FISEVIER

Contents lists available at ScienceDirect

Cleaner and Responsible Consumption

journal homepage: www.journals.elsevier.com/cleaner-and-responsible-consumption





An experimental study of consumer attitudes and intentions in electricity markets

Gina Dello Russo ^{a, *}, Ashley Lytle ^b, Steven Hoffenson ^a, Lei Wu ^c, Caitlin Mahoney ^b

- ^a School of Systems and Enterprises, Stevens Institute of Technology, Hoboken, NJ, 07030, USA
- b College of Arts and Letters, Stevens Institute of Technology, Hoboken, NJ, 07030, USA
- ^c Department of Computer and Electrical Engineering, Stevens Institute of Technology, Hoboken, NJ, 07030, USA

ABSTRACT

Challenges posed by climate change are increasing, and residential electricity use is a major contributor. Two ways for individuals to help mitigate this issue are reducing electricity consumption and investing in renewable energy sources. A large body of research has shown that social norms are effective in encouraging various pro-environmental behaviors such as energy use conservation, but less information is available about their ability to encourage investment in renewable energies. Research on incentives and fees has also demonstrated their potential impacts on pro-environmental behaviors in general, but it is less comprehensive regarding sustainable energy behaviors specifically. The combined influence of social norms with incentives or fees on pro-environmental energy behaviors has yet to be explored in the literature. In this study, three experiments are conducted to investigate norms, incentives and fees, and their combined effect on pro-environmental energy decisions. Through surveys that exposed participants to each of these stimuli, participants' attitudes, perceptions, and intended behaviors were measured. Data were collected about various consumer energy decisions along with the consumers' willingness to pay for renewable energy. Results of the survey experiments show that exposure to incentives and fees framed to reduce consumption significantly increased participants' perceptions of norms and willingness to pay for solar panels when compared to a control group, whereas other manipulations such as social norms and incentives and fees framed to motivate clean energy investments were not impactful on perceptions and intended behaviors. These results uncover the potential to decrease emissions resulting from residential electricity use by introducing incentives and fees on electricity bills and motivating individuals to reduce their consumption and invest in solar panel systems. These behavior changes will contribute to the sustainable development of electricity markets, reducing emissions and costs

1. Introduction

Electricity generation constitutes 27 percent of greenhouse gas emissions in the United States (U.S.), making it the second largest source of emissions and a significant contributor to the growing climate crisis (U.S. Environmental Protection Agency, 2020). The major stakeholders influencing the carbon footprint of electricity systems are governing bodies, electricity generation and delivery companies, and consumers. Research suggests that electricity consumption and its carbon footprint can be reduced through various means including government regulation, power producer decision making, and individual behaviors. Past research has found that individual behaviors such as conserving energy use (Bertoldi, 2022; Van Raaij and Verhallen, 1983), installing energy efficient appliances (Bertoldi, 2022; Gardner and Stern, 2008), and investing in renewable sources through solar panel installations (Arif, 2013; Razmjoo et al., 2021) or opting into renewable energy credit programs (Burns and Kang, 2012; Nguyen and Felder, 2020) are effective in helping reduce the negative impacts of electricity consumption.

Previous studies have delved into pro-environmental energy use

behaviors and suggested that social norms and incentives and fees are two influencing factors that could lead to pro-environmental energy decisions (Bertoldi, 2022; Grilli and Curtis, 2021). These results may support policy and business decision makers seeking to encourage responsible energy behavior; however, previous studies generally have not explored both norms and incentives or fees in the same context. The combination of social norm messaging with an incentive or fee provides the opportunity to leverage the joint power of social norms and extrinsic motivators. If incentives can be designed such that they do not crowd out intrinsic motivation but instead provide additional motivation for individuals to make pro-environmental decisions while reinforcing that these decisions are the norm through specific messaging, more people can be influenced by the combined intervention than either of the two approaches on their own. This study conducts comprehensive survey experiments to analyze the effects of social norms, incentives and fees, as well as norms combined with incentives or fees on consumer energy behavior. Effects on the following intended behaviors are measured: (1) energy conservation, through stated intentions to reduce energy use or install energy-efficient appliances; and (2) investment in renewable

E-mail address: gdelloru@stevens.edu (G. Dello Russo).

^{*} Corresponding author.

sources, through stated intentions to install solar panels or opt into renewable energy credit programs. The survey experiments were designed to address the following research questions:

- 1. To what extent does exposure to social norms influence attitudes and intended behaviors regarding household electricity choices?
- 2. To what extent do monetary incentives or fees influence attitudes and intended behaviors regarding household electricity choices?
- 3. To what extent does the combination of social norms with incentives or fees influence attitudes and intended behaviors regarding household electricity choices?

The experimental data generated by the experiments will provide a quantitative understanding of the impacts of energy policy interventions on intended consumer choices. This will be valuable for policy and tradeoff analyses as well as for developing advanced computational simulations of electricity market systems with active consumer participation.

2. Background

The causes and motives of human behavior have historically been of interest to psychologists, with special attention paid to the relationship between attitudes and behavior. Empirical research suggests that attitudes are strong predictors of behavior (Ajzen and Fishbein, 2005; Joshi et al., 2021; Kraus, 1995). The theory of planned behavior suggests that attitudes, perceived behavioral control, and subjective norms influence an individual's behavioral intentions (Ajzen, 1991). Furthermore, if a person has the means and opportunity to perform some behavior, a strong intention to carry out that behavior can serve as a predictor for the behavior (Ajzen, 1991). Consequently, determining the intervention strategies that are capable of influencing consumer attitudes, perceptions, and norms is an important step for developing strategies to motivate sustainable consumer energy behaviors. Recently, the focus has shifted to learning how behavior is affected by the introduction of external factors such as praise, reciprocity, social norms, increased commitment, scarcity, goal setting, providing information and feedback, and rewards (Cialdini, 2001; Guo et al., 2018). Of those found to be effective, social norms as well as incentives and fees are of particular interest in changing consumer electricity behavior.

2.1. Social norms

Social influence is the effect of a person or group on another individual's beliefs, attitudes, or behaviors (Forgas and Williams, 2001). Social norms, a type of social influence, are a set of explicit and implicit rules of how to behave. Numerous studies demonstrate the extent to which social norms influence people's intentions and behaviors (Cialdini and Jacobson, 2021; McDonald and Crandall, 2015). The majority of these studies are designed where participants must decide to engage or not engage in a target behavior after being shown a social norm message, such as "70% of your neighbors actively conserve water," compared to a control message, such as "conserving water helps the environment." A landmark study by Cialdini et al. (1990) consisted of participants walking through an area that was either clean or littered upon their entrance and witnessing a confederate (someone working with the experimenters) litter or not litter. This experiment resulted in 54% of participants who witnessed a confederate litter in an unclean environment littering themselves, while only 6% of those who saw no littering in a clean environment chose to litter. In the littering study, the norm message takes the form of a manipulated environment, while in other studies, it is explicitly stated (Kormos et al., 2015; Osbaldiston and Schott, 2012; Schultz et al., 2016; Varotto and Spagnolli, 2017). Since this experiment, similar effects have been observed for various pro-environmental behaviors such as recycling, reducing household energy consumption, water conservation and reusing towels during a

hotel stay (Bator et al., 2019; Chen et al., 2017; Han and Hyun, 2018; Lede et al., 2019; Varotto and Spagnolli, 2017). Thus, it is widely documented that social norms can be useful in encouraging pro-environmental behaviors.

Norms are frequently classified as being either descriptive or injunctive. Descriptive norms refer to what most people do while injunctive norms refer to what most people perceive as being right or wrong, or what they ought to do (Cialdini et al., 1990, 2006). Indeed, an injunctive norm describes a behavior most people approve of, which usually aligns with the descriptive norm that describes what most people actually do (Lapinski and Rimal, 2005). An example of a descriptive norm is "most Americans recycle," whereas an injunctive norm is "most Americans think recycling is good." Another way to distinguish norms is by their reference group, or the group of people holding the perceived norm (Cialdini et al., 1990). Norms can be activated or made more salient when the reference group for the norm is manipulated (Goldstein et al., 2008). For example, a person can be told that most people in their town recycle (proximal), or they can be told most people in their country recycle (distal). It is believed that the more proximal a reference group is, the more effective the norm will be (Borsari and Carey, 2003; Goldstein et al., 2008). This stems from people considering those closer to them as more important and identifying more easily with such groups (Neighbors et al., 2008).

Notable findings have come from testing real-world behavior using data from energy analytics company Opower. In an implementation of social norms research, Opower sent households Home Energy Reports (HERs) that compare households to similar neighbors, a measure of proximal norms, and give suggestions on how to reduce energy use (Allcott, 2011; Corner, 2011; Stern, 2013). Analyses of these social norm messages found a 2-percent reduction in energy use overall; this is a substantial reduction, as it is considered equivalent to what would occur if energy prices increased by 11-20 percent (Allcott, 2011). Opower's HERs provide useful insights and confirm past findings about the effective use of social norms to influence energy decisions. A more recent study suggests that social norms are more influential when presented to individuals with more adaptable personality types, while increasing perceived behavioral control is more effective for other personality types (X. Liu et al., 2021). The personality types highlighted by X. Liu et al. (2021) were studied in the context of energy-saving behavior amongst long-stay hotel guests where empirical data confirmed that norms have varying levels of influence depending on an individual's personality type, calling for individualized normative interventions (Wang et al., 2023b). A related study of energy-saving behaviors amongst long-stay hotel guests affirmed that increased perceived moral obligation leads to energy-saving behavior, and that energy-saving behaviors are influenced by personal norms and attitudes (Wang et al., 2023a). In the study reported here, social norms were designed to be as proximal as possible and were communicated through the use of infographics.

2.2. Incentives and fees

Incentives and fees are intended to either encourage or discourage target behaviors by adding an extrinsic motivation. An extrinsic motivation drives a person to complete an action that does not already come purely from their inner drive. It can be monetary, such as a subsidy or tax, or non-financial, like granting or revoking special privileges (Berry, 1984; Norberg-Bohm, 2000). B.F. Skinner, the figurehead of behavioral psychology, suggests that operant conditioning can explain the effectiveness of extrinsic motivation (Skinner, 1965, 2002). Operant conditioning states that if a behavior is followed by something pleasurable, or a positive reinforcement, then the individual is more likely to repeat that behavior, since they will associate it with the reward earned. The opposite is believed to hold true as well: A behavior followed by something unpleasant, or a positive punishment, is less likely to be repeated, since the individual does not want to experience the

punishment another time.

Indirect effects have been argued to result from incentives and fees as well. Some research has found that incentives and fees decrease intrinsic motivation (Benabou and Tirole, 2003; Rode et al., 2015), particularly in instances where the incentive is too large or the reward coincides with the intrinsic motivation (James Jr, 2005). Others found that monetary framing has no influence on intrinsic motivation, and rather, may increase the salience of social norms (Rode et al., 2015; Steinhorst and Klockner, 2018; Viscusi et al., 2011). For example, a fee for littering does not explicitly state that a person should not litter because others find it unacceptable, yet its existence implies that enough people find it unacceptable for the fee to be put in place. Some empirical studies have also found that for behaviors like quitting smoking, wearing a seat belt, and losing weight, incentives have generally only resulted in temporary behavior changes (Kohn, 1993, 1999). While there is ample research regarding incentives and fees motivating behaviors like those just mentioned, that which focuses on pro-social and pro-environmental behavior distinguishes itself from the rest because of its unique moral implications (e.g., rewarding somebody for doing what is good for society rather than just for themselves or their jobs).

In the energy consumption domain, financial incentives have consistently been found effective at reducing household energy use (Bertoldi, 2022; Delmas et al., 2013; Mi et al., 2021; Zhang and Wang, 2017), but they have not always shown to sustain such reductions after the incentive ends (Abrahamse et al., 2005). Larger incentives can be more effective (Stern et al., 1986), but more variation can result from the organization giving the incentive, the amount of marketing, the form of incentive (i.e., a grant or loan), and the types of interventions with which it is combined (Delmas et al., 2013; Y. Liu et al., 2021; Stern et al., 1986). Incentives have been shown to be more effective than information alone (Winett and Nietzel, 1975), stronger when combined with feedback or goal setting (Delmas et al., 2013; Y. Liu et al., 2021) and weaker when compared to feedback by itself (Mizobuchi and Takeuchi, 2012). They have also shown an ability to effectively reach lower-income households, and in general, attract attention to energy efficiency (Zhang and Wang, 2017), which may have a more prolonged impact. In this study, incentives and fees were implemented in the form of realistic electric utility bill graphics using artificial numbers and policies, to examine the effects on attitudes and behaviors related to energy conservation and investment in renewable energy.

3. Method

Since the use of social norms, incentives and fees, and the combination of norms with incentives or fees to encourage energy efficient behavior has yet to be thoroughly explored in the literature, this study consists of experimental surveys designed to measure the attitudes, perceptions, and intended behaviors of consumers following their exposure to these manipulations. All of these approaches to influencing consumer behavior in energy markets can be implemented with minimal physical change to existing electricity systems, making both options suitable for near-term implementation. In this study, participants responded to questions about four multi-item measures within the context of electricity markets: intended future energy behaviors, energy efficient behaviors, perceived norms, and perceptions of costs and benefits. Participants also responded to energy-related willingness-topay questions along with demographic questions to gauge existing behaviors in electricity markets. The experiments used a between-subjects design in which participants were randomly assigned to one condition from one of the three experiments, which cumulatively contained thirteen conditions.

To address the research questions established in Section 1, survey data were collected and analyzed to quantify the effects of social norms, incentives, and fees on consumers. The study was conducted via CloudResearch and Amazon's Mechanical Turk (MTurk) platform in February and March of 2022. MTurk, a popular behavioral science tool,

is an online, crowd-sourced employee marketplace that allows participants to complete online tasks in exchange for compensation (Kees et al., 2017; Mason and Suri, 2012). CloudResearch, formerly TurkPrime, provides additional features so that researchers can obtain high-quality participants from MTurk (Litman et al., 2017). A recent investigation into the data quality of online platforms for behavioral research found that CloudResearch provided high-quality data with complete and honest responses (Berry, 1984; Eyal et al., 2021). In the study reported here, participants were required to have completed at least 100 human intelligence tasks (HITs) prior to participating, with at least a 90-percent approval rate (i.e., participants who have not been frequently rejected for having provided poor or incomplete data), and were classified as "master" workers by Amazon. CloudResearch features also allow researchers to obtain diverse data collection in terms of education, socioeconomic status, geographic location, and other demographic variables. Prior to accepting the task, participants were informed that the survey would take a maximum of 20 min to complete and that they would be paid \$4.30 for successful completion. The payment was based on New Jersey's minimum wage at the time the survey was conducted, and once paid, participants could transfer the money to their Amazon account balance or bank account. Before conducting this study on MTurk, a pilot study was completed with the university's student subject pool. The pilot study provided the opportunity to identify and resolve any issues with the experiments prior to community data collection. The university's Institutional Review Board (IRB) approved this research prior to data collection under protocol 2021-005(N).

3.1. Study design

Potential participants viewed a posting on MTurk that described a one-time study on "attitudes, perceptions, and behaviors." Participants who proceeded to complete the survey were given a cover story to reduce social desirability as well as demand characteristics. They were told that the study was investigating their familiarity with current events. The survey stated that participants would be "randomly assigned to provide your beliefs about one of the following topics and comment on the presentation of information about that topic." All participants were then told that they were "randomly assigned" to the "renewable energy/energy consumption" condition. After the cover story, participants were actually randomly assigned to one of thirteen conditions across three different experiments: Experiment 1, Social Norms; Experiment 2, Incentives and Fees; and Experiment 3, Combined Social Norms and Incentives or Fees. After viewing the social norm message and/or bill graphic associated with their assigned condition, participants responded to attention checks to ensure their understanding of the manipulation. Next, they responded to questions about their perceptions, beliefs, and intentions, followed by various demographic questions. At the end of the study, participants were debriefed and compensated for their time.

3.1.1. Experiment 1: Social Norms

In Experiment 1, participants were randomly assigned to one of three conditions: (i) control environmental message (EM); (ii) norm to reduce consumption (NR); and (iii) norm to invest in renewable energy (NI). The social norm messages (NR and NI) promoted consuming less energy and choosing cleaner energy sources. For legitimacy, the message included a false citation to the U.S. Department of Energy, which was revealed to be fictional during the debrief at the end of the survey. The control environmental message condition (EM) did not relate to norms and included a generic save-the-environment message similar to past social norm and environmental behavior studies (Goldstein et al., 2008). Norm messages and the save-the-environment message were all communicated through the use of infographics. Figs. A.1-A.3 in the appendix contain the infographics used to communicate the control environmental message and social norm messages. All graphics were designed to be as aesthetically similar as possible to minimize biases

from such inconsistencies.

3.1.2. Experiment 2: Incentives and Fees

In Experiment 2, participants were randomly assigned to one of five conditions: (i) control bill (CB); (ii) incentive for reducing energy use (IR); (iii) incentive for investing in renewable energy (II); (iv) fee for not reducing energy use (FR); and (v) fee for not investing in renewable energy (FI). The incentives and fees were communicated to participants by showing them a fictional energy bill designed to look similar to the local power utility's energy bill, with some features simplified for the purpose of drawing attention to the manipulated parts of the bill. Figs. A.4-A.8 in the appendix contain the bill graphics used to communicate the control, incentive, and fee conditions.

All bill prices were kept consistent with the exception of the manipulated incentives and fees. The incentive for reducing energy use (IR) was a lower total energy bill due to an "energy saver discount" for households whose energy consumption is no more than 800 kWh per month. The incentive for investing (II) was a lower total energy bill due to a small government-issued subsidy given for having installed solar panels on the home or opting into the utility company's green energy program. The fee for not reducing use (FR) was a higher total energy bill due to dynamic pricing having been implemented by the utility, meaning that the participant had to pay more for some electricity that was used during peak consumption hours. The fee for not investing (FI) was a small government-issued carbon tax that could be avoided if consumers elect to install solar panels, participate in the utility's green energy program, or invest in renewable energy sources in some other way. The monetary value for all incentives and fees was \$15.60; the moderate monetary value was chosen to avoid crowding out intrinsic motivation as described in Section 2.2.

3.1.3. Experiment 3: Combined Social Norms + Incentives or Fees

In Experiment 3, participants were randomly assigned to one of five conditions: (i) control bill + environmental message (CB + EM); (ii) incentive for reducing energy use + norm to reduce consumption (IR + NR); (iii) incentive for investing in renewable energy + norm to invest in renewable energy (II + NI); (iv) fee for not reducing energy use + norm to reduce consumption (FR + NR); and (v) fee for not investing in renewable energy + norm to invest in renewable energy (FI + NI). The combined conditions used the same infographics, energy bills, and attention checks as in Experiments 1 and 2 accordingly. Additionally, the presentation order of the norm message and incentive or fee was randomized to avoid ordering bias.

3.2. Measures

Following the manipulations in the survey, participants responded to questions pertaining to their intended future behaviors, energy efficient behaviors, perceptions of norms, perceptions of costs and benefits, and willingness to pay for renewable energy and to conserve electricity. Four multi-item measures were used to create composite scores for the dependent variables, and the remaining questions were used to determine participants' willingness to pay to participate in various proenvironmental behaviors.

3.2.1. Intended future behaviors (FB)

An eight-item measure examined intended repeated future energy behaviors (adapted from Nolan et al., 2008) on a 1 (never) to 6 (always) scale. Participants were asked how often they expected to engage in each of the following behaviors within the next six months:

- 1. Recycling paper, plastic, glass, and other recyclable materials;
- Purchasing eco-friendly products over their less environmentally friendly counterparts;
- 3. Conserving my water consumption;
- 4. Reducing my energy consumption;

- 5. Washing and rinsing my clothes with hot water*;
- 6. Leaving lights on when I am not using them*;
- Actively keeping my thermostat setting close to the outdoor temperature (reducing use of heat and air conditioning to conserve energy); and
- 8. Referring my friends/family to enroll in clean energy programs.

Two of the items, indicated by asterisks in the list above, were framed in a reverse way where lower is more environmentally friendly, to ensure participants did not enter the same response for all items.

3.2.2. Efficient behaviors (EB)

A four-item measure captured participants' intended one-time future energy decisions on a 1 (very unlikely) to 6 (very likely) scale. Individuals are capable of reducing the environmental impact of electricity use by replacing their light bulbs with energy efficient bulbs, using energy efficient appliances, installing solar panel systems, and participating in clean energy programs (Albeck-Ripka, 2019; Arif, 2013). Since these pro-environmental actions can help reduce emissions, participants were asked how likely they were to do the following within the next 6 months:

- 1. Replace my light bulbs with energy efficient light bulbs;
- 2. Replace my appliances with energy efficient appliances (i.e., a refrigerator with an Energy Star certification);
- 3. Install solar panels on my home;
- 4. Participate in my power utility's green energy or renewable energy credit program.

Participants were also able to indicate that they already have made these decisions.

3.2.3. Perceived norms (PN)

A five-item measure assessed participants' perceptions of norms (adapted from Ozaki, 2011), on a 1 (strongly disagree) to 6 (strongly agree) Likert scale. The items were framed as affirmative statements as is commonly done in the literature when measuring pro-environmental norms and perceptions (Alzubaidi et al., 2021; Ozaki, 2011; Panda et al., 2020). Participants were asked whether they agree or disagree with the following statements:

- 1. I feel a moral obligation to engage in energy behaviors that are beneficial for the environment.
- Most Americans engage in energy behaviors that are beneficial for the environment.
- Most Americans believe it is morally right to engage in energy behaviors that are beneficial for the environment.
- 4. Most of my neighbors engage in energy behaviors that are beneficial for the environment.
- 5. Most of my neighbors believe it is morally right to engage in energy behaviors that are beneficial for the environment.

3.2.4. Perceived costs and benefits (PCB)

A four-item measure examined perceived cost and benefits (adapted from Nolan et al., 2008) on a 1 (strongly disagree) to 6 (strongly agree) Likert scale. Participants were asked whether they agree or disagree with the following statements:

- If I reduced my at-home energy consumption, I would personally receive financial benefits.
- If I did not reduce my at-home energy consumption, I would incur financial costs.
- If I invested in renewable energy sources by installing solar panels or participating in my utility's green energy program, I would personally receive financial benefits.

4. If I did not invest in renewable energy sources by installing solar panels or participating in my utility's green energy program, I would personally incur financial costs.

3.2.5. Willingness to pay (WTP)

Three measures of willingness to pay (WTP) were also captured through open response and multiple-choice questions, associated with solar panel installation, clean energy program enrollment, and upgrading to energy efficient appliances. The prompts for the solar panel and clean energy program WTP measures asked participants to write in monetary values in response to the following two questions:

- 1. How much money would you be willing to invest in installing a 1,000-Watt solar panel system on your home or property? (On average, it will reduce your electricity bill by about \$23 a month.)
- 2. How much would you be willing to pay each month to participate in your utility company's clean energy program? (Participating in a clean energy program means your electricity provider will ensure the electricity you purchase is generated from renewable sources.)

The third WTP measure asked about four appliance categories: refrigerators, clothes washers, clothes dryers, and central air conditioning units. In line with existing Energy Star appliance rebates, participants were asked: "To replace my [refrigerator/clothes washer/clothes dryer/central air conditioner] with an Energy Star certified [refrigerator/washer/dryer/unit] ..." Response options included the following, with numbers that corresponded to the specified appliance:

- I already have an Energy Star certified [refrigerator/clothes washer/clothes dryer/central air conditioner].
- I would need my utility company to offer no rebate.
- I would need my utility company to offer a [\$25/\$25/\$100/\$300] rebate.
- I would need my utility company to offer a [\$50/\$50/\$200/\$400] rebate.
- I would need my utility company to offer a [\$75/\$75/\$300/\$500] rebate.
- I would need my utility company to offer more than a [\$75/\$75/\$300/\$500] rebate.
- I would not do this.
- I do not own a [refrigerator/clothes washer/clothes dryer/central air conditioner].

3.3. Data cleaning and preparation

Prior to analyzing the survey responses, composite scores were created using the responses from the FB, EB, PN, and PCB measures. The responses for items within each measure were averaged, resulting in four normally distributed dependent variables on a 1–6 scale. A composite score was also created using the four appliance rebate (AR) questions, however, similar to the WTP for solar panels and WTP for clean energy measures, these responses were not normally distributed. Once the composite measures were created, responses were reviewed to ensure participants (n = 1,236) paid attention to the survey and completed it thoroughly. Participants (n = 20) were removed for leaving one or more of the dependent variables blank and (n = 68) for failing at least half of the attention checks, indicating inattention to the survey and manipulations. Following the calculation of the composite scores and the removal of inadequate responses, summary statistics were generated, and statistical analyses were performed.

3.4. Participants

Participants who qualified for the analysis included 1,148 residents of the Northeastern U.S. with a mean age of 39.80 (SD = 12.74). For this study, the Northeastern U.S. includes New Jersey, New York,

Pennsylvania, Connecticut, Massachusetts, Rhode Island, Vermont, New Hampshire, and Maine. Fig. 1 includes an overview of the demographics of the study participants.

Most participant demographics aligned with the demographics of the northeast region of the United States (U.S. Census Bureau, 2021). 53% of participants were women, the median participant age was 37, and the median household income was \$81,500, all of which align with local statistics. The education level of our sample was higher than the local statistic with 99.5% of participants being high school graduates or higher as compared to 90.4% of the northeast region. Furthermore, our sample race distribution was 77% White, 7% Asian, 7% Black or African American, 3% Hispanic or Latino, 0% American Indian or Alaska Native, 1% other, and 4% two or more races, whereas the race distribution of the northeast region is 63% White, 7% Asian, 10% Black or African American, 15% Hispanic or Latino, 0% American Indian or Alaska Native, 1% other, and 4% two or more races. Comparing the sample to the population, this study involved a larger percentage of White participants and a lower percentage of Hispanic or Latino participants than the true distribution in the region.

3.5. Hypotheses and analyses

The goal of this study was to determine the influence of social norms as well as incentives and fees on consumer attitudes, intentions, and beliefs with respect to electricity markets. Social norm messages and bill graphics were used to encourage participants to make more sustainable decisions. For each of the experiments and the normally distributed dependent variables, we hypothesized that:

H1. The experimental conditions will result in significantly increased FB, EB, PN, and PCB responses when compared to the control condition.

To test this hypothesis, multi-variate analyses of variance (MAN-OVAs) were conducted for each experiment with the four normally distributed composite dependent variables (i.e., FB, EB, PN, and PCB). In the case of a significant MANOVA result, individual analyses of variance (ANOVAs) were conducted for each of the dependent variables to determine whether they varied significantly among one or more conditions. In instances where the ANOVAs were significant, *t*-tests were used to determine which conditions had significant differences from the control group. For each of the experiments and the non-normally distributed dependent variables, we hypothesized that:

H2. The experimental conditions will result in significantly increased WTP for solar panels, WTP for clean energy, and AR responses when compared to the control condition.

To test these hypotheses, Kruskal-Wallis tests, the non-parametric equivalent of ANOVA tests, were conducted for each experiment with the WTP for solar panels, WTP for clean energy, and AR responses. Significant Kruskal-Wallis tests were followed by Mann-Whitney tests, the non-parametric equivalent of *t*-tests.

4. Results

The means and standard deviations of the intended repeated future energy behaviors, intended one-time energy efficient behaviors, perceived norms, and perceptions of costs and benefits measures were calculated for each condition across all three experiments.

As shown in Table 1, these four measures all had similar mean scores across experiments and conditions. The correlation matrix for these response variables is shown in Table 2.

A Spearman correlation analysis on the demographic variables and the dependent variables found one significant correlation between a demographic variable and a dependent variable: Education level and willingness to pay for solar panels produced a correlation coefficient of 0.11 with a *p*-value of 0.009. This suggests that, within our dataset, there is a weak positive relationship between education level and willingness to pay for solar panels, and there are no other relationships between the

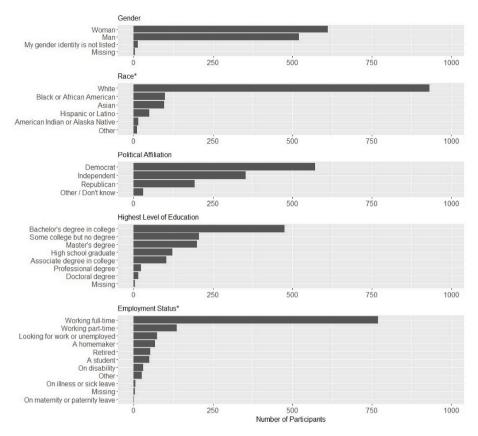


Fig. 1. Participant demographics; note that respondents were able to select multiple racial identities and employment statuses.

Table 1Number of participants (n) for each condition and mean and standard deviation (sd) of the future behaviors (FB), efficient behaviors (EB), perceived norms (PN), and perceived costs/benefits (PCB) composite variables.

	n	FB	EB	PN	PCB
		mean	mean	mean	mean
		(sd)	(sd)	(sd)	(sd)
Experiment 1					
Environmental Message	84	3.97	2.64	3.60	3.91
(EM)		(0.81)	(1.06)	(0.78)	(0.86)
Norm Reduce (NR)	87	4.12	2.96	3.77	3.91
		(0.77)	(1.13)	(0.84)	(1.04)
Norm Invest (NI)	93	4.06	2.99	3.84	3.79
		(0.88)	(1.25)	(0.83)	(1.13)
Experiment 2					
Control Bill (CB)	67	4.21	3.01	3.67	3.97
		(0.74)	(1.36)	(0.78)	(1.00)
Incentive Reduce (IR)	88	4.15	3.04	3.79	4.11
		(0.84)	(1.40)	(0.80)	(0.94)
Incentive Invest (II)	85	4.25	3.06	3.95	4.01
		(0.74)	(1.31)	(0.84)	(0.96)
Fee Reduce (FR)	88	4.10	2.98	3.98	3.90
		(0.86)	(1.48)	(0.75)	(0.98)
Fee Invest (FI)	91	4.25	3.13	3.72	4.15
		(0.74)	(1.26)	(0.79)	(0.83)
Experiment 3					
CB + EM	86	4.03	3.14	3.75	4.00
		(0.67)	(1.32)	(0.85)	(0.94)
IR + NR	96	4.18	3.14	3.92	4.10
		(0.75)	(1.36)	(0.70)	(0.82)
II + NI	94	4.16	2.96	3.99	3.91
		(0.82)	(1.33)	(0.90)	(0.98)
FR + NR	97	4.22	3.03	3.80	3.80
		(0.66)	(1.26)	(0.80)	(0.84)
FI + NI	92	4.06	2.94	3.85	3.67
		(0.83)	(1.28)	(0.80)	(1.03)

Table 2Correlation between the future behaviors (FB), efficient behaviors (EB), perceived norms (PN), and perceived costs/benefits (PCB) composite variables.

	FB	EB	PN	PCB
FB	1	0.290	0.396	0.353
EB	0.290	1	0.200	0.163
PN	0.396	0.200	1	0.279
PCB	0.353	0.163	0.279	1

participant demographics and their decision-making.

Fig. 2 illustrates the data distributions with box and whisker plots that display the minimum, median, maximum, interquartile range, and outliers for each composite dependent variable across all experimental conditions

Fig. 2 highlights the fact that the median score for each measure does not vary significantly between most experimental conditions. To further quantitatively evaluate the differences in means of these measures, MANOVAs were conducted for each of the experiments.

As shown in Table 3, the Experiment 2 MANOVA showed a statistically significant difference across conditions (p=0.0143), while those of Experiments 1 and 3 did not, indicating that the conditions in these latter experiments did not significantly alter the dependent variables. Following the significant MANOVA result for Experiment 2, ANOVAs were conducted for each of the dependent variables, with the results provided in Table 4.

According to Table 4, the PN ANOVA test produced a statistically significant result (p=0.005), whereas the other three dependent variables showed no significant differences across conditions. To further explore this dependent variable, t-tests were conducted to determine which incentive and fee conditions had PN mean values that varied significantly from the control condition in Experiment 2.

The t-test results, shown in Table 5, revealed that the PN means for

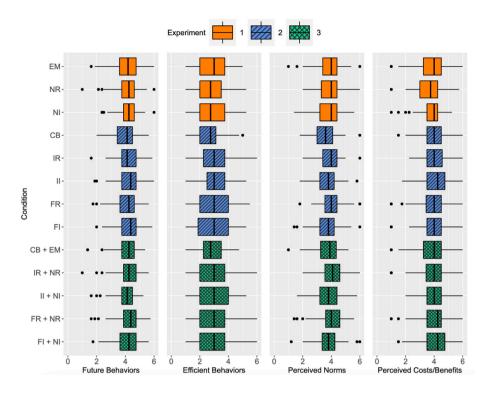


Fig. 2. Box and whisker plots showing minimum, median, maximum, interquartile range, and outliers for each dependent variable (columns) across each condition (rows). Experimental conditions include control environmental message (EM), norm to reduce consumption (NR), norm to invest in renewable energy (NI), control bill (CB), incentive for reducing energy use (IR), incentive for investing in renewable energy (II), fee for not reducing energy use (FR), fee for not investing in renewable energy (FI), and combinations thereof.

Table 3Results of MANOVAs with all dependent variables for each experiment.

	df	Pillai's Trace	F	p-value
Experiment 1				
Condition	2	0.016	0.526	0.837
Residuals	261			
	_			
Experiment 2				
Condition	4	0.073	1.934	0.0143*
Residuals	414			
Experiment 3				
Condition	4	0.034	0.974	0.483
Residuals	460			

Signif. codes: *p < 0.05, **p < 0.01, ***p < 0.001.

Table 4Results of Experiment 2 ANOVAs for each dependent variable.

	df	Sum Squared Error	Mean Squared Error	F	<i>p</i> -value
Future Beh	aviors	(FB)			
Condition	4	3.6	0.899	1.483	0.206
Residuals	414	250.9	0.606		
Efficient Be	ehavior	s (EB)			
Condition	4	11.8	2.956	1.681	0.153
Residuals	414	728.0	1.758		
Perceived 1	Norms ((PN)			
Condition	4	8.7	2.181	3.762	0.005**
Residuals	414	240.0	0.580		
Perceived (Costs/B	enefits (PCB)			
Condition	4	4.1	1.028	1.255	0.287
Residuals	414	339.2	0.819		

Signif. codes: *p < 0.05, **p < 0.01, ***p < 0.001.

the Experiment 2 IR and FR conditions differ significantly from the CB condition, with respective p-values of 0.010 and 0.003. The main difference between the effective and ineffective incentive and fee treatments here is the framing of the incentives and fees. When posed as a

Table 5Results of perceived norms (PN) *t*-tests between experimental incentive and fee conditions and the control bill (CB) condition in Experiment 2.

Condition	mean	t	<i>p</i> -value
Control Bill	3.603		
Incentive Reduce	3.918	-2.600	0.010*
Incentive Invest	3.725	-0.947	0.345
Fee Reduce	3.984	-3.054	0.003**
Fee Invest	3.673	-0.553	0.581

Signif. codes: *p < 0.05, **p < 0.01, ***p < 0.001.

reward for successfully reducing consumption or an additional charge for failing to reduce consumption, participants' pro-environmental norms were elevated; however, when framed to motivate investing in renewable energy sources, the treatments were not effective. This may be a result of the framing of the PN items, as participants may more strongly associate reducing consumption with "energy behaviors that are beneficial for the environment," as opposed to making the one-time decision to install solar panels or opt into a clean energy program.

As mentioned previously, participants also responded to other energy-related questions, including their WTP to install a 1,000-Watt (W) solar panel system on their home and their WTP per month to participate in a clean energy or renewable energy credit program with their utility provider. Table 6 includes summary statistics of the survey responses.

Participants stated a median WTP of \$500 with a mean of \$1,320 for a 1,000 W solar panel system. The large difference between the median

Table 6Participants' stated willingness to pay (WTP) to invest in a 1,000-Watt solar panel system and monthly WTP to participate in a clean energy program.

	Min	25th percentile	Median	Mean	75th percentile	Max
Solar Panels	0	100	500	1,319	1,500	10,000
Clean Energy	0	0	10	23.26	20	1,000

and the mean is the result of a relatively small number of participants responding with a willingness to invest very large amounts of money. To participate in a renewable energy credit program or clean energy program with their utility company, participants reported a median WTP of \$10 per month with a mean of \$23.26 per month. Again, the mean is much larger than the median due to a small number of very high response values.

The survey also gauged consumers' WTP to upgrade their refrigerator, washing machine, clothes dryer, and central air conditioning units to Energy Star certified appliances, with and without rebates. Fig. 3 displays the distributions of participant responses, where many responded that they either already have upgraded to efficient appliances or would be willing to do so without any rebate.

For each of the appliances, less than 5% of participants responded that they would not replace their existing appliances with Energy Star certified alternatives regardless of the rebate offered.

To evaluate the differences in the WTP measures for each condition, Kruskal-Wallis tests were conducted for each of the experiments.

According to the Kruskal-Wallis tests in Table 7, only the Experiment 2 WTP for solar panels responses varied significantly between conditions with a *p*-value of 0.0078. To better understand the influence of the incentive and fee conditions, Mann-Whitney tests were performed between the Experiment 2 control condition and each of the Experiment 2 incentive and fee conditions. The results from these tests are included in Table 8.

According to the Mann-Whitney tests, the IR, II, and FR conditions all varied significantly (p < 0.05) from the control condition. The

Table 7Results of Kruskal-Wallis tests for each experiment and the willingness to pay (WTP) for solar panels, WTP for clean energy, and appliance rebate (AR) variables.

	df	chi-squared	<i>p</i> -value
Experiment 1			
Clean Energy	2	0.63	0.7283
Solar Panels	2	0.42	0.8097
Appliance Rebates	2	0.13	0.9356
Experiment 2	_		0.0050
Clean Energy Solar Panels	4 4	5.01 13.85	0.2859 0.0078**
Appliance Rebates	4	5.23	0.2643
Experiment 3			
Clean Energy	4	2.06	0.7239
Solar Panels	4	1.13	0.8892
Appliance Rebates	4	1.61	0.8079

Signif. codes: *p < 0.05, **p < 0.01, ***p < 0.001.

significant *p*-values indicate that the distribution of responses in the control condition and experimental condition are not the same. In fact, the Hodges-Lehmann estimators indicate that participants in the IR, II, and FR treatment groups can be expected to be willing to pay about \$450, \$230, and \$300 more, respectively, for a 1,000-Watt solar panel system than participants in the control group.

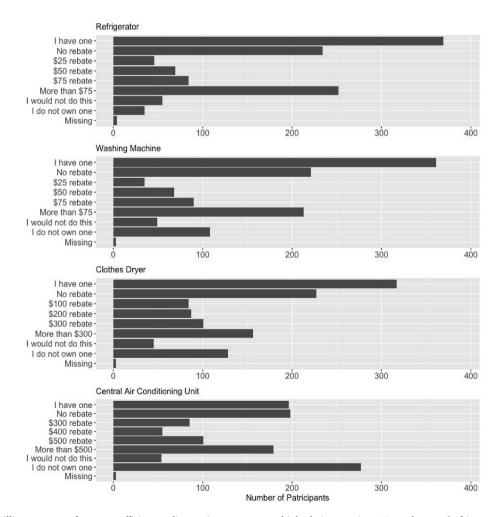


Fig. 3. Participants' willingness to pay for energy efficient appliances, in response to multiple choice questions: "To replace my [refrigerator/clothes washer/clothes dryer/central air conditioner] with an Energy Star certified [refrigerator/washer/dryer/unit] I would need my utility company to provide:"

Table 8Results of solar panel willingness to pay (WTP) Mann-Whitney tests between experimental incentive and fee conditions and the control bill (CB) condition in Experiment 2.

Experimental condition	median	W	<i>p</i> -value	Hodges-Lehmann estimator
Control Bill	\$500			
Incentive Reduce	\$1,000	2110	0.002**	-\$450
Incentive Invest	\$500	2146	0.011*	-\$230
Fee Reduce	\$900	2276	0.014*	-\$300
Fee Invest	\$500	2720	0.244	$-\$9.54 \times 10^{-5}$

Signif. codes: *p < 0.05, **p < 0.01, ***p < 0.001.

5. Discussion

5.1. Implications

The results from the statistical tests provide valuable insights into the research questions posed in Section 1. Since only Experiment 2 had significant MANOVA results, we reject the null hypothesis for that experiment. Rejecting the null hypothesis for Experiment 2 indicates that one or more of the incentive and fee conditions significantly influenced participant responses when compared to the other conditions in Experiment 2. The ANOVA results suggest that perceived norms (PN) were influenced by the manipulations, and the t-tests revealed that the IR and FR conditions resulted in significantly higher PN values than the control condition. Additionally, the Experiment 2 WTP for solar panels responses resulted in a significant Kruskal-Wallis test. The ensuing Mann-Whitney tests revealed significant differences between the control condition and the IR, II, and FR conditions. These results indicate that the probability of selecting an observation from one of those three experimental conditions that is larger than an observation from the control condition is higher than 50%.

Given that the Experiment 1 conditions showed no significant differences, the response to the first research question is that social norms, presented as they were in this study, do not significantly influence attitudes and stated intentions regarding energy consumption levels and choices. This does not align with the results from the Opower social influence study, which found social norm messaging to be effective in motivating households to reduce their electricity consumption (Allcott, 2011). On the other hand, Experiment 2 showed that when framed to encourage people to reduce consumption, both monetary incentives and fees bolster perceptions of pro-environmental norms; however, the incentives and fees framed to encourage investment in renewable energy did not influence perceptions, attitudes, nor intentions. Relating this back to the second research question, incentives and fees designed to motivate electricity conservation strengthen peoples' agreement with pro-environmental norms. Interestingly, the literature suggests that there are techniques that are more effective than monetary incentives and fees at inducing pro-environmental behaviors, particularly with respect to sustained behavior changes (Abrahamse et al., 2005); however, the results of this study suggest a shift in perceived norms, which often serve as predictors for people's decisions. Incentives and fees also influenced participants' WTP to install solar panels on their home. In each of the experimental conditions, the median WTP was no smaller than the median WTP in the control condition. Strategic policy design that allows consumers to benefit financially from participating in desired behaviors could accelerate adoption of such energy efficient behaviors (Maldet et al., 2022).

Finally, addressing the third research question, the joint power of social norms and monetary incentives or fees, as tested in Experiment 3, did not further promote energy conservation. This last point was counter to expectations, as it implies that the bill graphics were no longer influential or were somehow diluted in their effect when paired with the social norm messages. While the combination of monetary incentives and fees with social norm messages had not been studied previously, the

Opower case study presented home-energy reports alongside monthly electricity bills, suggesting that the presentation of social norm messaging alongside electricity bills can motivate consumers to reduce consumption (Allcott, 2011). A possible explanation for the ineffectiveness of the combined condition in this study is the order in which participants viewed the norm message and bill graphic. The presentation of these two graphics was randomized to avoid ordering bias, and it is possible that viewing the social norm message after the bill graphic led to participants focusing more on the norm message which was not influential on its own. It is also possible that participants received too much information in the combined condition and spent less time viewing each of the graphics. Since home energy reports are a low-cost intervention and have proven to be effective in provoking household energy conservation (Allcott, 2011; Henry et al., 2019) and this study has shown that monetary incentives and fees can influence perceptions, their combined implementation should be studied further to allow utility companies and policymakers to capitalize on these low-cost interventions.

The overall impacts of this study are multifaceted. First, the responses collected in the control conditions provide insights into existing self-reported attitudes, perceptions, and intended behaviors amongst people living in the northeastern United States. Knowledge of attitudes and perceptions within electricity markets allows policy makers to identify misconceptions or belief-behavior gaps and design interventions that address these issues. Second, the experiments presented uncover the influence of incentives and fees, social norms, and the combination of a norm with an incentive or fee on consumer electricity attitudes and behaviors. Based on the above discussion, the introduction of incentives and fees on electricity bills could lead to increased adoption of home solar panel systems, ultimately reducing total emissions from electricity generation. Third, the study design serves as a method of measuring the influence of different treatments on the perceptions and intentions of individuals in complex markets. It is particularly useful to discern motivators in markets where individuals make decisions based on many criteria and not simply economic utility.

5.2. Limitations and future research

There are several possible explanations for the lack of statistically significant findings in Experiments 1 and 3, all of which should be further explored in future research. First, this study was limited by the participants' manipulation exposure time. On average, participants spent 53.2 s examining the bill graphics and 36.4 s reviewing the norm messages, indicating that the social norm infographics and faux bill graphics might not have been studied long enough to impact their perceptions of norms and intended energy related behaviors. Significant results may be attainable with manipulations that are more engaging or that further emphasize the norm, incentive, or fee being communicated. Such emphasis could come from reiterating the norm, incentive, or fee, including interactive manipulations, graphic designs that draw more attention to pro-environmental behaviors, using videos to communicate the manipulations, or providing specific and detailed home energy use reports (Amon-Tanoh et al., 2021; Henry et al., 2019). Researchers have also suggested that repeated reminders could be useful in encouraging and maintaining energy conservation behaviors (Hess et al., 2022). These other means of communicating the norms, incentives, and fees could be explored in similar survey experiments to see if the presentation medium is a key to influencing behaviors and beliefs.

It is worth noting that stated behaviors tend to differ from actual behaviors, limiting our ability to truly quantify the influence of the experimental manipulations. More meaningful results might be achieved through studying the influence of social norm and incentive and fee manipulations on actual electricity consumption behaviors, as was done in the Opower study mentioned in Section 2.1 (Allcott, 2011). The Opower HERs also included norm messages that were more proximal than those used in this study, comparing participants directly to their

neighbors. Previous research suggests that the closer the participant is to the reference group, the more powerful the normative influences will be (Goldstein et al., 2008; Lac and Donaldson, 2018). As such, it is possible that in this study, the reference group of "residents of the Northeast" was not proximal enough to invoke a strong connection for the participants. Additionally, for the FB measure, nearly all conditions' composite scores were on average larger than 4.0, indicating that most of the participants do plan to occasionally participate in pro-environmental behaviors. Since these values were consistently high and the PN and FB responses were moderately correlated (r = 0.396), it is possible that people already consider these behaviors to be the norm. As such, participants may not require additional norm messages or financial motivation to take part in those behaviors and we are seeing a ceiling effect where participants already participate or believe in the target behaviors. Future studies could explore the use of varying levels of incentives and fees to determine whether there is a monetary threshold that needs to be met before people will adopt behavior changes or perceive norms differently. Future research may also include adapting and applying the experimental design to test the effects of norms and incentives or fees on consumer behavior in different contexts. Consumer behavior is complex and challenging to quantify, but this experimental design can be applied to uncover trends and tendencies in various markets.

Another area of future research would be to use the empirical data from this study in simulation models to study consumer decision-making in electricity markets and identify the policy structures that may lead to widespread pro-environmental consumer behavior. These data include extensive demographic information, generalized attitudes and perceptions, stated intended behaviors, and information about past energyrelated decisions made by consumers. This information can be used to define individual or aggregate residential consumers who make empirically-backed decisions on electricity consumption and renewable energy investment. It can also be used to define statistical distributions that generalize the behaviors and intentions of residents in the Northeastern United States, allowing for an overview of consumer trends in electricity markets. Furthermore, knowledge of past decisions made by consumers can help utility companies and policy makers measure the efficacy of various rebate, tax credit, and renewable energy programs and determine what motivates individuals to participate in these programs.

Appendix. Infographics and bill graphics used in experiments

6. Conclusions

This study presents an experimental survey design that quantifies the influence of social norms, incentives, and fees on consumer perceptions, beliefs, and intentions. Data were collected that uncovered baseline information on consumer behaviors, willingness to pay for renewable energy and efficient appliances, and the beliefs of individuals in energy markets. These data were used to evaluate the effectiveness of survey conditions that included different manipulations associated with norms, incentives, and fees. Based on the experimental results, monetary incentives and fees associated with reducing energy consumption significantly influenced participants' perceptions of energy-related norms. Incentive and fee conditions framed to reduce energy consumption also led participants to report higher median WTP values for 1,000-Watt solar panel systems than the control conditions. To expand upon these results and better understand consumer behavior in electricity markets, future research could investigate various levels of incentives and fees or explore different methods of communicating the norms, incentives, and fees. Alternatively, the behaviors and trends uncovered in this study could be employed in electricity market models to simulate and study consumer behavior over time and in the presence of different policy scenarios.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

This material is based upon work supported by the U.S. National Science Foundation under Grant Number ECCS-1953774. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.



Fig. A.1. Control environmental message (EM) infographic.



Fig. A.2. Norm to reduce consumption (NR) infographic.



Fig. A.3. Norm to invest in renewable energy (NI) infographic.



Fig. A.4. Control bill (CB) graphic.



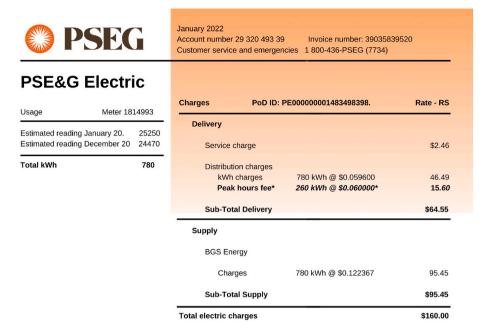
^{*}Energy Saver Discount, per new government regulations, is for households who use less energy. For your home, this applies when you use less than 800 kWh per month.

Fig. A.5. Incentive for reducing energy use (IR) bill graphic.

PSEG	January 2022 Account number 29 320 493 39 Invoice number: 3903583 Customer service and emergencies 1 800-436-PSEG (7734)	9520
PSE&G Electric	Charges PoD ID: PE00000001483498398.	Rate - RS
Usage Meter 1814993	-	
Estimated reading January 20 25250	Delivery	
Estimated reading December 20 24470	Service charge	\$2.46
Total kWh 780	Distribution charges kWh charges 780 kWh @ \$0.059600	46.49
	Sub-Total Delivery	\$48.95
	Supply	
	BGS Energy	
	Charges 780 kWh @ \$0.122367	95.45
	Solar Energy Subsidy*	- 15.60
	Sub-Total Supply	\$79.85
	Total electric charges	\$128.80

^{*}Solar Energy Subsidy is a credit that has been added to your bill per new government regulations if you have installed solar panels onto your home and/or began participating in our green energy program

 $\textbf{Fig. A.6.} \ \ \text{Incentive for investing in renewable energy (II) bill graphic.}$



*Any kWh used during peak hours are charged an additional fee due to higher demand during such times (9am - 6pm, or days projected to have an outdoor temperature of 100 degrees Fahrenheit or more

Fig. A.7. Fee for not reducing energy use (FR) bill graphic.

	PSEC		January 2022 Account number 29 320 Customer service and en		39520
PSE&C	S Electri	ic			
Usage	Meter 18	14993	Charges Po	D ID: PE00000001483498398.	Rate - RS
		25250	Delivery		
Estimated readi Estimated readi	ing December 20	24470	Service charge		\$2.46
Total kWh		780	Distribution charges		46.49
			Sub-Total Deliv	ery	\$48.95
			Supply		
			BGS Energy		
			Charges Carbon tax *	780 kWh @ \$0.122367 780 kWh @ \$0.02	95.45 15.60
			Sub-Total Supp	ly	\$111.05
			Total electric charges	7 1	\$160.00

^{*}Carbon taxes have been added to bills of consumers who have not installed solar panels or elected to participate in our green energy program per recent government regulations

Fig. A.8. Fee for not investing in renewable energy (FI) bill graphic.S

References

Abrahamse, W., Steg, L., Vlek, C., Rothengatter, T., 2005. A review of intervention studies aimed at household energy conservation. J. Environ. Psychol. 25 (3), 273–291. https://doi.org/10.1016/j.jenvp.2005.08.002.

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Ajzen, I., Fishbein, M., 2005. The Influence of Attitudes on Behavior.

Albeck-Ripka, L., 2019. How to reduce your carbon footprint. New York Times.

Retrieved. https://www.nytimes.com/guides/year-of-living-better/howto-reduce-your-carbon-footprint. (Accessed 12 January 2021).

Allcott, H., 2011. Social norms and energy conservation. J. Publ. Econ. 95 (910), 1082–1095. https://doi.org/10.1016/j.jpubeco.2011.03.003.

Alzubaidi, H., Slade, E.L., Dwivedi, Y.K., 2021. Examining antecedents of consumers' pro-environmental behaviours: Tpb extended with materialism and innovativeness. J. Bus. Res. 122, 685–699. https://doi.org/10.1016/j.jbusres.2020. 01.017.

Amon-Tanoh, M.A., McCambridge, J., Blon, P.K., Kouame, H.A., Nguipdop-Djomo, P., Biran, A., Cousens, S., 2021. Effects of a social norm-based handwashing

- intervention including handwashing stations, and a handwashing station-only intervention on handwashing with soap in urban côte d'ivoire: a cluster randomised controlled trial. Lancet Global Health 9 (12), e1707–e1718. https://doi.org/10.1016/S2214109X(21)00387-9.
- Arif, M.S., 2013. Residential solar panels and their impact on the reduction of carbon emissions. University of California, Berkeley. https://nature.berkeley. edu/classes/es196/projects/2013final/ArifM 2013.pdf.
- Bator, R.J., Phelps, K., Tabanico, J., Schultz, P.W., Walton, M.L., 2019. When it is not about the money: social comparison and energy conservation among residents who do not pay for electricity. Energy Res. Social Sci. 56, 101198 https://doi.org/ 10.1016/j.erss.2019.05.008.
- Benabou, R., Tirole, J., 2003. Intrinsic and extrinsic motivation. Rev. Econ. Stud. 70 (3), 489–520.
- Berry, L., 1984. The role of financial incentives in utility-sponsored residential conservation programs: a review of customer surveys. Eval. Progr. Plann. 7 (2), 131–141. https://doi.org/10.1111/1467-937X.00253.
- Bertoldi, P., 2022. Policies for Energy Conservation and Sufficiency: Review of Existing Policies and Recommendations for New and Effective Policies in Oecd Countries. Energy and Buildings. 112075.
- Borsari, B., Carey, K.B., 2003. Descriptive and injunctive norms in college drinking: a meta-analytic integration. J. Stud. Alcohol 64 (3), 331–341. https://doi.org/ 10.15288/jsa.2003.64.331.
- Burns, J.E., Kang, J.-S., 2012. Comparative economic analysis of supporting policies for residential solar pv in the United States: solar renewable energy credit (srec) potential. Energy Pol. 44, 217–225. https://doi.org/10.1016/j.enpol.2012.01.045.
- Chen, C.-f., Xu, X., Day, J.K., 2017. Thermal Comfort or Money Saving? Exploring Intentions to Conserve Energy Among Low-Income Households in the united states. Energy Res. Social Sci. 26, 61–71. https://doi.org/10.1016/j.erss.2017.01.009.
- Cialdini, R.B., 2001. The science of persuasion. Sci. Am. 284 (2), 76–81. https://hbr.org/ 2001/10/harnessing-the-science-of-persuasion.
- Cialdini, R.B., Jacobson, R.P., 2021. Influences of social norms on climate change related behaviors. Curr. Opin. Behav. Sci. 42, 1–8. https://doi.org/10.1016/j. cobeha.2021.01.005.
- Cialdini, R.B., Reno, R.R., Kallgren, C.A., 1990. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. J. Pers. Soc. Psychol. 58 (6), 1015. https://doi.org/10.1037/0022-3514.58.6.1015.
- Cialdini, R.B., Demaine, L.J., Sagarin, B.J., Barrett, D.W., Rhoads, K., Winter, P.L., 2006. Managing social norms for persuasive impact. Soc. Influ. 1 (1), 3–15. https://doi.org/10.1080/15534510500181459.
- Corner, A., 2011. Social Norm Strategies Do Work–But There Are Risks Involved.

 Guardian Professional Network. http://www.theguardian.com/sustainable-business/socialnorm-behaviour-change.
- Delmas, M.A., Fischlein, M., Asensio, O.I., 2013. Information strategies and energy conservation behavior: a meta-analysis of experimental studies from 1975 to 2012. Energy Pol. 61, 729–739. https://doi.org/10.1016/j.enpol.2013.05.109.
- Eyal, P., David, R., Andrew, G., Zak, E., Ekaterina, D., 2021. Data quality of platforms and panels for online behavioral research. Behav. Res. Methods 1–20. https://doi.org/10.3758/s13428-021-01694-3
- Forgas, J.P., Williams, K.D., 2001. Social Influence: Direct and Indirect Processes, vol. 3. Psychology Press. https://doi.org/10.4324/9781315783031.
- Gardner, G.T., Stern, P.C., 2008. The short list: the most effective actions us households can take to curb climate change. Environment 50 (5), 12–25. https://doi.org/
- Goldstein, N.J., Cialdini, R.B., Griskevicius, V., 2008. A room with a viewpoint: using social norms to motivate environmental conservation in hotels. J. Consum. Res. 35 (3), 472–482. https://doi.org/10.1086/586910.
- Grilli, G., Curtis, J., 2021. Encouraging pro-environmental behaviours: a review of methods and approaches. Renew. Sustain. Energy Rev. 135, 110039 https://doi.org/ 10.1016/j.rser.2020.110039.
- Guo, Z., Zhou, K., Zhang, C., Lu, X., Chen, W., Yang, S., 2018. Residential electricity consumption behavior: influencing factors, related theories and intervention strategies. Renew. Sustain. Energy Rev. 81, 399–412. https://doi.org/10.1016/j. rser.2017.07.046.
- Han, H., Hyun, S.S., 2018. What influences water conservation and towel reuse practices of hotel guests? Tourism Manag. 64, 87–97. https://doi.org/10.1016/j.tourman. 2017.08.005.
- Henry, M.L., Ferraro, P.J., Kontoleon, A., 2019. The behavioural effect of electronic home energy reports: evidence from a randomised field trial in the United States. Energy Pol. 132, 1256–1261. https://doi.org/10.1016/j.enpol.2019.06.039.
- Hess, A.-K., Schubert, I., Samuel, R., Burger, P., 2022. Changing routinized household energy consumption using the example of washing, cooking, and standby: a randomized controlled field experiment of home energy advice. Clean. Respons. Consum. 4, 100052 https://doi.org/10.1016/j.clrc.2022.100052.
- James Jr., H.S., 2005. Why did you do that? an economic examination of the effect of extrinsic compensation on intrinsic motivation and performance. J. Econ. Psychol. 26 (4), 549–566. https://doi.org/10.1016/j.joep.2004.11.002.
- Joshi, Y., Uniyal, D.P., Sangroya, D., 2021. Investigating consumers' green purchase intention: examining the role of economic value, emotional value and perceived marketplace influence. J. Clean. Prod. 328, 129638 https://doi.org/10.1016/j. jclepro.2021.129638.
- Kees, J., Berry, C., Burton, S., Sheehan, K., 2017. An analysis of data quality: professional panels, student subject pools, and amazon's mechanical turk. J. Advert. 46 (1), 141–155. https://doi.org/10.1080/00913367.2016.1269304.
- Kohn, A., 1993. Why Incentive Plans Cannot Work. https://hbr.org/1993/09/why-incentiveplans-cannot-work.

- Kohn, A., 1999. Punished by Rewards: the Trouble with Gold Stars, Incentive Plans, A's, Praise, and Other Bribes. Houghton Mifflin Harcourt.
- Kormos, C., Gifford, R., Brown, E., 2015. The influence of descriptive social norm information on sustainable transportation behavior: a field experiment. Environ. Behav. 47 (5), 479–501. https://doi.org/10.1177/0013916513520416.
- Kraus, S.J., 1995. Attitudes and the prediction of behavior: a meta-analysis of the empirical literature. Pers. Soc. Psychol. Bull. 21 (1), 58–75. https://doi.org/ 10.1177/0146167295211007.
- Lac, A., Donaldson, C.D., 2018. Testing competing models of injunctive and descriptive norms for proximal and distal reference groups on alcohol attitudes and behavior. Addict. Behav. 78, 153–159. https://doi.org/10.1016/j.addbeh.2017.11.024.
- Lapinski, M.K., Rimal, R.N., 2005. An explication of social norms. Commun. Theor. 15 (2), 127–147. https://doi.org/10.1111/j.1468-2885.2005.tb00329.x.
- Lede, E., Meleady, R., Seger, C.R., 2019. Optimizing the influence of social norms interventions: applying social identity insights to motivate residential water conservation. J. Environ. Psychol. 62, 105–114. https://doi.org/10.1016/j.jenvp. 2019.02.011.
- Litman, L., Robinson, J., Abberbock, T., 2017. Turkprime.com: a versatile crowdsourcing data acquisition platform for the behavioral sciences. Behav. Res. Methods 49 (2), 433–442. https://doi.org/10.3758/s13428-016-0727-z.
- Liu, X., Wang, Q.-C., Jian, I.Y., Chi, H.-L., Yang, D., Chan, E.H.-W., 2021. Are you an energy saver at home? the personality insights of household energy conservation behaviors based on theory of planned behavior. Resour. Conserv. Recycl. 174, 105823 https://doi.org/10.1016/j.resconrec.2021.105823.
- Liu, Y., Kua, H., Lu, Y., 2021. Spillover effects from energy conservation goal-setting: a field intervention study. Resour. Conserv. Recycl. 170, 105570 https://doi.org/ 10.1016/j.resconrec.2021.105570.
- Maldet, M., Revheim, F.H., Schwabeneder, D., Lettner, G., del Granado, P.C., Saif, A., Löschenbrand, M., Khadem, S., 2022. Trends in local electricity market design: regulatory barriers and the role of grid tariffs. J. Clean. Prod. 358, 131805 https://doi.org/10.1016/j.jclepro.2022.131805.
- Mason, W., Suri, S., 2012. Conducting behavioral research on amazon's mechanical turk.

 Behav. Res. Methods 44 (1), 1–23. https://doi.org/10.3758/s13428-011-0124-6.
- McDonald, R.I., Crandall, C.S., 2015. Social norms and social influence. Curr. Opin. Behay, Sci. 3, 147–151. https://doi.org/10.1016/j.cobeha.2015.04.006.
- Mi, L., Gan, X., Sun, Y., Lv, T., Qiao, L., Xu, T., 2021. Effects of monetary and nonmonetary interventions on energy conservation: a meta-analysis of experimental studies. Renew. Sustain. Energy Rev. 149, 111342 https://doi.org/10.1016/j. rser.2021.111342.
- Mizobuchi, K., Takeuchi, K., 2012. Using economic incentives to reduce electricity consumption: a field experiment in matsuyama, Japan. Int. J. Energy Econ. Pol. 2 (4), 318. https://dergipark.org.tr/en/pub/ijeeep/issue/31902/350694?publish er=http-www-cag-edu-tr-ilhan-ozturk.
- Neighbors, C., O'Connor, R.M., Lewis, M.A., Chawla, N., Lee, C.M., Fossos, N., 2008. The relative impact of injunctive norms on college student drinking: the role of reference group. Psychol. Addict. Behav. 22 (4), 576. https://doi.org/10.1037/a0013043.
- Nguyen, H.T., Felder, F.A., 2020. Generation expansion planning with renewable energy credit markets: a bilevel programming approach. Appl. Energy 276, 115472. https://doi.org/10.1016/j.apenergy.2020.115472.
- Nolan, J.M., Schultz, P.W., Cialdini, R.B., Goldstein, N.J., Griskevicius, V., 2008. Normative social influence is underdetected. Pers. Soc. Psychol. Bull. 34 (7), 913–923. https://doi.org/10.1177/0146167208316691.
- Norberg-Bohm, V., 2000. Creating incentives for environmentally enhancing technological change: lessons from 30 years of us energy technology policy. Technol. Forecast. Soc. Change 65 (2), 125–148. https://doi.org/10.1016/S0040-1625(00) 00076-7.
- Osbaldiston, R., Schott, J.P., 2012. Environmental sustainability and behavioral science: meta-analysis of proenvironmental behavior experiments. Environ. Behav. 44 (2), 257–299. https://doi.org/10.1177/0013916511402673.
- Ozaki, R., 2011. Adopting sustainable innovation: what makes consumers sign up to green electricity? Bus. Strat. Environ. 20 (1), 1–17. https://doi.org/10.1002/bse.650.
- Panda, T.K., Kumar, A., Jakhar, S., Luthra, S., Garza-Reyes, J.A., Kazancoglu, I., Nayak, S.S., 2020. Social and environmental sustainability model on consumers' altruism, green purchase intention, green brand loyalty and evangelism. J. Clean. Prod. 243, 118575 https://doi.org/10.1016/j.jclepro.2019.118575.
- Razmjoo, A., Kaigutha, L.G., Rad, M.V., Marzband, M., Davarpanah, A., Denai, M., 2021. A technical analysis investigating energy sustainability utilizing reliable renewable energy sources to reduce co2 emissions in a high potential area. Renew. Energy 164, 46–57. https://doi.org/10.1016/j.renene.2020.09.042.
- Rode, J., Gomez-Baggethun, E., Krause, T., 2015. Motivation crowding by economic incentives in conservation policy: a review of the empirical evidence. Ecol. Econ. 117, 270–282. https://doi.org/10.1016/j.ecolecon.2014.11.019.
- Schultz, P.W., Messina, A., Tronu, G., Limas, E.F., Gupta, R., Estrada, M., 2016. Personalized normative feedback and the moderating role of personal norms: a field experiment to reduce residential water consumption. Environ. Behav. 48 (5), 686–710.
- Skinner, B.F., 1965. Science and Human Behavior. Simon, Schuster. Skinner, B.F., 2002. Beyond Freedom and Dignity. Hackett Publishing.
- Steinhorst, J., Klöckner, C.A., 2018. Effects of monetary versus environmental information framing: implications for long-term pro-environmental behavior and intrinsic motivation. Environ. Behav. 50 (9), 997–1031. https://doi.org/10.1177/ 0013016517725371
- Stern, M.J., 2013. A Little Guilt, a Lot of Energy Savings. https://slate.com/technol ogy/2013/03/opower-using-smiley-faces-and-peer-pressure-to-save-the-planet.html

- Stern, P.C., Aronson, E., Darley, J.M., Hill, D.H., Hirst, E., Kempton, W., Wilbanks, T.J., 1986. The effectiveness of incentives for residential energy conservation. Eval. Rev. 10 (2), 147–176. https://doi.org/10.1016/0301-4215(85)90174-0.
- U.S. Census Bureau, 2021. American Community Survey 1-year Estimates. Retrieved from Census Reporter Profile page for Northeast Region. http://censusreporter. org/profiles/02000US1-northeast-region/.
- U.S. Environmental Protection Agency, 2020. Inventory of u.S. Greenhouse Gas Emissions and Sinks: 1990-2018. EPA, Washington, D.C tech. rep. EPA 430-R-20-0021.
- Van Raaij, W.F., Verhallen, T.M., 1983. A behavioral model of residential energy use. J. Econ. Psychol. 3 (1), 39–63. https://doi.org/10.1016/01674870(83)90057-0.
- Varotto, A., Spagnolli, A., 2017. Psychological strategies to promote household recycling. a systematic review with meta-analysis of validated field interventions. J. Environ. Psychol. 51, 168–188. https://doi.org/10.1016/j.jenvp.2017.03.011.
- Viscusi, W.K., Huber, J., Bell, J., 2011. Promoting recycling: private values, social norms, and economic incentives. Am. Econ. Rev. 101 (3), 65–70. https://doi.org/10.1257/aer.101.3.65.

- Wang, Q.-C., Lou, Y.-N., Liu, X., Jin, X., Li, X., Xu, Q., 2023a. Determinants and mechanisms driving energy-saving behaviours of long-stay hotel guests: comparison of leisure, business and extended-stay residential cases. Energy Rep. 9, 1354–1365. https://doi.org/10.1016/j.egyr.2022.12.051.
- Wang, Q.-C., Ren, Y.-T., Liu, X., Chang, R.-D., Zuo, J., 2023b. Exploring the heterogeneity in drivers of energy-saving behaviours among hotel guests: insights from the theory of planned behaviour and personality profiles. Environ. Impact Assess. Rev. 99, 107012 https://doi.org/10.1016/j.eiar.2022.107012.
- Winett, R.A., Nietzel, M.T., 1975. Behavioral ecology: contingency management of consumer energy use. Am. J. Community Psychol. 3 (2), 123. https://doi.org/ 10.1007/BF00877787.
- Zhang, X., Wang, Y., 2017. How to reduce household carbon emissions: a review of experience and policy design considerations. Energy Pol. 102, 116–124. https://doi. org/10.1016/j.enpol.2016.12.010.