



Accelerating demand for residential solar photovoltaics: Can simple framing strategies increase consumer interest?



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ABSTRACT

Household adoption of energy-efficient and renewable energy technologies has the potential to significantly reduce emissions from electricity generation. High upfront costs, however, are often a barrier to adoption, even when costs may be offset by future energy savings. Through a series of randomized experiments, we examine whether framing strategies grounded in behavioral economics and psychology can be used to increase the financial appeal of such products. Using mock ads for residential solar photovoltaics (PV), we test four frames: gain/loss framing, temporal framing, varied savings amounts, and simple vs. detailed savings calculations. Overall, we find that reframing the financial benefits of PV does not greatly influence the appeal of solar or the likelihood to respond to the mock ads. Instead, underlying consumer motivations and predispositions (i.e., perceived social support, consumer innovativeness, and personal pro-environmental norms) are the primary factors driving interest in adopting solar. Our findings suggest that tailoring messages to targeted consumer segments may be more effective than attempts to market the financial benefits of PV to broad audiences. The results also contribute to behavioral economics and psychology research by identifying contexts under which the gain/loss framing bias and the present/future framing bias may not apply.

1. Introduction

In the United States, renewable energy technologies such as residential photovoltaics (PV) have the potential to significantly reduce greenhouse gas emissions if widely adopted. Prior assessments have determined that there is sufficient suitable roof space for solar to provide 39% of the nation's electricity demand (Gagnon et al., 2016). For residential solar to become cost-competitive with retail electricity, however, the U.S. Department of Energy projects that a 70% reduction in residential PV prices, relative to 2010 prices, to \$1.60/Wdc is needed (Solar Energy Technologies Office, 2016). To date, most upfront cost reductions in PV installation have occurred on the module and hardware side. The costs of acquiring new customers, which as of 2016 comprise roughly \$2500 of each sale or 10–20% of the system price (Mond, 2017), have scarcely changed since 2010.

The process of selling solar to consumers, despite strong market growth, remains relatively understudied. While several researchers have looked at factors such as the role of peer effects on consumer

decision-making and adoption (Bollinger and Gillingham, 2012; Graziano and Gillingham, 2015; Palm, 2017; Rai and Robinson, 2013) and the types of events that spark initial interest in PV (Rai et al., 2016; Schelly, 2014; Sigrin et al., 2015), less is known about how to cost-effectively attract consumer attention. Prior research suggests that perceived financial benefits are a significant driver of interest in (Korcaj et al., 2015; Wolske et al., 2017), and ultimately adoption of PV (Drury et al., 2012; Kwan, 2012; Sigrin et al., 2015). It is unclear, though, whether the average consumer sees PV as financially advantageous. Given the relative novelty of PV—and of third party ownership models that allow homeowners to have solar panels without high upfront costs—many consumers may be unaware of available financing and incentives and, thus, assume that PV is not within their reach.

The challenge of how to capture consumers' attention when upfront costs are perceived to be high is not unique to residential solar. Most energy-efficient goods require paying a price premium now for monetary savings that may pay off many years in the future. Other work has shown that people tend to overlook life cycle costs and savings when

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evaluating goods such as energy-efficient appliances (Gately, 1980; Hausman, 1979; Ruderman et al., 1987) and fuel-efficient vehicles (Allcott and Knittel, 2017; Lane and Potter, 2007; Rezvani et al., 2015). Because it is unclear why customers are making these seemingly “irrational” decisions not to invest in energy-efficient items (Frederiks et al., 2015; Gillingham and Palmer, 2014), simple changes in the way that solar is presented to customers—based on principles from psychology and behavioral economics—may change their attitudes towards adopting solar.

This paper presents the results of three online survey experiments designed to test the effectiveness of simple and, therefore, potentially cost-effective strategies for reframing the financial benefits of PV to be more attractive to consumers. In our first two studies, we test (1) whether mock PV ads are more persuasive when they describe the financial gains of going solar versus the money lost by not going solar, and (2) whether these gains/losses are more compelling when framed on different time scales (every month, every year, or over the total lifetime of the panels). Based on insights from these two studies, our third study explores whether reactions to the ad are a function of the amount of savings claimed and the level of detail provided about how the savings were calculated. Without details on how the savings are estimated, consumers may be skeptical of high savings claims that sound “too good to be true,” especially since PV is a relatively novel and uncommon good. In each of our studies, we also compare the relative influence of the experimental conditions to that of respondent characteristics. To keep customer acquisition costs low, solar providers must weigh the tradeoffs of marketing PV broadly with a few common ads (such as those tested in our experiments) against those of targeting specific consumer segments using multiple tailored messages. Across our three studies, we find that simple framing strategies—which in theory should influence the appeal of PV—have little effect. Rather, characteristics of the individual, such as pro-environmental norms and consumer innovativeness, as well as perceptions of social support for going solar have a far greater impact on how individuals respond.

2. Studies 1 and 2: do loss frames and different temporal scales make PV more financially appealing?

Research from behavioral economics and psychology suggests that certain message framing strategies may be more effective than others. According to prospect theory (DellaVigna, 2009; Kahneman and Tversky, 1979), the pain of a potential loss is psychologically more powerful than the pleasure of an equivalent potential gain (e.g., \$100 lost feels larger than gaining the same amount). As a consequence, consumers are more likely to engage in risk-seeking behaviors to avoid potential losses. Based on these principles, several researchers have argued that loss framing may be an effective strategy to promote energy-efficient goods (Frederiks et al., 2015; Gonzales et al., 1988). In the context of marketing solar panels, ads may be more effective if they highlight monies lost by *not* getting solar (i.e., wasted dollars spent on more expensive utility-generated electricity) instead of focusing on how much money could be saved by going solar; this may be especially true if consumers view adoption of solar as risky. This leads to our first hypothesis:

H1. Loss frames will be more persuasive than gain frames in generating interest in PV.

Another factor that may influence consumer attitudes is the time frame over which savings are described. Research into time discounting suggests that consumers may find PV more compelling when the benefits are framed on a near-term monthly timescale rather than longer time frames such as annual or total lifetime savings. Generally speaking, people prefer smaller, sooner rewards than delayed, larger ones (DellaVigna, 2009; Frederick et al., 2002), especially under circumstances of uncertainty or risk. Furthermore, the benefits of PV may be perceived as larger when framed as multiple, monthly gains instead

of as a single total gain (Smith and Nagle, 1995). Likewise, losses that occur each month could be perceived as more painful (and therefore more motivating) than one bundled loss (Johnson et al., 1999; Kahneman and Tversky, 1979; Thaler, 1985).

In addition, how consumers evaluate PV adoption may depend on how they mentally account for the benefits of PV. Framing the benefits of solar in a way that comports with this mental accounting may therefore be important. For example, solar may be seen as a means to lower monthly energy bills, in which case expressing benefits (or losses) in terms of monthly savings would allow easy juxtaposition. Alternatively, PV may be seen as an additional source of income or as a long-term financial investment (Stern et al., 2018), leading people to be primarily interested in annual or overall savings, respectively. This leads to our second hypothesis:

H2. The time frame of solar benefits (i.e., monthly vs. annual vs. lifetime) will affect interest in PV.

As a confounding factor, construal level theory (CLT) suggests that people develop different mental representations (or “construals”) of situations depending on their perceived psychological distance (Trope and Liberman, 2010, 2003). These construal levels influence what information is considered in a given decision-making context (Trope et al., 2007). Psychologically distant situations, such as events that are perceived to occur in the future, activate high-level construals that are abstract and low-in detail. Under these circumstances, people tend to focus on identity-related goals, the desirability of an action, and *why* they might do a behavior. By contrast, temporally near events activate low-level construals that are more concrete and detail-rich. Under these circumstances, decision-makers focus on the feasibility of an action and *how* they might do the behavior.

Several researchers have proposed an interaction between gain/loss framing and temporal distance, where the effectiveness of a gain/loss frame depends on whether it is aligned with the present/future construal level of the message (Chang et al., 2015; White et al., 2011). Loss framed messages tend to provoke negative emotions and prime thoughts of how to take action, which may be particularly compatible with present-focused, low-level construal messages that encourage individuals to think concretely about how they might act. By contrast, gain-framed messages that highlight the desirable outcomes of acting may be compatible with future-oriented, high-construal level messages. White et al. (2011) found, for example, that college students reported greater intentions to recycle if messages described either what would be gained in the future by recycling or what might be lost in the near term by not recycling. Chang et al. (2015) similarly demonstrated that college students had greater intentions to buy an environmentally-friendly dish detergent if they either read about the environmental benefits of the soap ‘each year in the future’ or the negative environmental consequences of not using the soap ‘this year.’

In the present study, messages that describe the lifetime consequences of having solar may evoke higher-level construals than messages that describe the near-term monthly (or annual) consequences. If different temporal frames lead to different construal levels, then we might expect an interaction between gain/loss framing and the temporal scale of the message. This leads to our first research question:

RQ1. Is the effect of gain/loss frames on interest in PV moderated by the time scale on which savings (losses) are conveyed?

Finally, while reframing the financial benefits of solar may have advantages for generating new interest in PV, it is important to consider the impact of this approach relative to other possible outreach strategies. To keep customer acquisition costs low, solar providers must weigh the tradeoffs of spending marketing dollars on a general marketing campaign aimed at a broad audience versus tailoring messages to specific consumer segments. For example, past research suggests that individuals who feel a moral obligation to act on behalf of the

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