi thermostat made it easier for you to set your thermostat?*

( ) Yes

( ) No

17) If yes, in what way?

_____

18) Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?*

( ) More frequently

( ) Less Frequently

( ) The same amount

19) If you answered "more frequently" or "less frequently, please describe:

_____

Usage of Features

20) Thermostat Use. Please indicate how your frequency of use of the following thermostat features has changed over the course of the study period.*

	Use More Often	Use the Same	Use Less Often	Stopped Using	N/A (Never Used)
Adjust Temperature	( )	( )	( )	( )	( )
Program Schedule	( )	( )	( )	( )	( )
Check Inside/Outside Temperature	( )	( )	( )	( )	( )
Check Energy Usage History	( )	( )	( )	( )	( )
Activate Vacation Feature (Activates energy savings settings without changing regular schedule.)	( )	( )	( )	( )	( )

21) Skyport® Use. Please indicate how your frequency of use of the following Skyport® features has changed over the course of the study period.*

	Use More Often	Use the Same	Use Less Often	Stopped Using	N/A (Never Used)
Adjust Temperature	( )	( )	( )	( )	( )
Program Schedule	( )	( )	( )	( )	( )
Check Inside/Outside Temperature	( )	( )	( )	( )	( )
Check Energy Usage History	( )	( )	( )	( )	( )
Activate Vacation Feature (Activates energy savings settings without changing regular schedule.)	( )	( )	( )	( )	( )

22) Smartphone Use. Please indicate how your frequency of use of the following smartphone features has changed over the course of the study.*

	Use More Often	Use the Same	Use Less Often	Stopped Using	N/A (Never Used)
Adjust Temperature	( )	( )	( )	( )	( )
Program Schedule	( )	( )	( )	( )	( )
Check Inside/Outside Temperature	( )	( )	( )	( )	( )
Check Energy Usage History	( )	( )	( )	( )	( )
Activate Vacation Feature (Activates energy savings settings without changing regular schedule.)	( )	( )	( )	( )	( )

Thermostat Impact

23) Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?*

( ) Yes

( ) No

24) If yes, please describe:

_____

25) Since the Wi-Fi thermostat was installed, have you noticed a change in the thermal comfort of your home?*

( ) Yes

( ) No

26) If yes, please describe:

27) Since the Wi-Fi thermostat was installed, have you noticed any other impacts on your household?*

( ) Yes

( ) No

28) If yes, please describe:

_____

Household Characteristics

29) How long have you lived in your current residence?*

_____

30) When was your home built?*

( ) Before 1930

( ) between 1930 and 1939

( ) between 1940 and 1949

( ) between 1950 and 1959

( ) between 1960 and 1969

( ) between 1970 and 1979

( ) between 1980 and 1989

( ) between 1990 and 1999

( ) between 2000 and 2005

( ) or since 2006

( ) I do not know

31) How many rooms, not counting bathroom or unfinished basements, are in your home?*

( ) 1 (studio)

( ) 2

( ) 3

( ) 4

( ) 5

( ) 6

( ) 7

( ) 8

( ) 9

( ) 10 or more

32) How many people currently live in your house year-round?*

( ) 1

( ) 2

( ) 3

( ) 4

( ) 5

( ) 6

( ) 7

( ) 8

( ) 9

( ) 10 or more

33) Was your home occupied more, less, or the same as the previous heating season (2011-2012)?*

( ) Occupied more

( ) Occupied less

( ) Occupied about the same

34) If your home was occupied more or less, please describe:

_____

Product Satisfaction

35) Did you contact Venstar for support since the thermostat was installed?*

( ) Yes

( ) No

36) If yes, did you receive support?

( ) Yes

( ) No

37) If you received support, what did you receive support on?

_____

38) If you received support, how would you describe the helpfulness of the supper?*

( ) Very helpful

( ) Helpful

( ) Not very helpful

( ) I did not receive support

39) Please explain your rating:

_____

40) Please indicate the level of ease/difficulty you have experienced when using the following products/services:*

	Very easy	Easy	Neutral	Difficult	Very difficult	N/A
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone Application	( )	( )	( )	( )	( )	( )

41) Please indicate your satisfaction with the features provided by the following products/services:*

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied	N/A
Thermostat	( )	( )	( )	( )	( )	( )
Skyport® Account	( )	( )	( )	( )	( )	( )
Smartphone Application	( )	( )	( )	( )	( )	( )

Program Satisfaction

42) Please indicate your satisfaction with the Liberty Utilities Wi-Fi Thermostat Pilot Program:*

( ) Very Satisfied

( ) Satisfied

( ) Neutral

( ) Dissatisfied

( ) Very Dissatisfied

43) Please explain your rating:*

_____

44) Please provide any suggestions for improving the program:*

_____

45) Comments:

_____

Thank You.

Survey Complete

Thank you for participating in the Liberty Utilities Wi-Fi Thermostat Pilot Program and for completing our survey. Your feedback is important for this study as well as future programs and we appreciate your time.

Appendix E. Billing Analysis Regression Model Output

Table E-1 presents the regression output of the Wi-Fi thermostat model.

Table E-1. Wi-Fi Thermostat Preliminary Billing Analysis Regression Model Output

Source	Analysis of Variance				
	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	24	6531.78619	272.15776	1744.82	<.0001
Error	257	40.08692	0.15598		
Corrected Total	281	6571.87312			
Root MSE		0.39494	R-Square		0.9939
Dependent Mean		3.27206	Adj R-Square		0.9933
Coeff Variation		12.07016			

Source	Parameter Estimates				
	DF	Parameter Estimates	Standard Error	t value	Prob. T
INT1 * AVGHDD	1	0.25981	0.00299	86.78	<.0001
INT2 * AVGHDD	1	0.08718	0.00313	27.88	<.0001
INT3 * AVGHDD	1	0.1671	0.00316	52.93	<.0001
INT4 * AVGHDD	1	0.16484	0.00299	55.08	<.0001
INT5 * AVGHDD	1	0.12837	0.00318	40.4	<.0001
INT6 * AVGHDD	1	0.12451	0.00306	40.71	<.0001
INT7 * AVGHDD	1	0.10581	0.00308	34.31	<.0001
INT8 * AVGHDD	1	0.16305	0.0032	50.91	<.0001
INT9 * AVGHDD	1	0.13119	0.00458	28.66	<.0001
INT10 * AVGHDD	1	0.10838	0.00372	29.17	<.0001
INT11 * AVGHDD	1	0.11322	0.00479	23.64	<.0001
INT12 * AVGHDD	1	0.13231	0.00308	42.9	<.0001
INT13 * AVGHDD	1	0.16134	0.00383	42.12	<.0001
INT14 * AVGHDD	1	0.10761	0.00307	35.03	<.0001
INT15 * AVGHDD	1	0.12546	0.00369	33.96	<.0001
INT16 * AVGHDD	1	0.06254	0.00341	18.32	<.0001
INT17 * AVGHDD	1	0.17335	0.00382	45.43	<.0001
INT18 * AVGHDD	1	0.12677	0.00377	33.64	<.0001
INT19 * AVGHDD	1	0.08023	0.00374	21.43	<.0001
INT20 * AVGHDD	1	0.19347	0.00269	71.95	<.0001
INT21 * AVGHDD	1	0.18589	0.00351	52.9	<.0001
INT22 * AVGHDD	1	0.06442	0.00274	23.5	<.0001
INT23 * AVGHDD	1	0.08719	0.00264	33.04	<.0001
POST * AVGHDD	**1**	**-0.01098**	**0.00137**	**-8.03**	**<.0001**

Appendix F. Participant Data

Cadmus summarized each participant's survey responses and indoor temperature data. The following data are displayed for each participant (when available):

1. Table summarizing key survey responses
2. Screenshot of programmed temperature settings at time of mid-study survey
3. Temperature profile showing average hourly indoor temperature over the study period
4. Temperature map showing hourly indoor temperature patterns for each day in January through April.

Participant 1

Table F-1. Summary of Key Survey Responses for Participant 1

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Never	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	Less Frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, can be easily read and understood	Post-Study

Figure F-1. Screenshots of programmed thermostat settings for Participant 1, taken on January 8, 2013

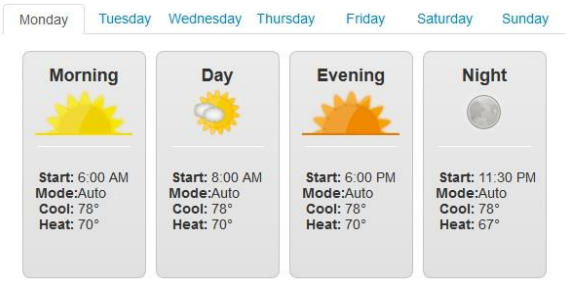


Figure F-2. Average Temperature Profile for Participant 1

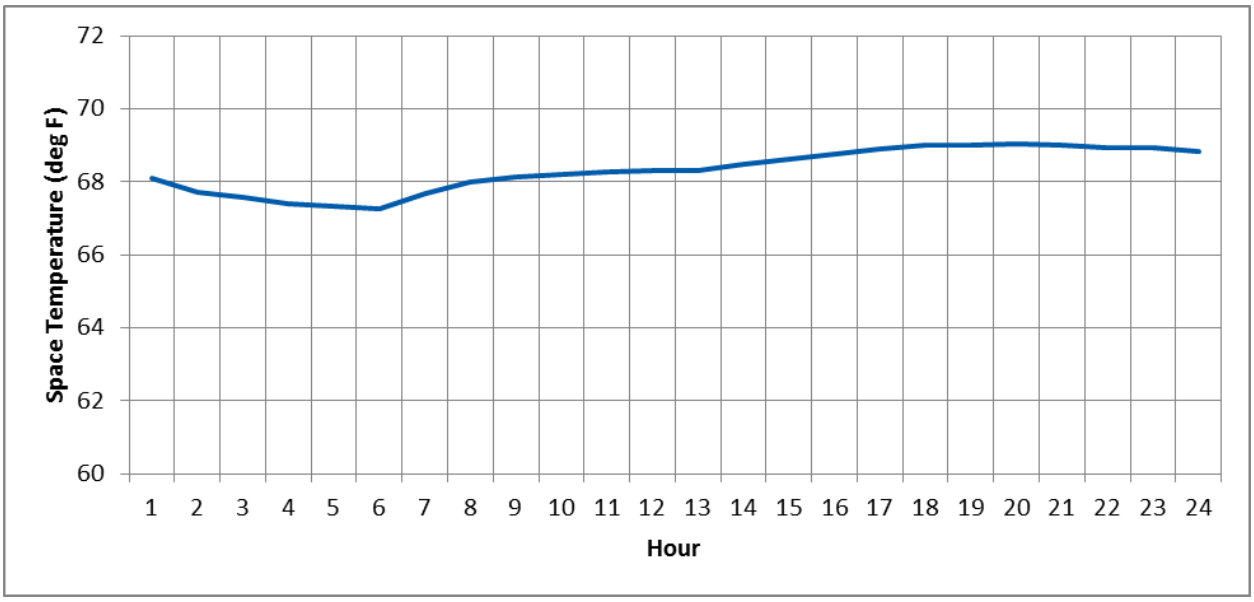
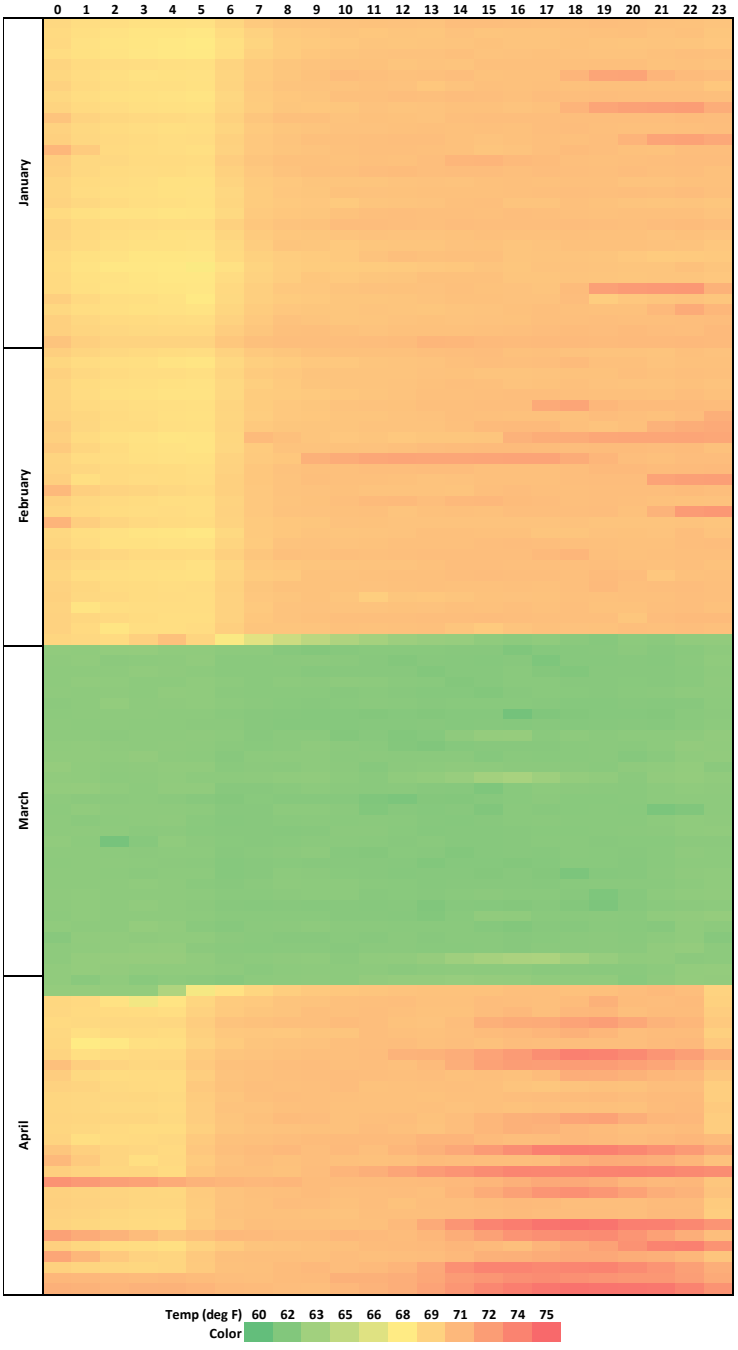


Figure F-3. Temperature Map for Participant 1



Temperatures in January and February are very similar, but there is a significant temperature drop in the month of March. The participant reported that they were on vacation 2/28 – 4/2.

Participant 2 (two thermostats)

Table F-2. Summary of Key Survey Responses for Participant 2

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Several times per month, at most	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	No	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Not Available	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	Not Available	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Not Available	Post-Study

Figure F-4. Screenshots of programmed thermostat settings for Participant 2 (Thermostat 1), taken on January 8, 2013

Figure F-5. Average Temperature Profile for Participant 2 (Thermostat 1)

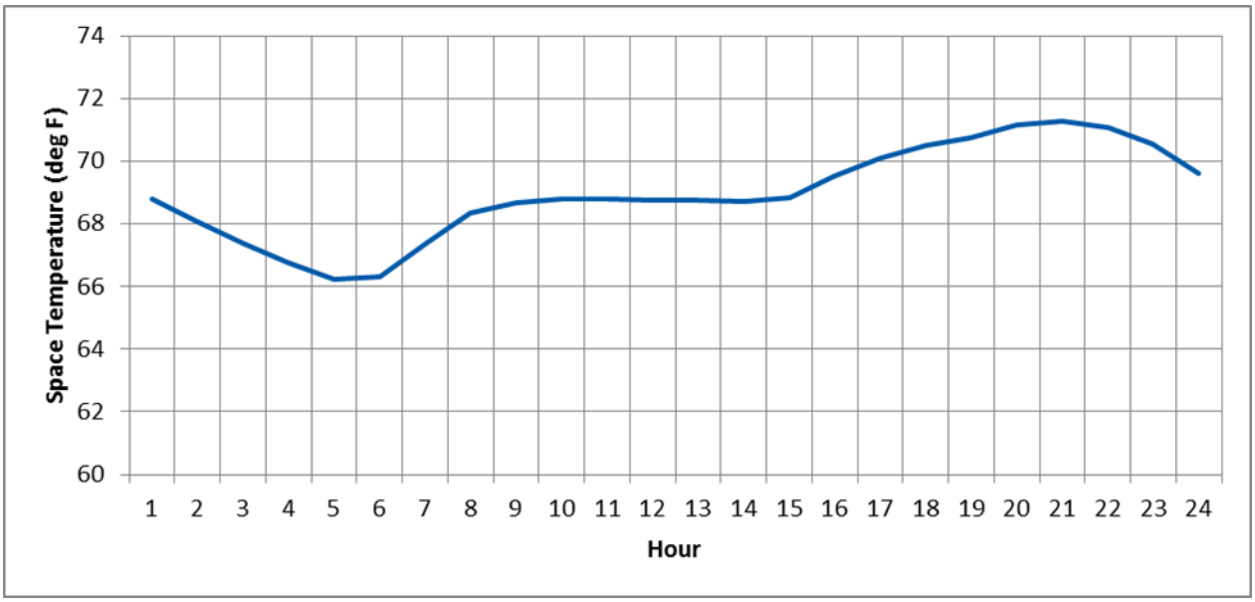
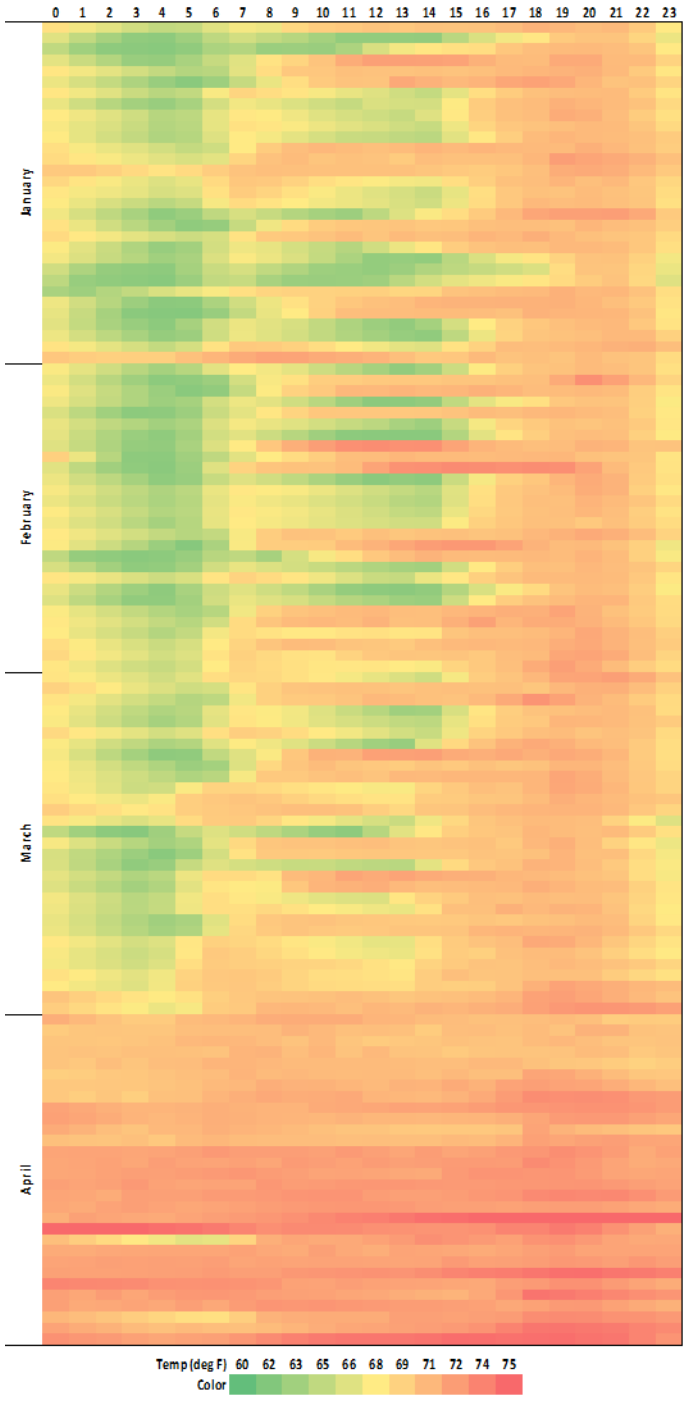


Figure F-6. Temperature Map for Participant 2 (Thermostat 1)



For the first three months, the temperature patterns are similar. For the first six hours of the day, temperatures in the 60°F's were recorded. As the day progresses, temperatures sometimes remain in the 60°F's, and sometimes increase to the 70°F's.

Figure F-7. Screenshots of programmed thermostat settings for Participant 2 (Thermostat 2), taken on January 8, 2013

Figure F-8. Average Temperature Profile for Participant 2 (Thermostat 2)

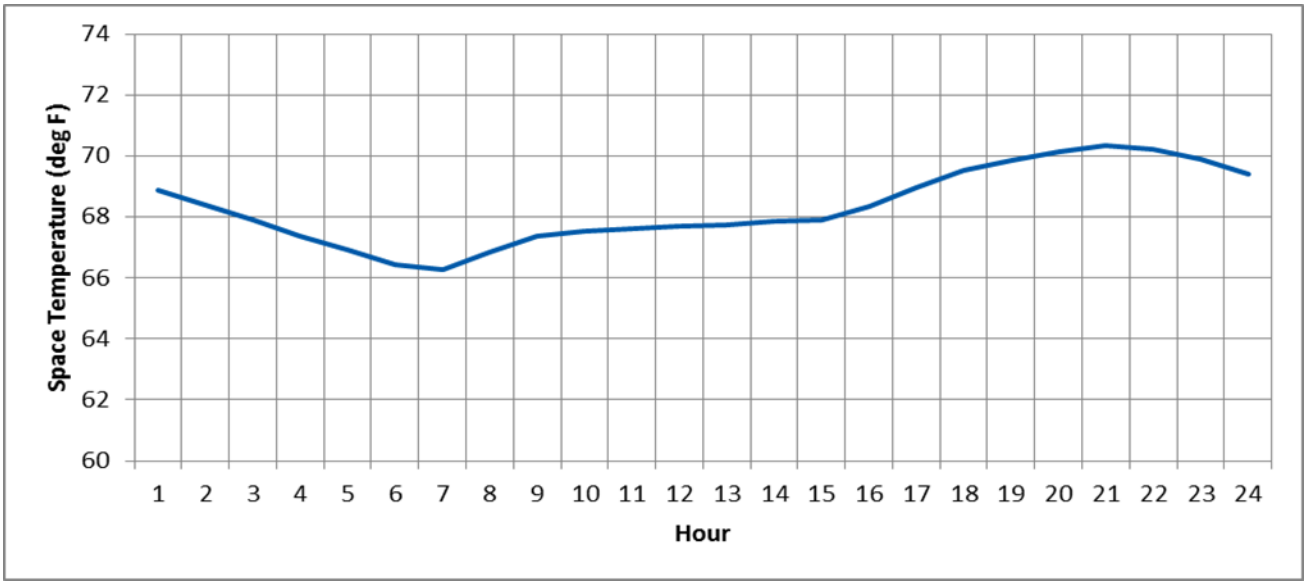
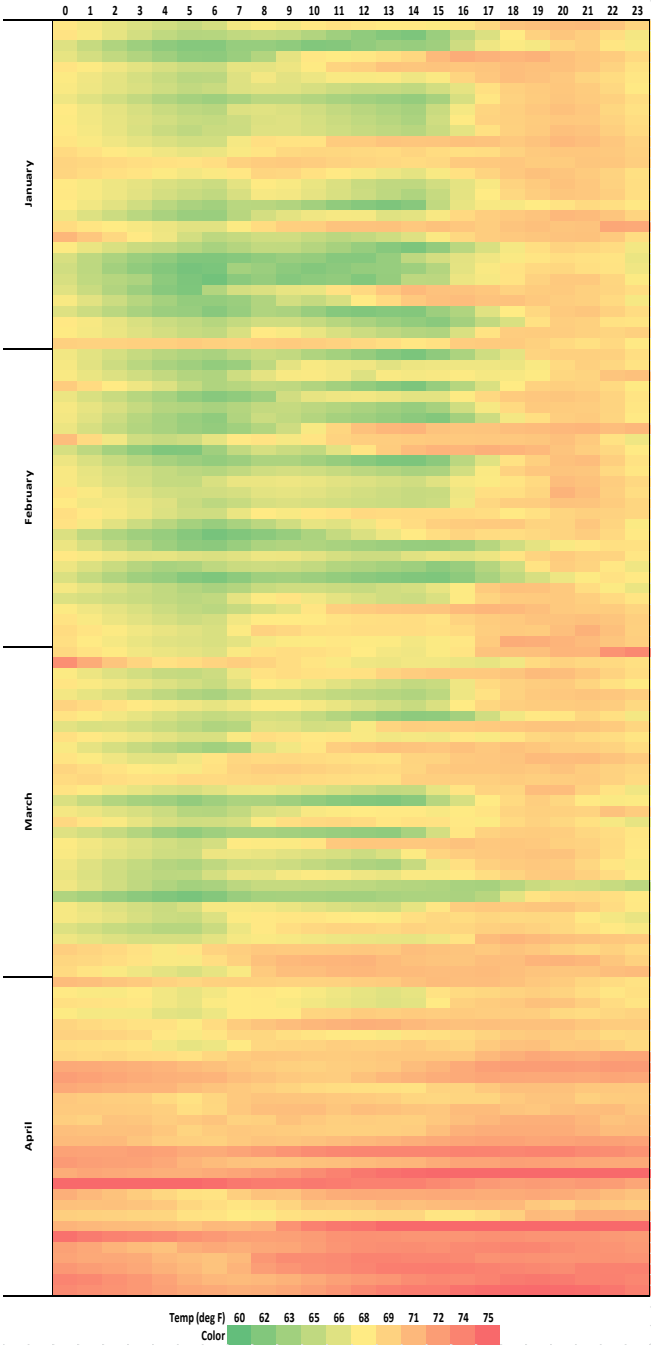


Figure F-9. Temperature Map for Participant 2 (Thermostat 2)



For the first three months, temperatures in the 60°F's were recorded for most days on weekdays. In April, temperatures begin to be in the 70°F's consistently.

Participant 3 (two thermostats)

Table F-3. Summary of Key Survey Responses for Participant 3

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes, I try to lower the temps if I happen to not be home to reduce my usage.	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, The mobile app has made it easy to check the outside temp and house temperature settings when I am out of town or away for a night or two.	Post-Study

Screenshots of programmed thermostat settings for Participant 3 (Thermostat 1) are not available.

Figure F-10. Average Temperature Profile for Participant 3 (Thermostat 1)

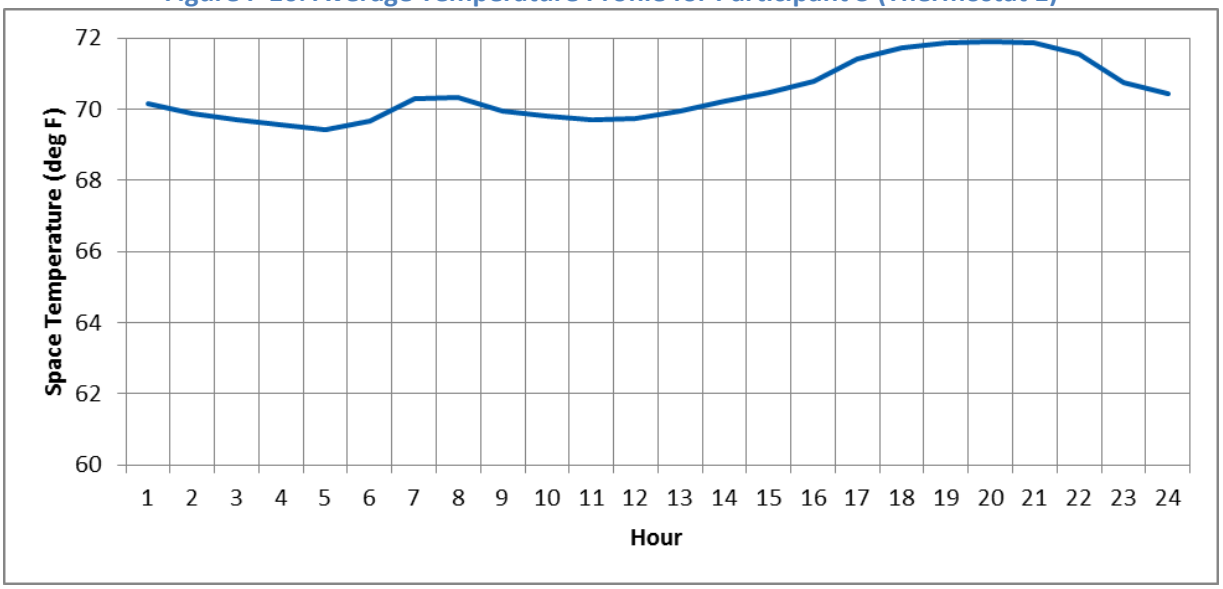
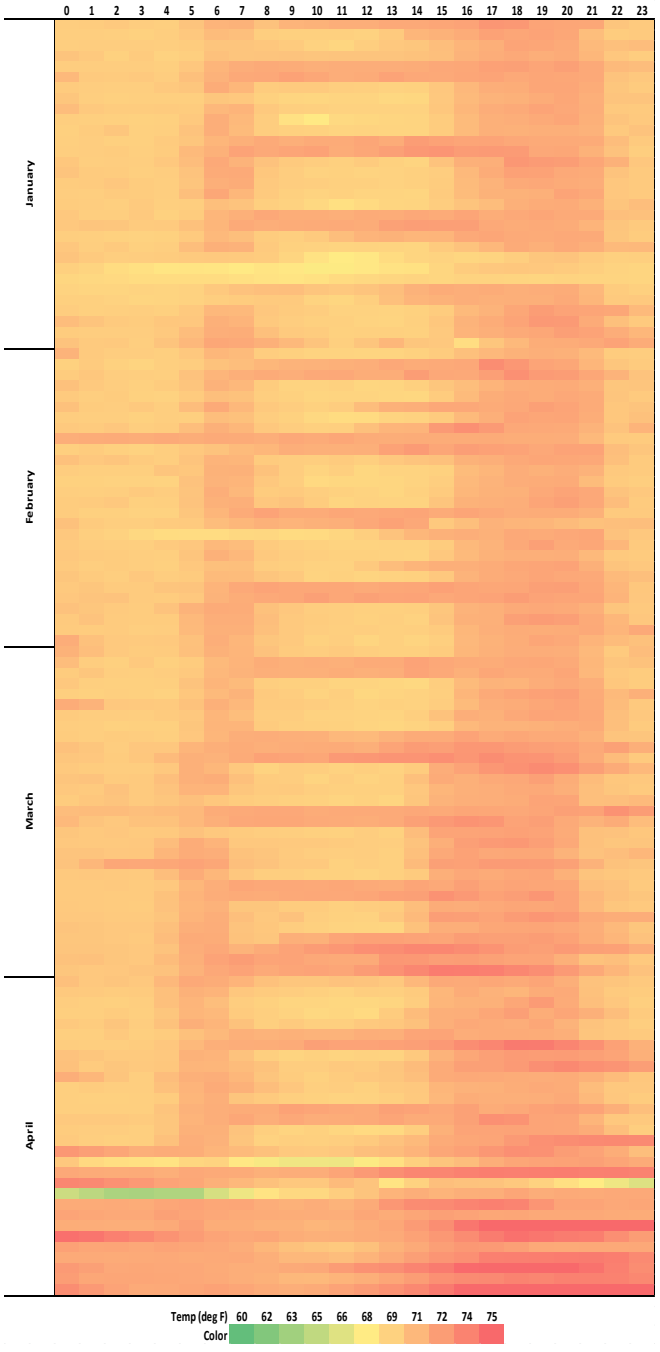


Figure F-11. Temperature Map for Participant 3 (Thermostat 1)



The participant has two consistent setback periods each day when the temperature is in the high 60°F's. Otherwise, the temperature is usually in the low 70°F's.

Screenshots of programmed thermostat settings for Participant 3 (Thermostat 2) are not available.

Figure F-12. Temperature Map for Participant 3 (Thermostat 2)

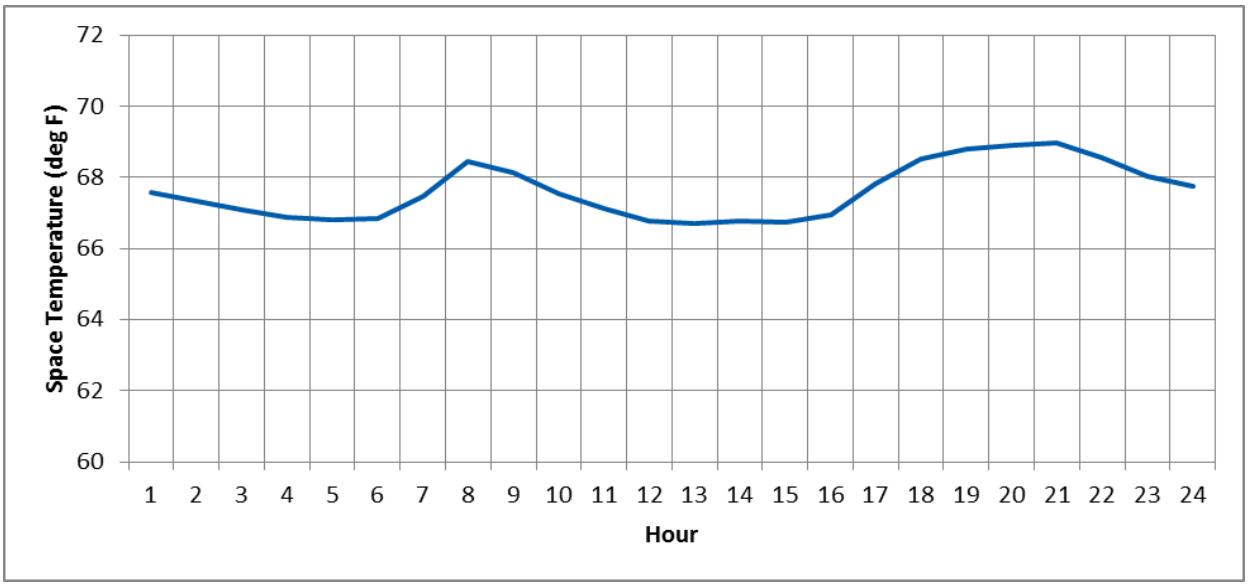
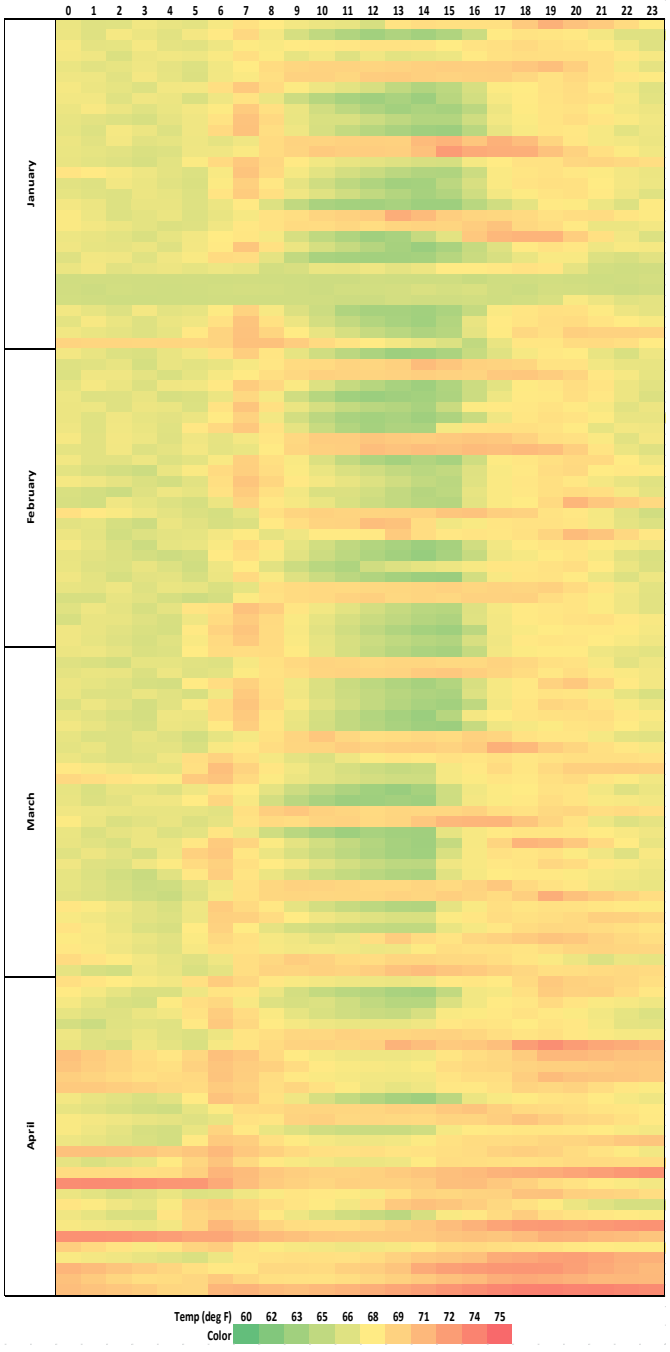


Figure F-13. Temperature Map for Participant 3 (Thermostat 2)



For the first three months, temperatures are in the mid 60°F's and low 70°F's in the morning. At noon, temperatures decrease to the low 60°F's. In the evening, they rise again to the mid-high 60°F's. The first half of the month of April shows similar patterns to the previous months, but the second half shows higher temperatures.

Participant 4

Table F-4. Summary of Key Survey Responses for Participant 4

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes, Adjust as needed	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More Frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, changing as needed through my phone	Post-Study

Figure F-14. Screenshots of programmed thermostat settings for Participant 4, taken on January 7, 2013

Figure F-15. Average Temperature Profile for Participant 4

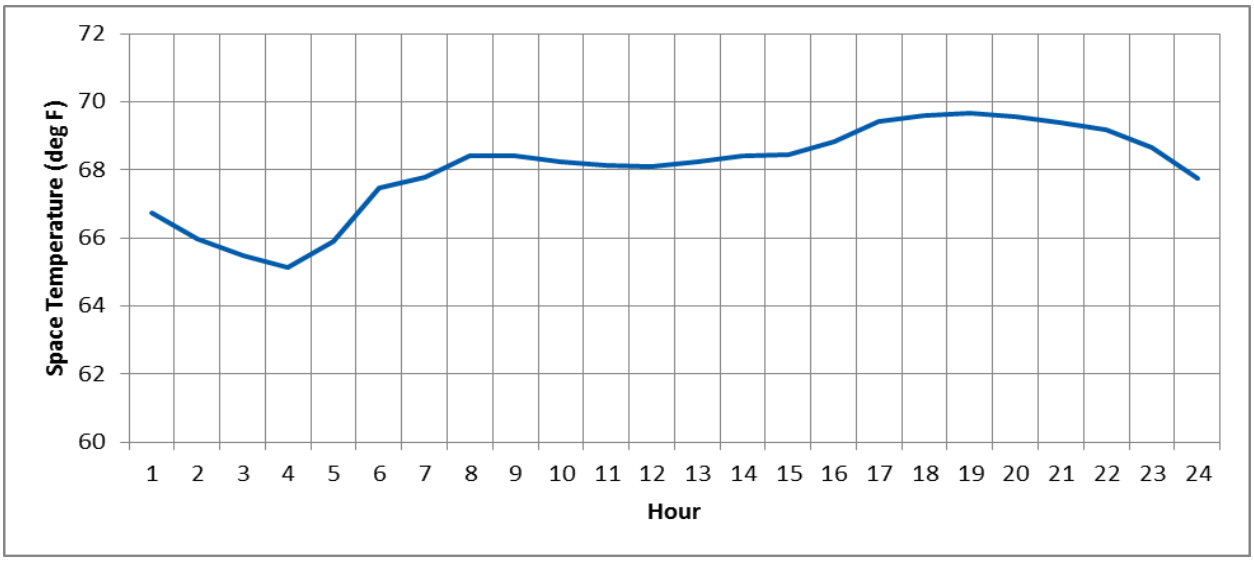
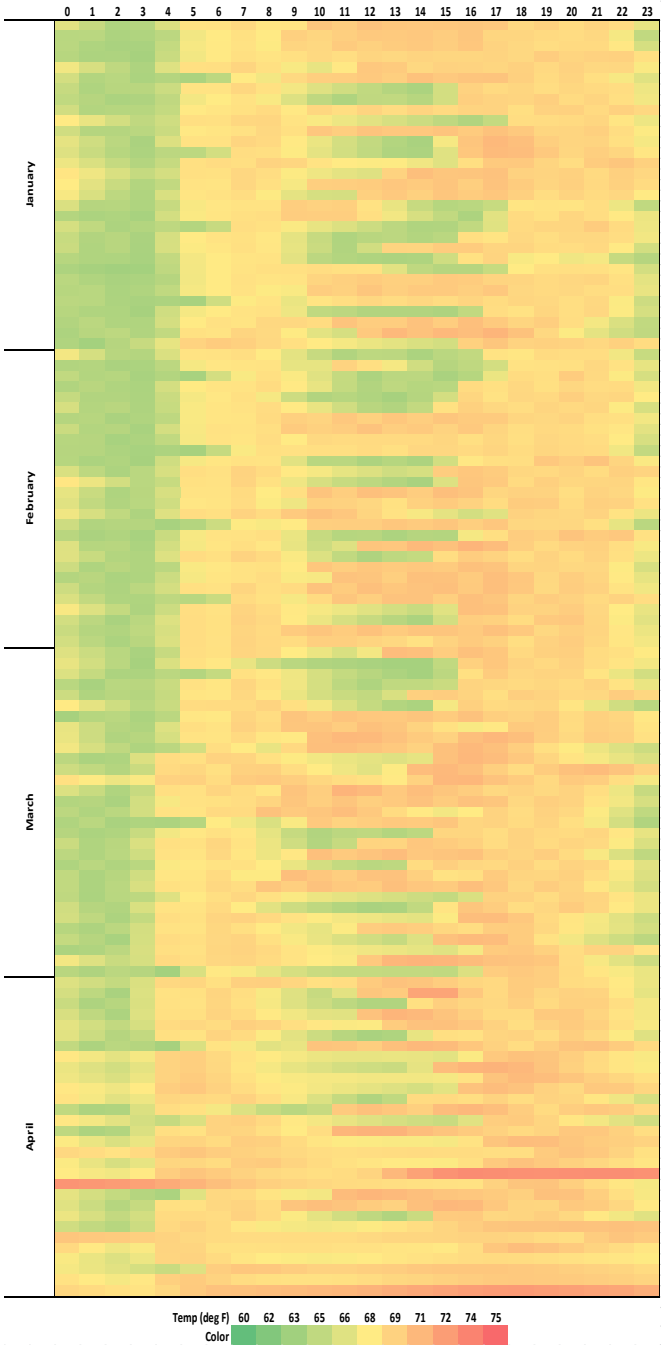


Figure F-16. Temperature Map for Participant 4



For the first three months, temperatures are in the low to mid 60°F's for the first 5 hours of the day. The month of April shows increased temperatures towards the end of the month.

Participant 5

Table F-5. Summary of Key Survey Responses for Participant 5

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes, conscientious about adjusting temp when we are out and then readjusting when we are returning.	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Figure F-17. Screenshots of programmed thermostat settings for Participant 5, taken on January 7, 2013

Figure F-18. Average Temperature Profile for Participant 5

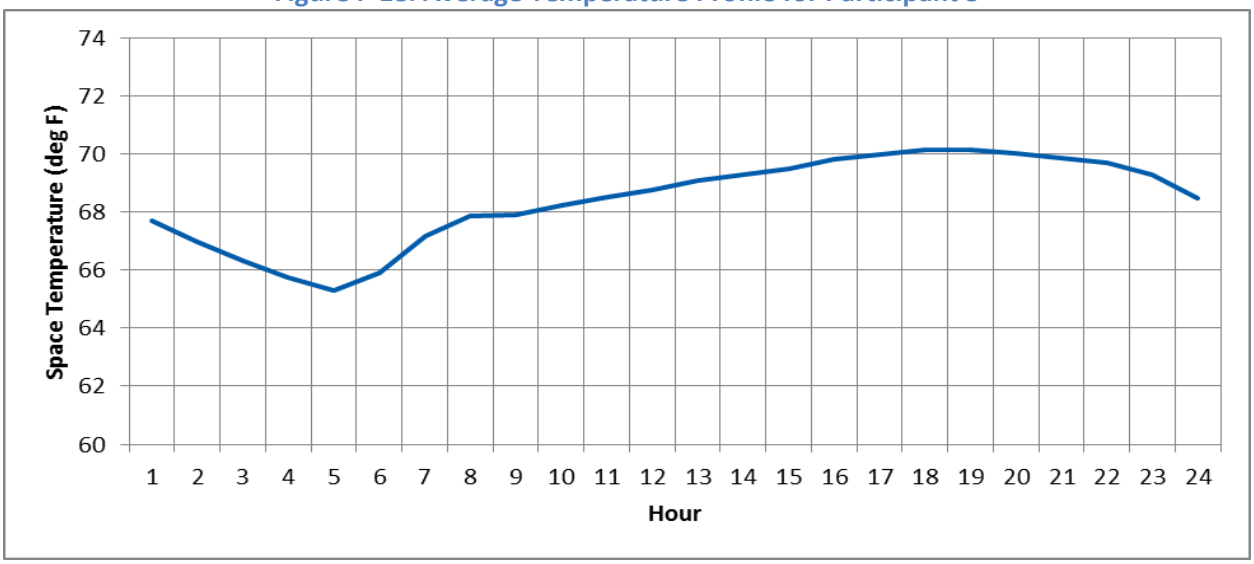
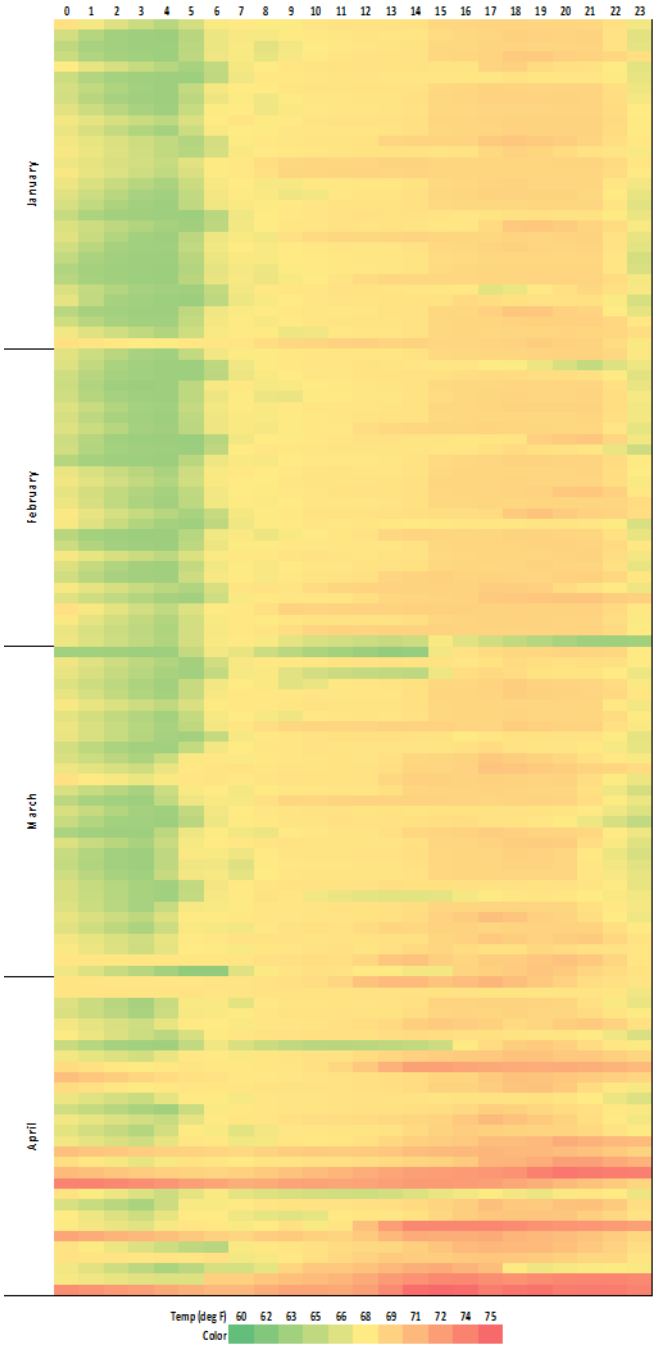


Figure F-19. Temperature Map for Participant 5



For the first three months, temperatures are in the low to mid 60°F's at night. In mid-April, temperatures increase to the mid 70°F's.

Participant 6

Table F-6. Summary of Key Survey Responses for Participant 6

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Unknown	Baseline Survey
Baseline Vacation Settings	Unknown	Baseline Survey
Baseline Temp Decision	Unknown	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, iPhone	Post-Study

Figure F-20. Screenshots of programmed thermostat settings for Participant 6, taken on January 7, 2013

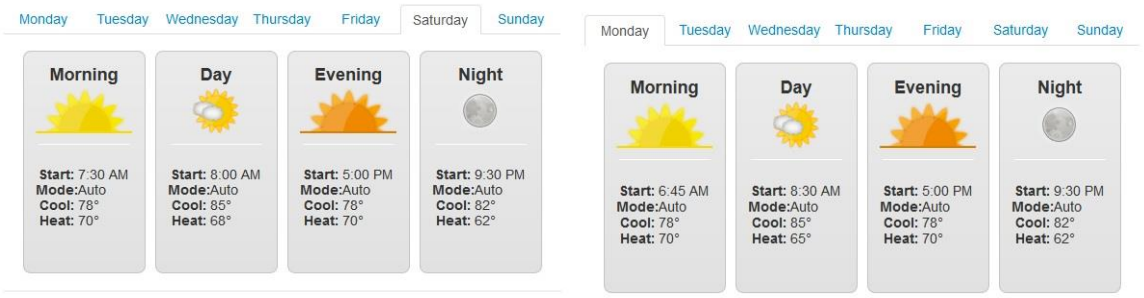


Figure F-21. Average Temperature Profile for Participant 6

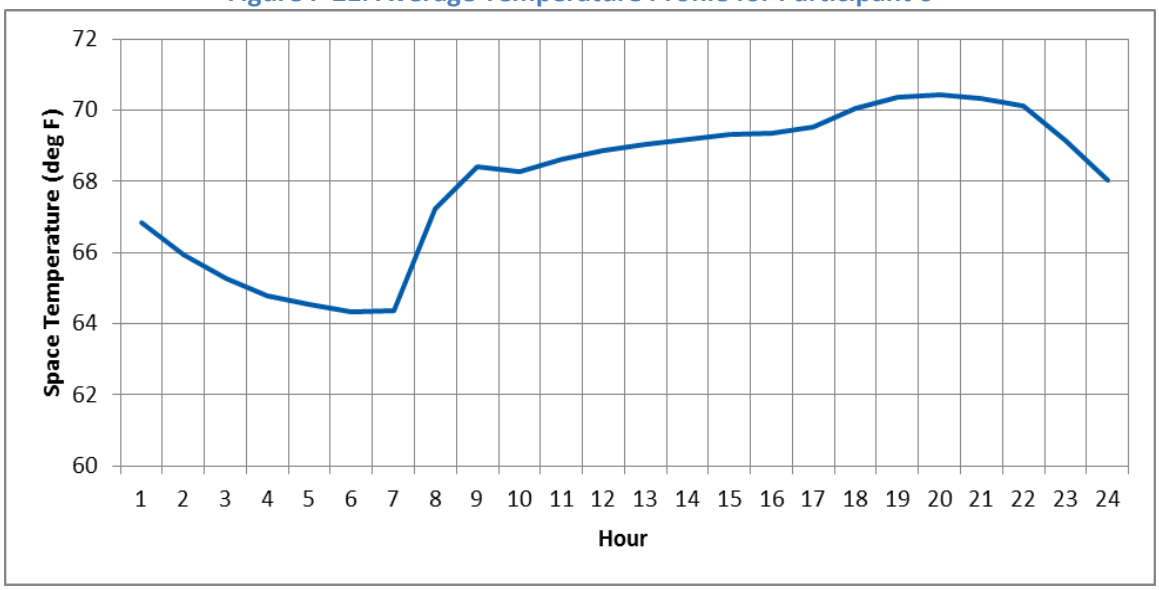
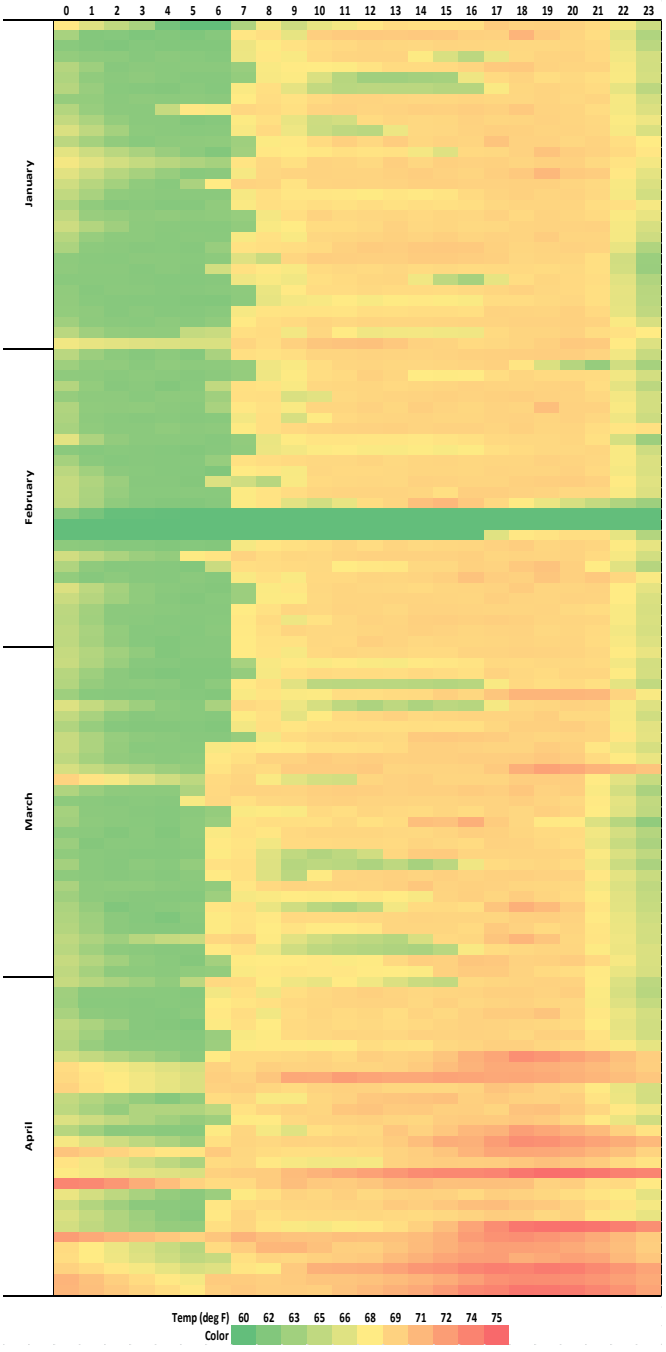


Figure F-22. Temperature Map for Participant 6



For the first three months, there is a consistent temperature pattern. Temperatures are in the low 60°F's at night and mid-high 60°F's during the daytime. There is a period of unusually low temperatures in February. The participant may have been on vacation for this period and set the temperature to a low level.

Participant 7

Table F-7. Summary of Key Survey Responses for Participant 7

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Bill	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, I find it much easier to use my phone to control the thermostat.	Post-Study

Figure F-23. Screenshots of programmed thermostat settings for Participant 7, taken on January 7, 2013

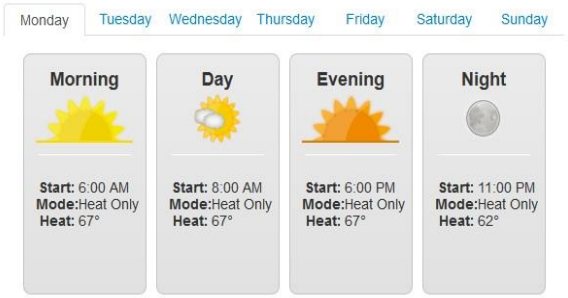


Figure F-24. Average Temperature Profile for Participant 7

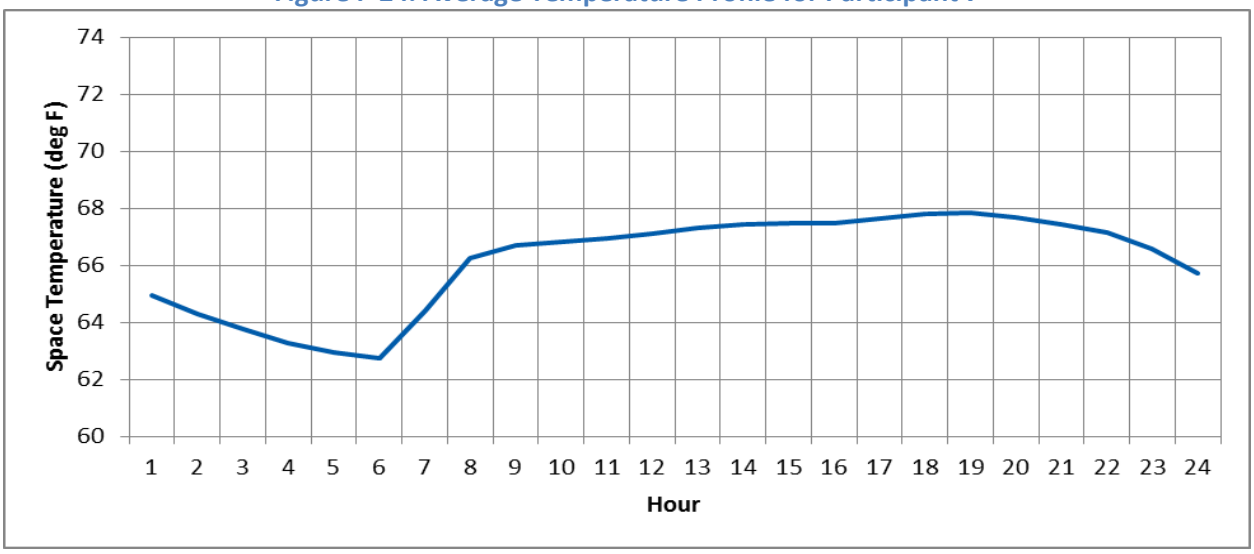


Figure F-25. Temperature Map for Participant 7

The temperature patterns are consistent throughout the four months. Temperatures are in the low 60°F's at night and the mid to high 60°F's during the day. There are a few days in February where temperatures are in the low 60°F's during the daytime.

Participant 8

Table F-8. Summary of Key Survey Responses for Participant 8

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes, Change temp when we are not at home.	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, Easier to program than the programmable thermostat we replaced.	Post-Study

Figure F-26. Screenshots of programmed thermostat settings for Participant 8, taken on January 7, 2013

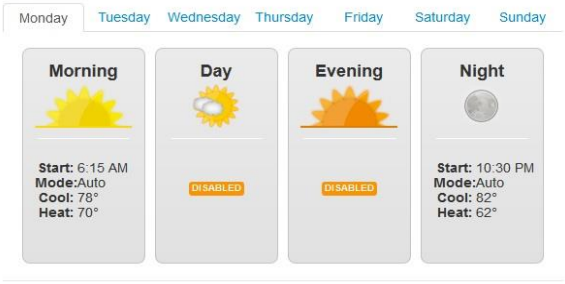


Figure F-27. Average Temperature Profile for Participant 8

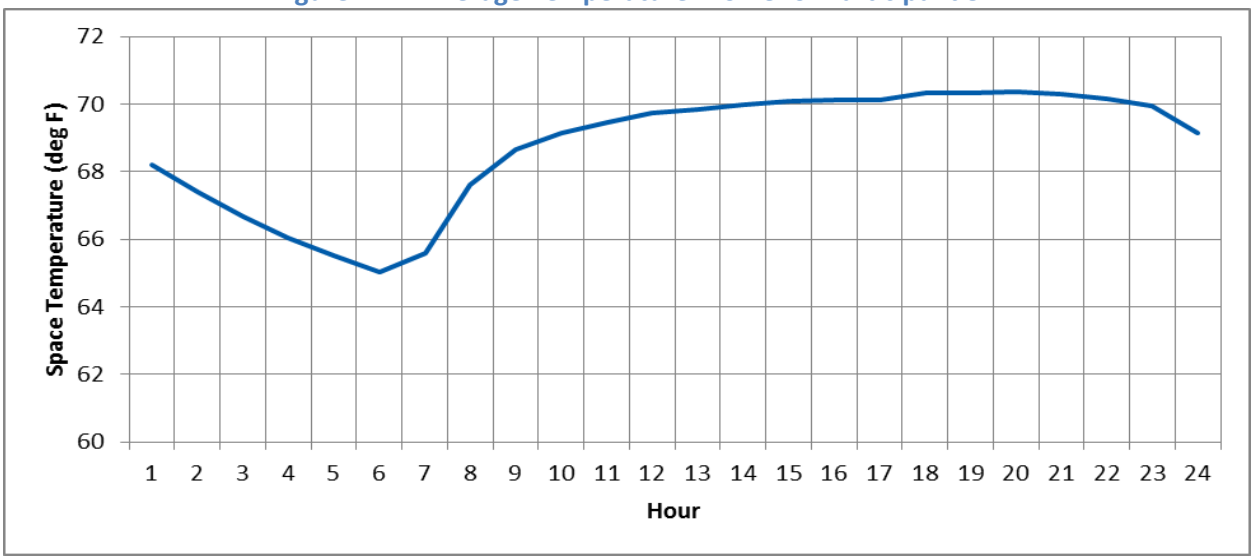
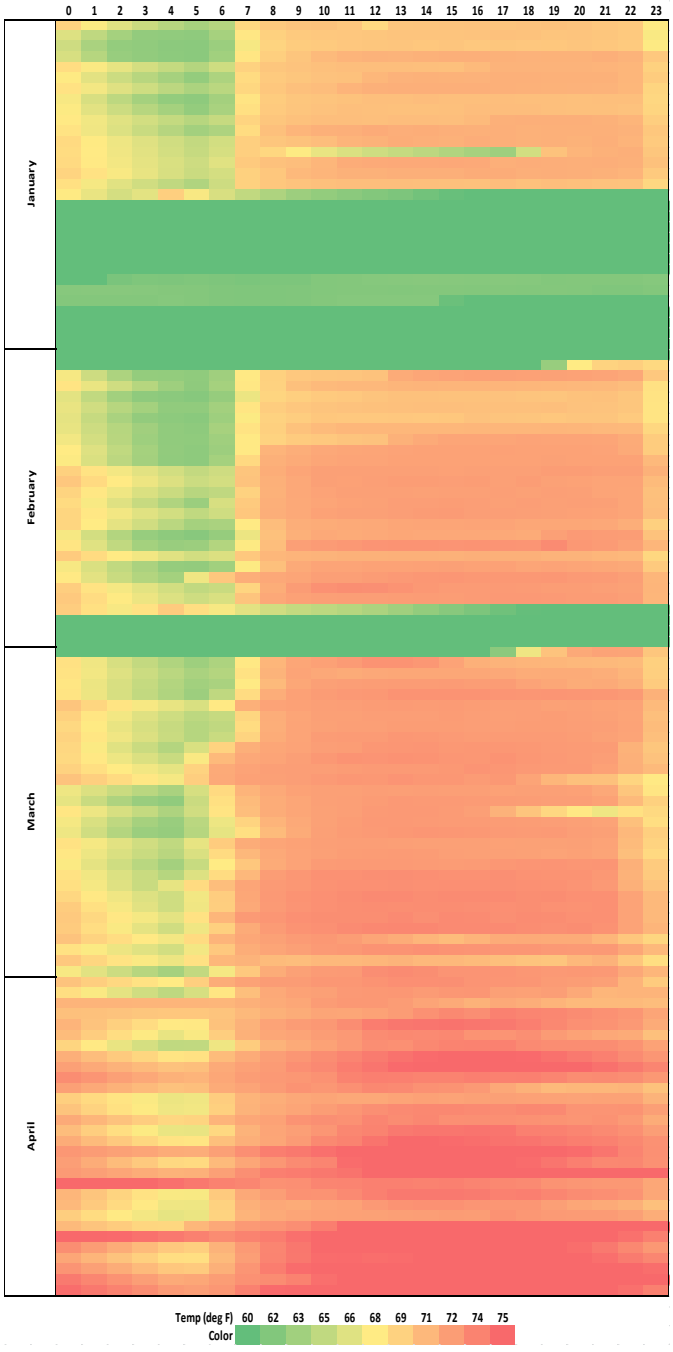


Figure F-28. Temperature Map for Participant 8



The first half of January shows a temperature schedule with a regular setback period at night. The second half of January, and a portion of February, show constant temperatures in the low 60°F's. The participant may have gone on vacation for these periods. April shows temperatures increasing as high as the mid 70°F's.

Participant 9

Table F-9. Summary of Key Survey Responses for Participant 9

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manual	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Other	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Screenshots of programmed thermostat settings for Participant 9 are not available.

Figure F-29. Average Temperature Profile for Participant 9

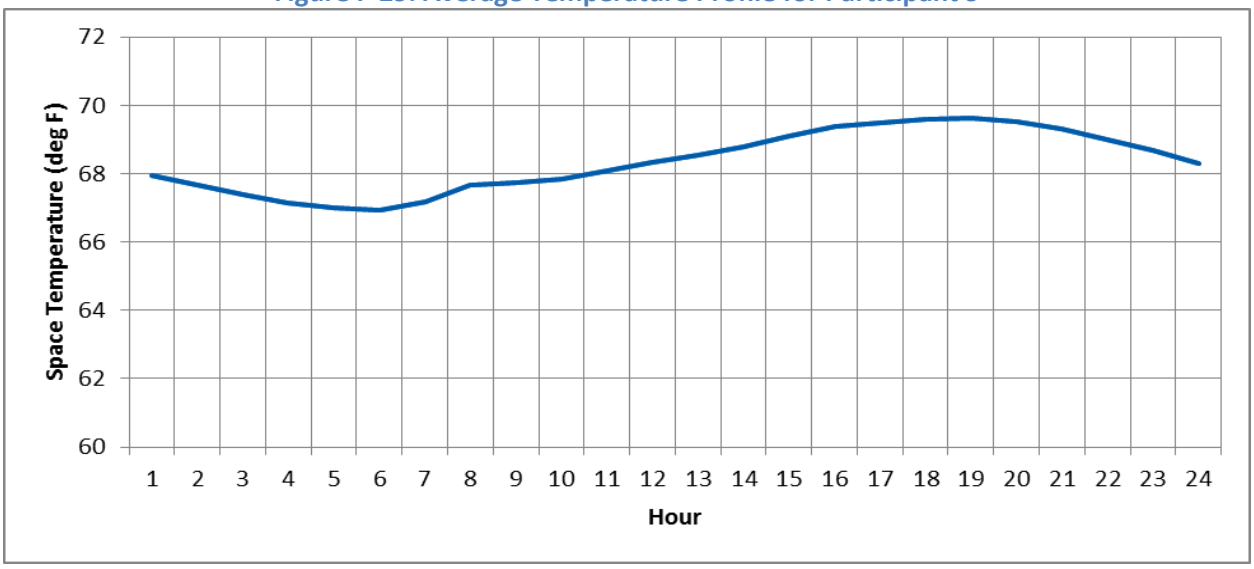
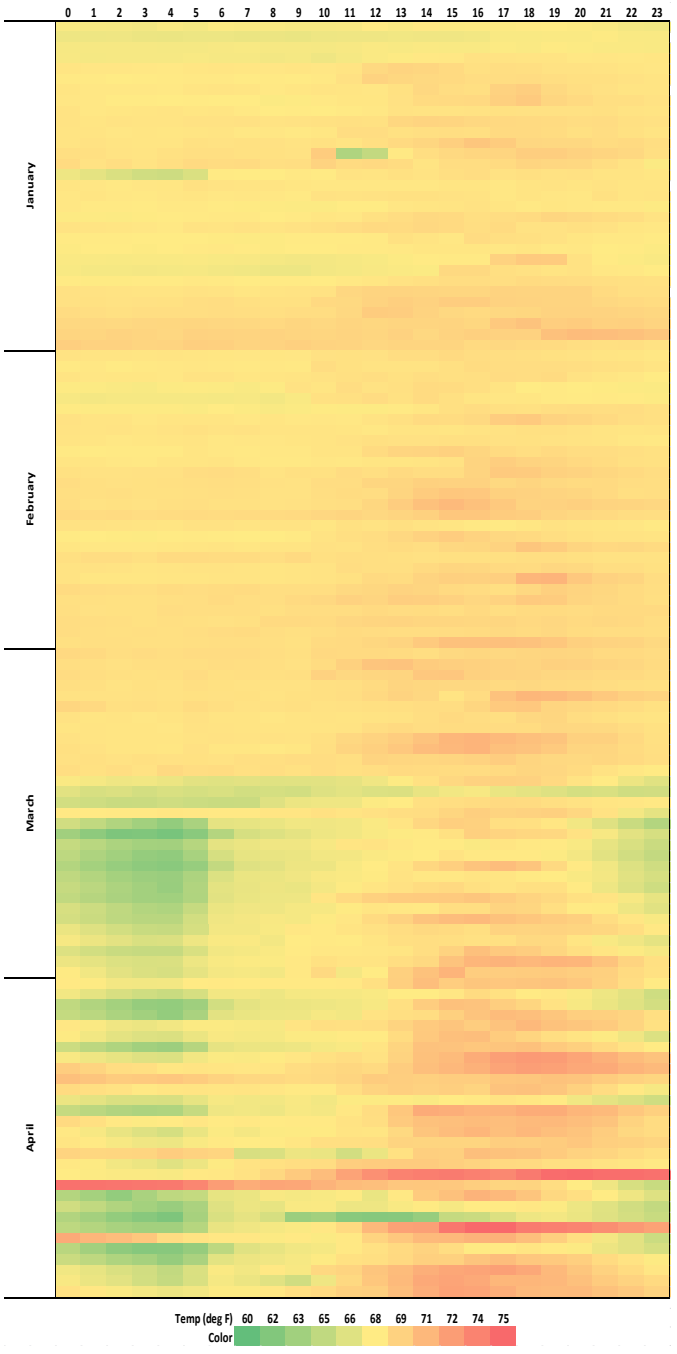


Figure F-30. Temperature Map for Participant 9



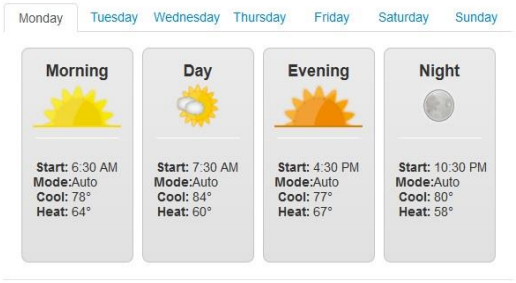
For the first two months, the temperature readings are fairly consistently in the high 60°F's throughout the day. Mid-March shows temperatures consistently in the low to mid 60°F's at night, implying the participant may have programmed a schedule in mid-March.

Participant 10

Table F-10. Summary of Key Survey Responses for Participant 10

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Both	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Figure F-31. Screenshots of programmed thermostat settings for Participant 10, taken on January 7, 2013



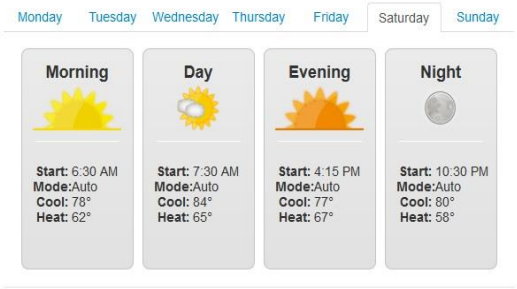


Figure F-32. Average Temperature Profile for Participant 10

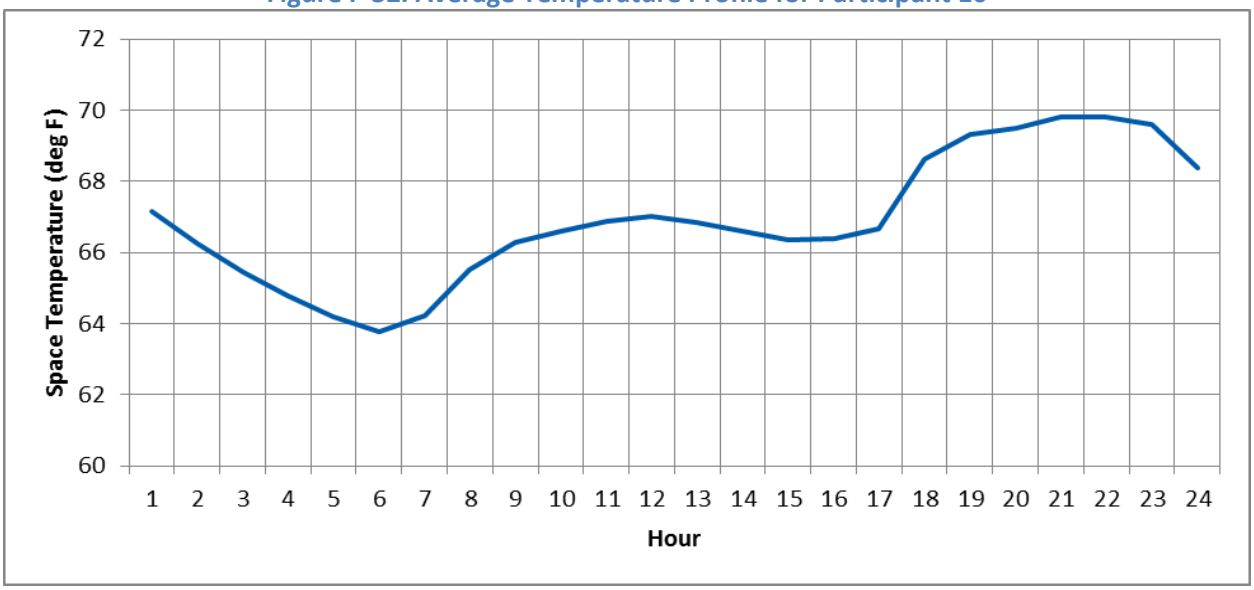
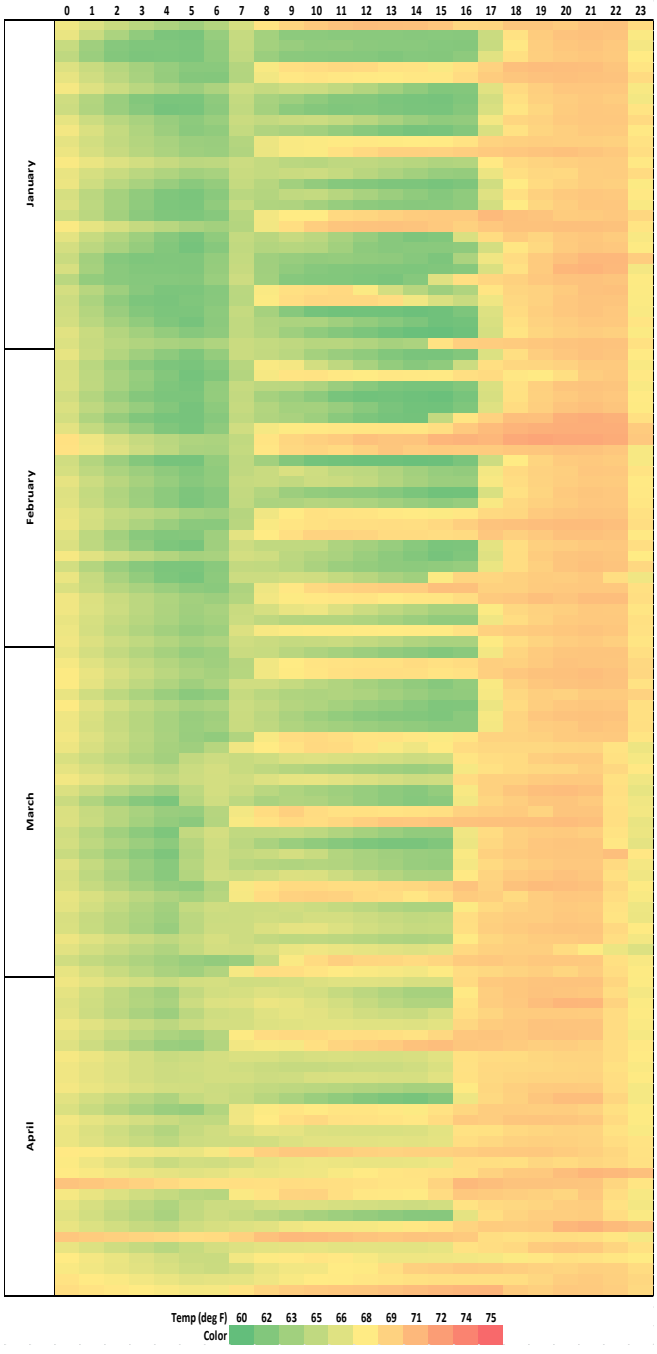


Figure F-33. Temperature Map for Participant 10



The participant appears to have a regular setback period during the weekdays and weekends. The setback period is longer during the weekday, where it remains in the low to mid 60°F's until 4pm. On the weekend, however, the temperature increases to the high 60°F's by 8am.

Participant 11

Table F-11. Summary of Key Survey Responses for Participant 11

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manuel	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Both	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Figure F-34. Screenshots of programmed thermostat settings for Participant 11, taken on January 7, 2013

Figure F-35. Temperature Map for Participant 11

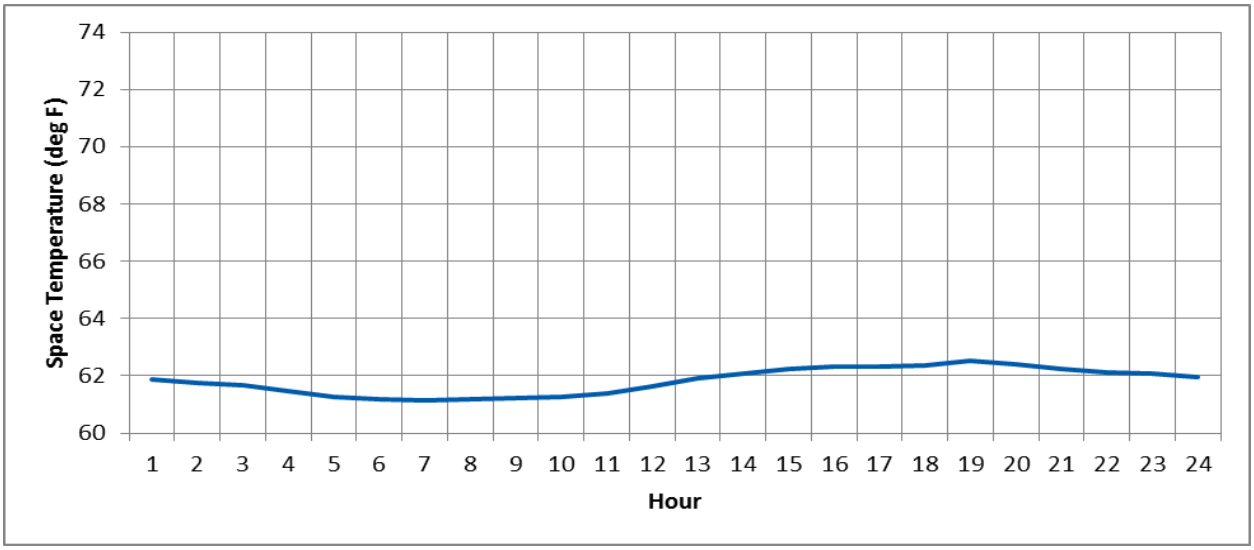
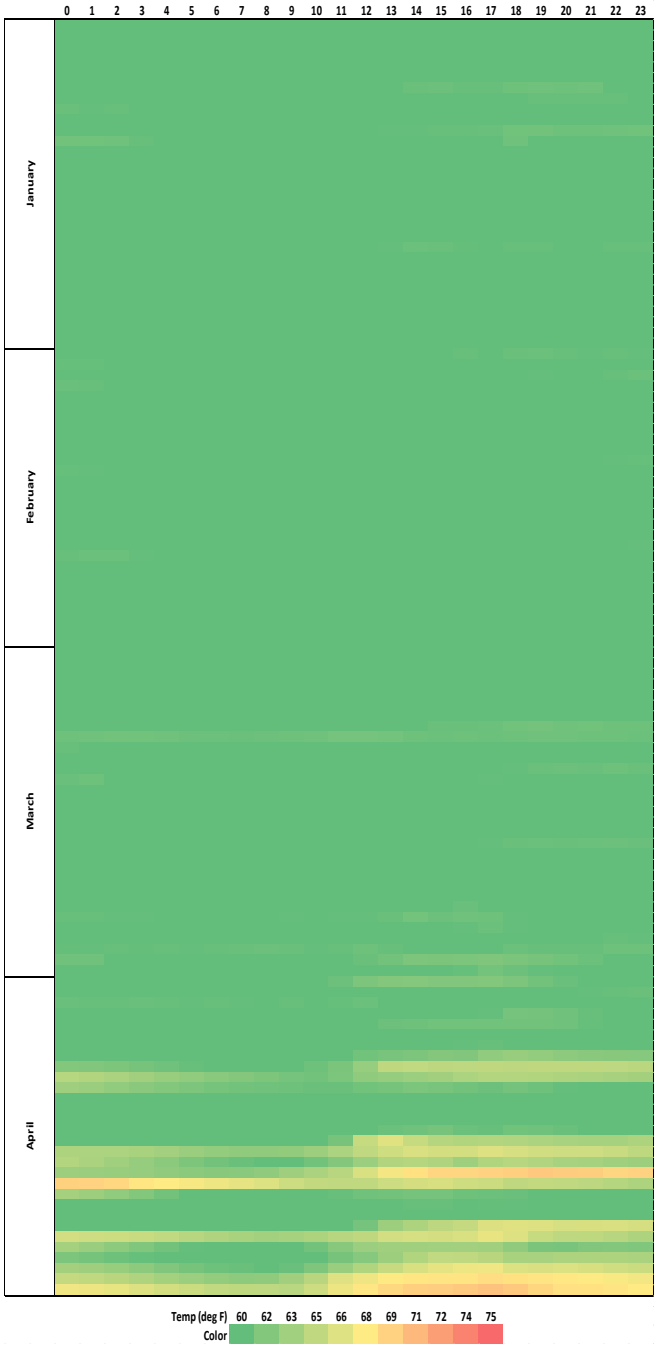


Figure F-36. Temperature Map for Participant 11



Temperatures are consistently in the low 60°F's until mid-April. The pattern suggests that no schedule was programmed.

Participant 12

Table F-12. Summary of Key Survey Responses for Participant 12

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manuel	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes, I would adjust to save more energy, such as at night	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Once per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, More intuitive. Love the touch screen.	Post-Study

Figure F-37. Screenshots of programmed thermostat settings for Participant 12, taken on January 7, 2013

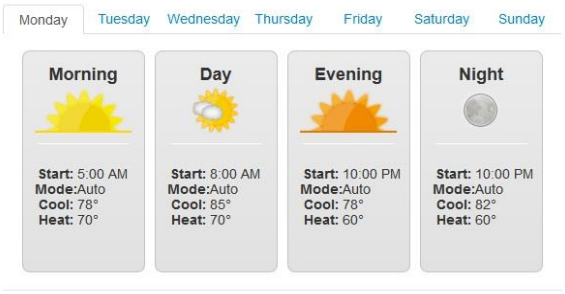


Figure F-38. Average Temperature Profile for Participant 12

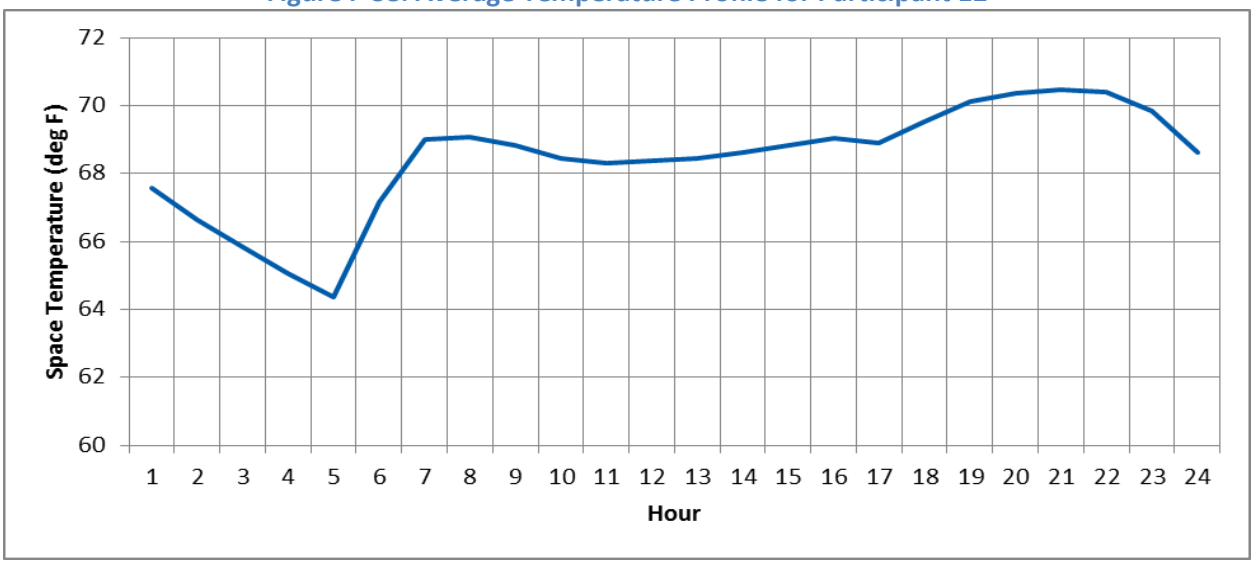
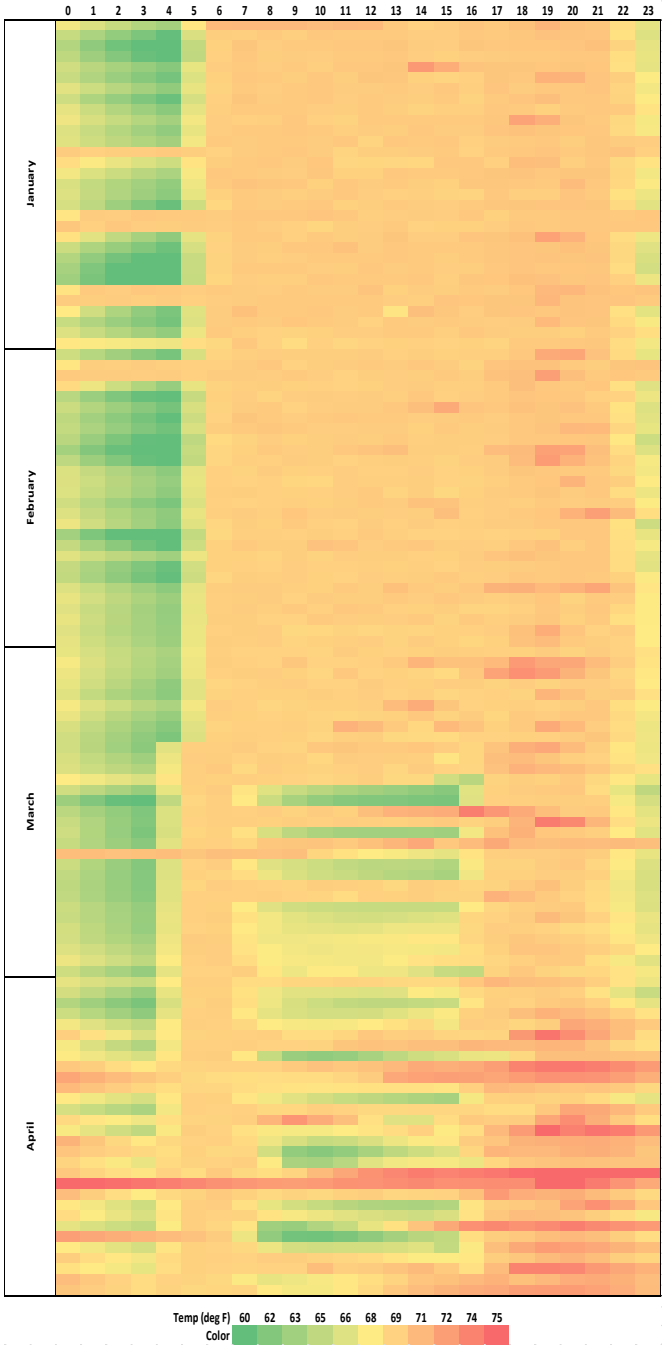


Figure F-39. Temperature Map for Participant 12



The data show temperatures in the mid to low 60°F's at night and high 60°F's to low 70°F's during the daytime. In mid-March, a second setback period appears to have been programmed for the hours of 7am – 4pm.

Participant 13

Table F-13. Summary of Key Survey Responses for Participant 13

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Single Setpoint	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, web interface makes setting it might easier, and ability to use Android phone allows setting it remotely with ease.	Post-Study

Figure F-40. Screenshots of programmed thermostat settings for Participant 13, taken on January 7, 2013

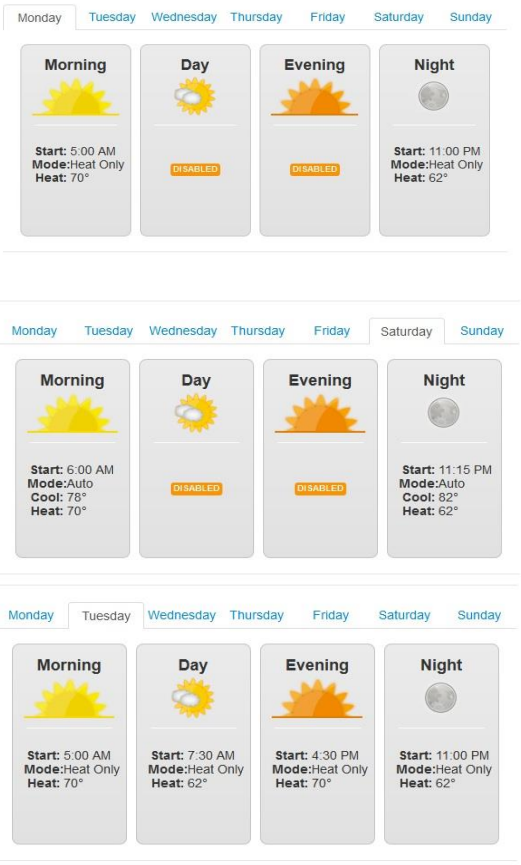


Figure F-41. Average Temperature Profile for Participant 13

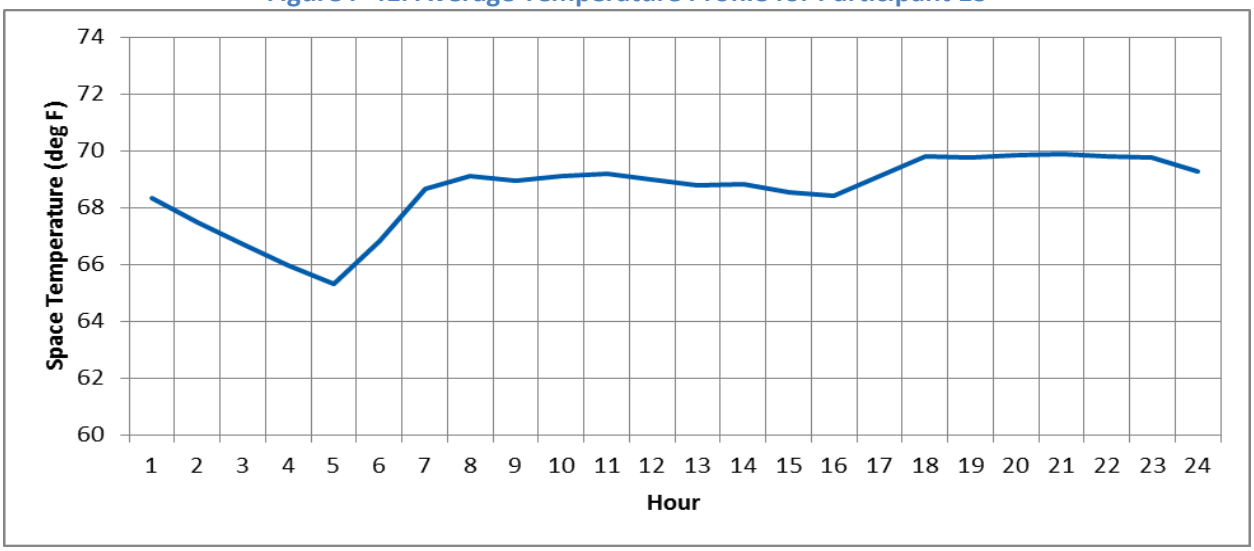
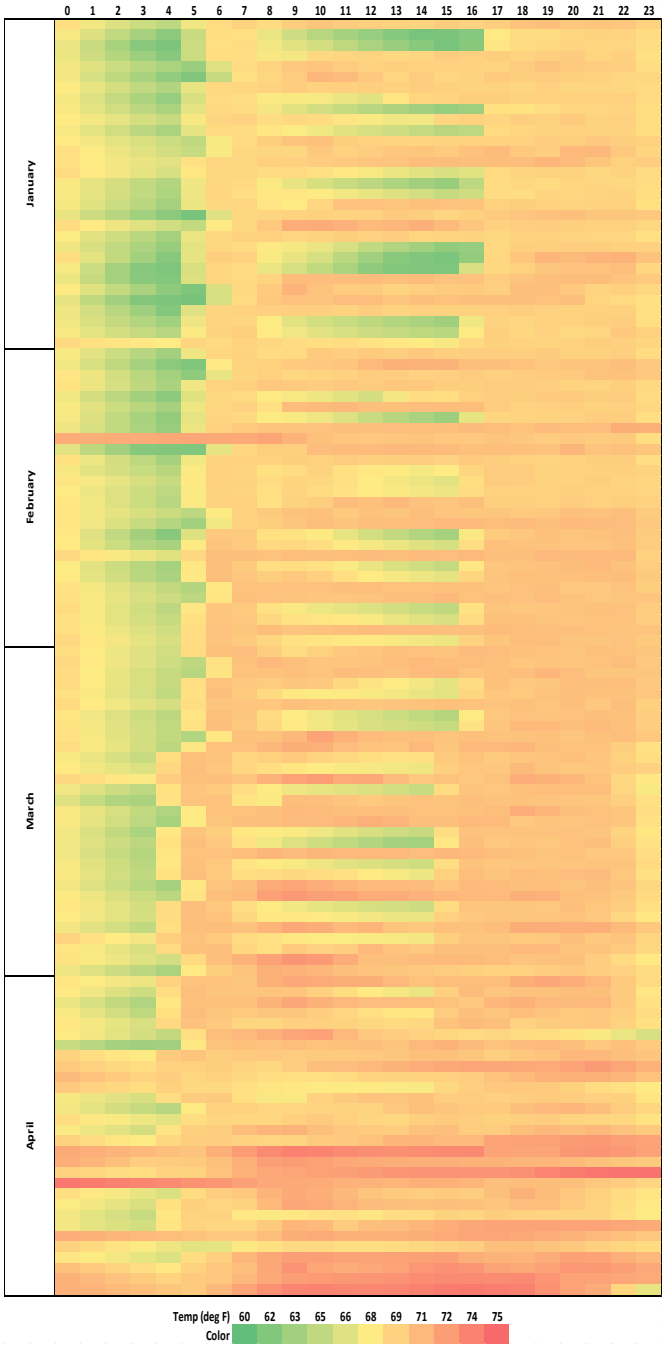


Figure F-42. Temperature Map for Participant 13



The temperature patterns indicate that a regular setback period was set up at night and that this setback period is extended on weekends. Three to four times a week, there appears to be a second setback period during the daytime.

Participant 14

Table F-14. Summary of Key Survey Responses for Participant 14

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	Less Frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, the PC-enabled web interface.	Post-Study

Figure F-43. Screenshots of programmed thermostat settings for Participant 14, taken on January 7, 2013

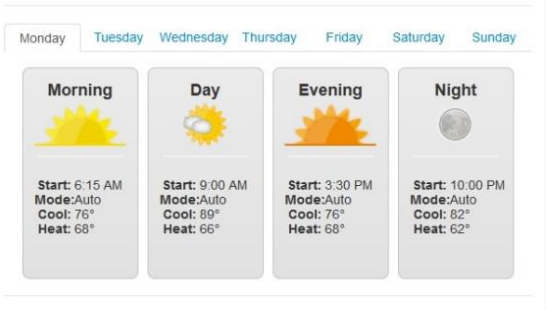


Figure F-44. Average Temperature Profile for Participant 14

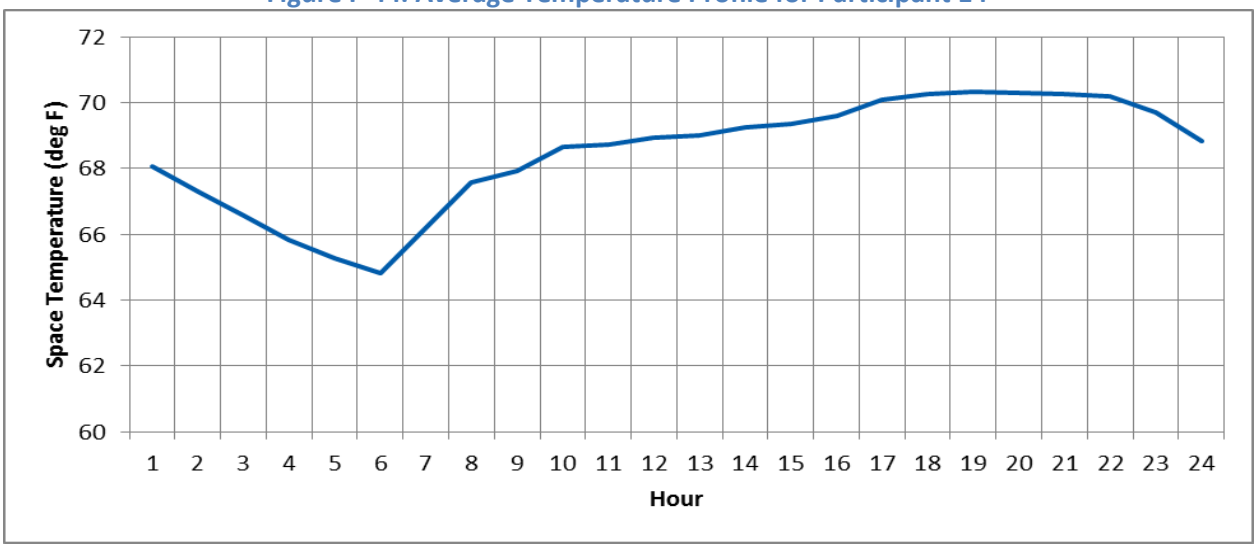
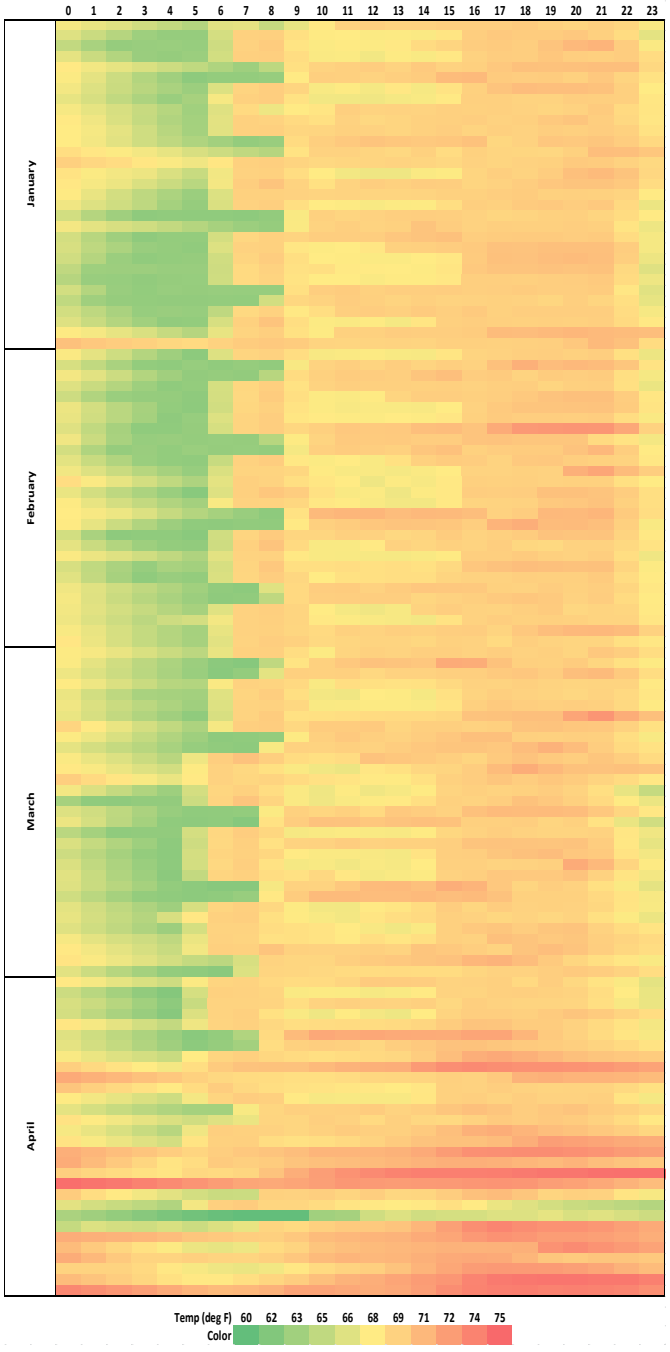


Figure F-45. Temperature Map for Participant 14



There is a regular setback period in the low 60°F's at night. This setback period ends at 5am on weekdays and 8am on weekends. Otherwise, temperatures tend to be in the high 60°F's to low 70°F's.

Participant 15

Table F-15. Summary of Key Survey Responses for Participant 15

Survey Question	Survey Reponse	Survey Name
Baseline Thermostat Settings	Manual	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Both	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per day	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, use of smartphone adds a new option.	Post-Study

Figure F-46. Screenshots of programmed thermostat settings for Participant 15, taken on January 7, 2013

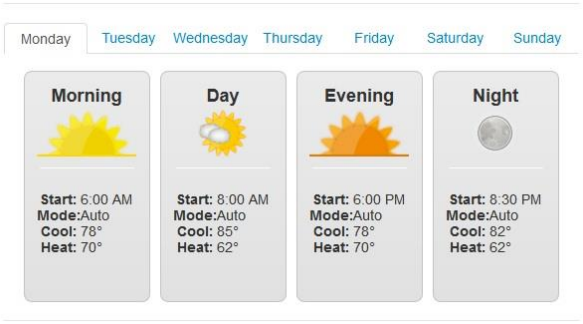


Figure F-47. Average Temperature Profile for Participant 15

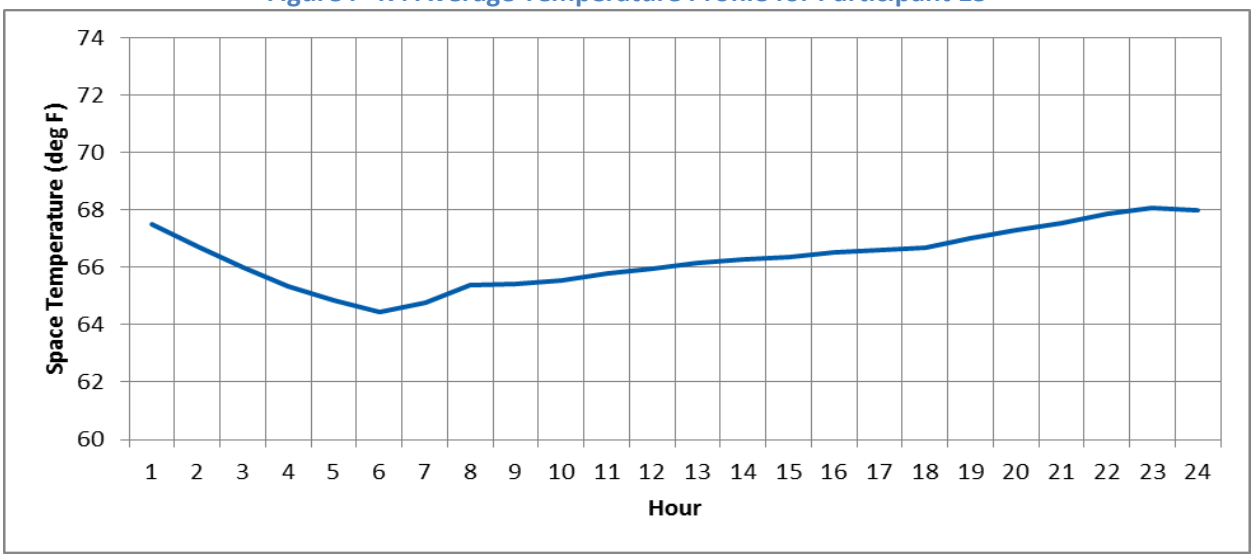
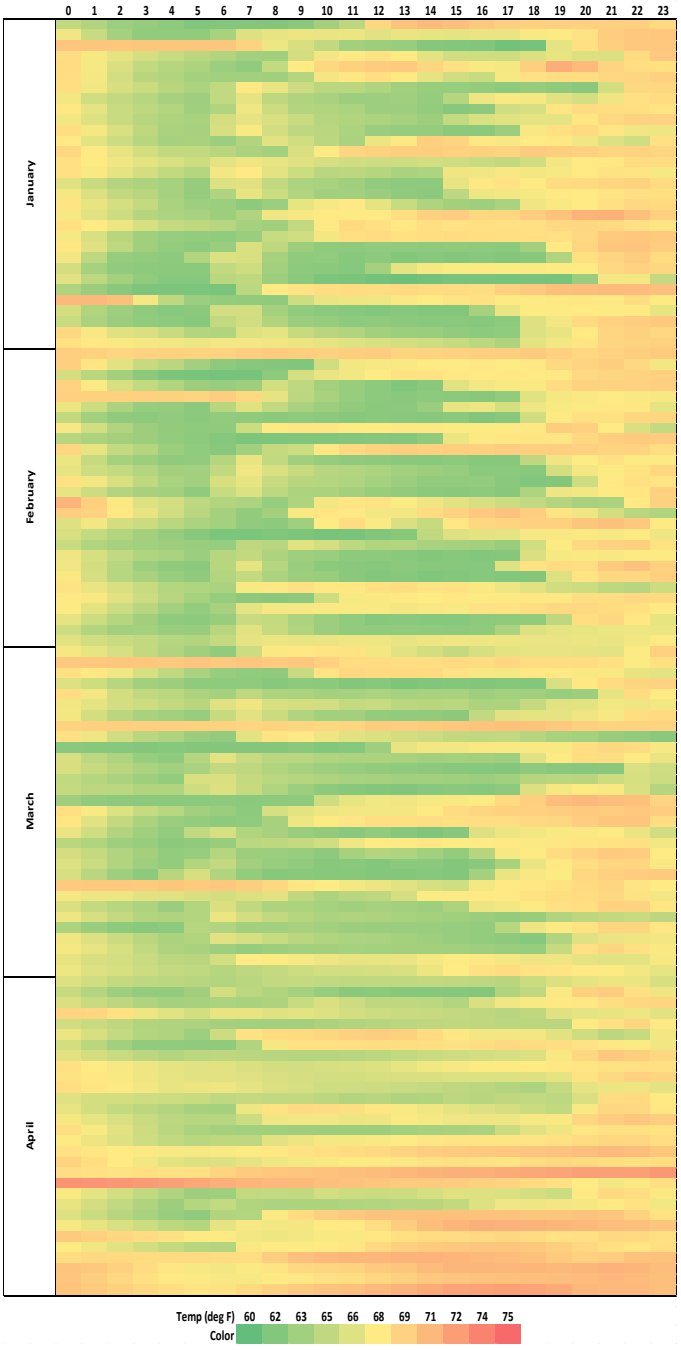


Figure F-48. Temperature Map for Participant 15



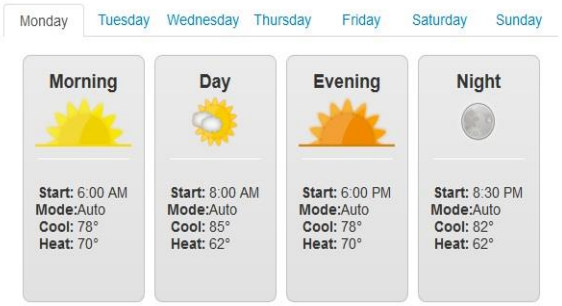
It is difficult to distinguish if a nighttime setback period was programmed. Temperatures stay in the low 60°F's at night and during the day on most days. The participant appears to regularly setback their thermostat, but at inconsistent times. This implies they control their thermostat manually and/or wirelessly, as opposed to programming.

Participant 16

Table F-16. Summary of Key Survey Responses for Participant 16

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manual	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per day	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, I used my cell phone	Post-Study

Figure F-49. Screenshots of programmed thermostat settings for Participant 16, taken on January 7, 2013



Average Temperature Profile for Participant 16 is not available.

Figure F-50. Temperature Map for Participant 16

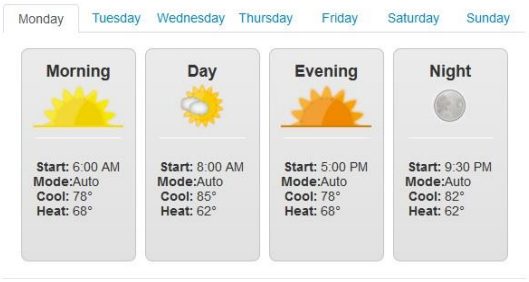
There does not appear to be a consistent programmed schedule. Temperatures remain in the low to mid 70°F's for the majority of the time period. There are some periods of temperatures in the low 60°F's between 8am and 6pm in January and February, but otherwise any setback periods are inconsistent. There is a period in February where temperatures drop to the mid 60°F's. The participant may have been on vacation for this period.

Participant 17

Table F-17. Summary of Key Survey Responses for Participant 17

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Unknown	Baseline Survey
Baseline Vacation Settings	Unknown	Baseline Survey
Baseline Temp Decision	Unknown	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, manual settings with app	Post-Study

Figure F-51. Screenshots of programmed thermostat settings for Participant 17, taken on January 7, 2013



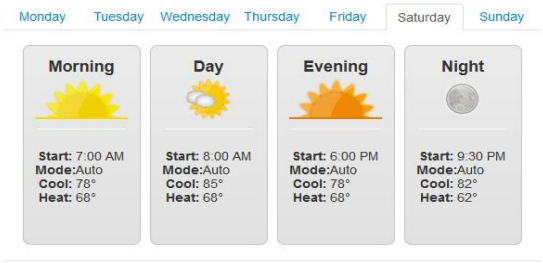


Figure F-52. Average Temperature Profile for Participant 17

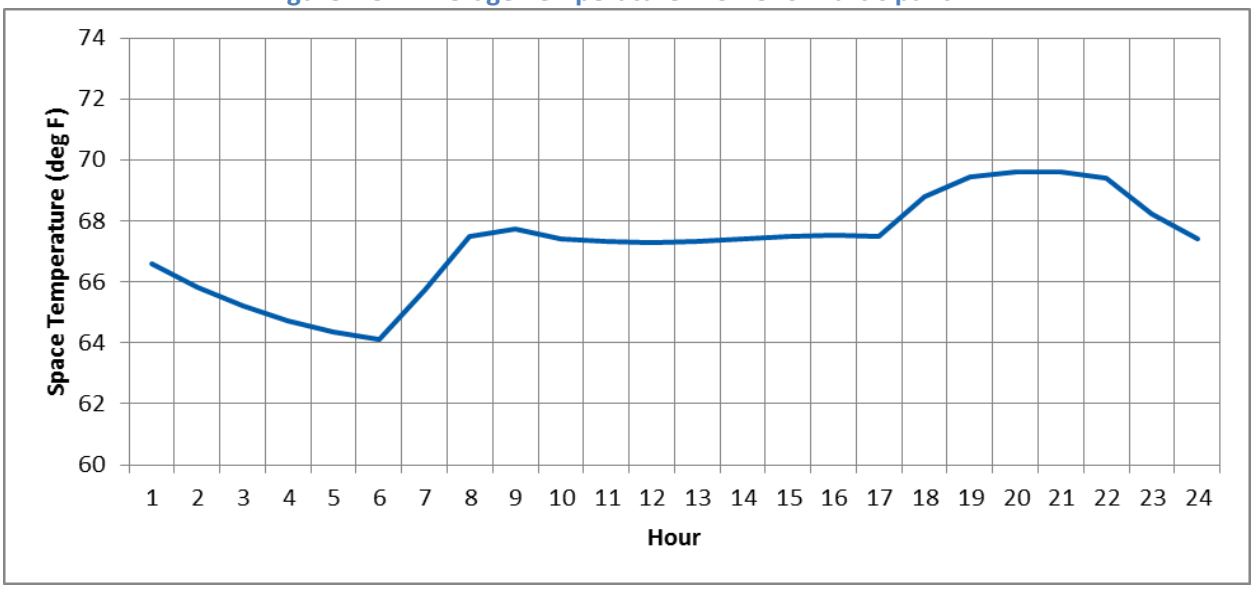
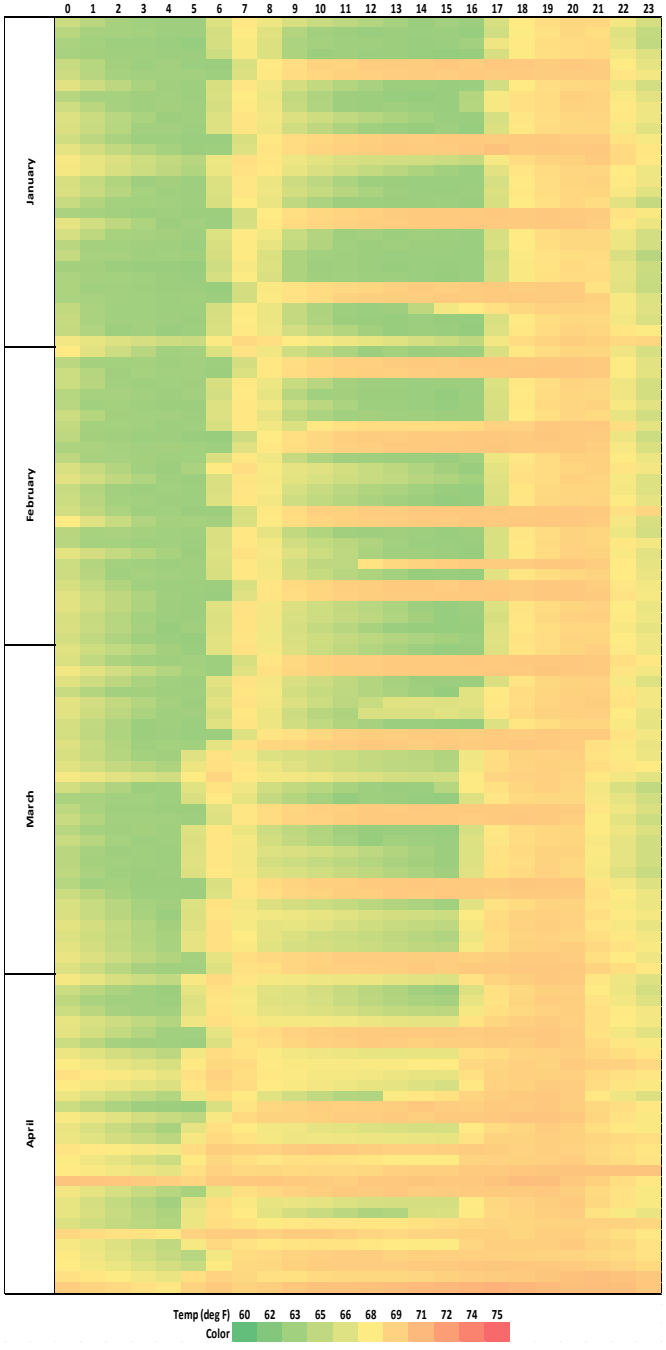


Figure F-53. Temperature Map for Participant 17



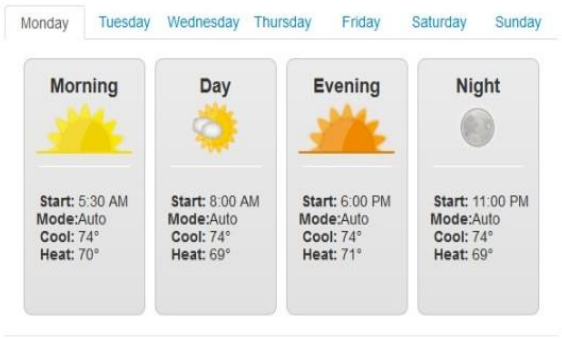
This participant appears to have regular setback periods at night and during the daytime on weekdays. On weekends, their nighttime setback extends later in the morning than on weekdays.

Participant 18

Table F-18. Summary of Key Survey Responses for Participant 18

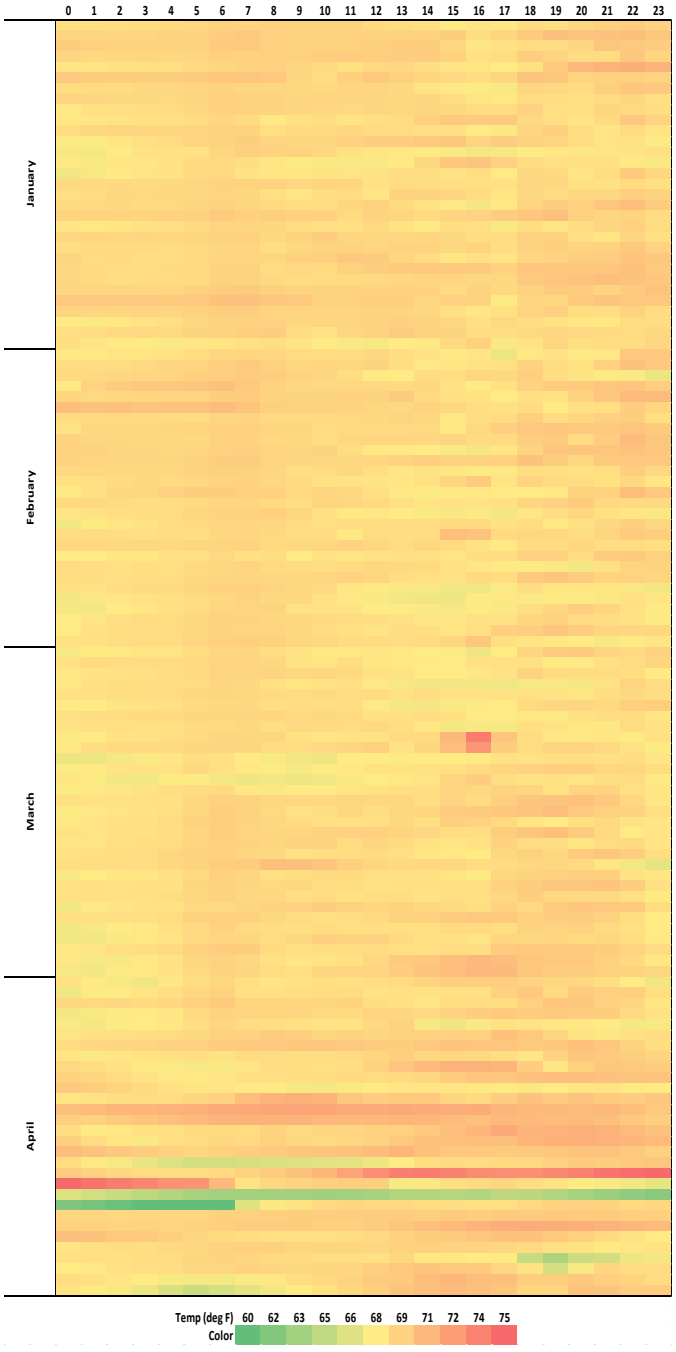
Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manual	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Figure F-54. Screenshots of programmed thermostat settings for Participant 18, taken on January 7, 2013



Average Temperature Profile for Participant 18 is not available.

Figure F-55. Temperature Map for Participant 18



Temperatures are consistently in the high 60°F's to low 70°F's. There may be a setback period between 8am and 6pm, but if so, it is only a difference of a few degrees.

Participant 19

Table F-19. Summary of Key Survey Responses for Participant 19

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Once per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Figure F-56. Screenshots of programmed thermostat settings for Participant 19, taken on January 7, 2013

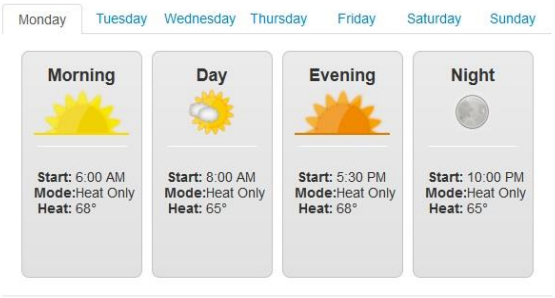


Figure F-57. Average Temperature Profile for Participant 19

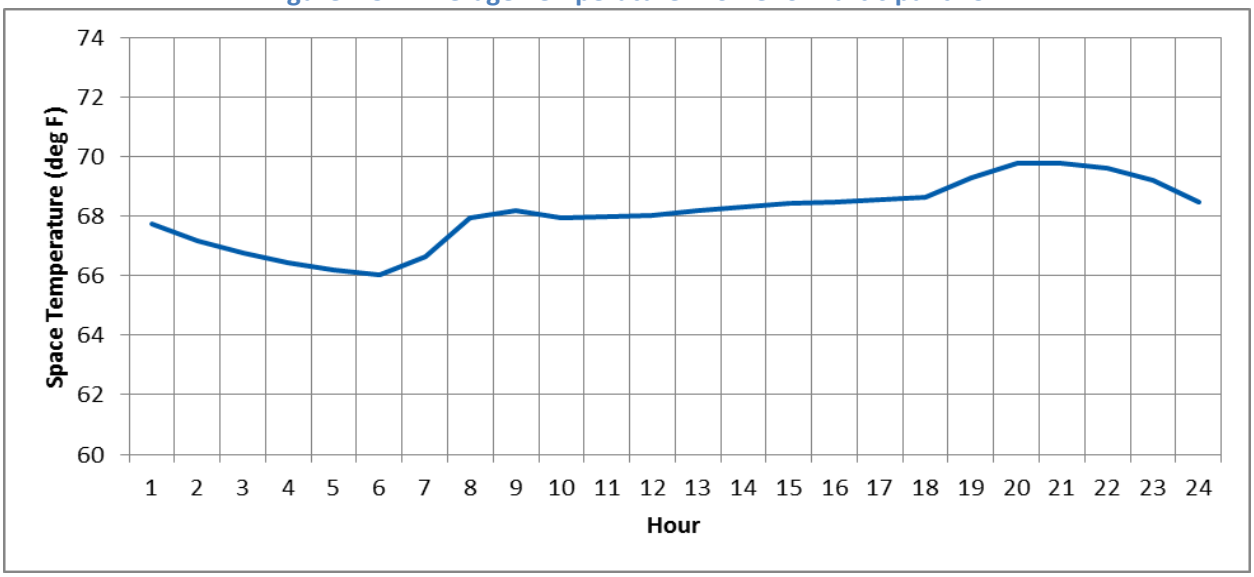
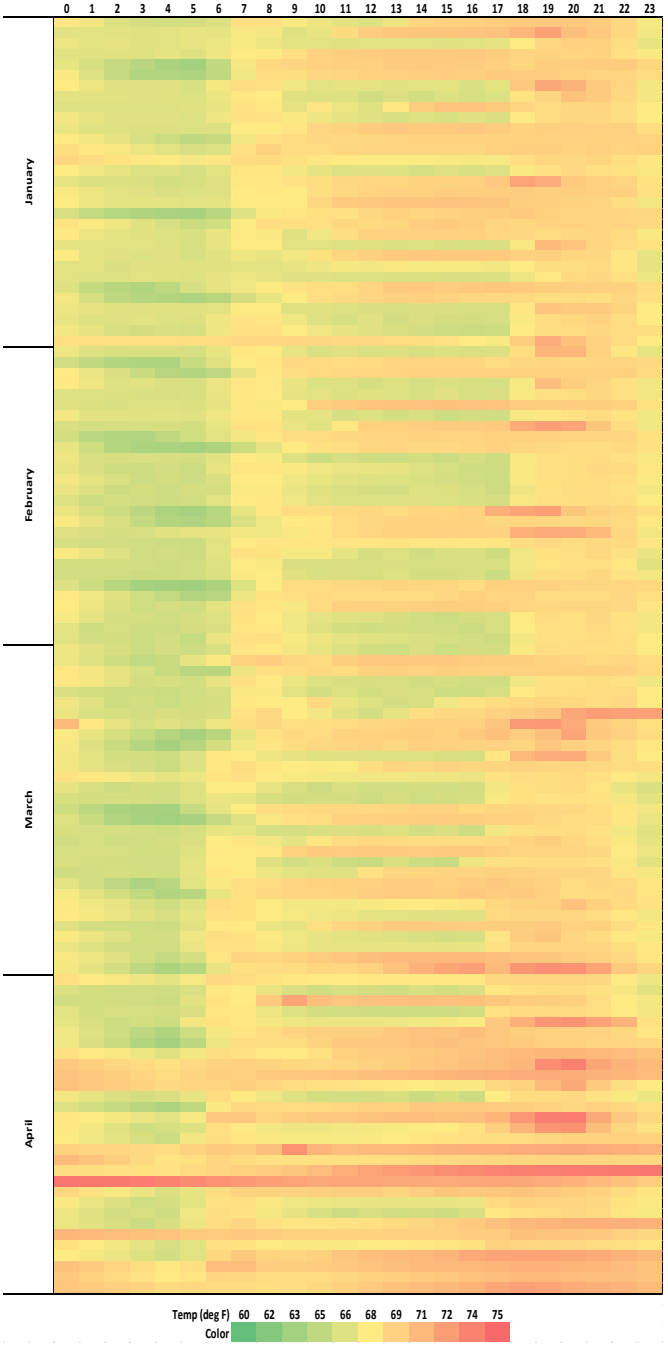


Figure F-58. Temperature Map for Participant 19



The participant appears to have regular setback periods at night and during work hours. The nighttime setback period appears to be longer on weekends.

Participant 20

Table F-20. Summary of Key Survey Responses for Participant 20

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manual	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	Yes, try to keep low to minimize energy usage as compared to prior week	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per day	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, I can set the temp from my phone or computer.	Post-Study

Figure F-59. Screenshots of programmed thermostat settings for Participant 20, taken on January 7, 2013

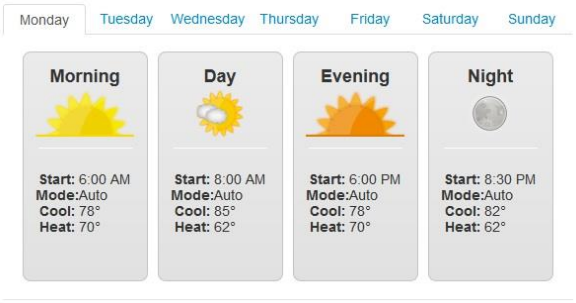


Figure F-60. Average Temperature Profile for Participant 20

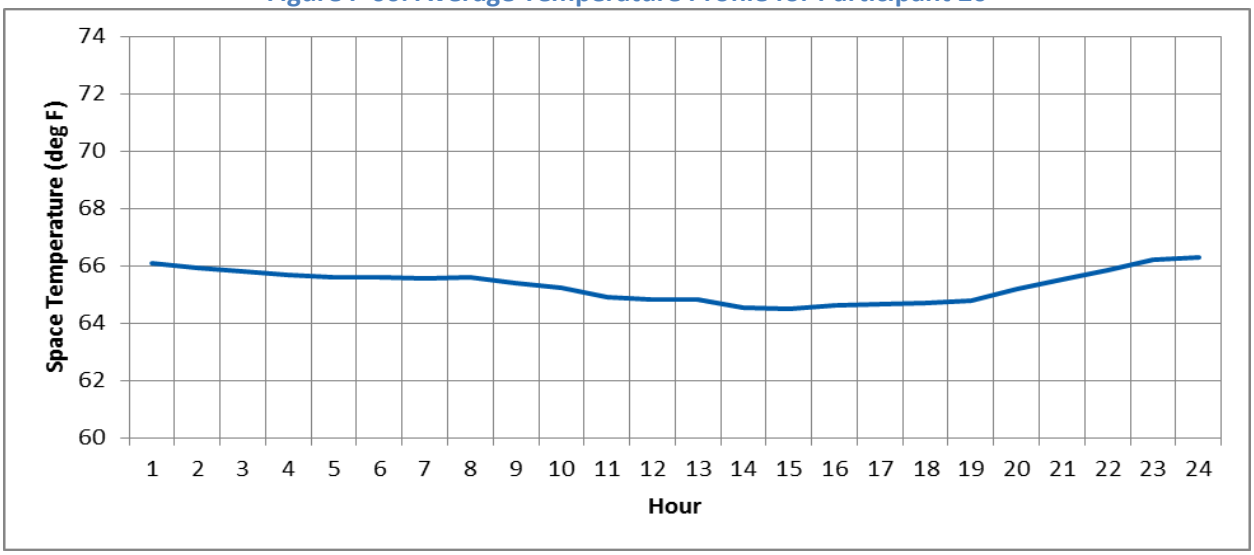
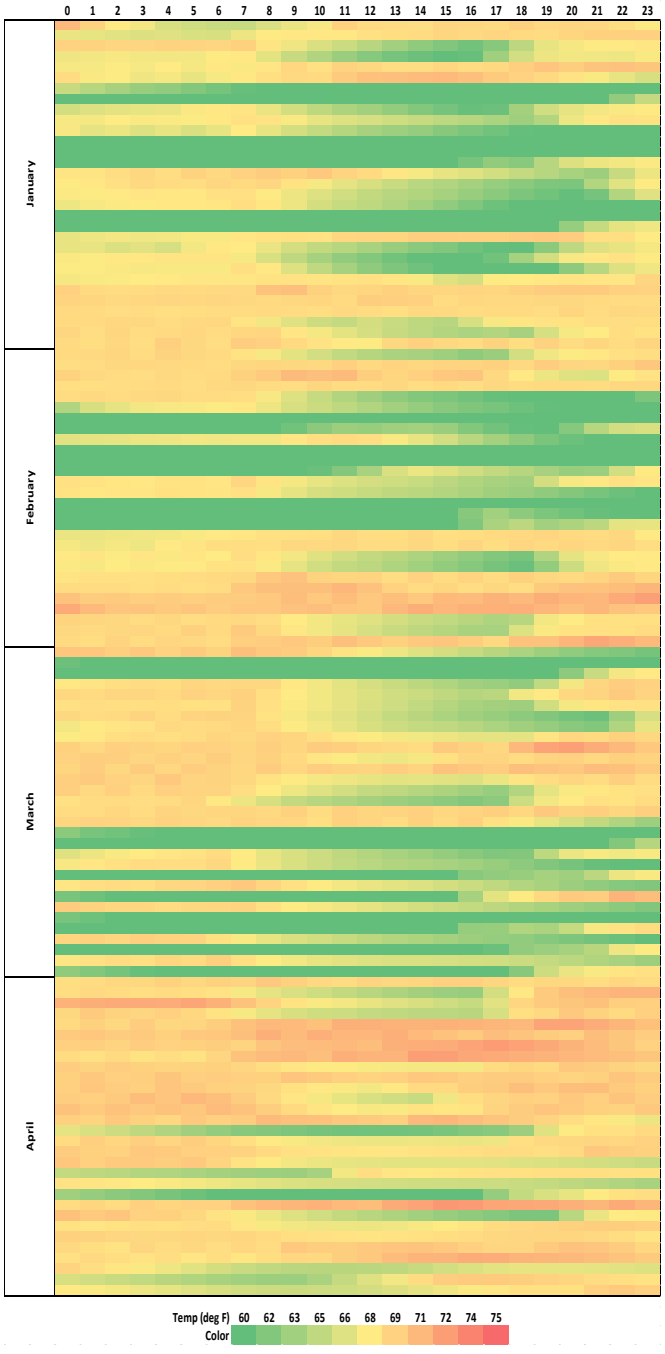


Figure F-61. Temperature Map for Participant 20



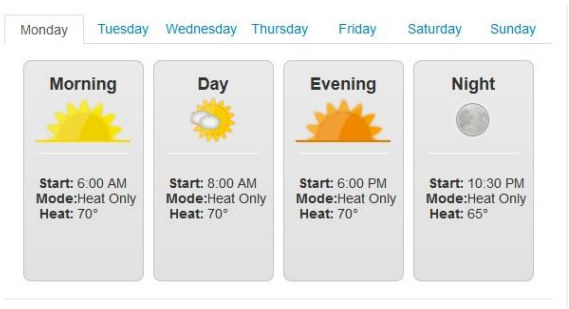
No schedule appears to be programmed. Temperatures are in the low 60°F's for days at a time, as well as high 60°F's for days at a time with no apparent pattern.

Participant 21

Table F-21. Summary of Key Survey Responses for Participant 21

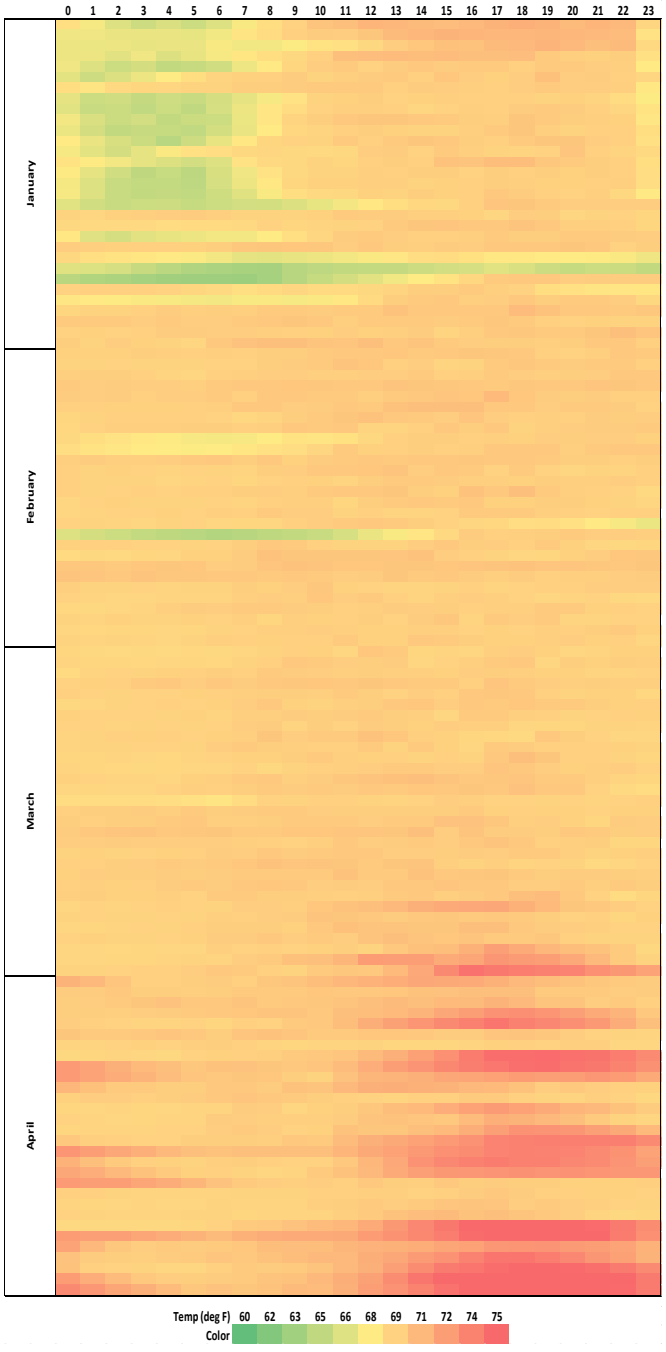
Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manuel	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Once per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, big buttons, can configure remotely.	Post-Study

Figure F-62. Screenshots of programmed thermostat settings for Participant 21, taken on January 7, 2013



Average Temperature Profile for Participant 21 is not available.

Figure F-63. Temperature Map for Participant 21



In January, the participant appears to have programmed a setback for the nighttime with temperatures dropping from the high 60°F's to mid-60°F's at night. However, temperatures remain in the high 60°F's and low 70°F's starting at the end of January. This indicates that the participant may have switched to a single setpoint.

Participant 22

Table F-22. Summary of Key Survey Responses for Participant 22

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, easier to program	Post-Study

Figure F-64. Screenshots of programmed thermostat settings for Participant 22, taken on January 7, 2013

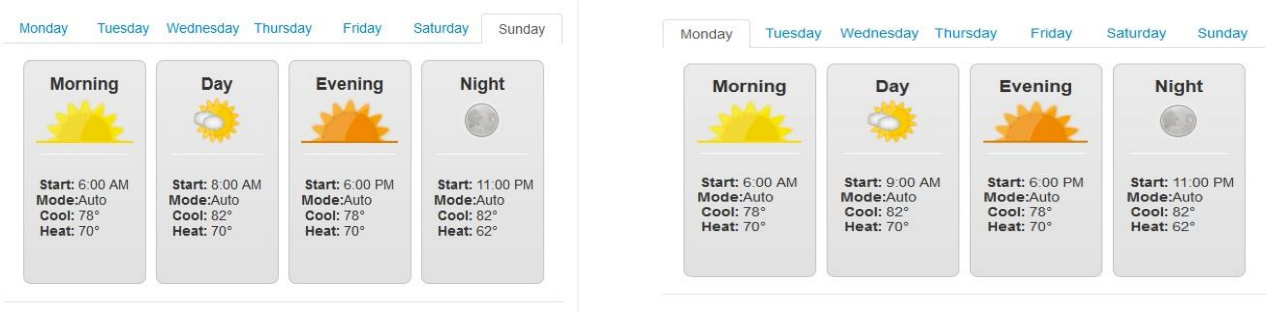


Figure F-65. Average Temperature Profile for Participant 22

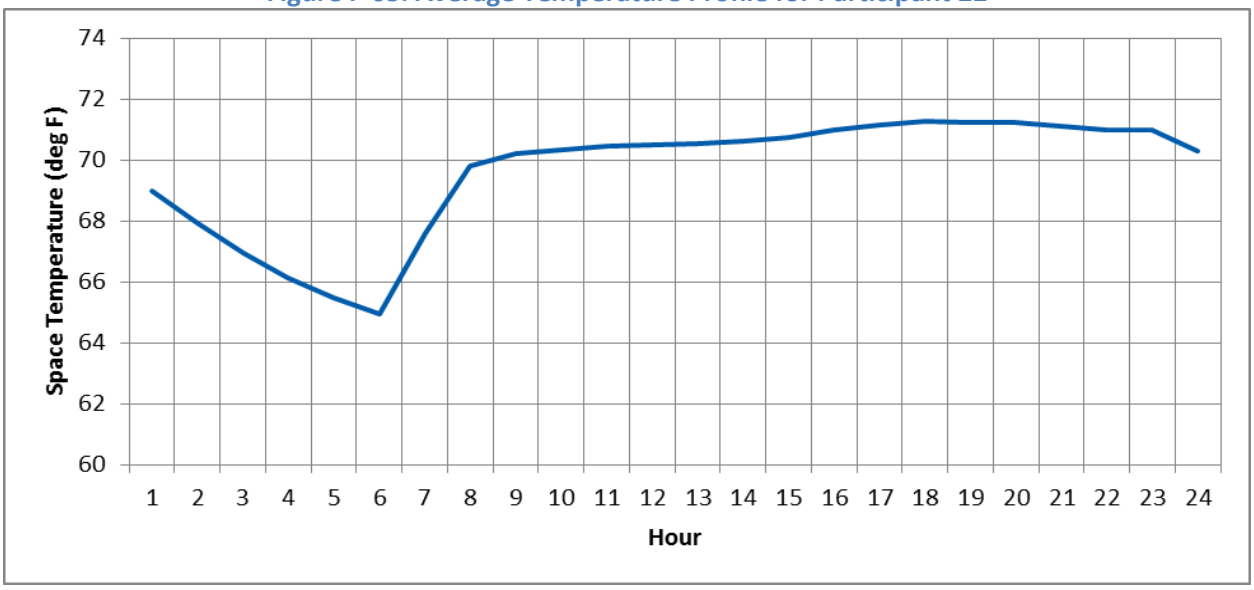


Figure F-66. Temperature Map for Participant 22

The participant appears to have a consistent setback period at night with temperatures in the low 60°F's. During the daytime, temperatures are in the high 60°F's and low 70°F's.

Participant 23

Table F-23. Summary of Key Survey Responses for Participant 23

Survey Question	Survey Reponse	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, can do it remotely from anywhere	Post-Study

Figure F-67. Screenshots of programmed thermostat settings for Participant 23, taken on January 7, 2013

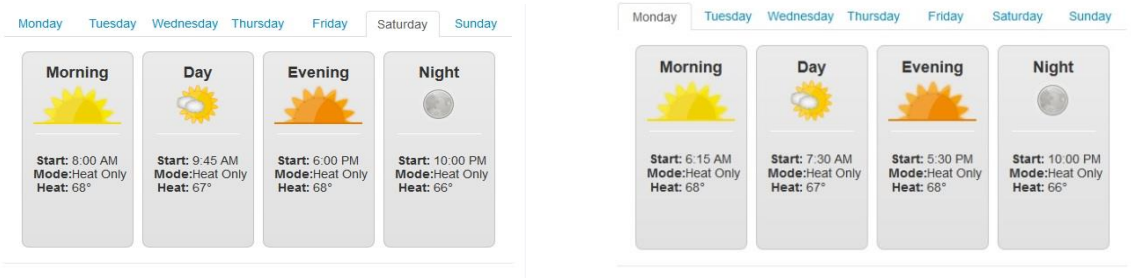


Figure F-68. Average Temperature Profile for Participant 23

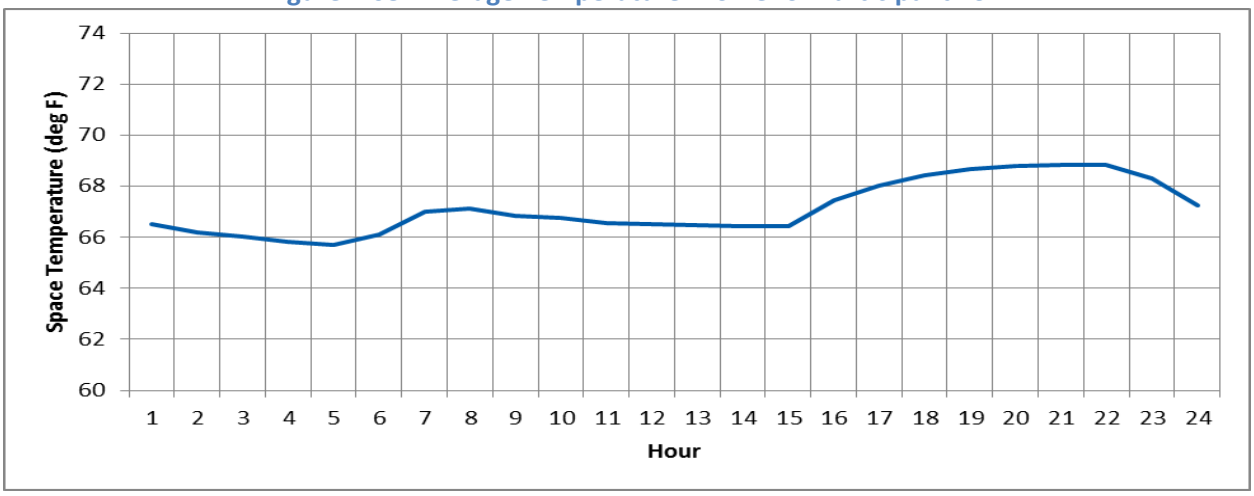
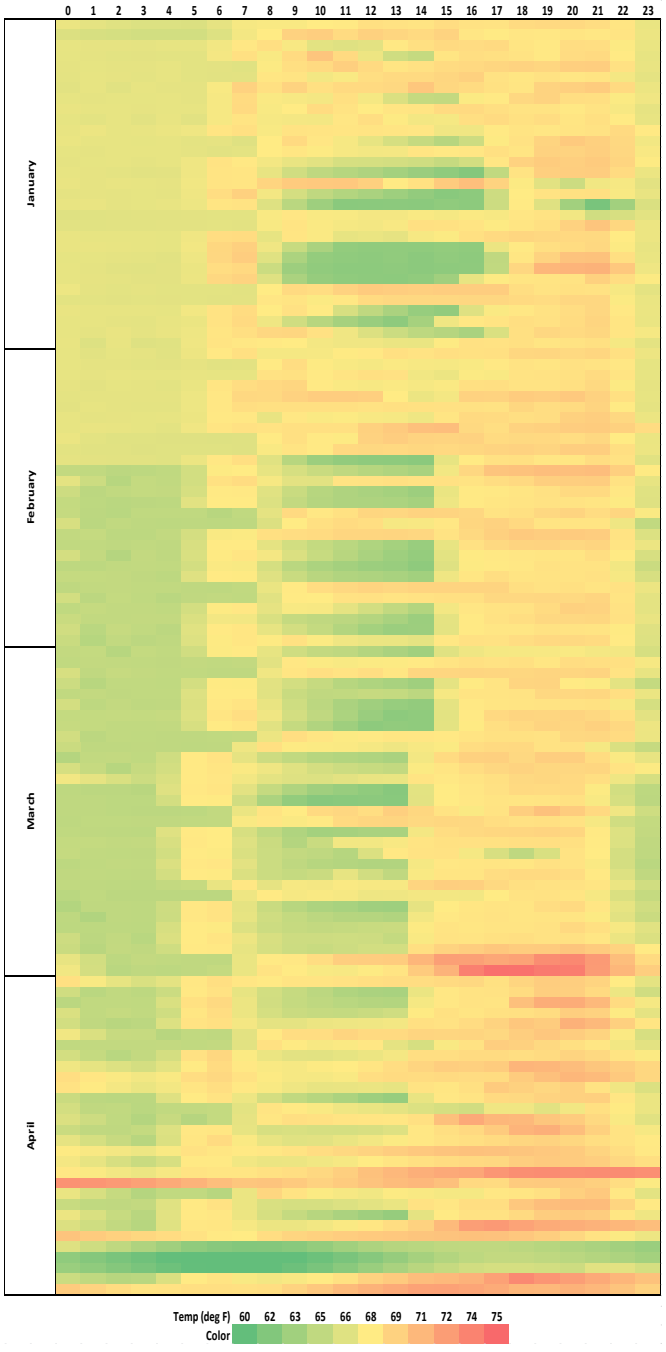


Figure F-69. Temperature Map for Participant 23



The participant appears to have a regular setback period at night. The nighttime setback temperature decreases from the mid to high 60°F's in January, to the mid-low 60°F's in February. A second setback period for daytime appears to have been scheduled sometime in mid-January.

Participant 24

Table F-24. Summary of Key Survey Responses for Participant 24

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	No Setback	Baseline Survey
Baseline Temp Decision	Both	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per month, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Screenshots of programmed thermostat settings for Participant 24 are not available.

Figure F-70. Average Temperature Profile for Participant 24

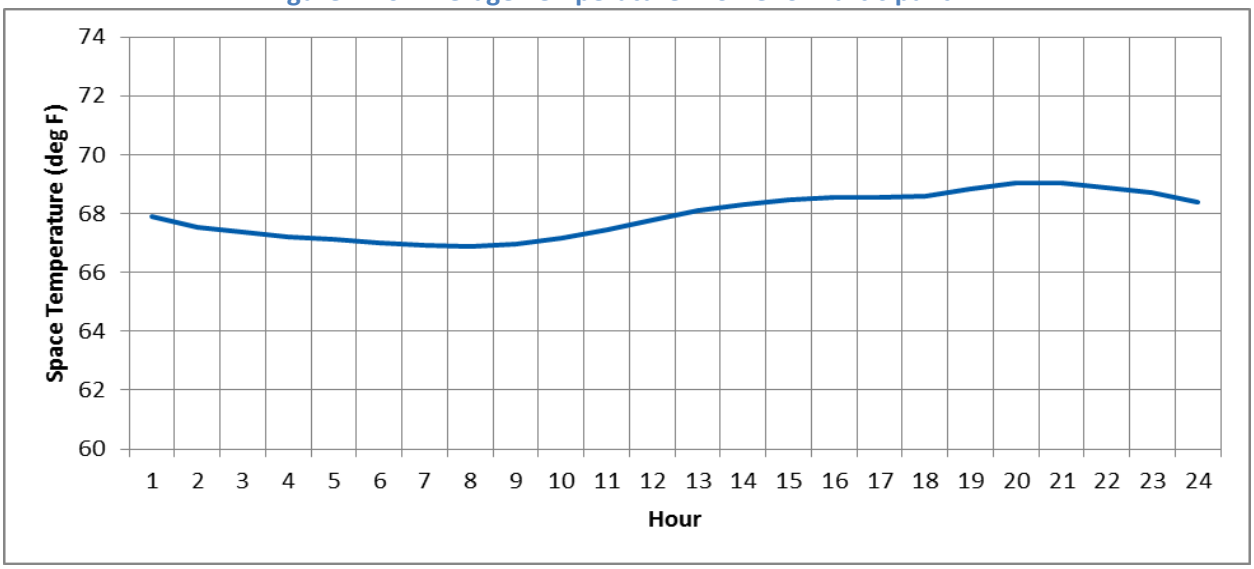
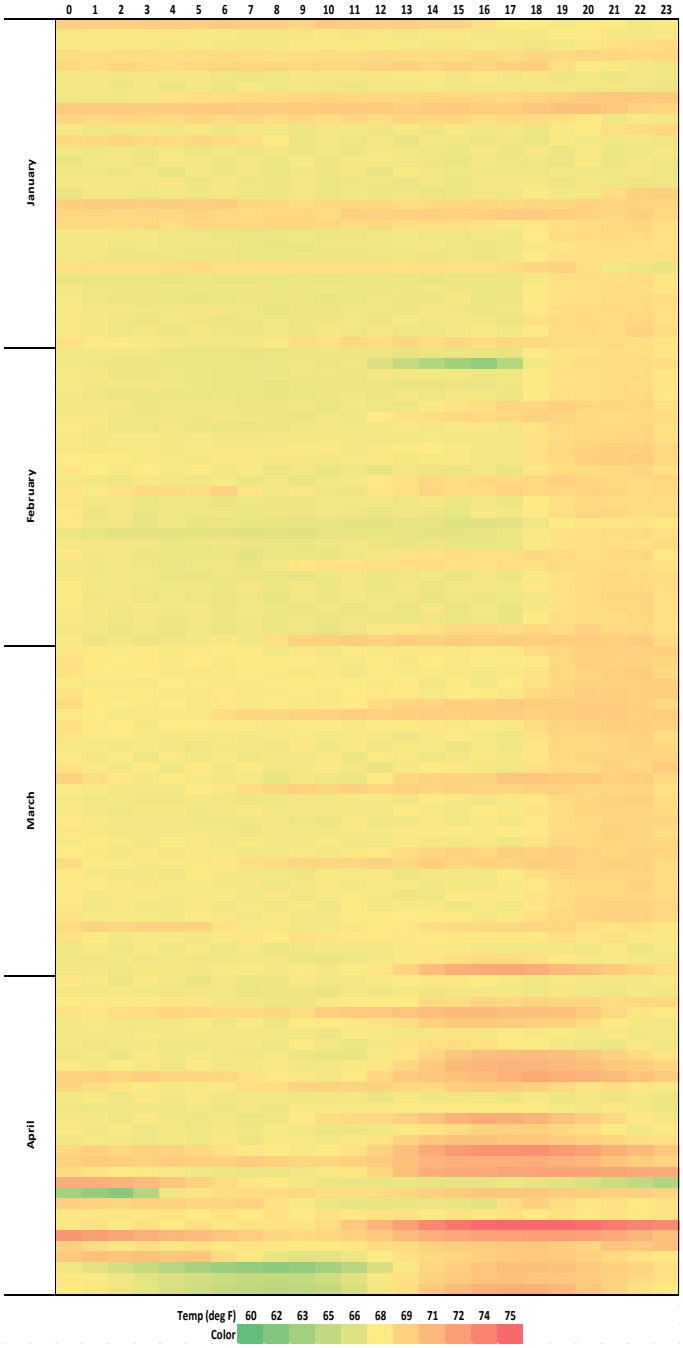


Figure F-71. Temperature Map for Participant 24



There is no significant setback period. At night, the temperatures increase several degrees from the mid to high 60°F's to the high 60°F's.

Participant 25

Table F-25. Summary of Key Survey Responses for Participant 25

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	No	Post-Study

Figure F-72. Screenshots of programmed thermostat settings for Participant 25, taken on January 7, 2013

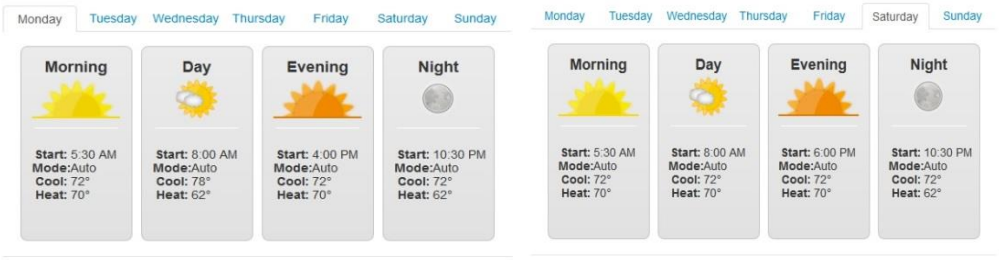


Figure F-73. Average Temperature Profile for Participant 25

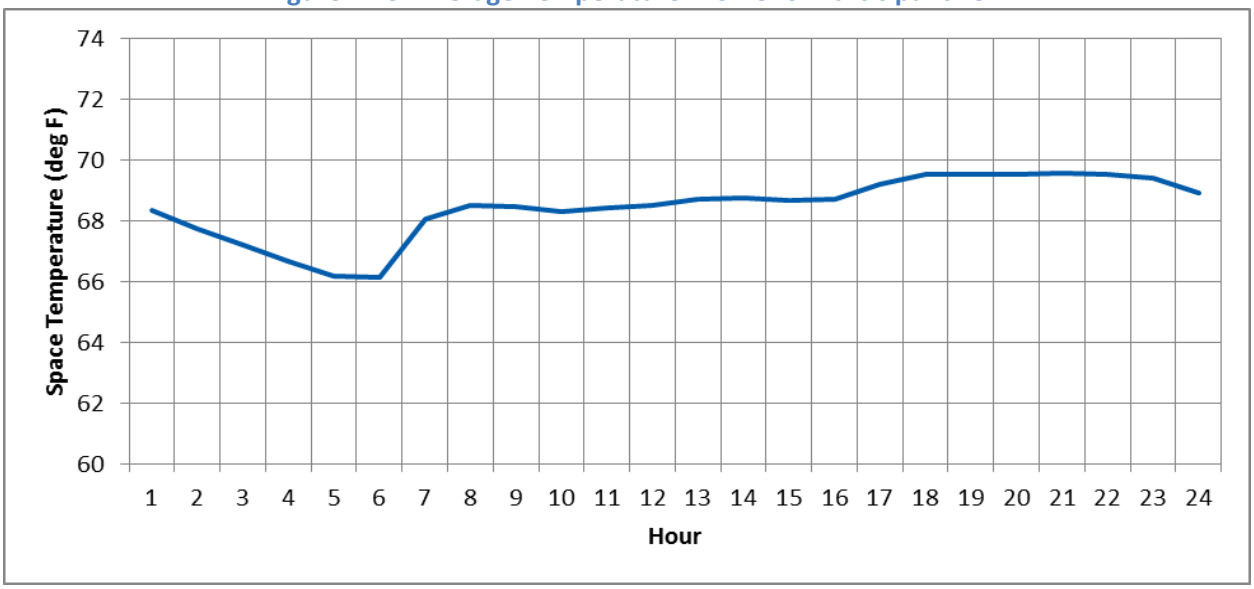
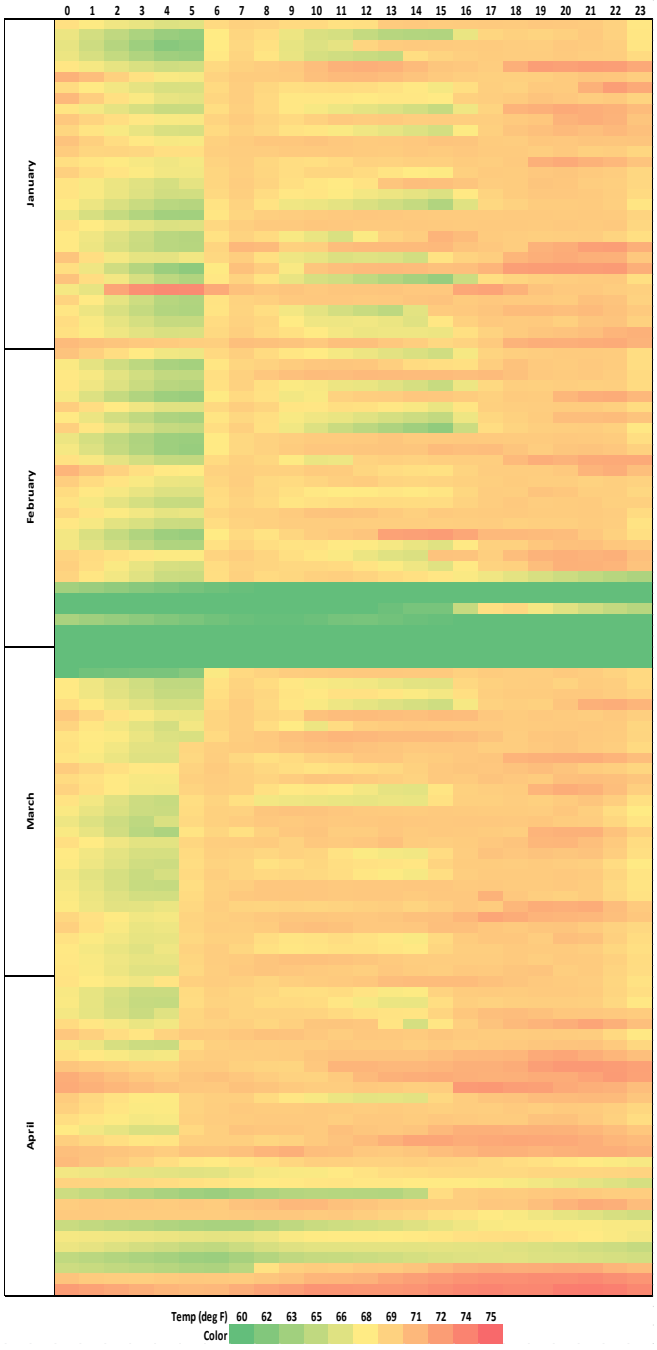


Figure F-74. Temperature Map for Participant 25



There appears to be one setback period at night in the low 60°F's. During the daytime, temperatures are usually in the high 60°F's and low 70°F's. There are several days in February where the temperature remains in the low 60°F's. The participant may have been on vacation during this period.

Participant 26

Table F-26. Summary of Key Survey Responses for Participant 26

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Manuel	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, very easy to set the schedule since we use the same every weekday	Post-Study

Figure F-75. Screenshots of programmed thermostat settings for Participant 26, taken on January 7, 2013

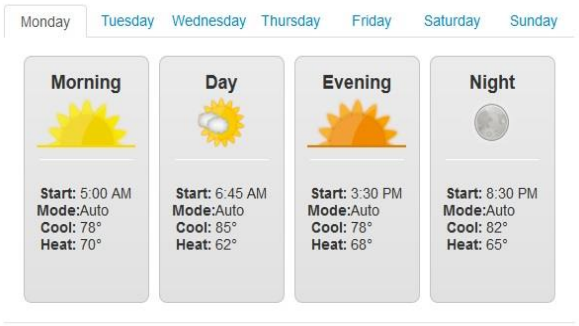


Figure F-76. Average Temperature Profile for Participant 26

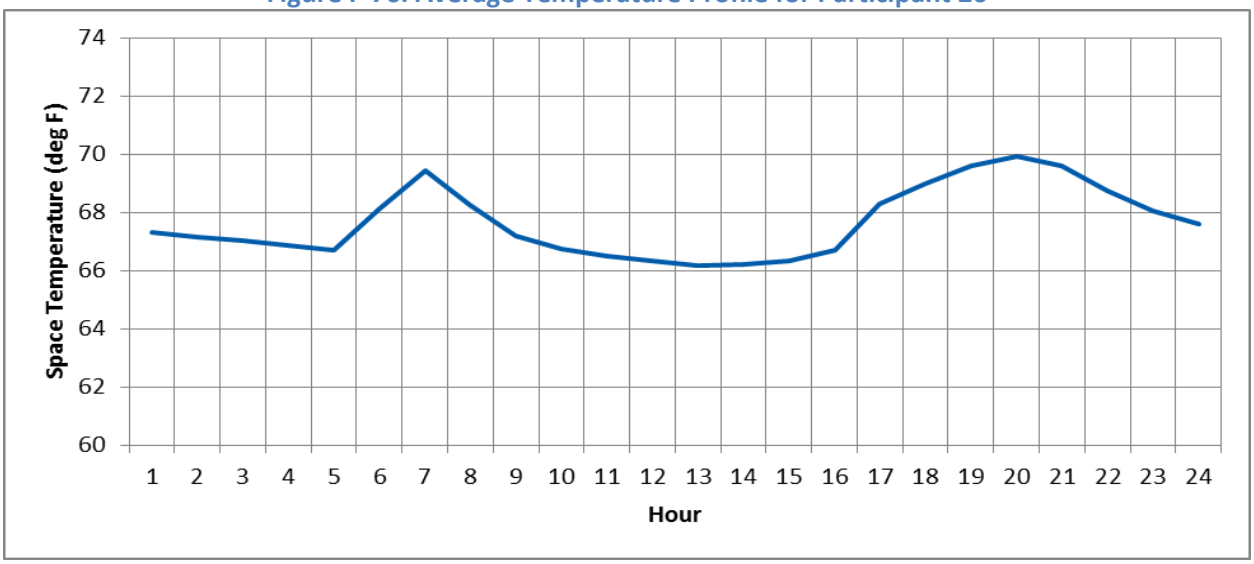
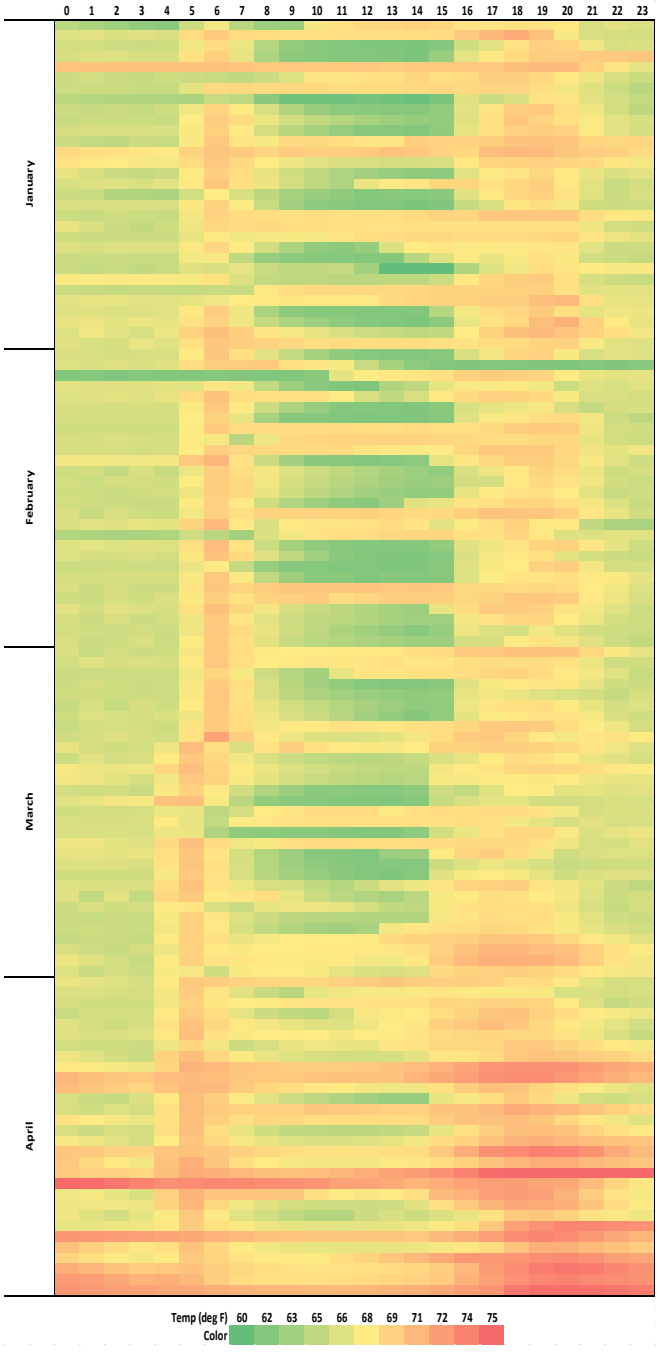


Figure F-77. Temperature Map for Participant 26



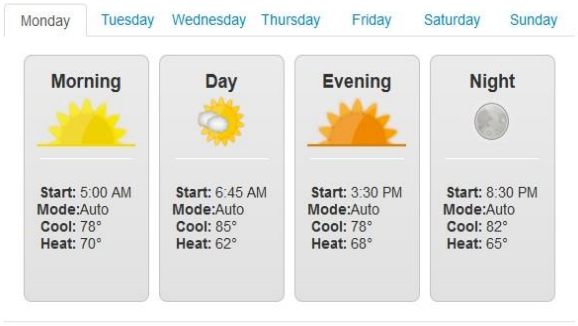
The participant appears to have two regular setback periods—at night and between the hours of 8am and 4pm.

Participant 27

Table F-27. Summary of Key Survey Responses for Participant 27

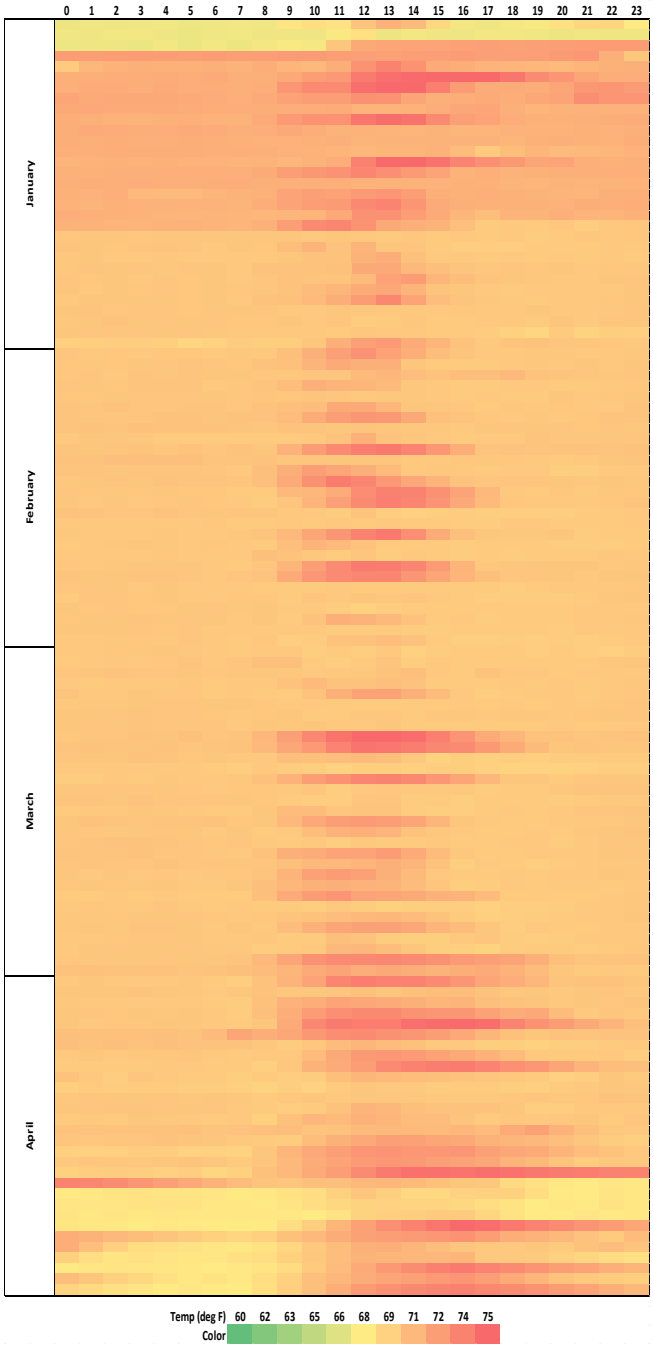
Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Single Setpoint	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	N/A	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Other	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, can do it by my phone when I'm not home	Post-Study

Figure F-78. Screenshots of programmed thermostat settings for Participant 27, taken on January 7, 2013



Average Temperature Profile for Participant 27 is not available.

Figure F-79. Temperature Map for Participant 27



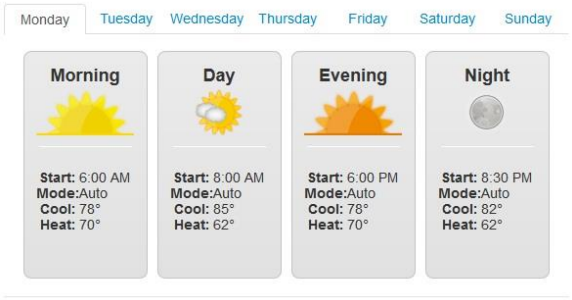
The participant does not appear to have a programmed schedule. Temperatures tend to increase from the low 70°F's to mid-70°F's during the day, but at inconsistent times.

Participant 28 (two thermostats)

Table F-28. Summary of Key Survey Responses for Participant 28

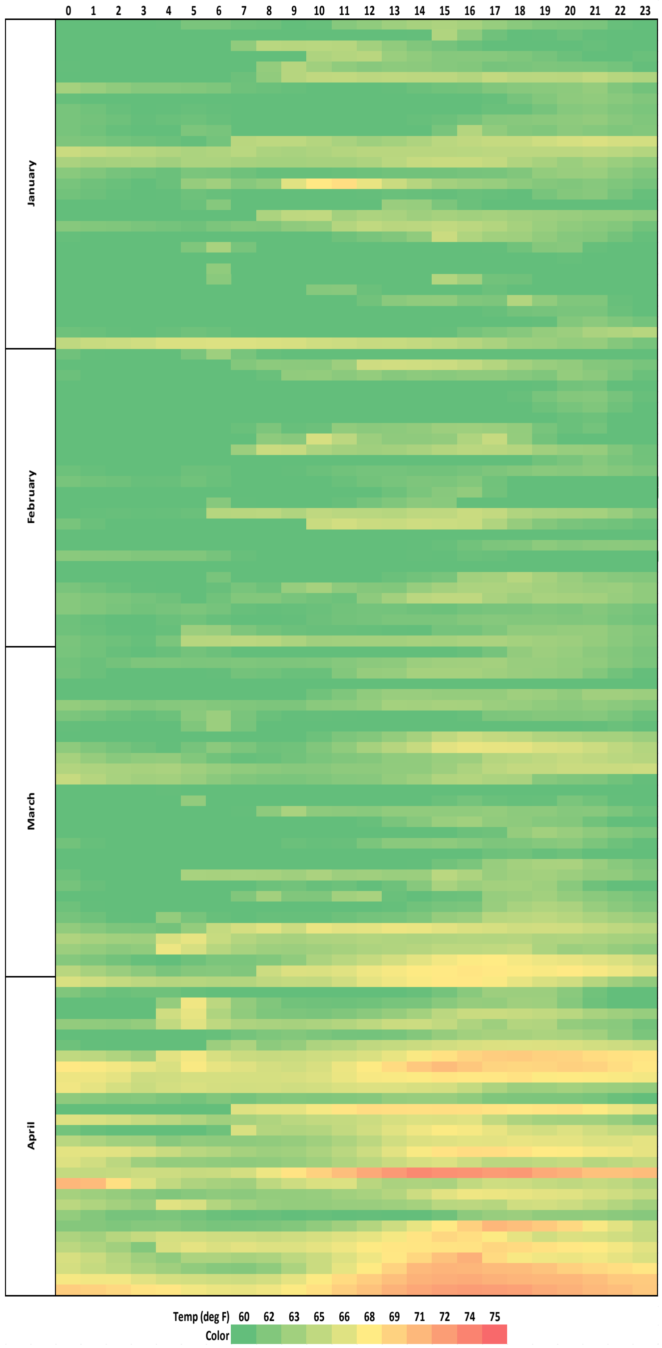
Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Comfort	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Once per day	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have increased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	More frequently	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, Touch screen makes it easier and very intuitive.	Post-Study

Figure F-80. Screenshots of programmed thermostat settings for Participant 28 (Thermostat 1), taken on January 7, 2013



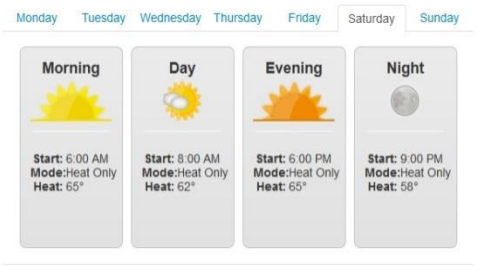
Average Temperature Profile for Participant 28 (Thermostat 1) is not available.

Figure F-81. Temperature Map for Participant 28 (Thermostat 1)



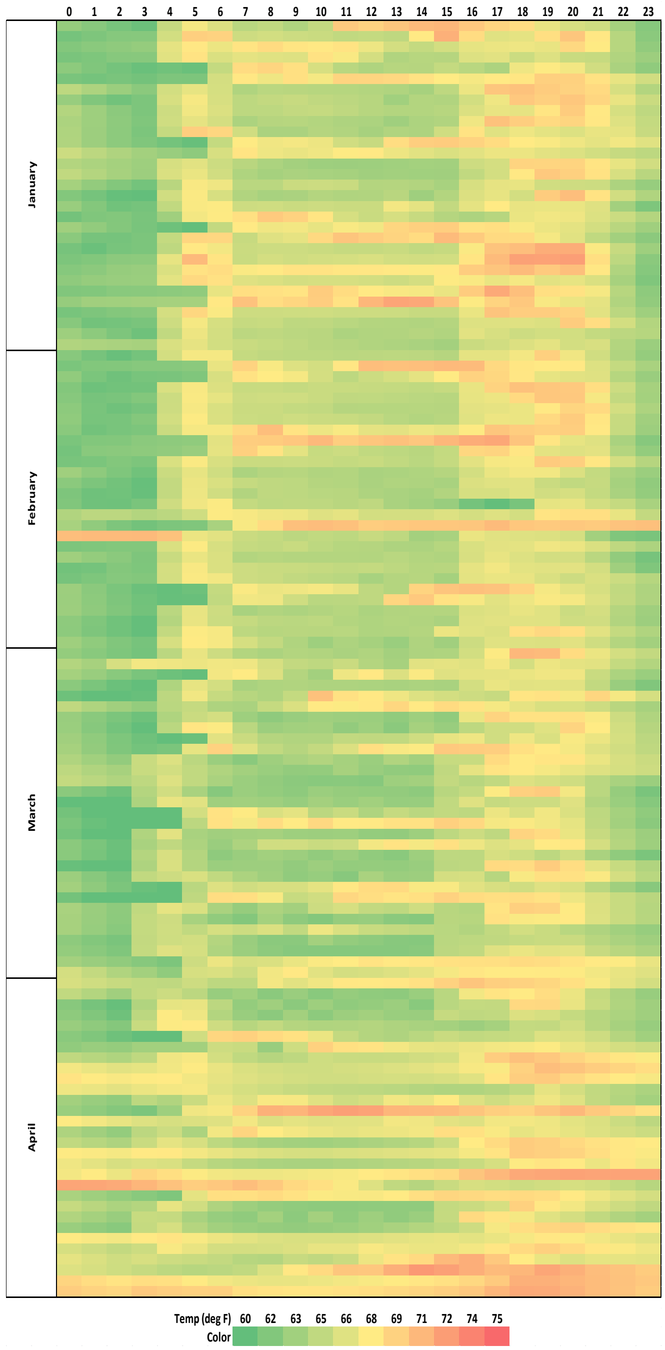
There does not appear to be a programmed schedule. Temperatures remain between the low 60°F's and mid 60°F's for the majority of the study period.

Figure F-82. Screenshots of programmed thermostat settings for Participant 28 (Thermostat 2), taken on January 7, 2013



Average Temperature Profile for Participant 28 (Thermostat 2) is not available.

Figure F-83. Temperature Map for Participant 28 (Thermostat 2)



The participant appears to have programmed regular setback periods at night and between the hours of 7am and 3pm.

Participant 29

Table F-29. Summary of Key Survey Responses for Participant 29

Survey Question	Survey Response	Survey Name
Baseline Thermostat Settings	Program	Baseline Survey
Baseline Vacation Settings	Setback	Baseline Survey
Baseline Temp Decision	Bill	Baseline Survey
How do you interact with the smartphone app?	Check temperature of outside/inside	Mid-Study
If you check your energy usage history, has this affected how you use the thermostat?	No	Mid-Study
Which of the following best describes how often you manually change your thermostat settings?	Several times per week, at most	Mid-Study
Since the Wi-Fi thermostat was installed, have you noticed a change in your energy bills?	Yes, my energy bills have decreased	Post-Study
Would you say you interact with your Wi-Fi thermostat more frequently, less frequently, or the same as you did with your standard programmable thermostat?	The same amount	Post-Study
Has the new Wi-Fi thermostat made it easier for you to set your thermostat?	Yes, remotely	Post-Study

Figure F-84. Screenshots of programmed thermostat settings for Participant 29, taken on January 7, 2013

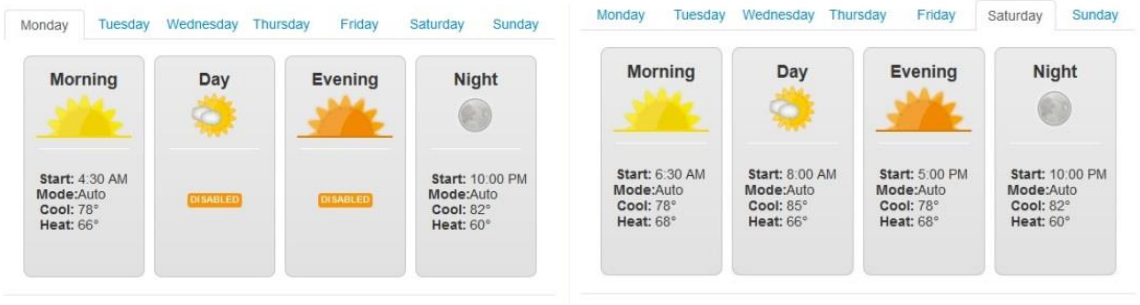


Figure F-85. Average Temperature Profile for Participant 29

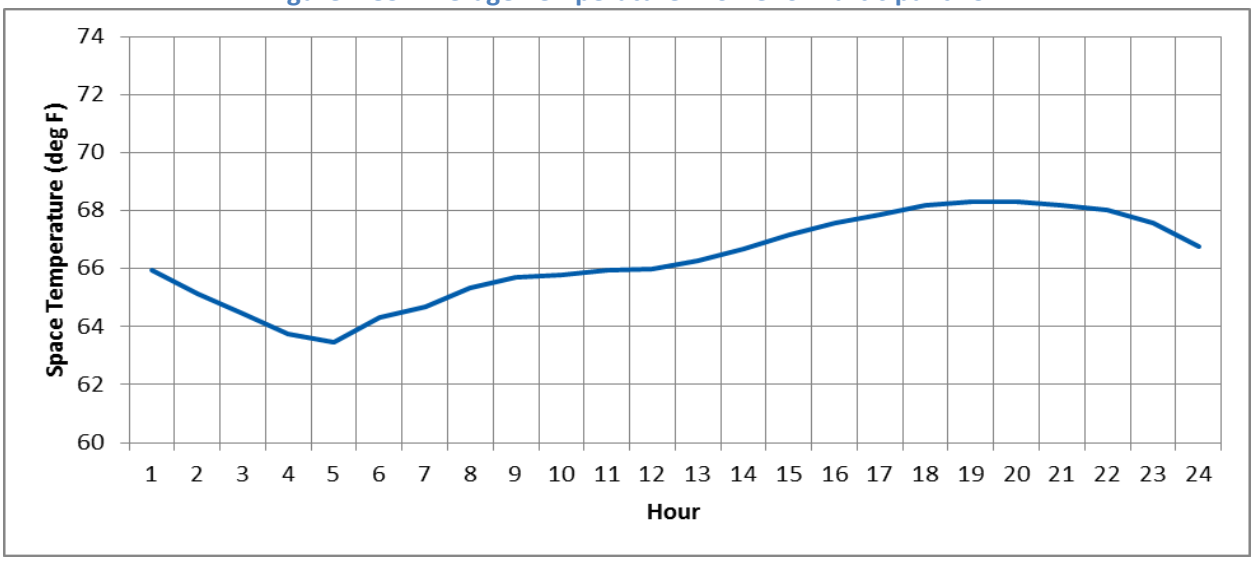
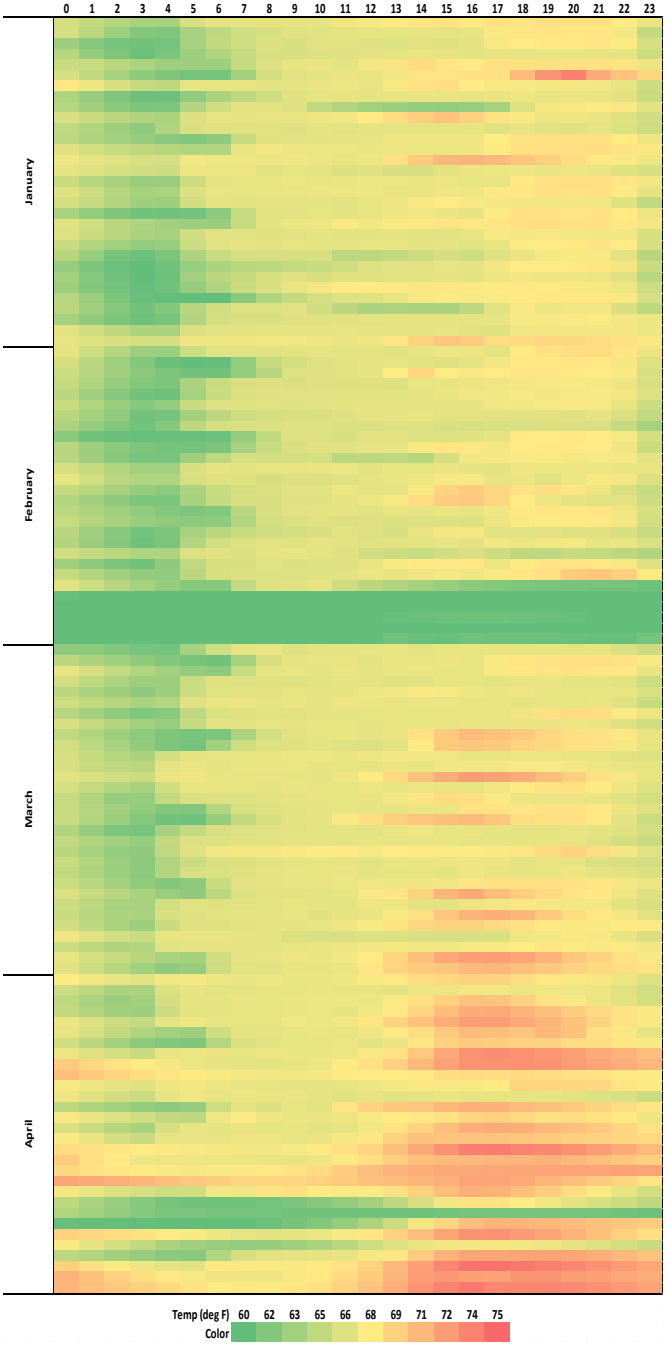


Figure F-86. Temperature Map for Participant 29



The participant appears to have scheduled one regular setback period at night. The setback period is extended on weekends. In February, there was a period where temperatures dropped to the low 60°F's for several days in the row. The participant may have been on vacation during this period.