

Green is Good – The Impact of Information Nudges on the Adoption of Voluntary Green-Power Plans^{*}

Eric Cardella[†]
Texas Tech University

Bradley T. Ewing[‡]
Texas Tech University

Ryan B. Williams[^]
Texas Tech University
Texas A&M AgriLife
Research

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Abstract

A recent trend has been a move toward greater reliance on renewable or “green” energy sources, especially in the residential sector. Using a choice experiment, this paper examines how providing information regarding the efficiency, cost, and environmental impacts of different power-generating sources impact consumers’ preferences for adopting voluntary green-power plans. Based on 21,000 plan choices from two different samples totaling over 1,800 respondents, our results indicate that information nudges significantly impact respondents’ choice of plan. Promoting the advantages of the green plan *or* the disadvantages of the “gray” plan increase green plan adoption. The magnitudes of these effects are economically significant and equivalent to a change in the monthly premium of \$4/month, and the effect persists as respondents progress through the choice sets. We document interesting heterogeneous treatment effects based on income, education, environmental attitudes, and existing participation in a green plan. Our results have clear energy policy and green power marketing implications of a plausible, economical, and effective mechanism to increase adoption of green-power plans.

Keywords: Renewable Energy, Green Power, Information, Nudge, Choice Experiment

JEL Codes: Q40, Q20, Q50, Q01, C83, C90, D91, M3

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[†] Corresponding author: Rawls College of Business, Texas Tech University, Lubbock, TX 79409; Telephone: (806) 834-7482; Email: eric.cardella@ttu.edu

[‡] Rawls College of Business, Texas Tech University, Lubbock, TX 79409; Telephone: (806) 834-3939; Email: bradley.ewing@ttu.edu

[^] Department of Agriculture & Applied Economics, Texas Tech University, Lubbock, TX 79409; Telephone: (806) 834-6195; Email: ryan.b.williams@ttu.edu

1 Introduction

In the U.S., as well as in many other developed nations, there has been a growing trend toward greater reliance on renewable energy sources. One prominent area embodying this increase is renewable or “green” electric power generation, both in the U.S. and globally. As of 2016, the EIA reported that approximately 55% of renewable energy is used for electric power generation, and electric power generated from renewable sources accounted for roughly 15% of the total generation in the U.S.¹ Furthermore, the U.S. Department of Energy reported in 2015 that renewable electricity grew to 16.7% of installed capacity, and green power continues to grow with renewables accounting for 64% of the new capacity additions in 2015.²

Certainly a key contributing factor to the continued growth in renewable energy infrastructure has been supply-side increases arising from energy policy and regulatory reform (e.g., Renewable Portfolio/Electricity Standards, Clean Power Plan, Renew300, and Green Power Partnership).³ That said, increasing consumer demand for green power – stemming from its environmental benefits and sustainability – has also played an important role. Prior research suggests that many people express a preference for greater reliance on green power (Greenberg, 2009), and consumers are often willing to pay a green premium, typically in the range of \$5-\$15 per month (see Menegaki, 2008; and Sundt & Rehdanz, 2015 for a review). As a result, in recent years residential consumers have been increasingly offered the option to participate in voluntary green-power programs. As of 2016, The U.S. Department of Energy’s National Renewable Energy Laboratory (NREL) reported that more than a dozen states

¹ Worldwide, the EIA estimated that renewable energy accounted for approximately 22% of global electricity generation in 2015 and this is predicted to increase to 31% by 2040, with the increase primarily being driven by increases in wind and solar production. ([https://www.eia.gov/outlooks/archive/ieo17/pdf/0484\(2017\).pdf](https://www.eia.gov/outlooks/archive/ieo17/pdf/0484(2017).pdf)).

² Conventionally, the bulk of residential electric power has been predominately generated from the combustion of coal or natural gas. The U.S. Department of Energy reported in that in 2015 nearly 2/3 of the production in the electric power sector is coal or natural gas based (2015 Renewable Energy Data Book).

³ We refer readers to the American Wind Energy Association (<http://www.awea.org/advocacy/>) for a discussion of these policies, as well as papers by Bird et al. (2005), Menz (2005), Menz & Vachon (2006), Vachon & Menz (2006), Gan et al. (2007), Fowlie et al. (2014), and Hollingsworth & Rudik (2018) for more detailed discussions surrounding the various policies and regulatory reforms aimed at promoting growth in renewable energy.

mandate that green power be offered in competitive markets, and over 750 electric utilities offer green plans (see Clark et al., 2003; Bird & Sumner, 2010; and Dagher et al., 2017 for further discussion).⁴ That said, the take-up rate of green plans remains relatively low, conservatively estimated at less than 5% (e.g., O’Shaughnessy et al., 2016). Given their increased availability, combined with the evidence of apparent preferences for green power, it is important to think about mechanisms to increase take-up of green plans. Such insights can be valuable for renewable-energy policy, as well as for the operational strategies of electric-utility providers in response to renewable electricity generation becoming more cost effective.

The aim of this study is to empirically examine how non-price, information “nudges” impact consumers’ choices over residential electricity plans.⁵ Specifically, we evaluate how the provision of information about the energy efficiency, production and social costs, and the environmental impacts of different electricity-generating sources impact consumers’ preferences for adopting green power. We conduct a choice experiment, administered via online survey, where respondents make a series of choices between adopting either a green-power plan, or a conventional “gray-power” plan where the electricity is generated from a hydro-carbon source.⁶ Prior to making their choices, we systematically vary whether individuals receive: (i) positive or negative information about the gray plan, (ii) positive or negative information about the green plan, (iii) a combination of positive or negative information about both plans, or (iv) neutral information (generic facts about electricity). As part of the design, we also vary the expected monthly price premium associated with the green plan, which enables us to

⁴ Hollingsworth & Rudik (2018) empirically document a positive association between more stringent renewable portfolio standards (RPS) and the wholesale supply of renewable electricity. Moreover, they also find a positive spillover effect where more stringent RPS in one state reduces fossil fuel electricity generation in other states.

⁵ Nudges, as defined by Thaler & Sunstein (2008), refer to changes in the choice setting or architecture that can predictably alter behavior without forbidding available options or significantly changing the economic incentives. As such, nudges have the property of being liberty preserving in that they do not restrict the choice set of the choosers or the economic costs associated with the choices (Sunstein & Thaler, 2003; Camerer et al., 2003). In our context, providing different types of information about the plans falls into this category as it doesn’t restrict the choice set between plans and also does not change the associated cost of each plan.

⁶ We note here that in the actual experiment we referred to this plan as the “conventional” plan, rather than the “gray” plan to avoid possible negative connotations associated with this labeling. However, for ease of exposition, we refer to this plan as the gray plan through the paper.

quantify the size of the information-effect relative to the pure-price effect. Lastly, we consider how existing participation in a green plan, personal attitudes toward the environment and green energy, and other socio-demographic measures impact plan choice, as well as their possible moderating role on the information effects. Importantly, by using a choice experiment we are able to consider several different information conditions, which when combined with a sizable and diverse sample, provides robust inference of the plausible impact of information nudges on voluntary green-plan adoption.

Based on results from 1,838 respondents over two distinct samples and 21,384 plan-choice scenarios, we find that nudging respondents with information about the attributes relating to the electricity-generating source significantly impacts plan choice. Specifically, providing *pro-green* information (*advantages* of green and/or *disadvantages* of gray) significantly increases green plan adoption by roughly 18%-26% relative to the baseline rate of green plan adoption. Conversely, *pro-gray* information (*disadvantages* of green and/or *advantages* of gray) significantly decreases green plan adoption by roughly 11%-18% relative to the baseline rate. Importantly, our main results are generally robust across different levels of monthly price premium for the green plan. Moreover, the estimated magnitude of the information intervention is proportional to an estimated magnitude resulting from a \$4 change in the monthly price premium of the green plan.

We also find that different “types” of respondents react differently to the information intervention. In particular, more educated respondents appear to be more sensitive to pro-green information and less sensitive to pro-gray information; thus, more educated people are more “nudge-able” into adopting the green plan. In terms of environmental attitudes, respondents who report being more pro-environmental are less responsive to the pro-green information and more responsive to the pro-gray information; the implication here is that respondents who are more concerned with the environment are less inclined to choose the green plan after receiving some information that the green plan is not all that good, or that the gray plan is not all that bad. Lastly, we find that respondents who report already being a participant in a green-power plan (at their current electric utility) effectively show no significant response to either

the pro-green or pro-gray information; this suggests that this type of information intervention nudge might be more effective when targeted toward conventional gray plan participants or new customers.

Prior research has documented many factors that can motivate people to engage in pro-environmental behaviors and the purchase of green-energy products (see Steg & Vlek, 2009; Herbes & Ramme, 2014; Steg et al., 2014 for a review). Among the various factors, psychological motivations can be important, which provide a plausible channel through which information interventions could impact plan choice. Steg & Vlek (2009) discuss how informational strategies, which they define as “being aimed at changing perceptions, motivations, knowledge, and norms, without actually changing the external context in which choices are made” (p. 313), can be instrumental in promoting pro-environmental behavior by “targeting” psychological motivations. Regarding power-plan decisions, we argue that providing salient information about the advantages of a certain plan (or the disadvantages of the alternative plan) can be persuasive by appealing to these psychological motivations, ultimately impacting plan choice. Moreover, the efficacy of these information interventions ought to be relatively large in the choice between green and gray plans, relative to other energy choice domains, since choosing to participate in the green plan is relatively convenient and inexpensive (Steg & Vlek, 2009; Steg et al., 2014).

Our study contributes to the recent and growing literature focusing on how non-price nudges can influence energy consumption behaviors (e.g., Allcott & Mullainathan, 2010; Croson & Treich, 2014; Kunreuther & Weber, 2014; Allcott, 2016; Liebe et al., 2018 for reviews of this literature). Much of the research in this area has focused on conservation efforts and energy/electricity usage behaviors. We complement this literature by considering how information nudges impact people’s “upstream” decision of whether to participate in voluntary green-power programs. Given the focus of governments and other regulating bodies around the world to reduce GHG emissions and curb global warming, it is important to think about feasible methods to promote growth in renewable energy. As such, within the residential sector, not only must we consider how nudges can impact energy usage and conservation, but also how they can impact plan selection. Promoting the voluntary adoption of green-power plans through non-

price, information interventions can be feasible, economical, and welfare-enhancing; thus, our study is an important contribution to the possible applications of using nudges to motivate consumers to make more environmentally friendly energy decisions.

While conventional economic levers (e.g., lowering prices, altering incentives, imposing regulation) can be effective in increasing the adoption of green plans, such levers can also be costly and inefficient from a total welfare perspective.⁷ Our results suggest that, as an alternative, nudging in the form of providing targeted information about the advantages of renewable power generation and/or the disadvantages of conventional gray-power generation can sizably increase the take-up of voluntary green-power plans; moreover, such information interventions could be implemented at a relatively low cost and without some of the inefficiencies and choice constraints associated with conventional economic policies. From a green-power marketing standpoint, utility companies have the ability to advertise many different factors associated with their green-power plans, and often do provide information to potential customers about the advantages of their green-power plans (Herbes & Ramme, 2014).⁸ A natural and important question arises as to whether, and the extent to which, different information marketing approaches are effective at stimulating demand. Our results suggest that such pro-green marketing efforts can indeed be effective at increasing the take-up of voluntary green-power plans. Providing clear and salient information about the advantages of green power and/or the disadvantages of gray power can be a cost-effective means of increasing participation in voluntary green-power programs, especially for new customers or existing gray plan customers.

2 Review of Related Literature

We focus our review primarily on the existing literature related to residential electricity usage and the adoption of green power, as this most closely relates to our study. In addition, we also review the

⁷ See Madrian (2014) and Loewenstein & Chater (2017) for more general discussions regarding conventional economic policy interventions in markets, and the possible advantages and benefits of using non-conventional interventions or nudges to shape behavior.

⁸ Casual observation of webpages found on the Green-e, green-power certified programs (<https://www.green-e.org/>), reveals many utilities within the U.S. provide similar information on the benefits of their green-power plans.

literature on non-price interventions—nudges—in the domain of energy consumption. The clear focus of regulating bodies on promoting renewable electricity, in combination with the greater availability of voluntary green-power plans offered by utilities, has garnered substantial research attention aimed at identifying factors that influence consumer demand and take-up of such plans.

Not surprisingly, much of the prior research related to residential green power adoption has focused on the role of the price premium. Even less surprisingly, many studies have found that the price premium is an important determinant in consumers' decisions to adopt a green-power plan, with higher price premiums resulting in lower adoption (e.g., Menegaki, 2008; Ma et al., 2015; and Sundt & Rehdanz, 2015 for reviews of this literature).⁹ That said, using various techniques and sampling procedures, most prior studies in this domain tend to consistently estimate a positive willingness to pay (WTP) among residential consumers to purchase plans where (at least some of) the power is generated from renewable sources.¹⁰ While the WTP estimates vary across studies (Sundt & Rehdanz, 2015), they tend to be clustered in the range of \$5-\$15 per month. The results from our survey indicate that 37% of all plan choices were for the green plan when the price premium ranged from \$5-\$15, which is generally consistent with the findings of these prior studies.

Besides the price premium, prior studies have also documented other factors relating to the plan attributes and consumer characteristics that can impact preferences toward adopting green power (see Oerlemans et al., 2016 for a review). In terms of plan attributes, the following have been shown to impact preferences for adopting green power plans: the specific type of generating source (e.g., wind, solar, biomass, hydro, etc.) (Borchers et al., 2007; Kaenzig et al., 2013), environmental and wildlife impact

⁹ Wisser et al. (2005), Mewton & Cacho (2011), Conte & Jacobsen (2016), and Dagher et al. (2017) use actual plan participation data to estimate the impact of price premiums on green participation behavior (among other factors of interest) and find that price premium negatively impacts green participation. In addition, all three studies estimate that the green premium is relatively price inelastic, suggesting that adopters of green plans are not very price sensitive.

¹⁰ For example, Goett et al. (2000), Roe et al. (2001), Borchers et al. (2007), Longo et al. (2008), Scarpa & Willis (2010), Cicia et al. (2012), Gracia et al. (2012), Kaenzig et al. (2013), and Cardella et al. (2017) use choice experiments to document a positive WTP for green power. Similarly, Champ & Bishop (2001), Zarnikau (2003), Whitehead & Cherry (2007), Wisser (2007), Diaz-Rainey & Ashton (2008), Bollino (2009), Yoo & Kwak (2009), Mozumder et al. (2011), and Oliver et al. (2011) use contingent valuation approaches to document a positive WTP for green power (Oerlemans et al., 2016 review this literature and conduct a meta-analysis).

(Bergmann et al., 2006), and price volatility of the plan (Cardella et al., 2017). In terms of consumer characteristics, Ek (2005) finds that individuals who are more environmentally conscious have a more positive attitude toward wind power, and Clark et al. (2003) and Kotchen & Moore (2007) find that pro-environmental respondents were more likely to have enrolled in a green power program, while Mozumder et al. (2011), Oliver et al. (2011), Cicia et al. (2012), Gracia et al. (2012), and Amador et al. (2013) find that more environmentally conscious people have a higher WTP for green power. Income has also been shown to be positively related to preferences and willingness to pay for green power adoption (Clark et al., 2003; Borchers et al., 2007; Kotchen & Moore, 2007; Longo et al., 2008; Bollino, 2009; Yoo & Kwak, 2009; Mozumder et al., 2011; Oliver et al., 2011; Conte & Jacobsen, 2016), as well as higher levels of education (Conte & Jacobsen, 2016) and urban versus rural (Bergmann et al., 2008).

More recently, there has been a growing interest in how non-price interventions, or nudges, can influence energy consumption behavior.¹¹ Much of this literature focuses on end usage of residential consumers and possible mechanisms for fostering conservation behavior. Informative discussions of these different types of interventions and their effectiveness, and reviews of the relevant literature are provided by Abrahamse et al. (2005), Steg (2008), Steg & Vlek (2009), Allcott & Mullainathan (2010), Croson & Treich (2014), Kunreuther & Weber (2014), and Allcott (2016).¹² More in the spirit of the type of nudge we consider in our study, several papers have examined the impact of various types of information provision on energy conservation behavior and other pro-environmental behaviors. For example, Asensio & Delmas (2015) find that providing information about negative health effects and

¹¹ The growing research interest in how, and the degree to which, nudges can impact behavior spans well beyond energy consumption behavior. There is substantial literature on how nudges can impact behavior across a host of other domains, including, but not limited to: financial planning, retirement planning, education, healthcare, and risky behaviors. We refer interested readers to Johnson et al. (2012), Madrian (2014), Benartzi et al. (2017), Loewenstein & Chater (2017), and Loewenstein et al., (2017) for interesting discussions and reviews of this literature.

¹² Providing usage feedback (typically through smart metering) has been shown to promote conservation behavior (e.g., Gans et al., 2013; Houde et al., 2013; Schleich et al., 2013; Jessoe & Rapson, 2014; and Delmas et al., 2013; Ramos et al., 2015 for reviews). Providing users with information about peer consumption and cues of social norms has also been shown to be effective in reducing energy consumption (e.g., Schultz et al., 2007; Allcott, 2011; Ayres et al., 2013; Costa & Kahn, 2013; Allcott & Rogers, 2014; Delmas & Lessem, 2014; Ho et al., 2016; Allcott & Kessler, 2019; see Abrahamse & Steg, 2013 and Ramos et al., 2015 for reviews). Setting usage goals is also effective in reducing usage (e.g., McCalley & Midden, 2002; Abrahamse et al., 2007; Loock et al., 2013; Harding & Hsiaw, 2014).

pollution associated with electricity production reduces household usage. Ito et al. (2017) find that “moral suasion” in the form of providing a motivational information statement that conservation is needed during peak times leads to lower usage.¹³ Reiss & White (2008) and Costa & Gerard (2015) find that public campaigns calling for conservation are effective in reducing residential electricity usage.¹⁴ Ek & Soderholm (2010) find that providing information about cost savings associated with energy conservation does result in less energy use,¹⁵ while Gilbert & Zivin (2014) document a similar finding where sending spending reminders to the household decreases usage. Ungemach et al. (2017) find that providing information about the environmental attributes of a car (i.e., greenhouse gas rating) increases the likelihood of choosing a more fuel-efficient car. These prior studies suggest that providing information in a variety of different forms can influence energy consumption behavior.¹⁶ That said, these prior studies have focused on usage and conservation efforts, while our study complements this prior work by examining how information impacts the upstream decision of households on whether to opt into participating in a voluntary green-power plan.

We are aware of a few prior studies that have looked specifically at how non-price interventions can impact the plan choice. Most closely related to our study, Momsen & Stoerk (2014) use a choice experiment to examine the impact of several different types of nudges (e.g., priming, mental accounting, framing, decoy effects, social norms, and defaults) on the decision to choose a voluntary green plan. Of particular relevance, one of their implemented nudges involves *subtly* priming respondents by asking

¹³ Ferraro & Price (2013) document a similar effect where providing an appeal for water conservation significantly reduces monthly water usage.

¹⁴ Cutter & Neidell (2009) document a similar effect relating to public transit use where the “Spare the Air” campaign in the San Francisco Bay Area decreased traffic volume and increased public transit use. However, Holladay et al. (2015) find little evidence that appeals for conservation efforts reduce energy usage and CO₂ emissions.

¹⁵ Allcott & Taubinsky (2015) document a similar effect of providing information about costs and other factors on the decision to purchase CFL lightbulbs.

¹⁶ There is a body of literature looking at the effect of energy-efficient labeling (e.g., Energy Star) on consumer purchase behavior (see Banerjee & Solomon, 2003 for a review). Generally, this research suggests that labeling products as more energy efficient and/or cost effective increases the willingness to pay for such appliances (e.g., Shen & Saijo, 2009; Ward et al., 2011; Houde, 2017) and, ultimately, the adoption of such appliances (Newell et al., 1999; Sanchez et al., 2008; Newell & Siikamäki, 2014).

them to either write down everything they know about the link between energy production and climate change, or re-assemble statements about the same relationship; they find that this pre-intervention does not increase take-up of the green plan. Of all the nudges they consider, only the default nudge of having the green plan pre-selected increases take-up. This is consistent with the studies by Pichert & Katsikopoulos (2008), Sunstein & Reisch (2013), Ebeling & Lotz (2015), and Ghesla (2017) who also find that defaulting participants into the green plan increases participation. In our study, we examine how providing direct and salient information about the advantages and/or disadvantage of the plans impacts green plan adoption, which more closely resembles the marketing efforts of many utilities offering voluntary green plans and other green marketing organizations. In doing so, we complement the existing literature aimed at deepening our understanding of factors that can impact residential demand for green power. Additionally, our paper considers another application – participation in green power programs – of how non-price nudges can be used to influence energy choices and promote pro-environmental behavior (Liebe et al., 2018).

3 Experimental Survey Design

We designed an online survey, which was developed and administered through Qualtrics, and embedded a choice experiment where respondents made a series of choices between a conventional, gray-power plan and a renewable, green-power plan. A detailed description of the experimental protocol with a copy of instructions is provided in Appendix A. In total, 1,838 respondents completed the survey. Prior to making their plan choices, respondents systematically received different information about the electricity generation of either one or both plans. This enables us to empirically identify the impact of the provided information on the take-up rate of the green plan. After completing the plan choice scenarios, respondents completed a short demographic and attitudinal questionnaire.¹⁷

¹⁷ Importantly, and as we would expect, a post-hoc examination reveals virtually no differences in the measured respondent demographics, characteristics, and attitudes across the different information manipulations. Specifically, a series of ANOVA tests reveals no statistically significant effects of the information manipulation on any of these collected measures. As such, our randomization to information manipulation was successfully achieved.

3.1 Choice Experiment of Electric Power Plan

In the experimental component of the survey, respondents were simultaneously presented with information on two hypothetical plans offered by a local electric utility, and they were asked to select which plan they *would* select. This scenario was intended to represent a scenario of a prospective customer who needs residential electricity and is, thus, required to choose one of the two plans offered; in that regard, not choosing an available plan is not in the choice set. For each plan, respondents received information about: (i) generating source of the electricity, and (ii) average expected monthly price. A sample choice set is presented in Figure 1.¹⁸

[Insert Figure 1: Example Choice Scenario]

The two plans were labeled **Plan A – Conventional Electricity** and **Plan B – Green Electricity**. The generating source for the conventional plan was described as being produced by either coal or natural gas, while the generating source for the green plan was described as being produced by either wind or solar.¹⁹ Each choice set always consisted of one gray plan and one green plan option. Across choice sets, the average expected monthly price for the green plan took one of three possible values: (i) \$105/month, (ii) \$110/month, or (iii) \$115/month, while the average expected monthly price for the gray plan was always normalized to \$100/month.²⁰ This manipulation of expected monthly prices for the green plan is

¹⁸ As part of a separate research project, Cardella et al. (2017), we also manipulated the monthly price volatility as one of the attributes of each plan. Monthly price volatility for each plan was presented to respondents in the form of a price distribution table that displayed the possible monthly prices and the corresponding percent chance of each price occurring, as depicted in the sample choice set in Figure 1. In total we considered five different price volatility manipulations, which are reproduced in Appendix E. Given the primary research question of this study, which is the effect of informational nudges on plan choice, we collapse the price volatility dimension of the choice set and present results that are aggregated over the different price volatility levels. However, all of our main results presented in Section 4 are robust if we disaggregate the data and look at the informational effects within each level of price volatility; in other words, the monthly price volatility of the plan does not moderate the informational effects.

¹⁹ We chose wind and solar for the type of green electricity generation based on previous work by Ek (2005), Borchers et al. (2007), Gracia et al. (2012), Kaenzig et al. (2013), and Ma & Burton (2016) suggesting that consumers generally have a more positive attitude about these two sources of renewable energy generation. Moreover, the EIA reports that increases in global renewable electricity production over the next several decades will be driven largely from increases in wind and solar generation ([https://www.eia.gov/outlooks/archive/ieo17/pdf/0484\(2017\).pdf](https://www.eia.gov/outlooks/archive/ieo17/pdf/0484(2017).pdf)).

²⁰ The EIA reported that in 2017, average US household electricity usage was 867 kWh/month. At an average cost of \$.12/kWh, this would put average monthly expenditure at \$104/month. As such, we feel \$100/month as the baseline monthly rate for the gray plan is very representative of what participants in our sample would be accustomed to.

equivalent to a monthly premium of the green plan of \$5, \$10, or \$15, respectively. These specific values of the price premium were chosen to be consistent with actual observed and documented average premiums of green power programs (Bird et al., 2002; Bird & Sumner, 2010), as well as within the general range of estimated willingness to pay for green power (e.g., Roe et al., 2001; Zarnikau, 2003; Borchers et al., 2007; Wiser, 2007; and Mozumder et al., 2011).²¹

We implemented a blocked, orthogonal, fractional factorial design with 48 distinct choice sets divided into four blocks of 12 choices.²² Respondents were randomly assigned to one block and presented with all 12 corresponding choice sets, one at a time. Respondents were asked to choose their preferred plan in each choice set, from which we estimated the main effects.

3.2 Plan Information Manipulation

The main manipulation involved the information respondents received prior to the plan-choice experiment. Before viewing the set of 12 choice scenarios, we provided respondents with *six* information statements pertaining to either the *advantageous* or the *disadvantageous* attributes associated with generating electricity from the given source. The statements centered on environmental impacts, relative costs, production efficiency, and health impacts. The idea was that information about advantages of a given energy-generating source was meant to frame that corresponding plan in a positive light, while information about the disadvantages was meant to frame that corresponding plan in a negative light. A list of the specific information statements that were used is provided in Supplemental Appendix B.

For the green plan, the information statements about the advantages include: its non-depleting nature, its non-emission of greenhouse gases or other air pollutants, its reduced dependence on foreign oil trade, and its non-dependence on fresh water resources; the corresponding disadvantageous statements include:

²¹ Furthermore, inspection of green-power programs certified by Green-e (<https://www.green-e.org>) and listed on their website reveals that most programs advertise a price premium of the green plan in the range of \$5-\$15/month, with an estimated base rate of \$100/month for a standard customer.

²² Our main-effects, full factorial design, consisted of $3 \times 5 \times 5 = 75$ choice sets, which included the three price premiums and five possible price-volatility levels for each of the plans as described in Footnote 15. The FACTEX and OPTTEX procedures in SAS v9.4 were used to generate the orthogonal, fractional factorial design.

its intermittency, its large land requirements that can disturb ecosystems, its difficulty to store, and its relative inefficiency and higher cost. Conversely, for the gray plan the information statements about the advantages include: its abundance, its continuous production, its relative low cost, its ease of storage, and its relative efficiency; the corresponding disadvantageous statements include: its nonrenewable properties, its generation of greenhouse gases and pollutants, environmental damages, and possible health hazards. We were intentional about choosing characteristics that generally accompany descriptions or discussions surrounding either the pros or cons of these types of plans.

Lastly, we also had a condition where respondents were presented with *neutral* information in the form of *six* generic statements about energy and electricity including: average electricity usage per household, transmission and distribution, and prices. We refer to this condition as the *Baseline*. The *Baseline* condition establishes the benchmark level of green plan adoption in our sample, around which we can then evaluate the effect of the main information conditions on the adoption rate of the green plan.

We implemented a between-groups design where respondents were randomly assigned to one of the possible information treatments (including the Baseline), which are outlined in Table 1.²³ The four single information conditions—*PosGreen*, *NegGreen*, *PosGray*, *NegGray*—allow us to investigate the impact of providing targeted information on the attributes of the generating source of energy for one plan. Intuitively, the *PosGreen* and *NegGray* conditions are “pro-green” nudges that are targeted toward promoting the adoption of the green plan. Conversely, the *NegGreen* and *PosGray* conditions are “pro-

²³ For completeness of the full factorial design, we had two additional conditions that provided positive information about both the green and gray plan (*PosGreen+PosGray*) or negative information about both the green and gray plan (*NegGreen+NegGray*). In essence, these conditions could be viewed as “ambiguous” informational nudges, as they either promote both plans or dissuade both plans. Given that these conditions have “offsetting” information statements, we anticipated no impact of these conditions on take-up of the green plan. However, our motivation in including these conditions was to allow for the possibility that respondents perceive these offsetting information statements in a systematically biased way; for example as being relatively more positive toward the green plan (when positive information is provided about both plans) or being relatively less negative toward the green plan (when negative information is provided about both plans). Ex-post examination of the data reveals that these two ambiguous information conditions had little impact on adoption of the green plan, confirming our initial supposition. Specifically, there are no significant differences in green plan adoption between these two conditions and the *Baseline*. We include these two conditions in all regression analyses, but for brevity, they are omitted from the main results. All regression results are robust if we, instead, omit these conditions. This data and corresponding analysis is available upon request.

gray” nudges that are targeted toward promoting the adoption of the gray plan. Regarding the two dual-information conditions—*PosGreen+NegGray*, *NegGreen+PosGray*—we are interested in how providing information on the attributes of both plans impacts adoption of the green plan. Specifically, for the *PosGreen+NegGray* condition, is there a cumulative pro-green nudge effect that may increase green plan adoption relatively more than just the *PosGreen* or *NegGray* conditions. Likewise, for the *NegGreen+PosGray*, is there a cumulative pro-gray nudge effect that may decrease the adoption of the green plan relatively more than just the *NegGreen* or *PosGray* conditions.

[Insert Table 1: Summary of Information Conditions]

We acknowledge that the six statements likely do not describe all attributes associated with electricity production from the given source. That said, our aim was to provide information that highlighted either the possible advantages or disadvantages of electricity generation from renewable green power generation or conventional gray power generation; moreover, we included information about several different attribute domains. As such, we can gain insights into how either the promotion of the green plan and/or dissuasion of the gray plan (and vice versa) impacts the overall adoption of voluntary green-power plans. Importantly, by also varying the price premium of the green plan across choices, we are able to compare the magnitude of the information effects relative to the magnitude of the price impacts.

3.3 Information Manipulation Check

It is important to first verify that the information conditions impacted perceptions of the plans in the intended ways. To do so, we recruited an independent student sample of 136 respondents (who did not participate in the choice survey) to evaluate the statements. A detailed description of the procedure and additional results are presented in Supplemental Appendix C.

For the six neutral statements that comprised the *Baseline* condition, we asked respondents to rate whether each statement supported conventional, hydro-carbon electricity or renewable, green energy. Responses were on a 7-point Likert scale (1=supporting hydro-carbon electricity; 4=neutral; 7=supporting green electricity). For each respondent we averaged their responses over the six statements

to generate a composite rating of the block of statements; the mean composite was 3.63 and the median was 3.83, suggesting that these six statements pertaining to general electricity facts were indeed viewed as being relatively neutral, as intended.

We implemented a similar approach for validating the information statements pertaining the green and gray plans. Participants were either presented with all the information statements about the green plan or the gray plans (in random order), and then asked to indicate whether the statement was a positive or negative property. Responses were, again, on a 7-point Likert scale (1=very negative; 7=very positive). For the green plan, the six statements that comprised the *PosGreen* condition had an average composite rating of 5.70, while the six statements that comprised the *NegGreen* condition had an average rating of 2.90. Importantly, these averages are both significantly different from the neutral scale rating of 4 ($p < .001$ in both instances). For the gray plan, the six statements that comprised the *PosGray* condition had an average composite rating of 5.41, while the six statements that comprised the *NegGreen* condition had an average rating of 2.33. Again, both of these average measures are significantly different from the neutral scale rating of 4 ($p < .001$ in both instances). Based on the responses from the sample of independent evaluators, the information manipulations were effective at conveying the desired information: (i) the set of information statements aimed at promoting the advantages of the green plan or the gray plan were, in fact, evaluated positively; (ii) the set of information statements aimed at promoting the disadvantages of green plan or the gray plan were, in fact, evaluated negatively.

3.4 Participant Sampling

Our survey utilized two distinct samples. The first sample is a representative panel generated by Qualtrics Panels, LLC. For this sample, we restricted participation eligibility to individuals responsible for paying their electricity bill. After the initial screening, this sample consisted of 1,150 respondents (79% overall response rate): 69% were female, a median age range of 35-44 years, and over 900 distinct zip codes were reported. The second sample consists of business school students. Participants were

recruited via email from a large database who enroll to participate in research studies.²⁴ A total of 688 students completed the survey: 50% were female, the median age range was 18-24 years. The students were not required to be responsible for paying their own electricity bill, although we did ask respondents this question, and 64% indicated in the affirmative. Considering a separate student sample, in addition to a more representative sample of adult utility customers, is useful since students represent the next generation of electric utility consumers; hence, better understanding their (potentially different) attitudes and behavior toward green-power adoption, is crucial for informing policy aimed at stimulating the adoption of green-power alternatives and predicting future trends of residential electricity consumption.²⁵ Together, the results from two distinct samples provides more robust inferences regarding the impact of providing informational nudges on the adoption of voluntary green-power plans.

4 Results

For each respondent, we observe their preferred plan choice for each of the 12 choice sets.²⁶ All respondents were treated with one of possible information conditions outlined in Section 3.2. Our primary focus is on estimating how these informational nudges impact the respondents' choice of the green plan.

4.1 Comparison of Qualtrics Panel Sample and Student Sample

Recall, our survey utilized two distinct samples: (i) a representative Qualtrics panel of 1,150 respondents, and (ii) the student sample of 688 respondents. We first compare response behavior across the two

²⁴ This subject pool utilizes a research credit system, whereby participants receive research credits for participating in research studies. These credits count toward satisfying requirements in the specific classes that they are enrolled in. The research pool system offers non-research alternatives, so participation remains voluntary. In essence, the research credit acts as compensation in same way paying a fixed monetary amount to survey respondents would do.

²⁵ Additionally, Gossling et al. (2005) document evidence that students generally have a positive attitude toward green power, which suggests that they may be the population most likely to consider green- power alternatives. Relatedly, Mills & Schleich (2012) find that university education increases the stated importance of energy conservation. Therefore, students might be the most susceptible to information nudges aimed at promoting the adoption of green power. That said, using only a student sample may overstate preference for green power and, possibly, bias the estimates of the overall information effect.

²⁶ As part of IRB compliance, we did not implement forced response. However, 94% of respondents did make a selection in all 12 choice sets. Because of the small fraction of non-responses, we end up with slightly fewer (21,384) observed choices than the total number of all choices sets ($1,838 \times 12 = 22,056$). We include all choice observations in the data, although our results are robust if we include only those respondents that answered all 12 choice sets.

samples. Aggregated over all choices, respondents from the Qualtrics panel chose the green plan 36.9% of the time, while respondents from the student sample chose the green plan 37.3% of the time; this difference is not statistically different (t-test: $p = .773$).²⁷ In addition, a factorial ANOVA reveals no significant main effect of the student sample ($p = .807$) or interaction between the student sample and the information condition ($p = .516$) on green plan choice. In our view, this is sufficient to conclude that there are no concerning sample differences with regard to respondent behavior. As a result, we pool the data across both samples for the remainder of the analysis to provide a larger sample size, additional power, and more robust inference regarding the main results that are gleaned from the response data; when appropriate we control for sample in all regression analysis.²⁸

4.2 Effect of Information Manipulation on Green Plan Choice

We proceed by examining the effect of the information conditions on respondents' decisions to adopt the green plan. Figure 2 plots the aggregate percentage of green plan choices across the different information conditions (with error bars representing 95% confidence intervals of the mean). The information conditions are grouped into **pro-green** (*PosGreen*, *NegGray*, *PosGreen+NegGray*) and **pro-gray** (*NegGreen*, *PosGray*, *NegGreen+PosGray*) categories. Everything is in reference to the *Baseline* information condition, which resulted in an aggregate green plan adoption rate of 36.2%. Importantly, there are clear impacts of the information conditions on the adoption of the green plan, which are jointly significantly different (ANOVA: $p < .001$).²⁹

²⁷ Because each subject makes multiple plan choices, we create a subject-level measure that is simply the proportion of choices for the green plan. When necessary, all statistical testing in the remainder of the analysis is performed using this conservative, subject-level measure of green plan choice, which ensures independence of observations across each information condition. However, if we assume independence of all choices, a Chi-squared test similarly reveals no significant difference in green plan choices across the two samples ($p = .538$).

²⁸ All our main results regarding the impact of the information conditions on green plan choice are qualitatively robust if we analyze each of the two samples separately. Hence, for brevity, we report the pooled results.

²⁹ As part of the post-survey questionnaire, we asked participants if their current electric utility uses any green energy sources. Of the 1,838 total respondents, 308 (16.8%) reported *Yes*. It is reasonable that some, if not all, of these respondents received information about the advantages of green energy and/disadvantages of gray energy from their utility. As such, the information intervention in this study might have been less effective on this subgroup. Importantly, however, our main results regarding the aggregate impact of the information conditions on green plan adoption are robust if we exclude the 308 respondents whose current utility uses green energy; Appendix D re-produces Figure 2 excluding all choices made these 308 respondents, and the baseline rate of green plan choice is essentially unchanged

[Insert Figure 2: Impact of Information Conditions on Adoption of Green-power Plan]

Looking first at the pro-green information conditions, we see from Figure 2 that all three conditions increased the adoption of the green plan. Specifically, 43.7% of choices were for the green plan in the *PosGreen* condition, 45.6% in the *NegGray* condition, and 42.7% in the *PosGreen+NegGray* condition; all three conditions are significantly higher compared to the *Baseline* rate of 36.2% ($p = .002$, $p = .003$, $p = .031$, respectively). Moreover, the difference between the *PosGreen* and *NegGray* conditions is small and insignificant ($p = .664$), suggesting that both are similar in their effectiveness. Lastly, the proportion of green-plan choices in the *PosGreen+NegGray* is very similar to the *PosGreen* and *NegGray* conditions, which suggests little evidence of a cumulative information effect.

In terms of the three pro-gray conditions, we see that each decreased the adoption of the green plan (i.e., increased the adoption of the gray plan). The proportion of choices for the green plan were 29.6% in the *NegGreen* condition, 32.1% in the *PosGray* condition, and 28.9% in the *NegGreen+PosGray* condition, although, only *NegGreen* and *NegGreen+PosGray* are significantly different from the *Baseline* of 36.2% ($p = .042$, $p = .032$, respectively). Similar to the pattern that emerged with the pro-green condition, we see little difference between the *NegGreen* and *PosGray* conditions ($p = .580$). Likewise, there appears to be little cumulative pro-gray information effect, if any, as there is no significant difference between *NegGreen+PosGray* and *NegGreen* ($p = .595$), or *PosGray* ($p = .381$).

To directly estimate the impact of the information conditions, price-premium, and other socio-demographic variables on the likelihood that the green plan is chosen, we estimate a logistic regression model with green plan choice as the binary dependent variable. To account for the possible serial correlation stemming from respondents making multiple plan choices, we clustered standard errors at the respondent level. Table 2 reports the estimated marginal effects for several different specifications.³⁰

(35.1%); likewise, the change in green plan adoption associated with the other information condition essentially mirrors those in Figure 2 for the entire sample.

³⁰ We present the results from a logit model with clustered standard errors at the respondent level as our preferred specification, as it allows us to include socio-demographic variables as controls (which do not vary over choices at the individual level). However, our main results regarding the impact of price volatility and price dispersion are robust to

In each specification, we include indicator variables for the treated information conditions, relative to the *Baseline* condition as the excluded condition.³¹

[Insert Table 2: Estimated Logit Model with Green Plan Choice as Dependent Variable]

Looking at Table 2, we see that the estimated information effects generally mirror those depicted in Figure 2. The three pro-green conditions all have a positive and statistically significant effect on green plan choice (column 1); moreover, this effect is stable and robust after controlling for a host of respondent characteristics (column 2) as well as the price premium associated with the green plan (columns 3 and 4). In terms of the magnitudes of the effects, the estimated marginal effects for these pro-green conditions in the full model (column 4) range from .058 (for *PosGreen+NegGray*) to .078 (for *PosGreen*). None of the estimated effects across these pro-green conditions are significantly different from each other, suggesting similar effectiveness. Our data indicate that nudging respondents by providing information on the advantages of green electricity production and/or the disadvantages of gray electricity production increases adoption of the green plan by as much as 7.8 percentage points relative to the *Baseline* condition, which corresponded to a roughly 22% increase from the *Baseline* rate.

In terms of the pro-gray conditions, Table 2 reveals that all three have a negative impact on green plan choice, although this estimated effect is significant only for the *NegGreen* and *NegGreen+PosGray* conditions (column 1); furthermore, this pattern is robust across the inclusion of respondent characteristic controls and the price premium (columns 2-4). The magnitude of the estimated marginal effects from the full model in column 4 are -.052 for *NegGreen* and -.077 for *NegGreen+PosGray* (not significantly different from each other). Thus, nudging respondents with negative information about green electricity and positive information about gray electricity decreases take-up of the green plan by

alternative specifications, including a probit model and linear probability model. Our main results are also robust and stable if we alternatively estimate a random effects logit, or to the inclusion of respondent fixed effects.

³¹ We include an indicator *Student*=1 for respondents in the student sample to control for any possible sample differences; however, as seen in Table 2, the *Student* indicator is insignificant in all specifications, further supporting our claim that there are no substantial subject pool differences in responses.

as much as 7.7 percentage points relative to the *Baseline* condition, which corresponds to a roughly 21% decrease from the *Baseline* rate.

Conventional economic theory as well as prior research suggests that the price premium associated with the green plan should be an important determinant in the decision to adopt the green plan, and our data confirm this to be true. Namely, from columns 2 and 4 of Table 2, we see that the *\$10 price premium* and *\$15 price premium* indicators both have large and significant negative impacts on green plan choice. The estimated marginal effects imply that moving from a \$5/month price premium to a \$10/month price premium reduces the likelihood of selecting the green plan by 10.9 percentage points, while moving to a \$15/month price premium reduces the likelihood by 23.1 percentage points. Assuming linearity in the price effect, this implies that each \$1 increase in the monthly price premium of the green plan reduced take-up of the green plan by roughly 2 percentage points.

Lastly, we briefly report on the results regarding the respondent characteristics included as controls. Of the included demographic variables – *male*, *education*, *income*, and *children* – only *education* and *children* have significant effects; namely, higher levels of self-reported education are associated with an increase in green plan selection, while respondents who report having children are less likely to adopt the green plan. Not surprisingly, respondents who reported being enrolled in a plan where at least some of the electricity is generated from a green source, *green plan customer*, are significantly more likely to adopt the green plan. Consistent with prior studies mentioned in Section 2, we do find that pro-environmental attitudes positively relate to choosing the green plan. To generally measure pro-environmental attitudes, we include the score for the 15-item New Ecological Paradigm (Dunlap et al., 2000; Kotchen & Reiling, 2000), *NEP scale*, and this measure enters positively and is statistically significant. We also include a 5-point Likert-scale measure of the importance that electricity be generated in a renewable manner, *green electricity*. This measure also has a positive and significant effect on green plan choice; as we would expect, respondents who think renewable electricity is important are more likely to choose the green plan, all else equal.

Importantly, our data enable us to compare the magnitude of the information nudges relative to the magnitude of the green price effect. In particular, providing pro-green nudges increases adoption of the green plan by as much as 7.8 percentage points, while opposite pro-gray nudges can decrease green plan adoption by as much as 7.7 percentage points. To put this in relative context, these estimated effects are roughly equivalent in magnitude to the effect of a \$4/month change in the price of the green plan.

4.3 Response to Information Condition Stratified by Price Premium of Green Plan

Next, we examine if, and to what extent, the magnitude of the price premium of the green plan impacts how people respond to the information nudges. We dis-aggregate the choice data by price premium and compare green plan adoption across information conditions. For brevity, we focus specifically on the comparison between the lowest price premium (\$5/month) and highest price premium (\$15/month). Figure 3 separately displays the aggregate percentage of the green plan choice across information conditions for the \$5 (Panel A) and \$15 (Panel B) price premiums (with error bars representing 95% confidence intervals of the mean). A factorial ANOVA reveals a highly significant main effect of price premium ($p < .001$) and information condition ($p < .001$), as well as a significant interaction between the premium and the information condition ($p < .001$). In Table 3, we separately report the results for the full logistic regression of green plan choice for \$5, \$10, and \$15 price premium levels.

[Insert Figure 3: Impact of Information Conditions by Price Premium]

Comparing between the \$5 and \$15 price premiums, we see some differences emerge in terms of the effectiveness of positive versus negative information. In particular, when the premium is \$15, respondents seem to be relatively more responsive to the negative information (in both the pro-green and pro-gray cases). In the pro-green case, the *NegGray* condition increased choice of the green plan by 10.2 percentage points from the *Baseline*, while the *PosGreen* condition comparably increased choice of the green plan by only 3.9 percentage points; this difference is significant ($p = .007$). Moreover, based on the results of the logistic regression reported in Table 3, only the *NegGray* condition indicator enters significantly at the \$15 price premium. Similarly, in the pro-gray case, the *NegGreen* condition

decreased choice of the green plan by about 6.8 percentage points from the *Baseline*, while *PosGray* led to essentially no change in choice of green plan; this difference is also significant ($p < .001$). Table 3 reveals only the *NegGreen* condition indicator loads significantly at the \$15 price premium. Thus, the negative information about either the green plan or the gray plan evokes a stronger behavioral response at the high \$15 price premium for the green plan.

**[Insert Table 2 – Estimated Logit Model with Green Plan Choice as Dependent Variable by
Price Premium]**

Conversely, at a \$5 price premium, respondents seem to be relatively more responsive to positive information compared to the corresponding negative information. Specifically, in the pro-green case, the *PosGreen* condition increased the choice of green plan by 10.6 percentage points, while the *NegGray* condition increased it by only 5.5 percentage points; this difference between the two conditions is significant ($p = .037$). Moreover, the logistic regression result in Table 3 reveals that only the *PosGreen* condition significantly increased green plan choice relative to the *Baseline* level at the \$5 price premium. A similar pattern emerges for the pro-gray case, where the *PosGray* condition decreased green plan choice by 8.9 percentage points, while *NegGreen* decreased it by only 5.6 percentage points, although this difference between the two is not significant ($p = .190$). However, only the *PosGray* condition significantly reduced green plan choice relative to the *Baseline*. At the low \$5 price premium for the green plan, positive information (especially about the green plan) seems to evoke a stronger response.

Overall, the data suggest that the cost of the green plan, relative to the gray plan, can be an important factor in determining the differential effectiveness of information nudges. When the voluntary green plan is not *too* expensive, then highlighting the positive attributes of green electricity generation would be most effective in promoting adoption of the green plan. Conversely, if the green plan is relatively expensive, then highlighting the negative aspects of gray electricity generation seems to have more bite; perhaps appealing to some implicit degree of moral wrongdoing by choosing the “bad” gray plan is more effective in overcoming the relatively high price premium of the green plan. The other side of this story

is that when the green plan is expensive, then information about the possible disadvantages of renewable electricity can really handicap its adoption; here, it seems people jump at the opportunity to justify not paying the premium for the green plan if the green plan is really “not all that good”.

4.4 Heterogeneous Responses to Treatment of Information by Respondent Characteristics

Table 1 shows that some of the individual respondent characteristics significantly impacted the decision to adopt the green plan. While this direct effect is certainly of interest, it is also important to think about how different “types” of respondents might differentially respond to the information nudges. Specifically, we consider how respondents’ level of income, education, and general environmental attitude impact their responses to the information nudge. For both income and education, we classify respondents into two group: (i) *higher* if they are above the median, and (ii) *lower* if they are at or below the median. For environmental attitude, we also stratify respondents into two groups: (i) *more environmental* if their NEP score is above the median, and (ii) *less environmental* if their NEP score is at or below the median. Lastly, we also consider whether respondents are enrolled in an existing green plan at their current utility company. To streamline the presentation of the data and analysis, we aggregate over all information conditions within the given type of nudge condition: *pro-green* or *pro-gray*. Moreover, for this sub-sample analysis, we use only the Qualtrics panel, where we have sufficient variation in respondent characteristics of interest for meaningful analysis. Figure 4 presents stratified data. Because the *Baseline* level of green plan choice differs based on how respondents are categorized (e.g., *more environmental* vs. *less environmental*), Figure 4 reports the *% change* in aggregate green plan choice, relative to the corresponding *Baseline* level. By reporting everything as a % change relative to baseline, we account for the fact that different groups might be more/less responsive to the information nudge based on their baseline level of green plan adoption. We also perform sub-sample analysis, and the logistic regression results of green plan choice for each sub-sample are reported in Supplemental Appendix D. Overall, the results support the main findings reported below.

[Insert Figure 4: Impact of Information Conditions by Respondent Characteristics]

Looking first at respondent income, Panel A of Figure 4 reveals very little difference in how lower- and higher-income respondents are affected by the information intervention. Both income groups show a large positive response to the pro-green information conditions and a large negative response to the pro-gray conditions. There is a significant main effect of information condition (ANOVA: $p < .001$), but the interaction between information condition and income is not significant (ANOVA: $p = .578$). So while higher-income respondents may be more inclined to purchase the green plan, there is little statistical evidence that they *differentially* react to information. Looking next at education level, Panel B reveals some differences in how more-educated respondents react to the information intervention. Indeed, there is a significant main effect of education (ANOVA: $p < .001$), and interaction between education and information condition (ANOVA: $p < .001$). In particular, we see that more-educated respondents are relatively more likely to choose the green plan after receiving the pro-green information, while less-educated respondents are much less likely to choose the green plan after receiving the pro-gray information. Possibly one way to interpret this is that less-educated respondents are more *skeptical* or cautious regarding green-power; hence, they do not show as large of a positive response to pro-green nudges, and show a much larger negative response to the pro-gray nudges.

Panel C of Figure 4 compares how respondents with different environmental attitudes respond to the information. It is evident that measured environmental attitudes impact how the information intervention impacts green plan choice; there is a significant main effect of environmental attitude (ANOVA: $p < .001$), and interaction effect of environmental attitude and information condition (ANOVA: $p < .001$). Specifically, less-pro-environmental respondents are more responsive to the pro-green information and show a larger increase in green plan adoption. However, the opposite is true for the pro-gray information. Namely, more-pro-environmental respondents exhibit a stronger negative response to the pro-gray conditions. The intuition here is that individuals who are more concerned about the environment are less likely to be influenced by pro-green information, as this information likely just confirms their existing beliefs. At the same time, individuals with more concern for the environment are more responsive to

pro-gray information; if it is revealed that the gray plan is not that bad or the green plan is not that good, the more-pro-environmental respondents exhibit a larger decrease in green plan adoption.³² This could also be consistent with a moral licensing story (Blanken et al., 2015), where more-pro-environmental respondents use the pro-gray information as justification to “license” their pro-gray choice.

Lastly, Panel D of Figure 4 compares the behavior of existing green plan customers versus non-existing green plan customers. Importantly, we see a significant difference in how these two groups react to the information intervention (ANOVA: $p < .001$). As we would expect, existing green plan customers are much less responsive to both the pro-green and pro-gray information interventions, in that neither appear to impact the green plan adoption rates for the existing green plan customers. Conversely, the non-existing green plan customers show a large positive response to the pro-green conditions and a large negative response to the pro-gray conditions. The main implication here is that individuals who are not existing green plan customers are much more “nudge-able” in that their behavior is more influenced by the pre-choice, information intervention.

4.5 Persistence of Information Manipulation

Recall, in our choice experiment respondents faced a series of twelve plan choice scenarios after having been treated with the information manipulation. A benefit of this design feature is our subsequent ability to examine the persistence of the information manipulation over the plan choices. To do so, we reproduce our main logit specifications reported in Table 2 with the addition of interaction terms between each of the six information conditions and the choice number – *choice#* – which takes value from 1 to 12. Because the dependent variable takes the value one when the green plan is chosen, a negative, significant interaction of *choice#* with the three pro-green conditions

³² As expected, the more-environmental respondents have a much higher Baseline level of green plan adoption (45%) compared to the less-environmental respondents (30%). However, even if we consider absolute changes from the baseline, a similar result emerges. Namely, pro-green information results in only a 4 percentage point increase in green plan adoption for more-environmental sample compared to an 11 percentage point increase for the less-environmental sample. Correspondingly, the pro-gray information results in a 14 percentage point decrease in green plan adoption for the more-environmental sample compared to only a 3 percentage point reduction for the less-environmental sample.

(*PosGreen*, *NegGray*, and *PosGreen+NegGray*) would indicate a “wear-off” effect, while a positive, significant interaction of *choice#* with the three pro-gray conditions (*PosGray*, *NegGreen*, and *PosGray+NegGreen*) would indicate a “wear-off” effect. Table 4 presents the results.

We see a striking pattern emerge in comparing the persistence of the pro-green and pro-gray information conditions. Specifically, when looking at the bottom of Table 4, we see that the interaction terms of the three pro-green conditions with the *choice#* are never statistically significant across all four reported specifications. However, when looking at the interactions of the three pro-gray conditions with the *choice#*, all but one of the twelve reported interactions are positive and statistically significant. Thus, the data reveals no significant wear-off effect of the pro-green information as the respondents progress through the choice sets, but there does appear to be a wear-off of the pro-gray information manipulations.

To portray these persistence results more clearly, Table 5 reports the estimated marginal effects of the 6 information conditions from the full specification reported in Column 4 of Table 4, evaluated at *choice#* = 1 (the first choice) and *choice#* = 12 (the last choice). Table 5 reveals the striking difference in the persistence of the manipulation between the pro-green and pro-gray conditions. Specifically, at *choice#* = 12, the marginal effects for the three pro-gray conditions are all positive and significant (ranging from 8.3 percentage points to 9.8 percentage points). Whereas the marginal effects for the three pro-gray conditions are negative and significant when evaluated at *choice#* = 1, but are all insignificant when evaluated at *choice#* = 12. This suggests that by the time respondents have reached choice set 12, there is no longer a significant effect of having received pro-gray information on the likelihood of choosing the green plan. On the other hand, those respondents who received pro-green information are about 9 percentage points more likely to choose the green plan in their last choice.

5 Discussion and Conclusions

There is a global concerted effort, especially from regulating bodies, to promote growth in renewable energy as a means to combat global warming, curb greenhouse gas emissions, and facilitate sustainability. Moreover, residential electricity usage accounts for a sizable share of overall energy

demand.³³ As such, deepening our understanding of the possible factors that can influence consumers' attitudes and choices to adopt voluntary green-power plans versus conventional, hydro-carbon plans is critically important to the progression of renewable energy and the evolution of energy production and consumption. The aim of this study is to contribute to this understanding by examining how non-price, information nudges impact residential consumers' preferences for adopting voluntary green-power plan.

In particular, we carry out a choice experiment where respondents choose between a conventional *gray-power plan* and a renewable *green-power plan*. Prior to making their plan selections, respondents are randomly exposed to: (i) a *pro-green* nudge – receiving information about the advantages of green power and/or the disadvantages of gray power, or (ii) a *pro-gray* nudge - receiving information about the disadvantages of green power and/or the advantages of gray power. Importantly, we also vary the green-price premium across choice sets. Consequently, we are able to identify how these information interventions impact reported adoption rates of the green plan relative to a *baseline* rate of adoption, and compare the magnitude of the information effects relative to the magnitude of the price effect.

We document economically and statistically significant effects of the information interventions on adoption rates of the green plan. Notably, the pro-green information nudges increase green plan choice by 6-8 percentage points, relative to the 36% baseline rate of adoption. Conversely, the pro-gray information nudges decrease green plan choice by 5-8 percentage points relative to the baseline. Based on our estimates, the magnitude of the information nudges are roughly proportion to a change in the green plan price premium of roughly \$4 per month. Moreover, our results are generally robust across different levels of price premium for the green plan.

Interestingly, the estimated increase in green plan adoption after the pro-green information intervention is persistent and remains statistically significant throughout the entire set of choices. Whereas, we see a significant “wear-off” of the pro-gray information interventions; based on our

³³ For example, in 2016, the EIA reported that electric power generation accounted for roughly 40% of total U.S. energy consumption, and that the residential sector accounted for roughly 21% of energy consumption.

estimates, by the time respondents have progressed to their last choice set, there is no longer a significant effect of having received the pro-gray information on the likelihood of choosing the green plan. We acknowledge that the idea of persistence within our experimental framework needs to be interpreted with some caution (given the short elapsed time). That said, the fact that we see a striking difference in persistence between the pro-green and pro-gray information provides some suggestive evidence of the staying-power of pro-green information nudges on the decision to adopt voluntary green power plans.

Given the hypothetical nature of the choice experiment, it is possible that there is some bias and/or experimenter demand effects; presumably in the direction of higher levels of stated green plan adoption. Thus, some caution needs to be taken when interpreting treatment effects associated with the information nudges. Importantly, however, we identify our main information treatments effects relative to a *baseline* level of green plan adoption. Therefore, if we make the reasonable assumption that any green bias (if it exists) is uncorrelated with the information interventions, our estimated treatment effects *relative* to the baseline remain valid. Moreover, by varying price premium of the green plan, we can estimate a price effect and, thus, interpret the magnitude of the information effects *relative* to the price effect. As such, even if the absolute size of the information effects are possibly inflated, our results suggest that information nudges can impact green plan adoption by a similar magnitude to reasonably sized changes in the monthly green price premium.

Our study can be informative for renewable energy policy. Sustaining continued growth in renewable energy hinges on continued increases in consumer demand for green products. Among these, increasing the demand for residential, green electric power can be impactful for increasing overall renewable energy production as a share of total energy production. Our results suggest that policies aimed at providing more salient information about the environmental and social benefits of green-power generation, or the costs of gray-power generation could increase adoption of voluntary green-power plans, thus stimulating overall growth in the renewable energy sector. An example would be to mandate that electric utilities provide (transparent) information disclosures of energy generating sources and the associated

environmental impacts. In essence, mandating a type of “eco-labeling” for electric utility plans could increase take-up of green-power plans in the same way eco-labeling has promoted adoption of more energy-efficient durable goods. Moreover, promoting residential adoption of green-power plans through such information nudging might be preferred to conventional economic policies (e.g., subsidies, tax breaks, mandates) since nudges have the (desirable) property of being libertarian or choice-preserving, while also possibly aligning choices more in the direction of people’s preferences for more renewable energy; hence, falling under the category of being libertarian paternalistic (Thaler & Sunstein, 2008).

The results from our study also have important green-power marketing implications. Namely, providing information about the beneficial attributes associated with renewable electricity generation is a plausible mechanism that electric utilities could use to increase the take-up rate of voluntary green plans. Dagher et al. (2017) find that take-up of green plans is lower for new subscribers compared to existing customers. The findings from our study suggest that when marketing to new customers, utilities can “nudge” new customers to adopt the green plan by providing salient information about the benefits of the green plan. Relatedly, such information would be more effective if utilities target people who are not already green power customers. Alternatively, this could also cut the other way with utility companies being able to discourage customers from switching to an alternative green plan through program nudges. Regardless, our study suggests that this type of pre-plan-selection, information provision can be a useful strategy for electric utilities to steer new customers toward certain plans. Naturally, as renewable electricity generation becomes cheaper, via increasing efficiency from advancements in renewable energy technologies, this strategy would imply steering customers toward green plans.

Overall, we view our study as contributing to and extending the extant literature aimed at identifying the possible factors that influence consumers’ decisions to adopt green-power plans. Much of this prior literature has focused on price of the green plan or other conventional economic levers; namely, lowering the price of the green plan or raising the incentive to adopt the green plan. While prices and incentives are important determinants, they alone deliver an incomplete view. Our results suggest that non-price

interventions can also play an important role. Specifically, *nudging* people by providing (pre-choice) information about the advantageous or disadvantageous attributes of electricity generation associated with green and gray plans can significantly impact demand for voluntary green-power plans. From a descriptive perspective, our results can be informative for better understanding the possible factors that can impact growth of renewable energy and the overall electricity generation moving forward.

Viewed through a broad lens, non-price nudges have been touted by many academics, practitioners, and policy makers as effective instruments in promoting energy conservation (e.g., usage feedback, peer comparisons, social norms, and moral suasion). That said, recent work by Allcott & Kessler (2019) and Allcott & Greenstone (2017) suggests that there can be *indirect* costs associated with nudging conservation that are incurred when people change their behavior, which are typically not accounted for in welfare analysis. However, we argue that when it comes to electric power-plan choice, there are likely to be small (and possibly zero) indirect costs associated with choosing a green plan (because once they choose the plan, their actual usage behavior is presumably not impacted by how the energy is being generated). We conclude by positing that nudging the “upstream” decision of consumers to adopt voluntary green-power plans might be a more attractive means for promoting the broader pro-environmental/sustainability energy agenda. Thus, from a welfare perspective, if we want to reduce greenhouse gas emissions and make improvements on climate change, we might be better served focusing on using nudges to motivate people to adopt voluntary green-power plans. Overall, our study provides valuable insights regarding possible changes in energy consumption patterns in response to both regulatory changes and green power marketing aimed at promoting the adoption of green power.

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Figure 1: Sample Choice Scenario

<u>PLAN A – CONVENTIONAL ELECTRICITY</u>		<u>PLAN B – GREEN ELECTRICITY</u>	
Generating Source: Coal or Natural Gas		Generating Source: Wind or Solar	
Possible Monthly Price	Chance of Price	Possible Monthly Price	Chance of Price
\$93	15%	\$98	10%
\$100	70%	\$108	80%
\$107	15%	\$118	10%
Average Expected Monthly Price: \$100		Average Expected Monthly Price: \$108	

Figure 2: Impact of Information Conditions on Adoption of Green-power Plan

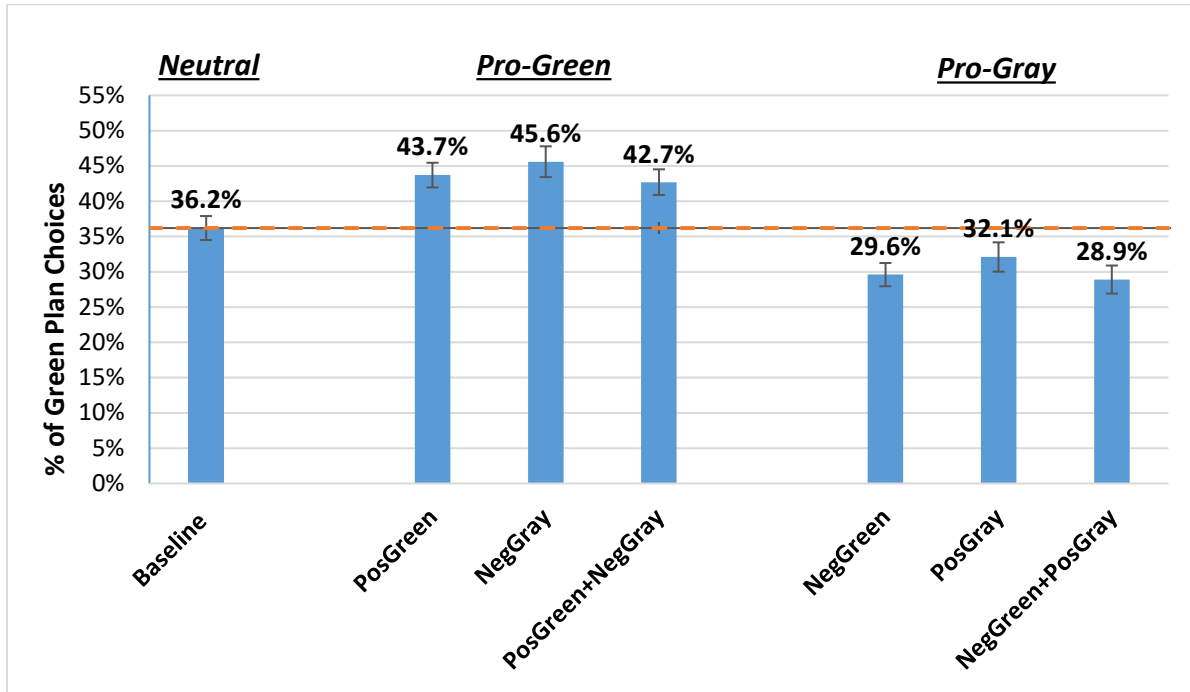


Figure 3: Impact of Information Conditions by Price Premium

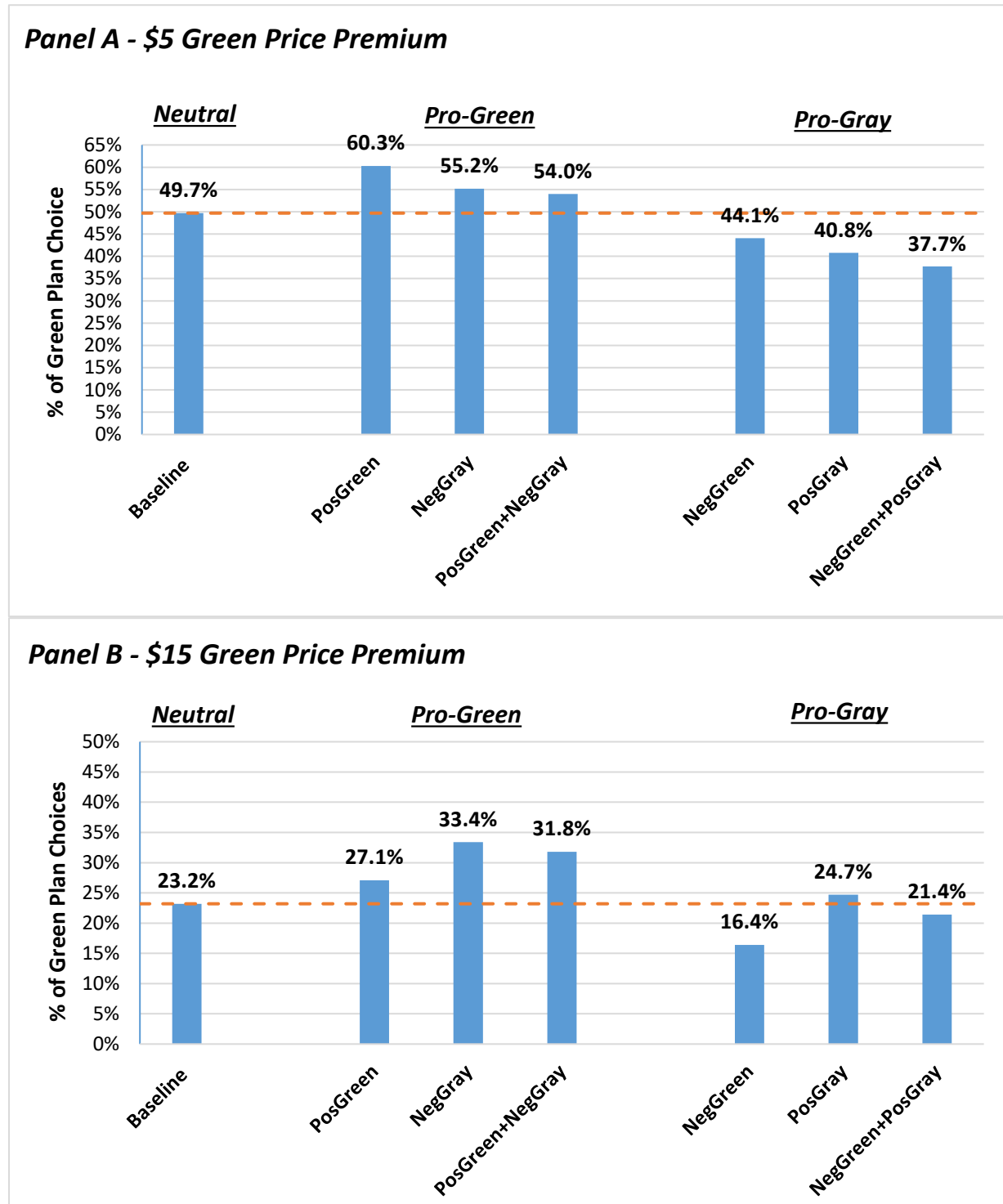


Figure 4: Impact of Information Conditions by Respondent Characteristics



Table 1 – Description on Information Conditions

Treatment Name	<u>Information on Green Plan</u>			<u>Information on Gray Plan</u>			Treatment Category
	None	Positive	Negative	None	Positive	Negative	
<i>Baseline</i>	✓			✓			<i>Neutral</i>
<i>PosGreen</i>		✓		✓			<i>Pro-Green</i>
<i>NegGreen</i>			✓	✓			<i>Pro-Gray</i>
<i>PosGray</i>	✓				✓		<i>Pro-Gray</i>
<i>NegGray</i>	✓					✓	<i>Pro-Green</i>
<i>PosGreen+NegGray</i>		✓				✓	<i>Pro-Green</i>
<i>NegGreen+PosGray</i>			✓		✓		<i>Pro-Gray</i>

Table 2 – Logit Models with Green Plan Choice as Dependent Variable

	Dependent Variable: <i>Green Plan Choice</i>			
	1	2	3	4
<i>PosGreen</i>	.073*** (.027)	.078*** (.025)	.073*** (.027)	.078*** (.025)
<i>NegGray</i>	.092*** (.033)	.076** (.032)	.092*** (.033)	.076** (.032)
<i>PosGreen+NegGray</i>	.065** (.032)	.058* (.031)	.065** (.032)	.058* (.031)
<i>NegGreen</i>	-.069*** (.026)	-.052** (.025)	-.069*** (.026)	-.052** (.025)
<i>PosGray</i>	-.039 (.034)	-.040 (.032)	-.039 (.034)	-.040 (.032)
<i>NegGreen+PosGray</i>	-.074** (.034)	-.077** (.032)	-.074** (.034)	-.077** (.032)
<i>\$10 Price Premium</i>			-.109*** (.006)	-.109*** (.006)
<i>\$15 Price Premium</i>			-.231*** (.008)	-.231*** (.008)
<i>Male</i>		-.013 (.016)		-.013 (.016)
<i>Education</i>		.016*** (.006)		.016*** (.006)
<i>Income</i>		.005 (.004)		.005 (.005)
<i>Children</i>		-.045** (.022)		-.045** (.022)
<i>Green Plan Customer</i>		.050** (.025)		.050** (.025)
<i>NEP Scale</i>		.002** (.001)		.002** (.001)
<i>Green Electricity</i>		.080*** (.010)		.080*** (.009)
<i>Student</i>	.008 (.016)	-.007 (.020)	.008 (.016)	-.006 (.020)
<i>Block Dummies</i>	Yes	Yes	Yes	Yes
<i>Respondent Clustering</i>	Yes	Yes	Yes	Yes
<i>N</i>	21,384	21,258	21,384	21,258

Notes: This table reports the results of a logit regression with green plan choice as the binary dependent variable. Marginal effects are reported with standard errors in parentheses.

*** significance at 1% level; ** significance at 5% level; * significance at 10% level

Table 3 – Logit Models with Green Plan Choice as Dependent Variable (by Price Premium)

	Dependent Variable: <i>Green Plan Choice</i>		
	\$5 Price Premium	\$10 Price Premium	\$15 Price Premium
<i>PosGreen</i>	.112*** (.032)	.084*** (.030)	.042 (.029)
<i>NegGray</i>	.048 (.039)	.111*** (.037)	.067** (.034)
<i>PosGreen+NegGray</i>	.046 (.038)	.064* (.035)	.063* (.033)
<i>NegGreen</i>	-.038 (.032)	-.060** (.031)	-.067** (.032)
<i>PosGray</i>	-.082** (.037)	-.040 (.037)	.001 (.036)
<i>NegGreen+PosGray</i>	-.111*** (.039)	-.078** (.037)	-.037 (.036)
<i>Respondent Controls</i>	Yes	Yes	Yes
<i>Block Dummies</i>	Yes	Yes	Yes
<i>Respondent Clustering</i>	Yes	Yes	Yes
<i>N</i>	7,096	7,064	7,098

Notes: This table reports the results of a logit regression with green plan choice as the binary dependent variable. Marginal effects are reported with standard errors in parentheses.

*** significance at 1% level; ** significance at 5% level; * significance at 10% level

Table 4 – Persistence of Information Conditions on green plan choice

	Dependent Variable: <i>Green Plan Choice</i>			
	1	2	3	4
<i>PosGreen</i>	.297** (.143)	.336** (.141)	.299** (.144)	.334** (.141)
<i>NegGray</i>	.311* (.164)	.276* (.170)	.312* (.167)	.268 (.173)
<i>PosGreen+NegGray</i>	.157 (.159)	.157 (.162)	.162 (.161)	.158 (.164)
<i>NegGreen</i>	-.487*** (.144)	-.416*** (.144)	-.506*** (.146)	-.437*** (.145)
<i>PosGray</i>	-.323* (.171)	-.319* (.172)	-.339* (.174)	-.346** (.174)
<i>NegGreen+PosGray</i>	-.518*** (.168)	-.527*** (.170)	-.530*** (.170)	-.551*** (.172)
<i>\$10 Price Premium</i>			-.484*** (.030)	-.509*** (.031)
<i>\$15 Price Premium</i>			-1.065*** (.041)	-1.111*** (.044)
<i>PosGreen X Choice#</i>	.003 (.012)	.002 (.013)	.005 (.012)	.005 (.012)
<i>NegGray X Choice#</i>	.013 (.013)	.011 (.014)	.015 (.013)	.015 (.014)
<i>PosGreen+NegGray X Choice#</i>	.018 (.013)	.017 (.013)	.019 (.012)	.019 (.013)
<i>NegGreen X Choice#</i>	.029** (.013)	.028** (.014)	.030** (.013)	.029** (.013)
<i>PosGray X Choice#</i>	.022* (.014)	.021 (.014)	.024* (.014)	.025* (.014)
<i>NegGreen+PosGray X Choice#</i>	.029** (.012)	.028** (.013)	.029** (.012)	.030** (.013)
<i>Choice#</i>	-.032*** (.009)	-.032*** (.009)	-.009 (.008)	-.008 (.009)
<i>Respondent Controls</i>	No	Yes	No	Yes
<i>Block Dummies</i>	Yes	Yes	Yes	Yes
<i>Respondent Clustering</i>	Yes	Yes	Yes	Yes
<i>N</i>	21,384	21,258	21,384	21,258

Notes: This table reports the results of a logit regression with green plan choice as the binary dependent variable. Estimated Coefficients are reported with standard errors in parentheses. The set of Respondent Controls (when included) are the same as those reported in Table 2.

*** significance at 1% level; ** significance at 5% level; * significance at 10% level

Table 5 – Marginal Effects of Information Conditions at Choice# = 1 and Choice# = 12

<u>Information Condition</u>	<u>Estimated Marginal Effects Evaluated at:</u>	
	<i>Choice# = 1</i>	<i>Choice# = 12</i>
<i>PosGreen</i>	.073*** (.029)	.087*** (.030)
<i>NegGray</i>	.060* (.036)	.098** (.038)
<i>PosGreen+NegGray</i>	.037 (.034)	.083** (.037)
<i>NegGreen</i>	-.082*** (.026)	-.018 (.029)
<i>PosGray</i>	-.065** (.032)	-.011 (.036)
<i>NegGreen+PosGray</i>	-.103*** (.030)	-.041 (.035)
<i>\$10 Price Premium</i>	-.106*** (.006)	-.109*** (.006)
<i>\$15 Price Premium</i>	-.231*** (.008)	-.239*** (.009)

Notes: This table reports the estimated marginal effects of the logit regression reported in Column 4 of Table 4 with green plan choice as the binary dependent variable. Columns 1 and 2 report the estimated marginal effects evaluated at choice# = 1 and choice# = 12, respectively. Standard errors in parentheses. *** significance at 1% level; ** significance at 5% level; * significance at 10% level