Evaluation of Behavioral Strategies for Effective Use of Programmable Thermostats in Multifamily Affordable Housing

Draft Final Report - Prepared for NYSERDA

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Abstract

This paper describes a field experiment to test two behavioral interventions designed to increase the effective use of programmable thermostats by low-income tenants who pay for utility bills. The target behaviors included using set back schedules in the winter heating months at night when tenants are asleep and during the daytime when tenants are not at home. Both the treatment and control groups received programmable thermostats, and the treatment groups also received customized thermostat settings based on their stated schedules and preferences. One treatment group was asked to commit to keep using the schedules during the winter. The experiment was designed to determine whether or not households were more likely to use and maintain programed setbacks if those were programmed for the occupants by a third party and they were reminded to maintain their programmed schedules with a prompt. The experiment also tested whether tenants would be more likely to maintain their programmed schedules if they were asked to commit to doing so.

Keywords

Field Experiment; Thermostat set-points and schedules; Prompts; Motivation; Randomized Controlled Trial; Energy Savings; Low-Income multifamily programs.

Acknowledgements

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[1] (daytime and/or nighttime setback)

Acronyms and Abbreviations

NYSERDA	The New York State Energy Research and Development Authority
Energy – saving schedules	Setting back the thermostat temperature set
Control group	Programmable thermostats installed with written directions on how to program
Prompt group	Programmable thermostats installed with written directions on how to program, thermostat set back schedules programmed by third party according to the household schedules and temperature preferences, a sticker affixed to thermostat to remind the families to keep using the thermostat to keep comfortable and save money
Prompt + Motivation group	Same as the Prompt group, plus elicited signed commitment to maintain programmed schedules
AHA	Albany Housing Authority

Executive Summary

In cooperation with the Albany Housing Authority (AHA), Fraunhofer CSE led a field experiment to evaluate the effectiveness of two behavioral interventions to increase the effective use of thermostats in affordable housing. An earlier Fraunhofer field study that evaluated the use of temperature setbacks during the heating season (Sachs et al. 2012) found that a majority of households preferred higher indoor temperatures during daily or overnight occupancy than the prior ENERGY STAR set point of 70ºF or 68ºF, respectively. As a result, to make their houses more comfortable, most participants changed the thermostat settings instead of programming a new temperature set-point schedule that included setbacks. This motivated the design of the two interventions tested in this study.

The field experiment took place in a residential development located in North Albany, New York between November 21st, 2014 and March 7th, 2015. The research target population consisted of 160 income-qualified households who pay their own utility bills and live in duplex apartments. Tenants were encouraged to use programmed thermostat setbacks to keep their homes cooler when they were not at home during the day and overnight when they were sleeping to save on their heating bills during the winter while maintaining comfortable indoor temperature.

The experiment involved custom-programming treatment groups' thermostats based on their household schedules and temperature preferences. The randomized controlled field experiment was designed with three experimental conditions:

1. Control group: Occupants were provided programmable thermostats and written instructions on how to program the thermostat according to the households' schedules and temperature preferences. The research team visited each household and explained how using programmed settings can improve the wellbeing of the family by saving on heating costs and keeping homes safe, healthy, and comfortable.
2. Prompt group: In addition to the Control group treatment, the research team custom-programmed thermostats according to the households' schedules and temperature preferences. The research team also placed a sticker by the thermostat to encourage the occupants to return to their programmed settings if programmed schedules were interrupted. The stickers were placed near the thermostats to remind tenants that they could press "run" to return to their programmed schedule.
3. Prompt + Commitment group: In addition to the Prompt group treatment, the research team wrote down the households' schedules and temperature preferences and asked residents to sign a commitment document, promising to maintain the programmed thermostat settings.

Prior to implementing the experiment, Fraunhofer CSE organized two focus groups with participants from similar socio-demographic groups as the experiment population. The focus groups revealed that benefits of using programmed thermostat settings included keeping homes more livable, healthier and comfortably cooler during the night. Using programmed settings was considered to be the "smart thing to do" to address household comfort and achieve utility bill savings. Some negative aspects raised by the focus groups included the difficulty in accommodating varied household members' schedules and potential conflicts arising from differences in temperature preferences among household members.

Three concept stickers were also tested with these focus groups. Following the focus group insights, and in collaboration with NYSERDA's Project Manager, the key message of the sticker was designed to remind participants that (1) they could return to their schedules by pushing the "run" button and (2) using their programmed settings was about saving money on their heating bills and keeping their homes comfortable.

To ensure consistent implementation of the experiment, Fraunhofer CSE coordinated all site visits to the tenants' apartments before the beginning of the experiment (21st November, 2014) when thermostats and temperature data loggers were installed) and all communications with tenants.

All apartments occupied on November 2014 (n=159), were randomly assigned to one of the three experimental conditions by an external party (Research Into Action). Households had the option to opt-out of the experiment. In total, 130 households remained in the study: 45 in the "Control" group, 40 in the "Prompt" group and 45 in the "Prompt + Commitment" group. Twelve households, distributed evenly among the groups, opted out-of the study, but for the purposes of evaluation their data was included in the study, each in their assigned group, as recommended by Todd *et al.* (2012).

Temperature data loggers were placed on the walls near the thermostats and set to gather air temperature every 10 minutes. The site managers distributed the notices informing tenants of the schedule of the home visits, two days in advance. Finally, the research team, accompanied by members of the local crew, interviewed each household, following a script that was designed and pre-tested with a focus group. For all households included in the experiment, historical gas billing data was obtained from the start of each lease. At the end of the experiment, the data loggers were collected and the settings of the thermostats were recorded.

Results indicated that households in both treatment groups ("Prompt" and "Prompt + Commitment") used programmed thermostat schedules more frequently than those in the control group: the "Control" group used programmed settings 5 percent of the time; the "Prompt" group used programmed settings 35 percent of the time; and the "Prompt + Commitment" group used programmed settings 24 percent of the time. The analysis also showed significant differences between groups in the time taken to override the schedule. Eighty-three percent of the households assigned to the "Control" group that were using thermostat schedules at the time of the home visit canceled the schedule in the first day. The "Prompt" group took an average of 3 days after the initial home visit for a similar percentage of households (83 percent) to cancel their programmed schedules, and the "Prompt + Commitment" group took and average of 40 days after the initial home visit for a similar percentage (74 percent) of households to cancel their programmed schedules.

The "Prompt" and "Prompt + Commitment" groups also had, on average, significantly lower average daytime temperatures than the "Control" group ("Prompt" group = -0.7ºF and "Prompt + Commitment" group -0.3ºF). The "Prompt" group also had significantly lower average daytime temperatures than the "Prompt + Commitment" group ($p<0.001$). Similar patterns were found for average nighttime temperatures (-1.1ºF for "Prompt" group compared with the "Control" group and -0.8ºF for "Prompt + Commitment" group $p<0.001$). Energy savings were 2 percent for "Prompt" group and 1 percent for "Prompt + Commitment" group, which suggests that adding the written commitment to the Prompt condition wasn't more effective[2]. Overall the analysis shows that despite the majority of households in the "Prompt" group having canceled their programmed

[2] This may have happened because the behavior that we were trying to promote, i.e. pressing run to go back to the schedule, was easy to do (Goldstein et al., 2008).

schedules by the third day of the experiment, the "Prompt" group returned to using their programmed schedules and saving more energy on average than the other groups.

Based on the results of this research pilot, we recommend that NYSERDA and the New York utilities serving low-income populations through the EmPower Program custom-program thermostats for participating EmPower households according to occupants' schedules and temperature preferences and attach a sticker to remind residents to press "run" to return to their programmed schedules. In addition, we recommend piloting an enhanced version of the most successful condition in this experiment, the "Prompt" condition, to include a nudge recommending that households consider reducing their nighttime and daytime temperatures when occupants are asleep or away from home according to DOE's recommendation (-7º to -10ºF for 8 hours a day from its normal setting, Energy.Gov, 2016), and depending on local case by case circumstances[3], to increase the energy-efficiency savings.

[3] Local regulations could apply and specific circumstances should be considered, because for example, houses may have to be obligated to keep a specific indoor temperature, during the winter, to keep water pipes from freezing.

1. Introduction

1.1. Previous research

Programmable thermostats have reached the technical maturity that makes them a low-risk home energy management investment. If used effectively, they can achieve about a 1 – 2 percent reduction in energy use for each degree (ºF) reduction in nighttime set-point temperature (Nelson & MacArthur, 1978). While 40 percent of residential thermostats in use in the United States are programmable, the availability of programmability does not automatically lead to the use of programmed settings or energy savings. Home occupants must be motivated to program their thermostats and select energy-saving settings, such as nighttime and daytime temperature setbacks (Nevius *et al.*, 2000).

Thermostat usability has been suggested as another barrier preventing households from effective use of energy saving settings (Meier *et al*., 2011). Laboratory testing of programmable thermostats indicated a wide range of usability issues among six different thermostat models, demonstrating that poor usability may influence peoples' ability to operate energy saving functions of programmable thermostats (Meier *et al*., 2011; Sachs *et al.* 2012). Moreover, in a field study by Sachs *et al.,* (2012), owners of both high- and low-usability thermostats frequently overrode the pre-programmed Energy Star default temperature set-point schedules to achieve a comfortable temperature in their homes. Reasons for keeping the thermostat temperature settings on hold include not knowing how to easily resume programmed schedules (Meier *et al.*, 2011). More broadly, Sachs *et al.* (2012) noted that existing behavior change models (Fogg, 2009) indicate that three factors are necessary to enable behavior change: ability, motivation, and a prompt to remind occupants to use programmed settings.

In this field experiment, we custom-programmed renters' thermostats to fit households' schedule and temperature preferences. This aspect is a key design feature since we expected that custom-programming the thermostats for each household would remove one trigger (discomfort) to override the settings. Fogg's behavioral model includes motivation to do a behavior and a timely prompt to remind individuals to perform the behavior. In this field experiment, we included a commitment request to motivate occupants to keep their schedules, and a prompt was provided in the form of a sticker. In accordance with these models, this experiment tested whether

a) programming thermostats with the household's schedules and temperature preferences,
b) reminding the occupants to return to their schedules after they override the schedules and
c) eliciting a written commitment from the participants to retain the schedules, are successful approaches to promote the use of thermostat programmed schedule, in low income households.

Techniques used in community based social marketing (McKenzie-Mohr & Smith, 1999), including reciprocity, commitment, use of community networks, and prompts, were implemented in this field experiment. For example, individuals were expected to reciprocate by keeping the schedules, once those had been programmed with the preferred settings of the occupants. Participants were asked to commit to keep the schedules by signing a certificate, and stickers were used as prompts as a reminder of the desired behavior. We used existing community networks, Albany Housing Authority staff, to help deploy the experimental conditions.

1.2. Research hypotheses

They study was designed to investigate the following research hypotheses:

- Programming thermostats to residents' schedules and temperature comfort preferences will encourage residents to maintain their schedules.
- Asking participants to commit to keeping their programmed schedules will encourage residents to use their programmed schedules.
- A prompt will be successful in reminding residents to return to using their programmed schedules after they have interrupted their programmed schedules.

The study also hypothesized that if the field experiment was successful, the participants would save on their heating bills because their homes would be kept, on average, at a lower temperature when they were sleeping or away from home.

In sum, the goal of this study is to determine if the occupants belonging to the treatment groups "Prompt" and "Prompt + Commitment", as described above, who were provided with customized, programmed thermostat settings, were more willing to use energy-saving thermostat set-point temperature schedules than occupants in the control condition who did not receive customized settings or any other part of the behavior intervention. Residents in all three conditions were reminded via a sticker that they could return to their programmed schedules anytime by hitting the "run" button on their thermostats.

2. Pilot Design

2.1. Population and site

Participants were income-eligible tenants in a multifamily duplex housing development located in Albany, NY, the North Albany Homes development. The Albany Housing Authority manages the residential development, and tenants pay their utility bills. The North Albany Homes development includes 160 duplex apartments in 80 multifamily housing buildings (Figure 1) that were built in 2003 for income-qualified tenants. Each of the 180 homes is individually metered for gas and electricity and has programmable thermostats that tenants can adjust to control space heating.

Figure 1: Experimental site

2.2. RCT Design - Groups and intervention details

As a co-funding agency, NYSERDA actively participated in the design of the experiment. The field experiment consisted of a randomized control trial with opt-out recruitment (opt-out RCT). Research Into Action, an evaluation expert contracted by NYSERDA to provide independent evaluation review of the pilot's experimental design and evaluation results, randomly assigned the households to the experimental groups. As a co-funding agency, NYSERDA actively participated in the design of the experiment. The randomization methodology took into account the number of rooms in each home, the number of occupants, and the date of the start of the tenant's lease. All units rented on November 2014 were included in the pilot and randomly assigned to an experimental condition. Appendix A provides detailed information about the procedures followed in each condition.

To increase trust among the participating households, the researchers worked with existing community networks and trusted messengers (local maintenance crew, site managers) to engage with tenants and deploy the experimental conditions. The full support of the Albany Housing Authority significantly contributed to the success of the field experiment. The pilot also adopted its engagement style to the socio-cultural references and values of the target population. Focus groups were conducted in advance of the pilot in the Boston area with renters of similar socio-economic background (income-eligible) to the tenants in North Albany Homes. Focus group participants (n=13) were recruited on craigslist, rented their apartments, paid their own heating bills, and the majority (67%) could control the temperature in their homes. Focus group results showed that comfort, saving on utility bills, and keeping their homes comfortable were important to participants and considered the smart thing to do. For a more detailed explanation of the focus groups methodology and results, please refer to Appendix B.

2.3. Experimental Design

The field experiment design aimed to minimize any disruption of the target population's routines at home. This is because social processes and individual responses may be altered just by the mere fact that the subjects are aware of being observed[4]. If the Hawthorne effect existed, it was held stable across groups because the experiment was designed to obtain "naturalistic" responses from tenants to minimize its potential effect.

Privacy and benefits of participation

The tenants' privacy was protected by not disclosing any personally identifiable information (PII) or data collected from the participants (for example, household schedules). By participating, households could benefit by saving money during the heating season and learn conservation behaviors to help them reduce their utility bills year-round.

Minimizing the feeling of invasion of privacy

Using local maintenance crew to replace and program the thermostats helped minimize tenants' perceptions that their privacy was being invaded. The old thermostat dial Honeywell models (Figure 2) were replaced by programmable models (Honeywell FocusPRO 6000), and temperature sensors (Onset HOBO U12-011 and Onset HOBO U12-012HOBO) were installed beside the thermostats in the same relative position (distance to the floor and distance to the thermostat) in each unit (Figure 3). The maintenance crew joined the researchers during the field interviews and distributed interview notices (please refer to Appendix B for specific details about the implementation methodology).

Standardized interview procedures

All interaction with participants was scripted and standard procedures used to decrease variability introduced in the interviews.

2.3.1. Opting out

Residents could opt-out from the study by denying access to their unit or refusing to be interviewed. Because the Albany Housing Authority had successful communication channels already established with the residents, their collaboration and agreement to disseminate information were critical to the success of the experiment It also gave a sense of "normality" and business as usual to features that were not the focus of the experiment (i.e., replacement of the thermostats, installation of temperature sensors, gathering utility data release forms, being the point of contact during the test, and disseminating information to the tenants). These procedures were essential to minimize the Hawthorn effect and the number of drop-outs.

[4] Social scientists have observed that the subjects of experimental research can change their behaviors under the presence of the research team. This effect is called the Hawthorne effect and has the tendency to dissipate as the influence of the researchers disappears (Babbie, 2007).

2.3.2. Data acquisition plan and thermostat replacement

The temperature data loggers were configured to record data every 10 minutes and were installed by the site maintenance crew before deployment of the behavioral interventions to: a) minimize the potential discomfort of the tenants from strangers installing unfamiliar pieces of equipment in their homes; b) increase the success rate of sensor installation, and c) create a baseline of temperature data before the field-behavioral intervention.

Figure 2: Dial thermostat (non-programmable)

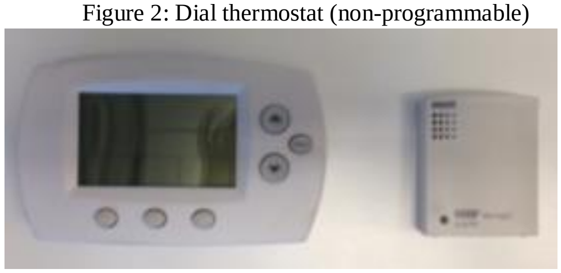

Figure 3: Programmable model and HOBO temperature data loggers

2.3.3. Deployment and recruitment actuals

Following the typical communication protocols between the Housing Authority and the tenants, the tenants received a notice, two days in advance of the field-work, informing them that two representatives would visit their residence between 10:00 am and 7:00 pm to confirm their thermostats were operating correctly. These visits followed the interview script included in Appendix C. In total, 142 families were recruited into the study. Successful recruitments are shown in Table 1, while Appendix D summarizes the main characteristics of participant homes.

Table 1: Summary of counts per group.

Groups	Control	Prompt	Prompt + Commitment
Effective recruitments	45	40	45
Opt-out	4	4	4
Opt-out (%)	9%	10%	9%

The temperature data loggers (Onset HOBO U12-011 or U12-012) measured the ambient temperature (ºF) adjacent to the thermostat. Temperature measurements were taken every ten minutes, between November 14th, 2014 and March 7th, 2015. The accuracy of the data loggers was evaluated in a climatic chamber, which changed temperatures at specific intervals between 64ºF (17.8 ºC) and 88ºF (31.1 ºC). (Appendix E describes the experimental procedures used to determine the data loggers were sufficiently accurate to measure differences in indoor temperature.) The evaluation confirmed that the data loggers were operating within the variability range established by the vendor (±0.63ºF or 0.35ºC) at that temperature range. Again, during the field deployment, one tenth of the data loggers were tested using an ONSET HOBO U-Shuttle and validated to be operating correctly. At the end of the experiment, the data loggers were removed.

2.4. Group equivalency checks

2.4.1. Characteristics of the experimental groups

During the first interview, tenants were asked a series of questions to help determine their household schedules and temperature preferences. According to the data of the first interview, 98 percent of the tenants in the "Control" group, 87 percent in the "Prompt" group, and 95 percent in the "Prompt + Commitment" group reported that they did not use schedules and for that reason the temperature of the houses remained constant (Figure 4).

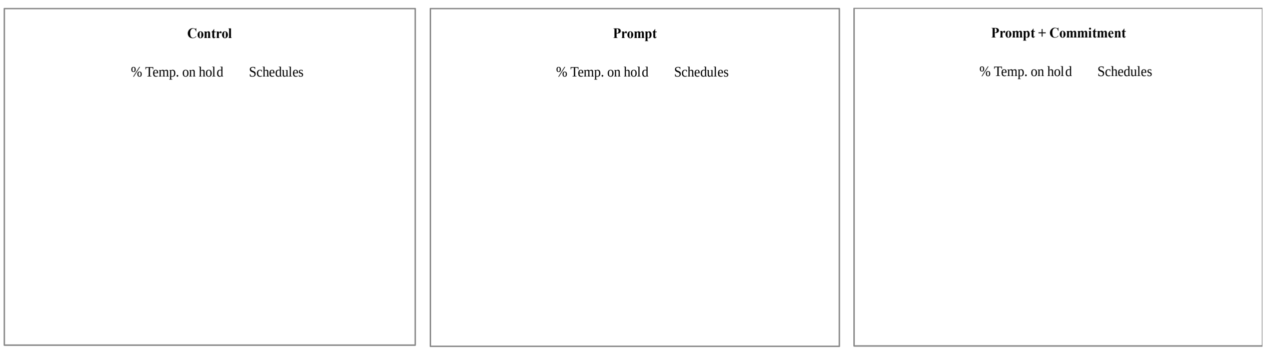

Figure 4: Percentage of occupants that report keeping thermostat temperature on hold during the winter

When asked about the daytime temperature they considered comfortable, tenants in the "Control" group reported average temperatures of 73ºF, tenants in the "Prompt" and "Prompt + Commitment" groups reported 72ºF (Table 2). In response to the question "What is a comfortable temperature in your home during the night?" Control group respondents reported 68ºF, on average, while the tenants in the "Prompt" and "Prompt + Commitment" groups responded 69ºF (Table 3). Tenants reported they generally make changes manually to their thermostat temperatures, using the arrows of the thermostat to increase or decrease the temperature and then pressing hold.

Table 2: Self-reported comfort preferences during the day

	Control (ºF)	Prompt (ºF)	Prompt + Commitment (ºF)
Min - Max	64-80	65-80	68-80
Average	72.0	72.4	72.6
Stdev	3.5	3.8	3.2
Trimean	72.2	72.3	73.8

Table 3: Descriptive statistics of self reported comfort preferences during the night

	Control (ºF)	Prompt (ºF)	Prompt + Commitment (ºF)
Min -Max	62-77	62-77	60-76
Average	70	69	69
Stdev	4	4	4
Trimean	71	68	71

Eight percent of the tenants in the “Control” and “Prompt” groups claimed to use programmed schedules and zero percent in the “Prompt + Commitment” group claimed to use programmed schedules. However, according to the results of the survey, the occupants rarely programmed those preferences into their thermostat unit. Regarding sleeping habits, tenants on average reported that the last person in the house typically goes to sleep around 10:00PM and the first person to wake up in the morning typically does so between 6:00AM and 6:30AM. Figure 5 and Figure 6 summarize time-to-go-to-bed, and time-to-wake-up, as a percentage of the total number of responses, for each group.

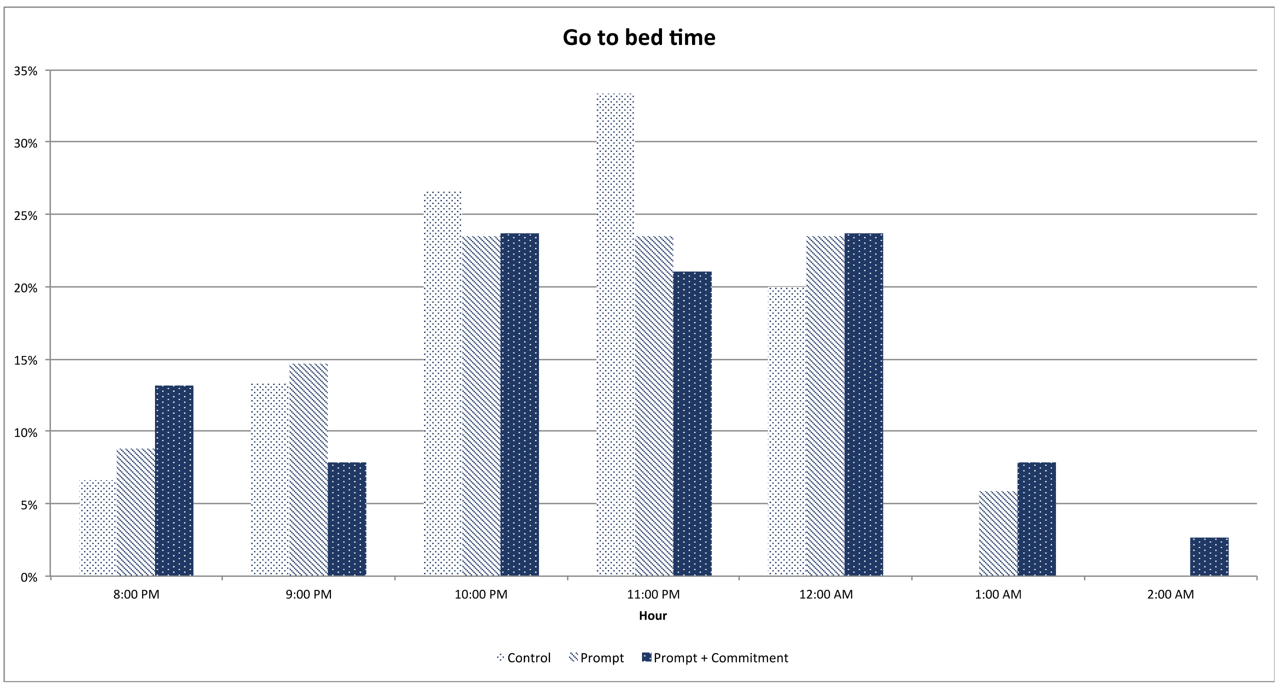

Figure 5: Time when last household member goes to bed at night as a percentage.

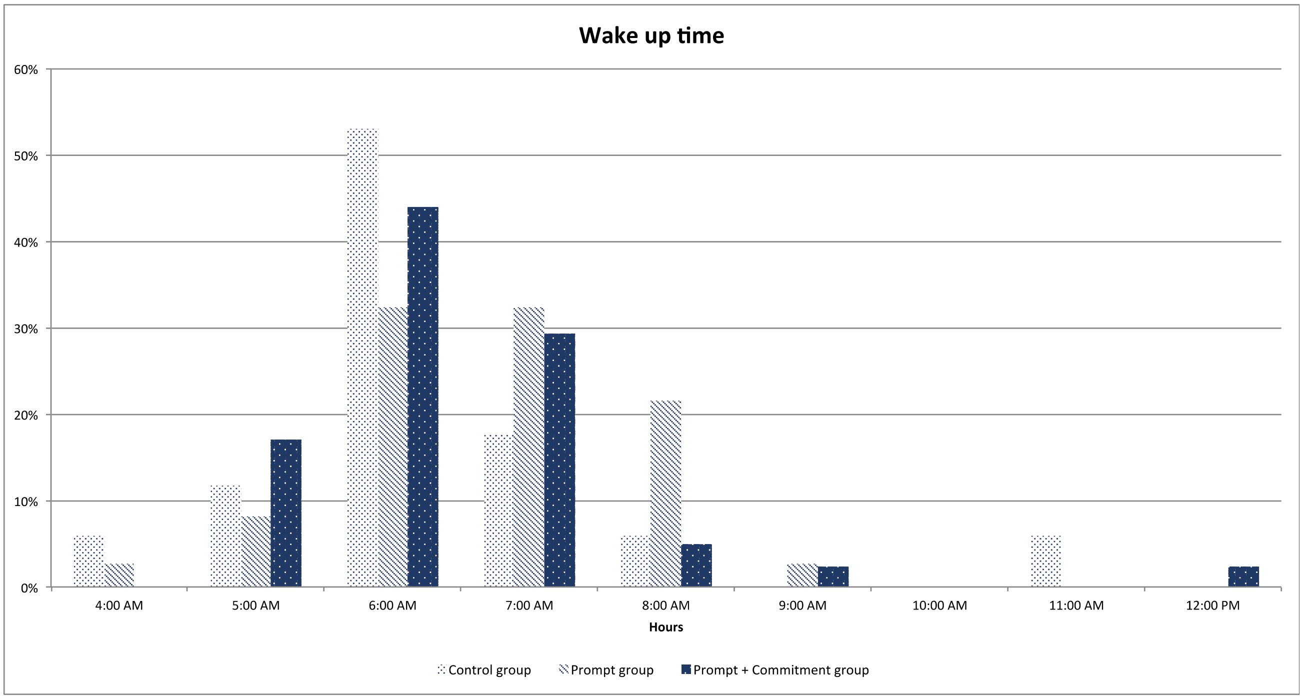

Figure 6: Time when first household member wakes up in the morning as a percentage

2.4.2. Analysis of baseline indoor temperature during the period before the start of the experiment

The baseline period between the installation of the temperature sensors and the beginning of the interviews (November 14th until November 20th) is the pre-treatment energy consumption period. Because not all households had sensors installed at the same time, it was difficult to evaluate similarities/differences between groups during the baseline period. The installation did not follow any project specific order and happened randomly across groups. The three datasets that were collected from the baseline period showed similar upward tendencies and homogeneity (Figure 7). An average daily temperature below 65ºF was collected on November 14, which increased to an average daily temperature value of 70ºF between November 15 and 17, depicting the impact of a steady increase in the average temperature. Between November 18 and 20, the average temperature of each group increased considerably, to an average of 73ºF for the "Control" group and 72ºF for the "Prompt" and "Prompt + Commitment" groups.

The Levene test (Table 4) confirmed the homogeneity of the variance between groups, and the one-way ANOVA model indicates that the groups appeared similar before the beginning of the experiment (p-value is > 0.05).

Table 4: Evaluation of the group similarities before the beginning of the experiment

Levene test results			ANOVA test results				
Df	**F value**	**p-value**	**Df**	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>F)**
2 ,18	0.1548	0.8577	2	0.159	0.0795	0.0097	0.9903

*p<0.05, ** p<0.01, ***p<0.001

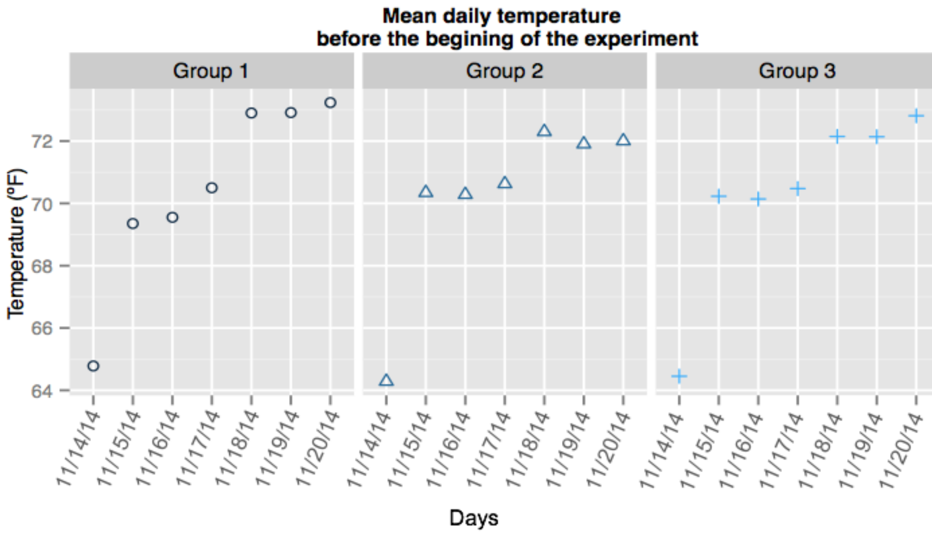

Figure 7: Average daily temperature, per group, before the start of the experiment

3. Analytical Approach

At the end of the pilot data collection period, the temperature sensors were removed and the temperature datasets uploaded to a PostgreSQL (release 9.4, version 1.2) database. The statistical package used in the analysis was R version 2.14.0 (R Foundation for Statistical Computing; Vienna, Austria).

3.1. Method to evaluate the differences in the number of days each group used programmed thermostat schedules

The indoor temperature datasets were used to determine if the thermostats were programmed to follow a schedule. Regular patterns in the dataset are easily recognized when the data is plotted against time. Typical regular patterns are illustrated in Figure 8.

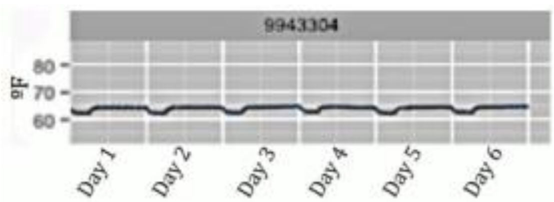

Figure 8: Nighttime temperature setback pattern with morning temperature recovery: temperature drop at 12:00AM

A supervised clustering algorithm (K-means) was used to determine the main "clusters" or time dependent temperature patterns in each home. The clusters represent a typical (average) day for a specific pattern and those patterns were compared with the schedule and comfort temperature narrated by the occupants in the beginning of the experiment (for more details about the method refer to Appendix F).

3.1.1. Method to evaluate the time to override the schedules

The time that each household took to override the schedules for the first time was determined by the number of days it took households to change the schedules that were programmed for the "Prompt" and "Prompt + Commitment" groups by the research team during their visits. To keep the intervention homogeneous across groups, the interviews were administered across the three groups. The apartments in the control group that were running thermostat schedules at the time of the visit were included in the analysis.

3.2. Evaluation of the differences between groups regarding average indoor temperature between groups

The researchers determined whether the interventions encouraged households to keep their homes at lower temperatures during the winter by using several different statistical approaches. To do so, the data were segmented in day and night periods and normalized. ANOVA parametric procedures helped establish the statistical significance of the differences that emerged in the analysis discussed in the following section.

3.3. Modeling energy savings

To calculate the average energy savings in each group, the researchers relied on the findings of Fels, M. F. (1986), who reports a linear relationship between household heating energy and the difference between indoor and outdoor temperatures.

The model takes into account the average daily temperature, for each unit and the average outdoor temperature, according to equation 1, where AveTindGx is average indoor temperature for Group x {“Prompt” group or “Prompt + Commitment” group}; AveTindG1 is average indoor temperature for “Control” group; and AveTout is average outdoor temperature.

$$\left[1 - \frac{AveT_{indx} - AveT_{out}}{AveT_{indG1} - AveT_{out}}\right] \qquad \text{Equation 1}$$

4. Results

4.1. Analysis of the number of days each group used thermostat schedules

Following the clustering procedures previously discussed (and described in detail in Appendix F), the number of days that each home used programmed schedules was determined and is reported in Table 5. The "Prompt" group used programmed schedules for the largest proportion of time (37 percent), followed by the "Prompt + Commitment" group (25 percent). In comparison, the "Control" group maintained programmed schedules for 6 percent of the experimental period.

Table 5: Total number of days in the experiment and number of days in schedule

Dataset	Total number of days in the experiment per group	Number of days in schedule per group	% in schedule
Control group	5293	298	5.6%
Prompt group	3408	1248	36.6%
Prompt + Commitment group	4141	1020	24.6%

We also calculated the average proportion of days participants in each group utilized programed schedules during the experimental period. The descriptive statistics of that series is described in table 6.

Table 6: Descriptive statistics: percentage of total days with thermostat[5] schedules

Group	Min	Max	N	Median	Mean	Std. Dev
Control group	0	0.75	48	0.08	0.15	0.19
Prompt group	0	0.99	48	0.21	0.28	0.28
Prompt + Motivation group	0	0.87	44	0.21	0.28	0.26

Results show a sharp median difference between treatment and control, indicating that the "Prompt" and "Prompt + Commitment" groups had a strong response to the treatment. However, because the data violated the normality assumptions, it had to be transformed.[6] The final analysis[7] confirms the differences between treatment and control groups (Table 7), however, analyses did not reveal a statistically significant difference between the two treatments (Table 8).

Table 7: Statistical differences between groups about consistent use of schedules

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.20	0.07	3.06	0.00**
Groups	0.09	0.03	2.85	0.00 **
RSE	R^2	R^2_{adj}	$F_{1,138}$	*p-value*
0.30	0.06	0.05	8.12	0.00***

[5] (daytime and/or nighttime setback)

[6] The first procedure was to evaluate the dataset for evidence of homogeneity of the variance and autocorrelation. The common procedures are the Levene and Durbin-Watson tests, respectively. With a p-value<0.05 the Levene test indicates that the variance is not homogenous among groups, and with a (D-W=0.8, *p-value*<0.0), we infer that the residuals appear somehow positively correlated. These results violate the assumptions of the ANOVA, therefore the data was transformed, using Tukey's ladder of powers (square root). According to the Bartlett's test, the variances of the resulting dataset are homogeneous (K-squared = 1.2 < $_{Ktab,2df}$ (5.99, p-value 0.53).

[7] ANOVA model and the Games-Howell post-hoc procedure to account for different sample sizes.

Table 8. Two by two comparison

Groups	*t*	Df	*p-value*
"Control" vs. "Prompt" groups	2.38	92	0.050*
"Control" vs. "Prompt + Commitment" groups	2.97	89	0.011*
"Prompt" group vs. "Prompt + Commitment" groups	0.44	90	0.897

*p<0.05, ** p<0.01, ***p<0.001

To summarize, the results indicate a statistically significant difference in the number of times households in the "Prompt" and "Prompt + Commitment" groups used programmed schedules in comparison with the "Control" group.

4.2. Analysis of the time to override the schedule

The research also analyzed the time each treatment group took to initially override their thermostat schedules. The majority (83 percent) of the "Control" group overrode their programmed schedules on the first day after the home visit and manually changed the temperature to suit their preferences. This indicates that the "Control" group's programmed schedules were not consistent with household members' comfort preferences and schedules. The same number (83 percent) of households in the "Prompt" group initially overrode their custom-programmed thermostat schedules within three days. In contrast, it took the "Prompt + Commitment" group almost 40 days to achieve a similar percentage (74 percent) of overrides. A small percentage of homes kept using schedules throughout the experiment (seven percent of households in the "Prompt" group and nine percent of households in the "Prompt + Commitment" group). Finally, we observed that despite the majority of households having canceled their programmed schedules early in the experiment, the majority of households in the "Prompt" group returned to using their programmed schedules in the course of the experimental period.

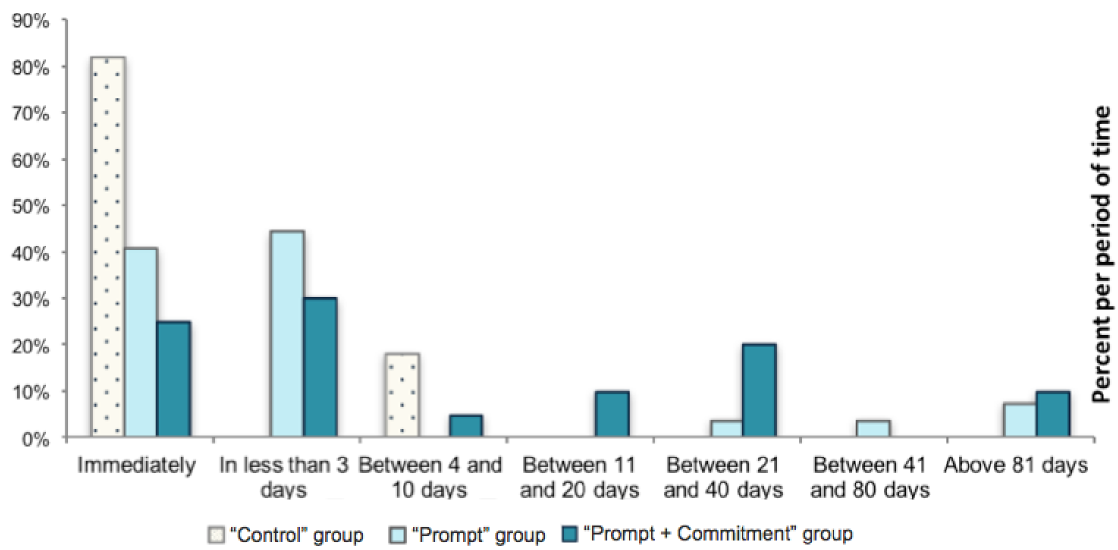

Figure 9: Frequency of overrides (y-axis), per group, for specific periods of time (x-axis)

4.3. Differences in average indoor temperature

ANOVA methods were used to examine whether there was a statistically significant difference in average indoor temperature between groups. The datasets were split into two periods of the day: "daytime", the period of the day ranging between 7:00AM and 4:50PM, and "nighttime", the period ranging between 10:00PM and 6:50AM[8]. The period of the day between 5:00PM and 10:00PM was excluded from the analysis.

4.3.1. Average indoor temperatures during the daytime period

The results indicate the household temperatures of the "Prompt" and "Prompt + Commitment" groups were, on average, slightly cooler during the day than for the "Control" group. Specifically, households in the "Prompt" group kept their homes on average 0.69ºF cooler and the households in "Prompt + Commitment" group kept their homes on average 0.29 ºF cooler than the "Control" households. The Tukey test suggests there is a statistically significant difference between the "Prompt" and the "Prompt + Commitment" groups, with the latter keeping their homes 0.4ºF warmer during the day than those in the "Prompt" group.

4.3.2. Average indoor temperatures during the nighttime period

Participants' survey responses indicated that the occupants move to and remain in their rooms during the nighttime period. With a p-value of 0.79, the Levene test indicates that the variance is statistically homogeneous among the groups. Households in the "Prompt" group kept their homes 1.1 ºF cooler than in the "Control" group and households in the "Prompt + Commitment" group kept their home 0.8 ºF cooler than the "Control" group. According to the Tukey test the households in the "Prompt + Commitment" group kept their homes slightly warmer on average temperature than households in the "Prompt" group (0.3 ºF warmers).

4.4. Supporting Findings

4.4.1. Second house visit: Record temperature and thermostat settings at the end of the experimental period

The local maintenance crew and the Fraunhofer CSE research team visited the apartment units a second and final time at the conclusion of the data collection period. During this visit, the research team determined if the homes were using programmed schedules at the time of the visit and recorded the temperature settings of the thermostats. The team observed differences in the use of programmed schedules and thermostat temperature settings between groups (Table 9). The "Prompt" and "Prompt + Commitment" groups had, on average, lower

[8] Those setback periods were in agreement with the interviews, and were periods of the day when the majority of the occupants reported being asleep or away during the day.

average daytime and nighttime temperatures in comparison to the “Control” group’s. Using chi-square statistics, the proportions between the “Prompt” and “Prompt + Commitment” groups were compared. The results (Table 9) indicate[9] that the differences between the “Control” and “Prompt” groups are statistically significant with the “Prompt” group having a significantly higher proportion of thermostats using programmed schedules. The differences between the “Prompt + Commitment” and the “Control” groups were not statistically significant.

Table 9: Analysis of the use of schedules at the time of the exit interview

	Control	Prompt	Prompt + Commitment
Households with schedules	3	12	10
Total	45	40	45
	Two by two comparison		
Yates corrects for small sample size	“Control” *vs.* “Prompt”	“Control” vs. “Prompt + Commitment”	“Prompt” *vs.* “Prompt + Commitment”
Chi-squared	6.4	3.2	0.3
Df	1	1	1
p-value	**0.01***	0.072	0.56
Chi-squared Tabulated	3.8	3.8	3.8

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

4.4.2. Modeling energy savings from the pilot

This section reports the estimated energy savings associated with the treatment groups. The calculations took into account the average differences between inside temperature and outdoor temperature, according to equation 1, section 3.3. During the experimental period, the average outdoor temperature was 23.9ºF. The results indicate that the “Prompt” households used 1.8 percent less energy on average than the “Control” households, and the “Prompt + Commitment” households used 1.1 percent less energy on average than the “Control” households over the heating season.

Table10: Percent savings for “Prompt” and “Prompt + Commitment”

Experimental Groups	Average indoor temp daytime (ºF)	Average indoor temp nighttime (ºF)	Average indoor temperature (ºF)	% Savings
Control	73.6	74.1	73.8	
Prompt	72.9	72.9	72.9	1.8%
Prompt + Commitment	73.3	73.3	73.3	1.1%

9 p-value < 0.05 and Chi-square calculated value above the tabulated value

5. Conclusions

The behavioral interventions consisted of various combinations of installing programmable thermostats in tenants' apartments, custom-programming tenants' thermostats according to the households' schedules and temperature preferences, providing stickers to prompt households to return to their programmed schedules, and asking households to voluntarily commit to using their programmed schedules.

This study examined whether custom-programming households' thermostats according to the occupants' schedules and comfort temperatures and providing a sticker to remind households that they can easily go back to using their programmed schedules when overridden, would result in increased the use of programmed thermostat schedules and household energy savings was upheld. Participants who received custom-programmed thermostat settings and a prompt in the form of a sticker used thermostat settings more than participants in a control group who received neither intervention, and their average daytime and nighttime indoor temperatures during the winter were significantly cooler than participants in the control group.

The study also examined whether asking participants to voluntarily commit to using programmed schedules in addition to custom-programming households' thermostats, and providing a reminder sticker would result in an increased the use of programmed thermostat schedules and energy savings compared to participants who were not asked to make a commitment. Results indicated that the commitment intervention was not a significant motivator to increase use of programmed schedules. However, the households that committed to maintain their programmed schedules took more time to initially override their programmed thermostat settings.

6. Recommendations

This field experiment shows that custom-programming thermostat schedules for low-income renters encouraged greater use of programmed schedules compared with renters who did not receive custom-programmed thermostat schedules. Further, renters who received custom-programed thermostat settings and used less energy during winter heating months than renters who did not.

Mismatches between default thermostat setpoints and household members' temperature preferences are a common barrier to the effective use of programmable thermostats. The results of this study show that custom-programming thermostat settings can help renters overcome this barrier. The results of the experiment show that custom-programming thermostats and using language that reminds household members that using programmed schedules is the "smart" thing to do to keep comfortable and save on energy bills during the winter, and that it is easy to "do the right thing" by simply pushing "run" to get back to their programmed schedules leads to greater use of nighttime and daytime temperature setbacks and lower average indoor space temperatures.

The results of this research show that it is possible to help low-income families take advantage of the energy saving features of thermostats and still remain comfortable during the winter. This research demonstrates the value of programing thermostats according to the occupants' schedules and to remind the occupants that they can keep control over their home and suggests that it is possible to help low-income residents save resources and money on utility bills.

Strong collaboration with the Albany Housing Authority was imperative to access the target population, because the Albany Housing Authority enabled an opt-out project design with a low opt-out rate (~10 percent), minimizing the effect of potential self-selection bias. This is an example of the importance of establishing local partnerships with reputed members (or organizations) of the local community, to support the diffusion of programs that rely on some kind of disclosure of sensitive information about the household occupants, under penalty of raising unnecessary concerns of safety and loss of privacy. We recommend future implementers to carefully study the target population, and local social-cultural and demographic context, before designing the details of the deployment of any measure that involves the disclosure of private information.

We recommend exploring how the successful interventions demonstrated in this pilot can be implemented in direct install low income energy efficiency programs. Specifically, we recommend that the successful interventions from this pilot be implemented in the EmPower New York Program, a direct install low income energy efficiency program managed by NYSERDA. We finally recommend piloting an enhanced version of the most successful condition in this experiment, the "Prompt" condition, to include a nudge recommending that households consider reducing their nighttime and daytime temperatures when occupants are asleep or away from home according to DOE's recommendation (-7º to -10ºF for 8 hours a day from its normal setting), and depending on local case by case circumstances10, to increase the energy-efficiency savings.

[10] Local regulation could apply, for example, to keep pipes from freezing.

7. References

- Babbie, E. (2007) The Practice of Social Science Research, 11th edition. Thomson-Wadsworth.
- Energy.Gov Energy Saver. The Internet: http://energy.gov/energysaver/thermostats. Assessed in August 2016.
- Fels, M.F. (1986). “PRISM: An Introduction.” Energy and Buildings 9, pp. 5-18.
- Fogg, B.J. (2009). “Creating Persuasive Technologies: An Eight-Step Design Process.” Presented at Persuasive’09, Claremont, California, April 26–29.
- Goldstein, N. J., Cialdini, R. B., & Griskevicius, V.. A room with a viewpoint: Using normative appeals to motivate environmental conservation in a hotel setting. Journal of Consumer Research (2008).
- McKenzie-Mohr, D. and Smith, W. (1999) Fostering Sustainable Behavior: An Introduction to Community Based Social Marketing. New Society Publishers, Jan 1, 1999 - Business & Economics. 160 pp.
- Meier, A., Aragon, C., Peffer, T., Perry, D., & Pritoni, M. (2011). Usability of residential thermostats: preliminary investigations. Building and Environment, 46, 1891- 1898.
- Nelson, L., & MacArthur, J. 1978. “Energy Savings through Thermostat Setbacks.” ASHRAE Transactions 83 (1): 319-333.
- Nevius, M., & Pigg, S. (2000). Programmable Thermostats That Go Berserk: Taking a Social Perspective on Space Heating in Wisconsin. Proceedings of the 2000 ACEEE Summer Study on Energy Efficiency in Buildings, 8.233-238.244.
- Sachs, O., Tiefenbeck, V., Duvier, C., Qin, A., Cheney, K., Roth, K. (2013). Field evaluation of programmable thermostats.U.S. Department of Energy, Energy Efficiency & Renewable Energy, Building Technologies Program.
- Todd, A., Stuart, E. and Goldman, C. (2012). Evaluation, Measurement, and Verification (EM&V) for Behavior-Based Energy Efficiency Programs: Issues and Recommendations. ACEEE Summer Study on Energy Efficiency in Buildings. 2-306 - 2-321.

8. Copyright for Intellectual Property

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Appendices

9. Appendix A: Focus groups Scripts and Results

Prior to implementing the experiment, the research team conducted two focus groups. The main objectives of the focus groups were to align the team's conversational referents and wording of the materials used in the project with the values and attitudes of the target population, we conducted two focus groups.

The focus group participants (n=13) were recruited on craigslist, came from the Boston area, rented their apartments and paid for utilities, and the majority (n=8) stated they could control the temperature in their homes. Focus group participants had similar socio-economic background (income-eligible) to the tenants in North Albany Homes.

Focus Group Scripts

Welcome, filling out forms, signing and collecting consent forms

(Begin at INSERT TIME/DATE)

Welcome to Fraunhofer. My name is XXX. Thank you for volunteering to participate in this focus group. The purpose of this focus group is to understand how you heat your homes and hear about things that are important to everyone. We will ask questions about your household's daily schedules, and preferred temperatures at night when you are sleeping and during the day when you are away from home. I will also ask if the cost of heating your home is about right or too much.

I will be your facilitator today- and this is XXX – who will assist me and take notes. In terms of your payment for participating today—we will mail you a check for 25 dollars after today's focus group. *(Collect forms)*

Ground rules

We will be here together for approximately 90 minutes so let's establish a couple basic rules. First, there is no right or wrong answers and each of you will likely have differing points of view of comfort preferences and daily routines. Please silence or turn off your cell phone before we begin. The restrooms are located out the door to the left. Before we begin, does anyone have any questions? *[hand out and recover the W2]*

Section 1: Breaking the ice

To start, we invite you to interact with these thermostats. Select the model that most closely resembles the thermostat you have in your home.

[*Allow participants to discuss and talk about thermostats. If there is a lull in the conversation, rely on these questions to facilitate conversation*]

- Tell us a little bit about your experience with heating your home during the winter.
  - Who gets too cold, who gets too warm?
  - How do you reach an agreement?
  - Who controls the thermostat?
- Is there anything that bars you from using the programmable settings of your thermostat?
- Tell me about your heating bills, do you feel you're paying too much? Has this changed lately? What do you do to reduce these bills?
- Do you program your thermostat to automatically change over the course of a day? Week? Do you use 7-day settings that include different schedules during the week and weekend?
- How does the weekend change your everyday habits/ how different are weekends from weekdays?
- If you had a small child would you want your home to be warmer than if you didn't have a small child in the house?
- Would you like it if someone came to your home to help program the thermostat?

Section 2: Salient beliefs

Eliciting salient beliefs regarding attitudes, social norms and control over the behavior. Target behavior shall be "heating your home at different temperatures during the day, when not at home, and overnight". We expected to understand the drivers and the barriers towards performing the behavior and understand latent familial conflicts.

Now, we will ask questions concerning your attitudes and beliefs towards how you heat your home.

What are some of the pros and cons of heating your home at different temperatures every day?
What do you enjoy/not enjoy about heating your home at different temperatures?
What would it make easy or difficult to heat your home at different temperatures?
What do you like/dislike about heating your home at different temperatures?

Section 3: Envelopes

This exercise was about finding the values that appeal to the target community —We explained that it is possible to save between 10% and 15% in heating bills by decreasing the temperature of the house, during the day, when the house is unoccupied, and at night. And asked participants to order some sentences or create their own arguments to convince a friend or family member to use programmable schedules.

We will now ask you to open the envelopes that are in front of you. In the envelopes, you will find a few statements. Imagine you are talking with a friend, and explaining that it is possible to save 10% to 15% just by reducing the temperature of the house when it is unoccupied and at night. Which of the following statements in the envelope do you think would make the most sense to your friend? Please arrange the statements in order with the first being the most important. And remember, that you don't have to use all of the sentences, you can make your own too.

Section 4: Stickers

[Place sticker options on the wall]

Figure 10: Stickers that were tested during the focus group

[Hand out worksheets]

Please rank the images from your favorite (1) to least favorite (3), and, for each sticker, write a few sentences in response to the following questions:

Can you please explain, with your own words, the meaning of the message on the sticker?
What do you like about each image?
What do you dislike about each image?

Section 5: Survey

PI: Our discussion is now over and the last thing that I need you to do is to fill out this quick survey that will take less than 5 minutes. This is a survey about the temperature(s) in your apartment now and this **winter**.

1. What time does the last person in your home go to bed?
   i. ___:___ am / pm
2. What time does the first person in your home get up in the morning?
   i. ___:___ am / pm
3. What is a comfortable temperature for you in the morning?
   i. ____˚F
4. Are there usually people home during the day?
   1. ☐ Yes ☐No
5. What is a comfortable temperature for your home at night?
   i. ____˚F
6. Do you turn down your thermostat before going to bed?
   i. ☐Yes, often ☐ Yes, sometimes ☐ No ☐Don't Know
7. Do you wear sweaters or sweatshirts at home in the winter? Do the other members of your household (also) wear sweaters or sweatshirts at home in the winter?
8. Number of people who live in your household : ______
9. How old are the people that live in your home? _______Other comments (optional):
10. What language do you speak most of the time at home?___________________________________

Materials: Pens; Consent forms; Tape Recorder; Notepad; Thermostats; Business cards – contact information; Copies of the survey; Worksheets

Main findings

Group discussion and individual work revealed that the majority of participants don't use thermostat schedules, but would turn the heat up or down manually or would keep the temperature on hold all day. The most common thermostat was the dial model, with which residents appeared to be very comfortable. A common argument to support the habit of keeping the house at the same temperature all day, brought up by participants that had programmable models, was that the heating system took time to heat the space. Familial tension over different thermal comfort preferences and variable familial schedules, were issues commonly raised by heads of household who used overnight schedules.

When asked about what strategies other than programmable thermostat settings they use to help keep the home comfortable and use less electricity/gas, participants mentioned weather-stripping the house and using the oven to heat the house.

Table 11, recaps the beliefs about keeping the home at lower temperatures when not at home and at night. Most participants mentioned saving money and comfort as an incentive to using schedules. Another participant mentioned making the house more livable, comfortable, healthier, and cost effective. The advantage of programming the thermostat is to not to have to worry about remembering to turn the temperature of the home up or down.

Participants referred to the fact it was disadvantageous to have to wait for the house to cool down or heat up as a consequence of using thermostat schedules. In addition, participants noted that different people have different comfort preferences; so suggesting a latent conflict between occupants about what is a comfortable temperature. Participants stated it was irritating to have to change the temperatures or having to remember to change the temperatures. Finally, in general, participants think that it is too complicated and time consuming to program a thermostat.

Issues were perceived in opposite perspectives. For example, "comfort" was seen as an advantage of programming thermostats, because the house is kept at a comfortable temperature during the night (cooler) and during the day, when the occupants are not home, but it could also be perceived as a disadvantage for the use of thermostat schedules, because of the pressure of family members with distinct preferences of thermal comfort. In this case, we analyzed the context to extract the emergent barrier or driver, instead of just focusing on the word.

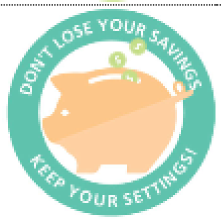
Table 11: Beliefs about keeping the home at lower temperatures when not at home and during the night

Advantages	Disadvantages	Like	Dislike
Don't worry about it	Waiting for house to cool or warm up	Comfort	Changing the settings
Save money		Forget about it	Too complicated
Save money	Requires you to change the temperatures	Stay comfortable	Dislike the noise made by the heating system coming online
Stay comfortable	Different people have different comfort preferences	Cost-effective	Waiting for system to start
No need for heat if no one is there		Save money	Price
Control costs	Irritating	Home feels more livable	Have to program the thermostat
The bill	Time-consuming	Healthier	
Allows for different activities	Having to remember		Being too hot/cold
Cost-effective	Constantly changing temperature		
Having to change the temperature	Remembering to change the temperature		Paying more in winter
Control costs			Dealing with others

Participant feedback about the sticker / prompt

The research team developed and tested three potential "prompt" stickers with the focus group participants. They were asked to explain in their own words what the stickers meant, to explain what they liked or disliked about each sticker, and to rank the stickers, one being the highest order and three the lower. The results are summarized in Table 4. We used the focus group feedback to inform the design if the sticker that was used in the experiment.

Table 12: Feedback about the sticker study

Choices		How do participants perceive the message of the sticker	*What do participants "like" about the sticker*	*What do participants "dislike" about the sticker*
	***First***	*"It is about keeping the house warm when people are at home" "Smart choice"*	*"Straight to the point" "I like the house" "Doing the smart choice was perceived as positive"*	*"Message not very clear"*
	***Second***	*"It is about saving money by using programmable schedules"*	*Straight to the point"*	*"The pig"*
	***Third***	*"It is about not wasting money"*	*"Putting money back in the bank"*	*"The pig" "Message is not very clear"*

The insights helped understand emergent principles and design elements that would be more effective in communicating with the target population, for example: targeted and actionable messages easy to understand, favorable self-perception (people like to perceive themselves as smart), and the concept that routines are flexible. The piggy bank concept was abandoned for the motive of the house.

Figure 11: Project Sticker / prompt and placement of the prompt in the data logger

In collaboration with the NYSERDA PI, the key message of the sticker was designed to remind participants that they could return to the schedule, by simply pushing a button (actionable behavior), which circumvents changes in routine. In parallel, thermostat schedules help residents to act smart, by keeping their homes comfortable and saving on utility bills.

Appendix B: Implementation Details

The details about the implementation of the field experiment are summarized in Table 13 and described with detail in the paragraphs below:

- ***Setup stage***: The maintenance crew installs the temperature data loggers in each unit, on the wall by the thermostat; the individual ID number of each data logger is assigned to the address where the sensor was installed; programmable thermostats are installed in place of non-programmable models. This stage occurred primarily between the 14th and 21st of November, while 10 percent of data loggers were installed later (until the 4th of December).
- ***Communication with tenants***: The site managers send a notice to the tenants informing them that their homes would be visited by staff, to attend to issues related with the operation of the thermostat and household comfort. The notices include the possible dates and times of the visits. No reference that could compromise the effect of the randomized allocation of homes to treatment conditions is given about the study. For example, the notices didn't explain that the visiting crew could schedule the thermostats. To avoid issues of mistrust, the researchers made an effort to be accompanied at all times by members of the maintenance crew. When the interviews had to occur after hours, (after 4:00pm) the team had to rely on hired temps, affiliated with the housing authority, who performed the introductions, and helped dissipate any discomfort or suspicion.
- ***Deployment***: A team composed of a researcher and a representative of the housing authority[11] visits the homes and interviews the tenants. During the interview the tenants are asked to describe a typical weekday and weekend, particularly focusing on when occupants are home. The interview focuses on the wake up, leave, return and sleep schedules of the families, to better fit the schedules to the lifestyles of the occupants. The interview is conducted to obtain both the approximate schedules and temperature comfort band of each family, for each time of day. The team explains how the programmable thermostat operates, and makes sure that instructions are visibly placed behind each thermostat. For Group 2 (Ability) tenants are offered the chance to have the thermostats programmed according to the occupant's schedules and comfort preferences. A sticker is placed on the temperature sensor, by the thermostat to remind occupants that they can hit the RUN button to go back to using thermostat schedules. In addition to the interview and actions that take place with Group 2, the homes that were assigned to Group 3, are asked to commit to keep the schedules that were programed in the thermostat according to their individual preferences, with a signature. The team relied on conversational scripts that had been carefully designed and tested beforehand to prevent contamination between groups.
- ***Recovery*** of data loggers and final visit: During the second visit to each unit, the data loggers recovered from each unit are tagged with labels that cross-reference the sensor with the address of the household, for additional validation of the preliminary assignment of sensor references to addresses. The team records the thermostat settings, that is, the existing temperature set-point schedule settings of the thermostat for each unit.

[11] Temporary workers available through the low income employment database resources of the housing authority

Table 13: Treatment conditions

Experimental Groups	**Control**	**Prompt**	**Prompt + Commitment**
Interviewer obtains information about the wake, leave, return and sleep schedules and comfort temperatures	x	x	x
A leaflet explaining how to setup the thermostat is left by the thermostat; team highlights the "hit run" function of the thermostat	x	x	x
Team explains that it is possible to keep the home warm in the winter when occupants are home and still save energy and money	x	x	x
Team programs the thermostat schedules and temperatures according to the preferences of the occupants		x	x
Team places a sticker in the temperature sensor that reminds occupants to "hit RUN" (button on the thermostat) to go back to using schedules		x	x
Occupants are asked to sign a commitment to keep using the thermostat schedules during the winter. Document contains reference to the schedules and comfort temperatures reported.			x
Interviewer retrieves sensors from the wall and records temperature settings from thermostats	x	x	x

Appendix C: Interview Scripts

Control group home interview script

Hi, I'm _____(name) and this is _____ (name) and we are visiting you today to check if your thermostat is working properly and to replace it with a programmable thermostat if needed.

The programmable thermostat can help you avoid wasting money this winter by heating your home when you are sleeping or when no one is home. Did you know that setting your heating temperature 10 degrees lower than your daytime setting when occupants of your apartment are sleeping, and setting your daytime temperature 10 degrees lower when no one is at home, can potentially save you up to 20% on heating bills?

We want to help you to lower your heating bills. The first step is figuring out the hours when your household is asleep and the hours when no one is home. The second step is determining what is a comfortable temperature for you when you are home.

[Interview]

Now, that you have a good idea of what your normal schedule is like, you can use this information to program your thermostat. The temperature settings you choose for the times when you and members of your household are home and not sleeping should be the temperature you prefer for your personal household comfort.

[Record previous settings of thermostat]

Here are the instructions to help you program your thermostat

[Show instruction behind the thermostat or place the spare instructions behind the thermostat]

You will need to program your thermostat if you want it to automatically change the temperature settings based on your household schedule. If you need to adjust the programmed temperatures, you can do this manually. For example, if someone comes to visit and asks you to turn up the temperature, you can do that and the new temperature will be in effect until the time of your next programmed temperature change (for example at 11 pm if that's when you go to bed). But if you press HOLD, it will maintain that new temperature until you press RUN and then it will return to your programmed settings. So you just need to remember to press RUN to return to your programmed settings.

This temperature monitor [show sensor on wall] will record the temperature inside your unit. This will help determine if the thermostat is performing, as it should. You don't need to do anything with it. We're going to check both the temperature monitor and the programmable thermostat now. We want to make sure they're working like they're supposed to.

[Fill in the top of the document (HOBO record number and household code]

- Great! Thanks for your time! We'll return in March 2015 to make sure your thermostat is operating properly and to remove the temperature monitor. We will send you a notice to let you know when we will visit you in March.

[If they ask to explain how to program the thermostat ...]

Part of this project is to get residents to program their thermostat themselves. Here are the instructions to program your thermostat. [show instructions]

Prompt group home interview script

Hi, I'm _____(name) and this is _____ (name) and we are visiting you today to check if your thermostat is working properly and to replace it with a programmable thermostat if needed. The programmable thermostat can help you avoid wasting money this winter by heating your apartment when you are sleeping or when no one is home. Did you know that setting your heating temperature 10 degrees lower than your daytime setting when occupants of your apartment are sleeping, and setting your daytime temperature 10 degrees lower when no one is at home, can potentially save you up to 20% on heating bills? We want to help you to lower your heating bills. The first step is figuring out the hours when your household is asleep and the hours when no one is home. The second step is determining what is a comfortable temperature for you when you are home. And we will use this information to program your thermostat for you.

[Interview]

Now we have a good idea of what your normal schedule is like so we can make sure you and your household will be comfortable. The temperature settings you choose for the times when you and members of your household are home and not sleeping should be the temperature you prefer for your personal household comfort. [Record previous settings of thermostat. Program / adjust new settings on thermostat]. If you need to adjust the programmed temperatures, you can do this manually. For example, if someone come to visit and asks you to turn up the temperature, you can do that and the new temperature will be in effect until the time of your next programmed temperature change (for example at 11 pm) if that's when you go to bed. But if you press HOLD, it will maintain that new temperature until you press RUN and it will return to your programmed settings. So you just need to remember to press RUN to return to your programmed settings. We will be placing this sticker on the thermostat to remind you that you can hit the RUN button to go back to your programmed schedule.

[place sticker on Thermostat] [Show instruction behind the thermostat or place the spare - instructions behind the thermostat.]

Now your thermostat is programmed with your daily schedule. These settings will help keep your home comfortable and should save you money. This temperature monitor [show HOBO on wall] will record the temperature inside your unit. This will help determine if the thermostat is performing as it should. You don't need to do anything with it. We're going to check both the temperature monitor and the programmable thermostat now. We want to make sure they're working like they're supposed to.

[Fill in the top of the document (HOBO record number and household code)]

Great! Thanks for your time! We'll return in March 2015 to make sure your thermostat is operating properly and to remove the temperature monitor. We will send you a notice to let you know when we will visit you in March.

Prompt + Commitment group home interview script

Hi, I'm _____(name) and this is _____ (name) and we are visiting you today to check if your thermostat is working properly and to replace it with a programmable thermostat if needed. The programmable thermostat can help you avoid wasting money this winter by heating your unit when you are sleeping or when no one is home. Did you know that setting your heating temperature 10 degrees lower than your daytime setting when occupants of your apartment are sleeping, and setting your daytime temperature 10 degrees lower when no one is at home, can potentially save you up to 20% on heating bills? We want to help you to lower your gas bills. The first step is figuring out the hours when your household is asleep and the hours when no one is home. The second step is determining what is a comfortable temperature is for you when you are home. And we will use this information to program your thermostat for you.

[Interview tenants]

Now we have a good idea of what your normal schedule is like so we can make sure you and your household will be comfortable. The temperature settings you choose for the times when you and members of your household are home and not sleeping should be the temperature you prefer for your personal household comfort.

[Record previous settings of thermostat. Program / adjust new settings on thermostat]

If you need to adjust the programmed temperatures, you can do this manually. For example, if someone comes to visit and asks you to turn up the temperature, you can do that and the new temperature will be in effect until the time of your next programmed temperature change (for example at 11 pm if that's when you go to bed. But if you press HOLD, it will maintain that new temperature until you press RUN and it will return to your programmed settings. So you just need to remember to press RUN to return to your programmed settings. Now your thermostat is programmed with your daily schedule. These settings will help keep your home comfortable and should save you money. Do you commit to using the thermostat to reduce energy use when you are asleep or away from home and keeping to this schedule? If yes, say great, please sign your name here and provide your apartment #. If tenants' ask why are they being asked to sign this commitment? The researchers say it is just another way of confirming that this is the schedule they prefer for their household.

Daytime: ___ degrees F between ___ am and ___ pm

Daytime: ___ degrees F between ___ am and ___ pm

Daytime: ___ degrees F between ___ am and ___ pm

Nighttime: ___ degrees F between ___ pm and ___ am

Signature: ________________________________ Apt. #: ____________

To remind you of your commitment to keep the settings, we have these stickers to put up on your thermostat or on the temperature sensor. Your sticker will also remind you that you can hit the RUN button to go back to your programmed schedule.

[place sticker on Thermostat] [Show instruction behind the thermostat or place the spare - instructions behind the thermostat].

Now your thermostat is programmed with your daily schedule. These settings will help keep your home comfortable and should save you money. This temperature monitor [show HOBO on wall] will record the temperature inside your unit. This will help determine if the thermostat is performing, as it should. You don't need to do anything with it. We're going to check both the temperature monitor and the programmable thermostat now. We want to make sure they're working like they're supposed to.

[Fill in the top of the document (HOBO record number and household code]

- Great! Thanks for your time! We'll return in March 2015 to make sure your thermostat is operating properly and to remove the temperature monitor. We will send you a notice to let you know when we will visit you in March.

Appendix D: Characteristics of the population

Table 14: Characteristics of the households that were screened into the study

CODE	NBR BEDR	Year Move In	Years Lived	GROUP	Number of occupants per age group					Total Number of occupants
					0-10	11-18	19-30	31-65	66-100	
1	3	2003	11	1	2	2	0	2	0	6
2	3	2010	4	3	1	1	0	1	0	3
3	3	2011	3	1	0	1	1	1	0	3
4	3	2005	9	1	1	0	1	1	0	3
5	1	2013	1	2	0	0	0	0	1	1
6	4	2013	1	1	N/D	N/D	N/D	N/D	N/D	N/D
7	4	2007	7	1	0	2	1	1	0	4
8	2	2014	0	3	1	0	1	0	0	2
9	2	2003	11	3	0	0	1	2	0	3
10	3	2010	4	1	2	1	0	1	0	4
11	3	2002	12	2	1	0	1	1	0	3
12	3	2009	5	2	1	1	0	1	0	3
13	2	2006	8	3	1	0	0	1	0	2
14	4	2003	11	1	2	2	0	1	0	5
15	4	2008	6	2	3	1	1	0	0	5
16	2	2001	13	1	1	0	0	1	1	3
17	2	2007	7	2	0	1	0	0	1	2
18	2	2002	12	3	0	0	1	1	0	2
19	2	2012	2	3	0	0	1	1	0	2
20	3	2005	9	3	0	1	0	2	0	3
21	3	2008	6	1	2	2	0	1	0	5
22	2	2008	6	1	0	1	0	1	0	2
23	2	2009	5	1	2	0	1	1	0	4
24	2	2002	12	1	0	0	0	1	0	1
25	1	1993	21	2	0	0	0	1	0	1
26	3	2011	3	3	0	0	1	1	0	2
27	2	2008	6	3	2	0	0	1	0	3
28	2	2002	12	2	0	2	0	2	0	4
29	3	2010	4	3	1	1	1	0	0	3
30	3	2009	5	3	0	2	0	3	0	5
31	3	2008	6	3	0	2	0	1	0	3
32	2	2010	4	1	0	0	0	1	0	1
33	3	2003	11	2	2	2	1	1	0	6
34	3	2002	12	2	1	1	0	1	0	3
35	3	2006	8	3	0	0	1	1	0	2
36	3	2007	7	3	0	0	2	1	0	3
37	3	2014	0	1	1	1	0	1	0	3
38	2	2004	10	1	1	0	0	2	0	3
39	3	2002	12	2	0	0	0	1	0	1

CODE	NBR BEDR	Year Move In	Years Lived	GROUP	Number of occupants per age group					Total Number of occupants
					0-10	11-18	19-30	31-65	66-100	
40	2	2008	6	3	0	1	0	1	0	2
41	2	2002	12	2	0	0	1	1	0	2
42	2	2009	5	3	0	0	0	2	0	2
43	3	2003	11	3	1	1	0	1	0	3
44	3	2002	12	3	0	2	0	1	0	3
45	3	2008	6	2	2	0	1	0	0	3
46	2	2002	12	1	1	0	0	1	0	2
47	3	2002	12	1	1	0	1	1	0	3
48	2	2001	13	3	0	0	0	1	0	1
49	3	2011	3	2	1	1	0	1	0	3
50	2	2014	0	1	1	0	1	0	0	2
51	3	2009	5	2	3	0	0	1	0	4
52	2	2002	12	1	1	1	0	1	0	3
53	3	2013	1	3	1	1	0	1	0	3
54	2	2003	11	3	0	0	0	0	2	2
55	2	2014	0	1	0	1	0	1	0	2
56	2	2010	4	2	0	1	0	1	0	2
57	2	2002	12	1	0	1	0	1	0	2
58	3	2002	12	1	2	1	0	2	0	5
59	3	1996	18	2	2	0	0	1	0	3
60	2	2002	12	3	1	1	0	1	0	3
61	2	2004	10	2	0	1	0	1	0	2
62	3	2010	4	1	2	0	1	0	0	3
63	3	2007	7	1	1	1	0	1	0	3
64	2	2009	5	3	1	0	1	0	0	2
65	2	2002	12	3	1	1	0	1	0	3
66	1	2012	2	3	0	0	0	2	0	2
67	3	2014	0	1	2	0	0	1	0	3
68	3	2012	2	1	2	3	0	1	0	6
69	3	2001	13	3	0	0	1	1	0	2
70	3	2002	12	1	2	1	0	1	0	4
71	2	2002	12	3	0	0	0	1	0	1
72	2	2010	4	1	0	1	0	1	0	2
73	2	2014	0	2	2	0	1	0	0	3
74	3	2011	3	1	1	2	0	1	0	4
75	2	2008	6	2	0	1	0	1	0	2
76	2	2002	12	2	0	1	0	1	0	2
77	4	2002	12	3	1	3	0	1	0	5
78	2	2013	1	1	0	1	0	1	0	2
79	2	2012	2	1	0	1	0	1	0	2
80	1	2002	12	3	0	0	0	1	0	1
81	2	2013	1	3	1	0	1	0	0	2

CODE	NBR BEDR	Year Move In	Years Lived	GROUP	Number of occupants per age group					Total Number of occupants
					0-10	11-18	19-30	31-65	66-100	
82	2	2002	12	2	0	1	0	1	0	2
83	2	2005	9	3	0	1	0	1	0	2
84	2	2006	8	1	1	0	0	1	0	2
85	2	2012	2	1	1	0	0	1	0	2
86	3	2012	2	2	0	0	2	1	0	3
87	3	2014	0	2	2	0	1	0	0	3
88	2	2008	6	1	1	0	1	1	0	3
89	2	2002	12	2	0	1	0	0	1	2
90	3	2003	11	1	1	1	0	1	0	3
91	2	2002	12	1	0	0	0	1	0	1
92	2	2002	12	1	0	0	0	0	1	1
93	3	2003	11	3	0	0	0	2	0	2
94	3	2006	8	2	2	0	1	1	0	4
95	3	2003	11	2	0	1	0	1	0	2
96	3	2007	7	3	1	1	0	1	0	3
97	2	2007	7	2	0	0	1	1	0	2
98	4	1994	20	3	2	3	0	2	0	7
99	3	2008	6	1	1	2	0	1	1	5
100	3	2002	12	2	3	0	0	1	0	4
101	4	1995	19	1	1	1	1	1	0	4
102	4	2008	6	3	1	1	1	1	0	4
103	2	2013	1	2	1	0	1	0	0	2
104	2	2002	12	2	0	0	0	1	0	1
105	4	2013	1	3	4	0	1	0	0	5
106	2	2002	12	3	0	0	0	1	0	1
107	1	2002	12	2	0	0	0	0	1	1
108	4	2008	6	1	2	2	0	1	0	5
109	3	2002	12	2	0	0	0	1	0	1
110	2	1998	16	2	2	0	1	1	0	4
111	4	2005	9	2	0	1	0	2	0	3
112	1	2002	12	1	0	0	0	0	1	1
113	3	2006	8	2	0	0	0	2	0	2
114	2	2005	9	2	0	1	0	1	0	2
115	3	2009	5	1	0	2	0	1	0	3
116	3	1998	16	3	1	0	1	1	0	3
117	4	2013	1	2	1	3	0	1	0	5
118	3	2002	12	3	0	1	1	1	0	3
119	4	1996	18	2	1	2	0	1	0	4
120	1	2002	12	3	0	0	0	0	1	1
121	3	2011	3	2	2	0	0	1	0	3
122	2	2003	11	1	0	0	0	0	2	2
123	2	2013	1	3	N/D	N/D	N/D	N/D	N/D	N/D

CODE	NBR BEDR	Year Move In	Years Lived	GROUP	Number of occupants per age group					Total Number of occupants
					0-10	11-18	19-30	31-65	66-100	
124	3	2006	8	3	0	1	1	1	0	3
125	2	2013	1	3	1	0	1	0	0	2
126	3	2009	5	3	3	1	0	2	0	6
127	2	2014	0	2	1	0	1	0	0	2
128	2	2007	7	1	0	0	0	1	0	1
129	4	2011	3	3	1	3	0	1	0	5
130	2	2006	8	3	0	0	0	1	0	1
131	2	2008	6	2	2	0	0	1	0	3
132	2	2005	9	2	0	0	0	1	1	2
133	2	2002	12	3	0	0	1	1	0	2
134	2	2013	1	1	1	0	1	0	0	2
135	4	2014	0	1	3	0	2	0	0	5
136	3	2007	7	2	0	2	0	1	0	3
137	2	2002	12	3	0	0	0	0	2	2
138	4	2011	3	2	0	0	3	1	0	4
139	2	2005	9	1	1	0	0	1	0	2
140	3	2002	12	1	0	1	1	1	0	3
141	2	2013	1	2	1	0	1	0	0	2
142	3	2002	12	1	0	0	1	2	0	3
143	2	2012	2	2	0	0	0	1	1	2
144	1	2006	8	1	0	0	0	0	1	1
145	2	2002	12	1	0	0	0	1	0	1
146	2	2002	12	2	0	1	0	1	0	2
147	3	2007	7	2	2	0	0	1	0	3
148	2	2014	0	3	0	0	0	2	0	2
149	2	2002	12	2	0	0	1	1	0	2
150	3	2005	9	1	1	1	0	1	0	3
151	2	2009	5	2	1	1	0	2	0	4
152	3	2002	12	3	0	0	2	1	0	3
153	3	2010	4	2	2	0	0	1	0	3
154	3	2013	1	3	0	2	1	2	0	5
155	2	2011	3	2	1	1	0	1	0	3
156	3	2008	6	2	1	1	0	1	0	3
157	3	2006	8	1	1	1	0	1	0	3
158	3	2002	12	3	2	1	0	1	0	4

Key: CODE is the Code of the housing unit. To better protect the identity of the tenants the addresses were replaced by a code; NBR BEDR refers to the number of bedrooms of each household.; Years Move In is the year the current tenants moved into the home; Years Lived, represents the number of years lived in the unit by each family. Group represents the allocation of each unit to each experimental group (G1 - Control; G2 - Ability; G3 - Motivation). Number of occupants per age group represents the number of individuals of each age group that lives in a certain unit at the date of the field interviews. Total number of occupants is the total number of occupants that share a unit; N/D represents no data.

Appendix E: Assessment of the reliability of the sensor infrastructure

We examined the temperature measurement variability of 110 temperature sensors [Onset HOBO model U12-011]. We placed the temperature loggers in an environmental climatic chamber (Thermotron model SM-16-8200, Figure 12, was programmed to vary temperature over 18 hours in the range of 64° to 88°F to observe the variation in transient and steady-state temperature response of identical data loggers at different time scales and temperature ranges. It was then possible to observe that all but two units were working properly, and within the variability established by the vendor of ±0.63°F.

Figure 12: Thermo-climatic Chamber. Placement of the HOBO's in the chamber

Appendix F: Clustering methods

The K-means algorithm is a supervised clustering procedure that for a specified number of clusters partitions the data by minimizing the distance (in this case, the Euclidean distance) of each point to the centroid. In this case, the centroid is a pattern that characterizes a typical day. The K-means classifier clusters together days that have identical patterns. An important aspect of the analysis is to determine if the set-point temperature drops and rises at a certain time, following a schedule; this is more important than the actual temperature values. That is because, in this experiment, we assume that the occupants should have the flexibility to “go back to the schedule” or change the temperature to increase comfort, and still save energy by decreasing the set-point temperature when the house is unoccupied or during the night. Each day was then classified with a 1 or with a 0 whether the temperature of the house was (or not) lowered overnight or during the day, respectively. For each home, we calculate the number of days the schedule is kept and divide by the total number of days each home participates in the experiment. Figure 13 shows an example of the daily temperature readings for the 24-hour period, during the course of the experiment. Figure 14 shows the main cluster hourly readings that explain the majority of the variability of the dataset, during the experimental period, for another home.

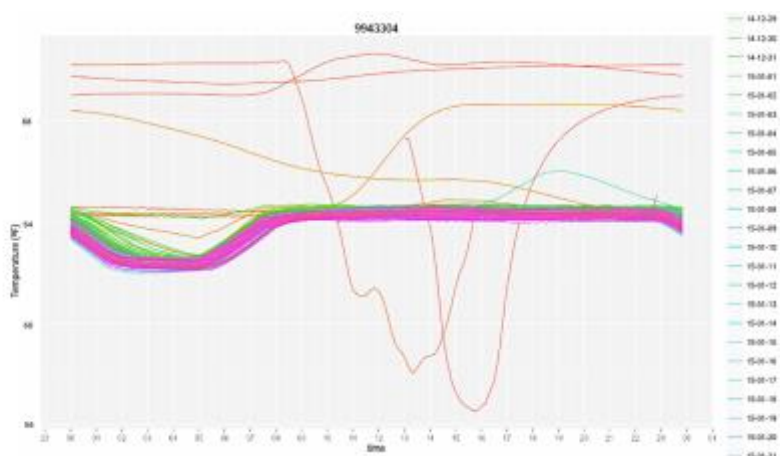


Figure 13: Actual temperature dataset over 24 hours for a period of time

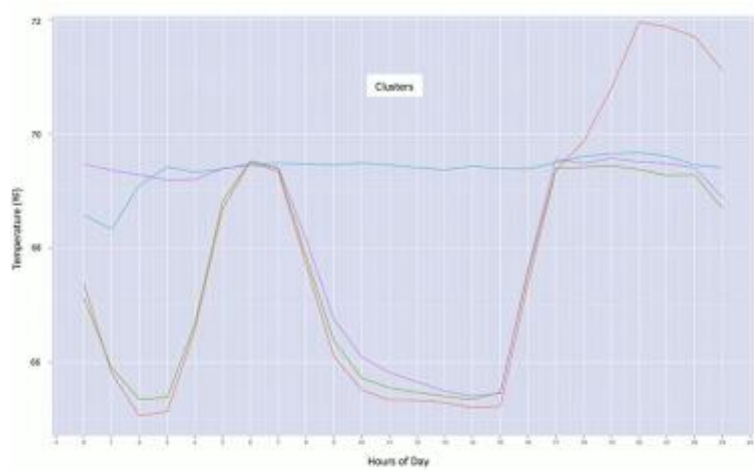


Figure 14: Example of clusters

Appendix G: Modeling indoor temperature during the experimental season

Analysis of the differences between groups for the daytime period (ANOVA)

The average daytime temperature for the time period between 7:00AM to 4:50PM, over the course of the experiment was calculated. The Levene test determined if variances were homogenous between groups. Once it was established that groups were homogenous (p-value = 0.65), an ANOVA test examined whether there were differences in average daytime temperature between the three experimental groups. With a significant p-value< 0.05, the ANOVA model suggests that at least one group is different from the rest (Table 16). The Tukey test determined the nature of those differences, (Table 17) indicating that both the "Prompt" and "Prompt + Commitment" groups had significantly lower average daytime temperatures than the "Control" group, although the "Prompt + Commitment" kept their homes warmer than the "Prompt" group.

Table 15: Descriptive statistics of the daily period

Groups	N (days)	Mean (ºF)	Standard deviation (ºF)
"Control" group	107	73.6	0.64
"Prompt" group	107	72.9	0.63
"Prompt + Commitment" group	107	73.3	0.66

Table 16: ANOVA model for the differences among groups for temperature over night

	Df	Sum Square	Mean Square	F	Pr(>F)
Group	2	25.68	12.84	31.06	4.77e-13***
Residuals	318	131.46	0.41		

**p<0.05, ** p<0.01, ***p<0.001*

Table 17: Tukey test of differences between groups

Groups	Diff. btw means	Std. Error	t-value	Pr(>|t|)	Upr Iwr	Lwr Upr
"Control" vs. "Prompt"	-0.69	0.09	-7.85	<1e-04***	-0.90	-0.48
"Control" vs. "Prompt + Com"	-0.29	0.09	-3.31	0.003**	-0.50	-0.08
"Prompt + Com" vs. "Prompt"	0.40	0.09	4.5	<1e-04***	0.19	0.61

**p<0.05, ** p<0.01, ***p<0.001*

Analysis of the differences between groups for the nighttime period (ANOVA)

The average nighttime temperature for the time period between 10:00PM to 6:50AM, over the course of the experiment, was calculated. With a p-value of 0.79, the Levene test indicated variance homogeneity between groups. With a p-value < 0.05, the ANOVA model revealed a statistically significant difference between at least two of the groups (Table 18). In Table 19, the nature of that difference is investigated. Households in "Prompt" and "Prompt + Commitment" groups consistently kept at a lower nighttime temperature compared with the "Control" group ("Prompt" group: -1.1 ºF and "Prompt + Commitment": -0.8 ºF), according to the Tukey test (Table 20), and consistent with the findings for daytime temperatures, the occupants in the “Prompt + Commitment” group maintained their homes at a slightly warmer average temperature than the “Prompt” group (+0.4 ºF).

Table 18: Comparison between groups

Groups	**N (days)**	**Mean (ºF)**	**Standard deviation (ºF)**
“Control” group	107	74.1	0.59
“Prompt” group	107	72.9	0.60
“Prompt + Commitment” group	107	73.3	0.60

Table 19: ANOVA model for the differences among groups for temperature over night

	Df	**SUM2**	**Mean2**	**F**	**p-value**
Group	2	73.1	36.6	103.6	<2e-16***
Residuals	318	112.2	0.4		

*p<0.05, ** p<0.01, ***p<0.001

Table 20: Tukey test of differences between groups

Groups	**Diff btw means**	**Std. Error**	**t-value**	**p-value**	**95% CI upper bound**	**95% CI lower bound**
“Control” vs. “Prompt”	-1.14	0.08	-14.10	<1e-05***	-1.34	-0.95
“Control” vs. “Prompt + Commitment”	-0.78	0.08	-9.56	<1e-05***	-0.97	-0.58
“Prompt” vs. “Prompt + Commitment”	0.37	0.08	4.54	2.38e-05***	0.18	0.56

*p<0.05, ** p<0.01, ***p<0.001