LONGITUDINAL ANALYSIS OF NORMATIVE ENERGY USE FEEDBACK ON DORMITORY OCCUPANTS' ENERGY CONSUMPTION

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ABSTRACT

Behavioral approaches to reduce energy consumption in the built environment are becoming increasingly common. In particular, the application of individual feedback and the use of social norms have shown promise in the short term in improving occupant energy use behavior in the home. However, the long term effects, role of messaging intensity, and relative effect of normative elements in feedback messages remain less clear. This paper attempts to address these gaps in the literature by conducting and analyzing two yearlong field experiments that test the effect of normative feedback messages on dormitory occupants' energy consumption. The analysis shows that adding normative elements to feedback messages had no effect on energy consumption in the short term. However, when examining behavior change by occupant concern for norms, it was

found that individuals with high concern for social norms positively responded to the normative elements with an estimated treatment effect of 14%. Conversely individuals with low concern for social norms had the opposite reaction with an estimated treatment effect of -5%. Further, it was discovered that the duration of normative messaging positively influenced the long term durability of behavior change. The long term effect of behavior change was twice as prevalent in individuals with high concern for social norms.

KEYWORDS

Social Norms; Normative feedback; Home energy use; Randomized experiment; Long term behavior change

1 INTRODUCTION

Buildings account for two-fifths all energy consumption and carbon emissions in developed countries, and significant effort has been given to reducing these anthropogenic sources of carbon emissions (Pérez-Lombard et al. 2008; Poel et al. 2007; USC 2007; EIA 2014; EPA 2012). Behavioral approaches in particular are becoming increasingly common and viable means to reduce energy consumption in the built environment (Abrahamse et al. 2005; Darby 2006; Dietz et al. 2009; McKenzie-Mohr 2000; Stern 2011; Wilson and Dowlatabadi 2007). In particular, the application of individual feedback and the use of social norms have shown promise in the short term for improving occupant energy use behavior in the home (Allcott 2012; Allcott and Rodgers 2013; Ayres et al. 2013; Schultz et al. 2007). In the extensive literature testing pro-environmental behavior interventions, very few studies have investigated treatment effects in the longer term, beyond a few months (Abrahamse et al. 2005; Geller 2002; Osbaldiston and Schott 2012). In a one study which investigated the longer term effects of behavior interventions, Staats et al. (2004) found that the Eco-team approach, an intensive and in-depth intervention methodology which combines many intervention techniques, produced durable behavior change. However, most studies to date apply an intervention and measure change in behavior only over a short period, a few months (Abrahamse et al. 2005). Then the intervention is withdrawn, and no more

measurements are taken. No data is collected and no insight is gained into whether or not treatment effects persist over time or what contributes to the persistence of treatment effects, yet understanding the long term effects of behavioral approaches is of great importance (De Young 1993).

The long term effects of feedback messages, in particular normative feedback, remain unclear despite the substantial amount of recent research work investigating these intervention methodologies (Darby 2006). Further, the relative benefit of adding normative elements to individual feedback messages remains debated. Therefore, this paper investigates the durability of feedback interventions and specifically addresses the relative impact of normative feedback on occupants' energy consumption relative to generic individual feedback.

To date, only a few studies have been conducted which have investigated normative feedback in the longer term, and to the best of the authors' knowledge, all have relied on data from the company oPower (e.g.., Allcott (2012), Allcott and Rodgers (2013), and Ayres et al. (2013)). oPower conducted large scale opt-out messaging experiments on monthly and quarterly feedback cycles. These studies provide a great foundation for exploring the durability of normative feedback, but are not without limitation and several key research questions remain unanswered. First, the oPower studies do not isolate the effect of normative messaging but rather confound the effect of the normative messages with individual energy use feedback as well as education and information making the relative effect of the normative elements of the intervention ambiguous. Second, the studies attempt to induce households through financial information/education to engage in capital improvements. This makes it impossible to determine how much energy improvements are a result of behavioral improvements versus capital improvements. Lastly, and perhaps most importantly, the studies only collect energy data. Without data on the behavioral determinants (e.g., environmental attitudes) of the households, it is not possible to gain significant insight into understanding what drives the effectiveness of the intervention (i.e., identify with what type of individuals the intervention is successful and with whom it is not) (Abrahamse et al. 2005).

Therefore, the authors conduct and analyze two separate year-long field experiments testing the durability and effect of normative feedback messaging on energy consumption. In the study, the authors specifically aim to answer the follow questions: 1) how do energy use behavioral determinants relate to each other as well as energy consumption?, 2) does adding normative

elements to individual energy use feedback messaging improve energy use behavior?, 3) what type of person is affected by normative messaging?, 4) does normative messaging promote more durable behavior change?, and 5) does the duration, i.e., intensity, of normative messaging affect behavior and the durability of behavior change?

This paper will proceed with an overview of the experiments conducted in this study. This is followed by the empirical strategies employed for analysis along with the results. Then, the authors present a discussion of the results and conclusions.

2 EXPERIMENT OVERVIEW

2.1 Site and Population Overview

The experiment site is a dormitory complex on a university campus in Seoul, South Korea. Seoul is a heating dominated climate; annually heating is the largest energy expenditure. The site consists of seven mid-rise dormitories up to eight stories tall containing over 1200 units. Units are either single or double occupancy. Each unit has the same built-in radiant floor heating system and air conditioning system in the ceiling. All rooms also have a bathroom and shower as well as mini-fridge. Six of the buildings mainly consist of graduate students, and one building almost exclusively houses undergraduate students. The seven buildings were constructed at the same time and are made from identical building materials.

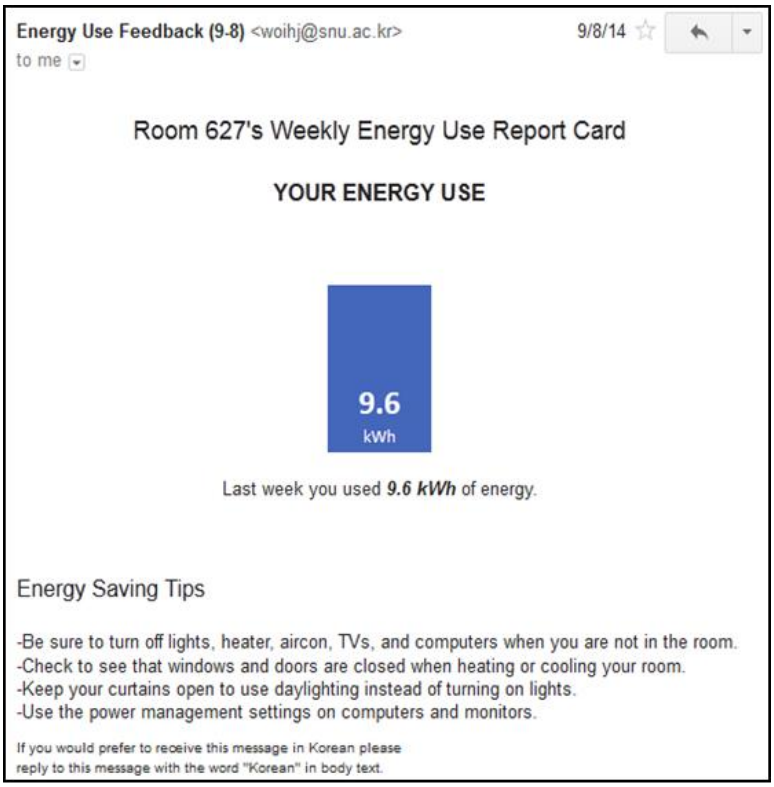
Undergraduate student presence in the dormitories often revolves around the academic calendar whereas graduate students tend to remain in the buildings year round. The academic year for schools in South Korea begins the first week of March and concludes the last week in December. The school has two semesters, spring and fall. The spring semester commences in March and ends the last week of June. From this time until the fall semester begins, the first week of September, undergraduate students do not reside in the dormitories. When the fall semester starts, the undergraduate students move back into their same rooms. Alternatively, graduate students move into their units the first week of March and live continuously in the same room until their contract expires, if they do not extend it, until the last week of February the following year. Both undergraduate and graduate students may live in the same unit for more than one year.

2.2 Feedback Messages

The energy use feedback messages were delivered in both English and Korean and were sent based on the language that participants selected in their intake survey. One of two different messages was sent to each participant during the course of the intervention, a control (Figure 1a) or treatment message (Figure 1b). Both the control and treatment messages feature common energy use feedback information including how much energy in kWh was consumed during the last reporting period, the previous week, along with a few energy conservation tips. The treatment message adds a descriptive norm message and an injunctive norm message. The descriptive norm message informs the participant of the mean energy use of other similar residents and the mean use of efficient residents, the top 10% of users, which provides a target for participant behavior. Complementing the descriptive norm messages is the injunctive norm message which comments on social desirability of the participant's current behavior (e.g., Best! Good job!). The top 10% of users receive the top rating "Best! Good job!/최상! 참 잘 했어요!" and two stars. The next 40% of users who have energy use below the median receive the rating "Good, keep working at it!/상, 계속 노력하세요!" and one star. Finally, participants who use more energy use than the median user receive the message "Poor, but keep working at it!/하, 조금 더 노력하세요!" and a frowning emoticon. Lastly, since all participants are renters, energy conservation tips provide suggestions for ways to improve energy consumption through behavioral improvement rather than focusing on financial motivations.

2.3 Experimental Design

The graduate and undergraduate student samples are divided into two separate experiments due to differences in occupancy throughout the year in addition to being physically segregated into different buildings. The graduate students are dispersed across six buildings and the undergraduate population is almost exclusively contained in a single building. Initially across the six graduate buildings, 220 rooms participated with a total of 276 individual participants. In the undergraduate building 152 rooms signed up to participate with a total of 219 individual participants.



Energy Use Feedback (9-8) <woihj@snu.ac.kr> 9/8/14

to me

Room 627's Weekly Energy Use Report Card

YOUR ENERGY USE

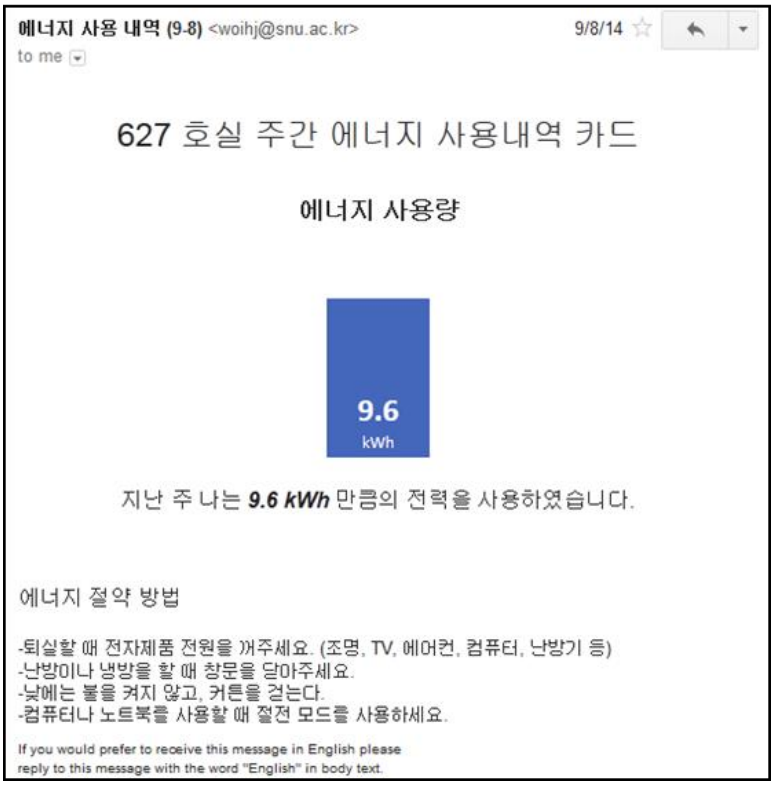
9.6
kWh

Last week you used ***9.6 kWh*** of energy.

Energy Saving Tips

-Be sure to turn off lights, heater, aircon, TVs, and computers when you are not in the room.
-Check to see that windows and doors are closed when heating or cooling your room.
-Keep your curtains open to use daylighting instead of turning on lights.
-Use the power management settings on computers and monitors.

If you would prefer to receive this message in Korean please
reply to this message with the word "Korean" in body text.



에너지 사용 내역 (9-8) <woihj@snu.ac.kr> 9/8/14

to me

627 호실 주간 에너지 사용내역 카드

에너지 사용량

9.6
kWh

지난 주 나는 ***9.6 kWh*** 만큼의 전력을 사용하였습니다.

에너지 절약 방법

-퇴실할 때 전자제품 전원을 꺼주세요. (조명, TV, 에어컨, 컴퓨터, 난방기 등)
-난방이나 냉방을 할 때 창문을 닫아주세요.
-낮에는 불을 켜지 않고, 커튼을 걷는다.
-컴퓨터나 노트북를 사용할 때 절전 모드를 사용하세요.

If you would prefer to receive this message in English please
reply to this message with the word "English" in body text.

Figure 1a: Control message with individual feedback and conservation tips in English and Korean.

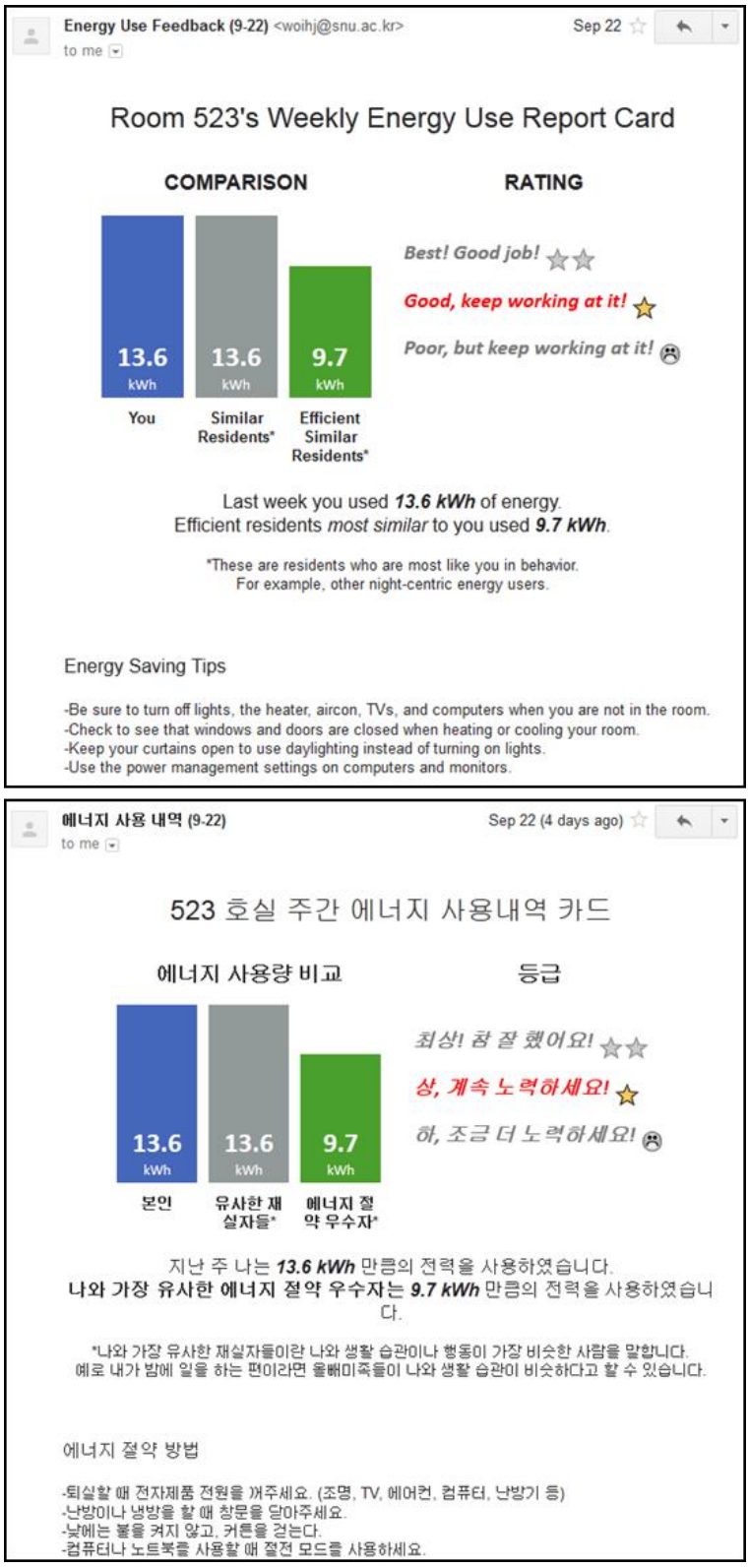


Figure 1b: Treatment message in English and Korean. The treatment message adds a descriptive and injunctive normative message.

For both the undergraduate and graduate student experimental groups' data collection began on March 3, 2014 and concluded on February 22, 2015 (Table 1). Pre-intervention data was collected for seven weeks from March 3 through April 20. For 16 weeks from April 21 through September 28 both experiments conducted their respective feedback interventions. After September 29 the interventions were stopped. Post-intervention data was collected for 21 weeks until February 22, 2015 for both experiments in order to examine the durability of the methods.

Table 1: Study timeline

	Study Phase		
	Pre-Intervention Data Collection	Intervention	Post-Intervention Data Collection
Dates	3/3/14 thru 4/20/14	4/21/14 thru 9/28/14	9/29/14 thru 2/22/15
Duration	7 Weeks	16 Weeks	21 Weeks

Three surveys were conducted during the course of the experiment. An intake survey was distributed to participants during a dormitory move in orientation held by the university which took place between March 3 and March 28. Surveys were handed out and collected in person. The second and third surveys were conducted electronically and sent out via email. The second survey was sent out upon withdrawal of the intervention on October 6, 2014. The final survey was sent out upon the conclusion of the follow-up period on March 1, 2015. These surveys repeat many of the questions from the intake survey but are not included in the analysis in this paper.

In the undergraduate building, experimental treatments were randomly assigned resulting in 76 rooms in both the treatment and control groups. Treatment and control rooms are randomly assigned throughout the building and not separated by floor level. The use of random assignment allows the researchers to clearly isolate treatment effects. Previous normative energy use feedback studies have suggested that it is not necessary to physically segregate treatment and control samples based off concerns for geographic spillover, i.e., people talking with their neighbors about the reports, and random assignment at the household has become standard practice for such studies (Allcott and Rodgers 2012). Feedback messages were sent weekly to participants for seven weeks from April 21 to June 8. Messaging was halted after this data until students returned from the summer recess on September 1 after which time messaging resumed for three more weeks.

Unlike the undergraduate student population, the graduate student population remained in their units throughout the year and was dispersed across six buildings. For this experiment with the graduate student population, treatment groups were assigned by building resulting in six treatment groups. The graduate student intervention schedule differs substantially from the undergraduate schedule. In contrast to the undergraduate student experiment where the treatment and control groups continuously received the same message throughout the entire intervention period, each graduate student treatment groups received both the control and treatment feedback messages. Upon the start of the intervention all treatment groups received the control message for the first three weeks. This is used as the baseline period for the graduate population. Every three weeks thereafter a new treatment group received the treatment message (Figure 2). Phasing in a new treatment group every three weeks allowed the researchers to test the effect of normative messaging duration on behavior change and behavior change durability. This experimental design has many benefits. First, it allows the researchers to control for building effects which may be present. Second, and most importantly, it permits the researchers to test the effect of the intensity of messaging on both immediate behavior change and long term behavior change; this is also referred to as messaging duration throughout this section.

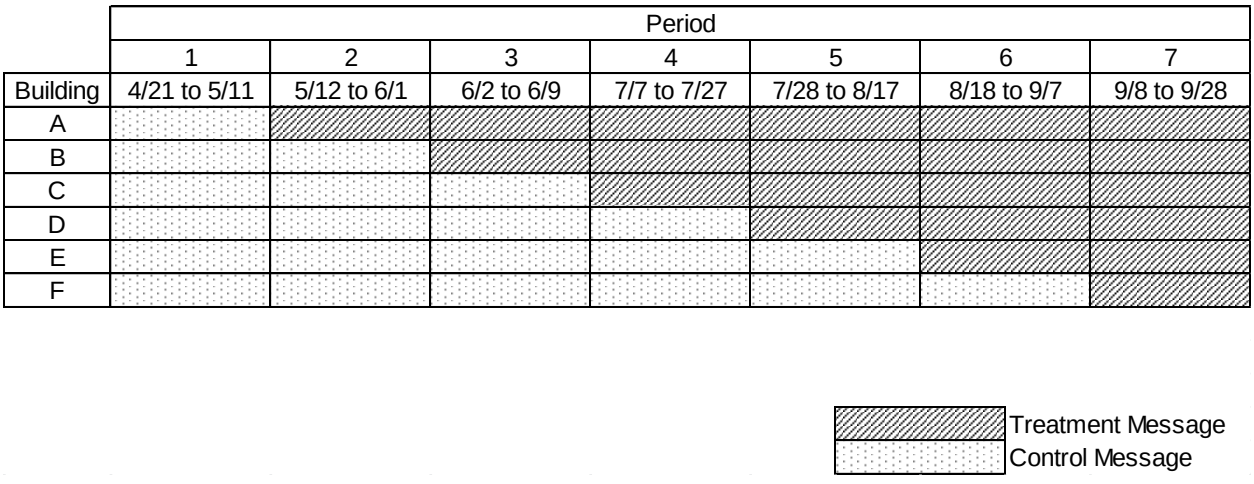


Figure 2: Graduate student experiment messaging schedule by treatment group.

2.4 Data

Data on each room's electricity consumption was collected on an hourly basis. The electricity energy use data includes all plug loads as well as heating, cooling, and lighting electricity usage. During the course of the intervention, this data was aggregated weekly and used in the feedback messages. For analysis purposes for both the graduate and undergraduate experimental groups, this data has been aggregated into four values to smooth out the significant hour to hour and week to week fluctuations in energy use. The four values are: baseline energy use, mean weekly energy use during the intervention period, mean short-term post-intervention weekly energy use, and mean full-term post-intervention weekly energy use. Post-intervention energy use value has been decomposed into two periods, short-term and full-term. The short-term period consists of only the first 12 of the 21 weeks of the post-intervention data collection period. The reason for this separation is that a significant portion of the undergraduate student population, 85% (185 out of 219) vacated their rooms beginning during the twelfth week of the post-intervention period. For the graduate student experiment the weekly energy use during the intervention is also aggregated into blocks to match the treatment schedule presented in Figure 2.

Table 2: Undergraduate students' pre-intervention Spearman Rank correlation coefficients between behavioral determinants and baseline energy used

	Variable	(1)	(2)	(3)	(4)	(5)
(1)	Baseline Energy Use	1.000				
(2)	Attitude	0.000	1.000			
(3)	Subjective Norm	0.005	-0.022	1.000		
(4)	Perceived Behavioral Control	-0.133'	0.363*	0.034	1.000	
(5)	Behavioral Intention	0.078	-0.474*	0.078	-0.357*	1.000

Notes: A lower attitude value indicates that one has negative attitudes toward energy conservation in the home. A lower subjective norm value indicates a higher level of concern and motivation to comply with the norm. A lower perceived behavioral control value indicates a low level of perceived control over one's energy consumption. The sample size is 219. Significant results at the .01 and .05 levels are respectively marked * and '.

The intake survey had 495 respondents and is the main source of data for occupant behavioral determinants (Appendix A). The survey was based off of the Theory of Planned Behavior and was designed to elicit occupant behavioral beliefs, normative beliefs, control beliefs, and behavior intention related to energy conservation in their home (Ajzen 1991; Ajzen 2015). Questions were asked using multiple bi-polar Likert items and transformed into Likert scale values

which represent the individuals' attitude, subjective norm, and perceived behavioral control towards energy conservation in the home (Ajzen 1991). Table 2 and 3 present the initial correlations between these behavioral determinants and baseline energy consumption for the undergraduate and graduate student samples. The correlations for the undergraduate and graduate student samples are highly similar and highlight some surprising relationships. Interestingly one's behavior intention, a direct measure of one's intention to conserve energy in the home or not, is not correlated with actual energy use. However, the behavioral determinants, with the exception of the subjective norm, are significantly and meaningfully correlated with behavior intention for both samples.

Table 3: Graduate students' pre-intervention Spearman Rank correlation coefficients between behavioral determinants and baseline energy used

	Variable	(1)	(2)	(3)	(4)	(5)
(1)	Baseline Energy Use	1.000				
(2)	Attitude	-0.112	1.000			
(3)	Subjective Norm	0.058	-0.134'	1.000		
(4)	Perceived Behavioral Control	-0.150'	0.356*	-0.104	1.000	
(5)	Behavioral Intention	0.071	-0.554*	0.133'	-0.351*	1.000

Notes: A lower attitude value indicates that one has negative attitudes toward energy conservation in the home. A lower subjective norm value indicates a higher level of concern and motivation to comply with the norm. A lower perceived behavioral control value indicates a low level of perceived control over one's energy consumption. The sample size is 276. Significant results at the .01 and .05 levels are respectively marked * and '.

Over the course of the study, rooms were lost to attrition and error. From the two samples 74 graduate rooms and 34 undergraduate rooms (15 treatment group rooms and 19 control group rooms) had to be removed. Of these room, 102 have been removed due to occupancy changes (i.e., occupants moved out or changed rooms), one due to a data recording malfunction, and five were identified as outliers–energy use more than three standard deviations away from the mean in any of the four periods being analyzed. No participants elected to opt out of the study. The authors are not concerned that the dropped data could bias the results since for groups the baseline energy consumption of the dropped rooms does not significantly vary from the rooms included in the analysis (undergraduate population: Welch t-test t=0.7045, df=41.578, p-value=0.485; graduate population: Welch t-test t=-1.4848, df=116.237, p-value=0.1403). Further, there is no reason to

suspect that moving is related to the behavioral characteristics of the occupants which are of interest for energy conservation. In addition to the data lost from the dropped rooms, lightning struck the building complex on June 9 and caused the site's data recording system malfunction. No data was collected between June 9 and June 23. This malfunction had no effect on the undergraduate student study; however, it slightly interrupted the graduate student experiment. As a result, no messages were sent out for the week of June 16, June 23, or June 30. Data was collected for the week of June 30 though and used as the input data for the July 7 messages.

Table 4: Graduate student mean energy use in kWh per week by floor and period

	Floor								
Time Period	First	Second	Third	Forth	Fifth	Sixth	Seventh	Eighth	All
Baseline	59.2	43.8	30.8	31.5	31.2	24.1	28.2	30.0	33.4
	(18.3)	(29.0)	(18.0)	(22.9)	(20.3)	(10.7)	(16.2)	(15.3)	
Intervention	22.4	16.7	15.1	16.1	15.2	14.8	16.6	15.3	16.2
	(6.8)	(5.0)	(4.7)	(4.3)	(4.8)	(4.7)	(6.5)	(5.1)	
Short-term Post Intervention	86.1	71.4	67.4	64.2	59.1	58.7	63.0	75.6	66.5
	(20.3)	(23.7)	(31.6)	(22.9)	(17.5)	(14.1)	(19.5)	(24.2)	
Full-term Post Intervention	105.4	92.5	85.2	82.6	74.4	76.1	77.7	94.5	84.3
	(18.4)	(25.4)	(32.8)	(26.6)	(19.8)	(14.9)	(20.6)	(25.8)	
Mean	62.3	51.0	43.7	43.4	40.3	38.3	40.8	46.6	45.8
Rooms	9	24	13	22	21	21	21	15	146

Note: Standard deviations are shown in parentheses.

Looking at room energy use, energy consumption was highly affected by seasonality and weather as well as by room floor level (Table 4). Energy use varies substantially by floor due to how heat flows through buildings, e.g., heating in the ground level floor diffuses to the second level which reduces the required heating load for the second floor[1]. As a result, interior floors in buildings require less space conditioning. The baseline periods are at the end of the winter months and occupants use substantially more energy for space conditioning than they do during the intervention which takes place in spring and summer. The post-intervention period extends from fall through winter, and units use considerably more electricity during this period for space heating. This increase in heating demand is clearly evident in the large difference in weekly energy

[1] Ground temperatures have a similar effect on the first floor.

consumption between the short-term and full-term follow-up periods. In addition, room occupancy type, single or double occupancy, contributes to room energy consumption. The graduate student population has both single and double occupancy rooms, but the undergraduate population only has double occupancy rooms.

3 EMPERICAL STRATEGIES & RESULTS

3.1 Graduate Student Experiment

3.1.1 Room Level Analysis

The authors begin the analysis of the graduate student experiment by estimating the following regression:

$$BaselineEnergyUse_{rft} = \beta_0 + \beta_1 Duration_{rft} + \alpha_f + \alpha_t + \varepsilon_{rft} \quad (1)$$

where $BaselineEnergyUse_{rft}$ is the mean weekly energy use of room r during baseline period and $Duration_{rft}$ is the duration in weeks that room r received normative feedback. Two separate dummy variables are also added to absorb fixed effects for each room floor level, α_f, and room type, α_t. The equation, and all others presented in this paper are estimated using Ordinary Least Squares (OLS) unless otherwise specified. This analysis is run as a check to test and see if initial differences exist between the assigned treatment groups prior to intervention.

Table 5: Graduate room baseline energy use comparisons by group selection

Explanatory Variable	(1)	(2)	(3)
Duration of Normative Messaging (weeks)	-0.008	-0.001	-0.002
	(0.012)	(0.012)	(0.012)
Floor Fixed Effects	No	Yes	Yes
Room Type Fixed Effects	No	No	Yes
Adjusted R^2	.000	.092	.095

Notes: OLS on log transformed baseline mean weekly energy use (kWh/week). Significance at the 0.05, 0.01, and 0.001 levels are designated by *, **, *** respectively. Standard error terms are in parentheses. The sample size is 146. Data is transformed to meet normality assumptions. Duration of messaging ranged from three to sixteen weeks.

Regression results are presented in Table 5. To meet normality assumptions, mean weekly energy consumption during the baseline period was log transformed. Column 1 omits the addition of floor and room type dummies; columns 2 and 3 sequentially add in the dummy variables. Results indicate there are no differences in energy use behavior prior to intervention by group selection.

Findings from the literature suggest that the addition of normative feedback to weekly messages should be more effective at inducing improvements in energy behavior. Therefore, the authors used difference-in-difference estimations to test the relative effect of a receiving normative feedback compared to individual feedback. For each pair of consecutive periods, e.g., period 1 to 2 (see Figure 2), mean difference in energy use between treatment and control groups was tested. No significant mean differences were found between any pair of periods. These results are likely a consequence of the high variance in energy use behavior among rooms and the limited sample size.

As effects were not present using higher frequency energy consumption data, it is possible the effects may be present when the variance in behavior is less. To reduce the variance in energy use behavior all energy consumption data during the intervention is aggregated. The literature suggests that since normative feedback is more effective than individual feedback alone, the duration for which rooms received normative messages would be hypothesizes to have lower levels of energy consumption. To test the effect of the duration of normative messaging on energy consumption during the course of the intervention, the authors use the following model specification:

$$IntEngUse_{rft} = \beta_0 + \beta_1 Duration_{rft} + \beta_2 BaseEngUse_{rft} + \alpha_f + \alpha_t + \varepsilon_{rft} \quad (2)$$

where $IntEngUse_{rft}$ is the mean weekly energy use of room *r* during the course of the intervention and $BaseEngUse_{rft}$ is the mean weekly energy use of room *r* during baseline period. The remaining variables are the same as in model specification (1).

Results from the regressions are presented in Table 6. Once again to meet normality assumptions, all energy use values are log transformed. Column 1 omits fixed effects dummies and the covariate for baseline energy consumption. Column 2 adds a covariate for room baseline energy use and columns 3 and 4 add in fixed effect dummies for floor and room type, respectively. Here, much like with the difference-in-difference estimations, normative messaging is found to

have no effect on energy consumption. Previous energy use behavior is the most significant predictor of current energy use behavior.

Table 6: Effect of duration of normative messaging on energy use during the intervention

Explanatory Variable	(1)	(2)	(3)	(4)
Duration of Normative Messaging (weeks)	-0.004	-0.002	0.001	0.001
	(0.006)	(0.005)	(0.005)	(0.006)
Log Baseline Energy Use (kWh/week)	---	0.246***	0.227***	0.227***
		(0.036)	(0.040)	(0.040)
Floor Fixed Effects	No	No	Yes	Yes
Room Type Fixed Effects	No	No	No	Yes
Adjusted R^2	.000	.233	.225	.219

Notes: OLS on log transformed energy use during the intervention (kWh/week). Significance at the 0.05, 0.01, and 0.001 levels are designated by *, **, *** respectively. Standard error terms are in parentheses. The sample size is 146. Data is transformed to meet normality assumptions. Duration of messaging ranged from three to sixteen weeks.

The results so far suggest that normative messaging in this sample had no significant effect on energy use behavior during the intervention. However, it is possible that differences could not be identified due to limitations of the study, e.g., sample size, and that receiving normative messages for longer durations had a positive effect the durability behavior change after the intervention was withdrawn. To test the effect of duration of normative messaging on energy use during the post-intervention, the following modeling specification was used:

$$PostIntEngUse_{rft} = \beta_0 + \beta_1 Duration_{rft} + \beta_2 BaseEngUse_{rft} + \alpha_f + \alpha_t + \varepsilon_{rft} \qquad (3)$$

where $PostIntEng_{rft}$ is the mean energy use of a room in the post-intervention follow-up period.

Regression results are shown in Table 7, and the columns present the same regressions as the columns in Table 6. In contrast to the previous results, during the post-intervention follow-up period, the duration of normative messaging significantly affected energy use. For each week, a room received the normative message that they used on average 0.85 kWh of energy less per week. To put this quantity into perspective, mean weekly energy use during the post-intervention period across all rooms was 84 kWh, and rooms received normative messages for between three and sixteen weeks. The explanatory power of the duration of messaging is quite low as would be expected since it is unlikely that the addition of normative message would cause very large swings

in one's behavior. Once again previous behavior has the greatest explanatory power as would be expected.

Table 7: Effect of duration of normative messaging on energy use in the post-intervention follow-up period

Explanatory Variable	(1)	(2)	(3)	(4)
Duration of Normative Messaging (weeks)	-0.818'	-0.760*	-0.790*	-0.849*
	(0.471)	(0.374)	(0.378)	(0.355)
Baseline Energy Use (kWh/week)	---	0.687***	0.681***	0.631***
		(0.074)	(0.080)	(0.076)
Floor Fixed Effects	No	No	Yes	Yes
Room Type Fixed Effects	No	No	No	Yes
Adjusted R^2	.014	.378	.400	.470

Notes: OLS on energy use after intervention withdrawal (kWh/week). Significance at the 0.1, 0.05, 0.01, and 0.001 levels are designated by ', *, **, *** respectively. Standard error terms are in parentheses. The sample size is 146. Duration of messaging ranged from three to sixteen weeks.

3.1.2 Individual Level Analysis

The previous section analyzed the effects of the intervention on the total sample and provided insight into system level outcomes and behavior. To enhance our understanding of who changed their energy use behavior as a result of the intervention, it is necessary to jointly consider intervention outcomes and individual behavioral determinants.

It is unlikely that the entire sample of participants would be equally affected by the addition of the normative element of the feedback message. It is reasonable to hypothesize that individuals who perceive pressure to conform to group norms and who possess a high motivation to comply with social norms would be more likely to be affected by normative messaging. Also individuals who have a high intention to conserve energy use may receive more benefit from the additional normative information in the messages which could improve behavior. On the other hand, given the normative nature of the intervention, there is little reason to suspect individual attitudes and perceived behavioral control toward energy conservation in the home would predict normative messaging effectiveness.

To begin this analysis, the authors cut the data into subsets conditional on occupant behavioral characteristics. For each behavioral determinant, the data was cut to only include

occupants with extreme values, approximately the top and bottom 25% of occupants for the given behavioral determinant under investigation. For instance, the occupants who identified themselves as being highly influenceable by social norms and the occupants who identified themselves as being highly un-influenceable by social norms were isolated. This process was repeated all four behavioral determinants (attitudes, social norms, perceived behavioral control, and intention).

Using theses subsets, the authors estimated the following regressions:

$$IntEngUse_{ift} = \beta_0 + \beta_1 Duration_{ift} + \beta_2 BaseEngUse_{ift} + \alpha_f + \alpha_t + \varepsilon_{ift} \quad (4)$$

$$PostIntEngUse_{ift} = \beta_0 + \beta_1 Duration_{ift} + \beta_2 BaseEngUse_{ift} + \alpha_f + \alpha_t + \varepsilon_{ift} \quad (5)$$

These regressions are slightly different from model (2) and (3) as they are run on the individual response level, *i*, and not the room level, *r*. In addition, standard errors are robust and clustered at the room level to control for correlations for rooms with multiple participants. All regressions using the sub-samples on mean participant energy consumption during the intervention, model (4), resulted in no significant differences between treatment groups once again. However, during the post-intervention follow-up, model (5), some sub-samples were significantly affected by the duration of normative messaging (Table 8).

Columns 1 through 3 include the entire population and sequentially add fixed effect dummies for floor and room type. Column 4 uses the same model specifications as column 3 except is run using only individuals who are highly influenceable by social norms. The effect of normative messaging duration is meaningfully larger than for the entire population at -2.084 compared to -0.942. This suggests that highly influenceable individuals receive additional benefit from receiving normative message for a longer duration. These equate to a treatment effects of 1.2% less energy use per week of messaging for the entire population and 2.4% per week of messaging for highly influenceable individuals. Column 5 uses the sub-population of individuals who have low motivation to comply with social norms and perceive little social pressure to conform to norms. As could be expected, longer exposure to normative messaging had no significant effect on these individuals. Column 6 shows the results using individuals who self-identified as high intention to conserve. Most occupants in the study stated they have a fairly high intention to use less energy in the home so this sub-population includes two-thirds of the entire population. For this group, the duration of treatment was significant but the effect is not meaningfully different from that of the

entire population (column 1). Lastly, subsets based on attitudes towards conserving and perceived behavior control had no significant effects. The lack of significance considering that the entire population (column 1) had a significant result is not meaningful, but rather a consequences of the smaller sample size as the non-significant treatment effects are approximately -1.0.

Table 8: Effect of duration of normative messaging on energy use in the post-intervention follow-up period conditional on occupant behavioral determinants

Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
Duration of Normative Messaging (weeks)	-0.942**	-0.953**	-1.008**	-2.084*	-0.900	-1.052*
	(0.335)	(0.334)	(0.317)	(1.010)	(0.595)	(0.407)
Baseline Energy Use (kWh/week)	0.790***	0.764***	0.727***	0.473*	0.786***	0.733***
	(0.071)	(0.075)	(0.072)	(0.177)	(0.124)	(0.091)
Floor Fixed Effects		Yes	Yes	Yes	Yes	Yes
Room Type Fixed Effects			Yes	Yes	Yes	Yes
Highly Influenceable by Norms				Yes		
Highly Un-influenceable by Norms					Yes	
High Intention to Conserve						Yes
Adjusted R^2	.417	.457	.512	.392	.570	.482
Observations	183	183	183	47	52	118

Notes: OLS on energy use after intervention withdrawal (kWh/week). Significance at the 0.1, 0.05, 0.01, and 0.001 levels are designated by ', *, **, *** respectively. Standard error terms are clustered at the room level and shown in parentheses. Duration of messaging ranged from three to sixteen weeks.

3.2 Undergraduate Student Experiment

3.2.1 Room Level Analysis

The analysis of the undergraduate student experiment follows the same form as the graduate student experiment. Analysis of this experiment differs in three regards. First, this experiment used random assignment of treatment and control, and the message that was sent to each room and participant remained constant. Second, the post-intervention follow-up period is shorter. Third, the undergraduate population only has double occupancy rooms so there is no fixed effect dummy for room type. To begin the analysis of this experiment we estimate the following regressions:

$$BaselineEnergyUse_{rf} = \beta_0 + \beta_1 T_{rf} + \alpha_f + \varepsilon_{rf} \quad (6)$$

$$IntEngUse_{rf} = \beta_0 + \beta_1 T_{rf} + \beta_2 BaseEngUse_{rf} + \alpha_f + \varepsilon_{rf} \quad (7)$$

$$PostIntEngUse_{rf} = \beta_0 + \beta_1 T_{rf} + \beta_2 BaseEngUse_{rf} + \alpha_f + \varepsilon_{rf} \quad (8)$$

where T_{rf} is a dummy variable which takes a value of 0 for control group rooms and 1 for treatment group rooms, and $PostIntEng_{rf}$ is the mean energy use of a room in the post-intervention follow-up period. The remaining terms are identical to those used in model (1) and model (2). Model (6) tests whether or not there are initial differences in the randomly assigned groups prior to intervention. Model (7) tests the effect of adding normative messages to the individual feedback on energy consumption during the intervention. Finally, model (8) tests this effect during the post-intervention period.

Table 9: Undergraduate room OLS regressions on energy consumption by treatment group

Explanatory Variable	(1)	(2)	(3)
Treatment Group	0.075	-0.298	2.095
	(0.077)	(1.012)	(3.151)
Baseline Energy Use (kWh/week)	---	0.211***	0.527***
		(0.022)	(0.067)
Floor Fixed Effects	Yes	Yes	Yes
Adjusted R^2	.153	.495	.463

Notes: OLS on energy use (kWh/week). Significance at the 0.05, 0.01, and 0.001 levels are designated by *, **, *** respectively. Standard error terms are in parentheses. The sample size is 118. (1) is on mean baseline energy use and is log transformed to meet normality assumptions. (2) is on mean weekly energy use during the intervention. (3) is on mean weekly energy use during the post intervention follow-up period. There are two groups, treatment and control.

Regression results are presented in Table 9. To meet normality assumptions for model (6), mean weekly energy consumption during the baseline period was log transformed. The other two models use untransformed data. Column 1 shows the results for model (6). The random room assignment resulted in both treatment groups not differing statistically when controlling for floor fixed effects. Model (7) results are presented in column 2. In contrast to previous studies, likely partially due to the limited sample size, no statistical differences in energy use are found between the two groups. During this period, the room's floor level and previous energy use have significant explanatory power and explain roughly 50% of the variance in energy use. In the post-intervention follow-up period, Model (8) column 3, the treatment groups once again do not statistically differ and room floor level and previous behavior retain their high explanatory power.

3.2.2 Individual Level Analysis

To investigate the effect of normative messaging on sub-samples, the same procedure of regressing subset samples based on behavioral determinants that was used in the graduate student study is used again here. For this analysis, the authors re-use the basic models from the room level analysis, models (6) through (8), except now the analysis is run using individual level data, *i*, instead of room level data, *r*. Once again standard errors are robust and clustered at the room level to control for correlations for rooms with multiple participants. In this investigation in addition to creating subset with the top and bottom 25% of each behavioral determinants very extreme users, the top and bottom 10% are also examined to see if more extreme behavioral values result in stronger treatment effects.

Running the regression model on mean baseline energy use for each sub-sample did not result with any statistical differences for any of the sub-samples based on treatment group assignment. This suggests that the randomization worked as intended.

Next model (7) is estimated with the changes as noted above. Regression results are presented in Table 10. Of all the behavioral determinants treatment only differed in the sub-samples for level of normative influencability. Column 1 shows the base model for the entire sample with the room floor dummy omitted. Column 2 adds in the room floor dummy. Floor effects explain approximately 3% of the total variance in energy use. Columns 3 through 6 present the results for the sub-samples based on level of social norm influencability. During the intervention, the treatment had a significant and meaningful effect on energy consumption conditional on occupant self-identified influencability to social norms. Across the continuum of influencability to social norms, the most extreme occupant, both high and low, had the most dramatic treatment effects. These results should be seen with some caution given the very limited sample sizes; however, steps were taken to check the robustness of the results against the influence of highly influential data points[2]. Extremely influenceable occupants who receive the normative message

[2] Since the sample size in the extreme samples is so limited the possibility of results being driven by a few highly influential data points is increased. Therefore, Cook's distance was used to identify highly influential data points (Cook 1977). If data points were identified as being highly influential they were removed and the regressions re-run. The results from the re-run regressions are presented in Table 4.9. In both cases, treatment effects matched significance levels and were in the same direction suggesting that the results are robust to influential data points.

used on average 8.5 kWh less per week relative to their counterparts who received the control message. At the other end of the influencability spectrum, the opposite effect is seen where recipients of the normative message actually used 5 kWh per week more than recipients of the control message. These two changes represent significant treatment effects of approximately 25% and 50% reductions and increases. Looking at the larger sub-samples, top 25% of each end of the continuum, the same direction of behavior is seen but with smaller treatment effects.

Table 10: Effect of normative messaging on energy use during the intervention conditional on occupant behavioral determinants in the undergraduate experiment

Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
Treatment Group	-0.746	-0.799	-8.450**	-1.247	4.096*	5.070*
	(0.808)	(0.805)	(2.467)	(1.563)	(1.532)	(2.073)
Baseline Energy Use (kWh/week)	0.199***	0.201***	0.083	0.205***	0.125**	0.097*
	(0.016)	(0.017)	(0.056)	(0.037)	(0.039)	(0.043)
Floor Fixed Effects		Yes	Yes	Yes	Yes	Yes
Highly Influenceable by Norms (top 10%)			Yes			
Highly Influenceable by Norms (top 25%)				Yes		
Highly Un-influenceable by Norms (top 25%)					Yes	
Highly Un-influenceable by Norms (top 10%)						Yes
Adjusted R^2	.461	.490	.511	.441	.438	.686
Observations	181	181	18	47	45	21

Notes: OLS on energy use during the intervention. Significance at the 0.1, 0.05, 0.01, and 0.001 levels are designated by ', *, **, *** respectively. Standard error terms are clustered at the room level and shown in parentheses.

This same procedure was used to test the effect of normative messaging on energy consumption in the post-intervention follow-up period conditional on behavioral determinants using the modified model (8). In contrast to the results just described, in the post-intervention period, the energy use of individuals based on treatment group did not statistically differ in any of the sub-samples. The social norm sub-samples did exhibit similar trends in treatment effects though where highly influenceable individuals who received the normative messages continued to use less energy and high un-influenceable individuals used more (Table 11). To contextualize these values, the mean energy use in the follow-up period for the undergraduate students was approximately 66 kWh.

Table 11: Effect of normative messaging on energy use in the post-intervention follow-up period conditional on occupant behavioral determinants in the undergraduate experiment

Explanatory Variable	(1)	(2)	(3)	(4)
Treatment Group	-3.513	-0.312	5.850	4.005
	(5.797)	(5.676)	(5.569)	(4.873)
Baseline Energy Use (kWh/week)	1.172***	0.627***	0.623***	0.306*
	(0.132)	(0.136)	(0.142)	(0.102)
Floor Fixed Effects	Yes	Yes	Yes	Yes
Highly Influenceable by Norms (top 10%)	Yes			
Highly Influenceable by Norms (top 25%)		Yes		
Highly Un-influenceable by Norms (top 25%)			Yes	
Highly Un-influenceable by Norms (top 10%)				Yes
Adjusted R^2	.903	.339	.530	.817
Observations	18	47	45	21

Notes: OLS on energy use during the intervention. Significance at the 0.1, 0.05, 0.01, and 0.001 levels are designated by ', *, **, *** respectively. Standard error terms are clustered at the room level and shown in parentheses.

4 DISCUSSION & CONCLUSION

The two longitudinal field experiments detailed in this paper aimed to address several important gaps in the literature on normative feedback interventions. The first question of interest is how suspected behavioral determinants (behavior intention, attitude, social norms, and perceived behavioral control) of energy consumption relate to each other and how do they relate to actual energy consumption. Attitude toward conserving and intention to conserve in the home had the highest correlation at -0.55 (a more favorable attitude correlated with higher intention). Interestingly though, positive attitudes towards conserving and behavior intention were not significantly correlated with actual energy use. The Theory of Planned Behavior postulates that behavior intention is usually fairly correlated and predictive of behavior when subjects have sufficient degrees of actual behavioral control (Ajzen 1991). This has been found to be true in numerous studies, buts was not found to be true here for either of the experiments as intention was not correlated with energy use prior to intervention. Its suspected the reason for the lack of correlation between these two variables has to do with the nature of the question which solicited

the occupant's behavioral intention to conserve energy. The question that directly measured behavior intention asked participants to what extent do they "plan to conserve more energy in the home." The responses to this question were heavily skewed towards strongly agree (Mean 2.37 on a bipolar scale from 1 to 7 with 1 being 'strongly agree') with only 3.8% of responses indicating no intention or negative intention to conserve. This could suggest that although occupants intend to conserve, they lack the tools (e.g., procedural knowledge) or sufficient motivation necessary to translate this intention into action.

In the undergraduate study in most cases adding normative elements to the feedback messages did not result in statistically significant less energy consumption relative to the individual feedback only messages. This was observed in both during the intervention and during the post-intervention follow-up period. This finding conceptually conflicts with the previous research which suggests that normative messages with both descriptive and injunctive norms will improve the effectiveness of energy use feedback messages (Schultz et al. 2007). In Schultz et al. (2007), it was found that feedback messages with both the injunctive and descriptive norm elements reduced energy consumption in high energy users and reduced the 'boomerang effect' of low energy users increasing their consumption to be in line with group norms. The combination of these two phenomena should in turn result in net energy reductions for rooms receiving normative messages relative to individual feedback only. This was not found to be consistent with findings from in the undergraduate study.

Many potential reasons exist which could explain this divergence in results. First, the Schultz et al. (2007) study intervened on a different demographic of consumers where occupants were responsible for energy expenditures whereas participants in the experiments in this study are indirectly billed for their energy expenditures. The additional inherent financial incentives to reduce energy consumption could have contributed to the effectiveness of the messages in the Schultz et al. (2007) study. Second, feedback in the Schultz et al. (2007) study was hand delivered, which incorporated hand written elements, and placed on participants' front doors. These characteristics could make the messages seem more personal and consequently make the participants feel a greater sense of social pressure and concern for the messages. Emails can be seen as distant and impersonal relative to hand written notes. The handwritten notes were also

publicly visible as they were place on front doors to homes which could further enhance the perceived social pressure to comply.

Additionally, in the current study it is possible that weather contributed to the lack of system level treatment effects in both the graduate and undergraduate groups during the intervention. During the intervention, the weather in Seoul was relatively mild and required almost no heating and cooling as evident by a mean weekly energy use rate of approximately 16 kWh per room. With limited space conditioning requirements the relative control occupants have over their energy consumption is greatly reduced. The potential improvement in energy use through behavioral improvements when space conditioning is not use is dramatically reduced. This could explain why in the graduate student experiment differences in energy consumption based on the duration of normative messaging became apparent in the post-intervention follow-up period when energy consumption demand was much greater.

From the graduate experiment, it was discovered that normative messaging duration had a significant effect on energy consumption in the longer term. Given this finding, one would suspect that the same pattern would be present in the undergraduate experiment but it was not. The difference in intervention messaging schedule could potentially explain this discrepancy. The graduate students received continuous normative feedback for up to sixteen weeks. The undergraduate treatment group received messaging for seven week then had a three month hiatus from living in the facility and receiving feedback before returning and receiving three more feedback messages. The long break could have nullified the effect of the previous seven weeks of messaging and made the intervention essentially equivocal to just the last three weeks of treatment. This would then imply that residents did not have enough time to develop and reinforce the perceived social norm and behavioral changes necessary to see improvements in the post-intervention period. The need for longer periods of continuous messaging is consistent with the finding from the graduate population where groups that received normative feedback for longer used less energy in the post-intervention follow-up period. Findings from Allcott and Rogers (2012) support this hypothesis.

The experiments also attempted to unearth information as to the prerequisite individual behavioral characters that moderate the effectiveness of normative feedback messages. In both experiments, it was found that only individuals who had a high motivation to comply with social

norms and perceived positive social norms exhibited meaningfully improved behavior as a result of receiving normative elements in their feedback messages. While this finding is intuitive, it had not yet been found in the field to the best of the authors' knowledge. It was also found that individuals who reported having little to no motivation to comply with social norms and perceived no social pressure increased their energy consumption when they received the normative message. Since these individuals reported essentially not caring about social norms, it is interesting that they responded negative to receiving them. Lastly, the fact that only individual social norm levels influenced the effectiveness of the treatment provides important insight into the role of the other behavioral determinants, particularly about attitude. Specifically, that it is not beneficial to attempt to change individual attitudes when conducting normative based feedback interventions and that effort would be better spent attempting to persuade occupants that a positive norm of energy conservation exists.

In conclusion, the experiments presented in this paper found that the normative messaging duration positively influences the durability of behavior change. Further, not all individuals are equally influenced by normative messaging. High norm individuals were found to be positively induced to change their energy use behavior whereas low norm individuals had the opposite effect. Developing and testing interventions to take advantage of this finding has the potential to reduce cost of intervention by limiting the population which should receive normative feedback. It also has the potential to improve the effectiveness of such programs by avoiding undesirable behavior change in large subsets of the population.

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APPENDIX A – INTAKE SURVEY: ENGLISH VERSION

OCCUPANT SURVEY

MICHIGAN ENGINEERING
UNIVERSITY of MICHIGAN ■ COLLEGE of ENGINEERING

SEOUL NATIONAL UNIVERSITY

This study is performed by University of Michigan and Seoul National University. The goal of this study is to evaluate energy consumption in the building. The result of this study will help building managers better operate the building.

- Participating in this survey is VOLUNTARY and you may stop at any time.
- All of your answers on this questionnaire will be CONFIDENTIAL.
- Your answers will be used ONLY FOR RESEARCH PURPOSES.

Thank you very much for your participation in this study.
We greatly appreciate it.

Instructions:

Many questions in this survey make use of rating scales with 7 places; you are to circle the number that best describes your opinion. For example, if you were asked to rate "Eating oranges" on such a scale, the 7 places should be interpreted as follows:

Typically, the taste of an orange is

good :	1	: 2	: 3	: 4	: 5	: 6	: 7	: bad
	extremely	quite	slightly	neither	slightly	quite	extremely	

If you think that oranges typically taste extremely good, you would circle *number 1*, as indicated below:

good :	(1)	: 2	: 3	: 4	: 5	: 6	: 7	: bad
	extremely	quite	slightly	neither	slightly	quite	extremely	

If you think that oranges do not either taste good or bad, you would circle *number 4*, as indicated below:

good :	1	: 2	: 3	: (4)	: 5	: 6	: 7	: bad
	extremely	quite	slightly	neither	slightly	quite	extremely	

If you think that oranges taste quite bad, you would circle *number 6*, as indicated below:

good :	1	: 2	: 3	: 4	: 5	: (6)	: 7	: bad
	extremely	quite	slightly	neither	slightly	quite	extremely	

When answering the questions, remember to:

*Please answer all questions

*Circle only one answer for each question

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Name _____ Building_____ Room_____

Please answer each question by circling the number that best describes your opinion. Although some questions might appear similar, they address slightly different issues, please read each question carefully. There are 31 questions.

For questions 1 to 11, during the past year, how often did you do the following when you had the opportunity?						
1.	Set thermostat to 18 degrees or lower during cool or cold weather?	Never	Rarely	Sometimes	Most of the time	N/A
2.	Set thermostat (air conditioner) to 25 degrees or higher during warm or hot weather?	Never	Rarely	Sometimes	Most of the time	N/A
3.	Turn off lights when I leave the room?	Never	Rarely	Sometimes	Most of the time	N/A
4.	Use a reusable water bottle, coffee cup, travel mug, etc.	Never	Rarely	Sometimes	Most of the time	N/A
5.	Use the power saving settings on my computer?	Never	Rarely	Sometimes	Most of the time	N/A
6.	Turn off my computer when not using it?	Never	Rarely	Sometimes	Most of the time	N/A
7.	Run washer only when I have a full load of clothes?	Never	Rarely	Sometimes	Most of the time	N/A
8.	Limit time in the shower?	Never	Rarely	Sometimes	Most of the time	N/A
9.	Recycle bottles, containers, and paper products	Never	Rarely	Sometimes	Most of the time	N/A
10.	Buy Products (besides food) that carry some type of ecolabel or certification (e.g. lumber, organic cotton clothing, household cleaning products)	Never	Rarely	Sometimes	Most of the time	Don't Know
11.	Buy locally grown or processed, organic, or fair trade food?	Never	Rarely	Sometimes	Most of the time	Don't Know

Circle the corresponding answer or fill in the blank

12. I am a _____ student: First year Sophomore Junior Senior Graduate/Professional Degree

13. List where you are most likely to be found in the SNU dorms (building and room number).
Bld____Rm_____, Bld____Rm_____, Bld____Rm_____, Bld____Rm_____, Bld____Rm_____,
Bld____Rm_____, Bld____Rm_____, Bld____Rm_____, Bld____Rm_____, Bld____Rm_____.

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Circle the number that best describes your opinion

14. I plan to conserve more energy in my home
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

15. In general, people should conserve energy, even if it is inconvenient.
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

16. Conserving more energy would negatively affect my comfort
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

17. Using less energy at home will have environmental benefits
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

18. Conserving more energy would be an inconvenience to me
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

19. Negatively affecting my comfort to conserve energy is
very undesirable : 1 : 2 : 3 : 4 : 5 : 6 : 7 : very desirable

20. Behaving in a manner that benefits the environment is good
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

21. My neighbors' think that I should be more environmentally responsible with my energy use
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

22. My close friends' think that I should be environmentally responsible with my energy use
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

23. Generally speaking, how much do you care what your neighbors think you should do
not at all : 1 : 2 : 3 : 4 : 5 : 6 : 7 : very much

24. Generally speaking, how much do you care what your close friends think you should do
not at all : 1 : 2 : 3 : 4 : 5 : 6 : 7 : very much

25. I know what consume energy in the home
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

26. If it is hot or cold, it would make it difficult for me to conserve energy at home
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

27. If I am mentally tired, it would make it more difficult for me to conserve energy at home
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

28. Knowing what consumes energy will enable me to reduce my energy use
strongly agree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly disagree

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29. It is either hot or cold in my home
Very rarely : 1 : 2 : 3 : 4 : 5 : 6 : 7 : very frequently

30. When at home, I am mentally tired
very rarely : 1 : 2 : 3 : 4 : 5 : 6 : 7 : very frequently

Use the following lines to briefly answer the follow question and add any comments you might have

31. If you currently actively attempt to conserve energy, why do you do so? If you currently do not, why not?

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