Center for Sustainable Energy Systems CSE

Measuring the effect of the Plug&Play system in the intention of American homeowners to purchase rooftop PV in the next few years

An application of the Theory of Planned behavior

Submitted by:

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1. Executive Summary

Plug&Play™ PV system is a cutting-edge technology that relies on lighter, adhesive solar modules, and a streamlined wiring system to simplify the installation process. While adoption of this technology is highly cost effective, with a payback period between 2-3 years, studies have shown that individuals will not necessarily adopt energy-saving technologies even when it is in their best interest to do so (Costanzo, et al. 1986).
Fraunhofer Center for Sustainable Energy Systems (CSE) is currently leading the development of the Plug&Play PV system.

The study applied the Theory of Planned Behavior to predict intentions to purchase photovoltaic systems in households. American homeowner survey participants (N=399) were asked to complete a questionnaire that measured TPB concepts such as attitudes, perceived social norms, and perceived behavioral control. Half participant pool was primed with a brochure describing the "look and feel" of purchasing and installing conventional PV and the other half with a new, easy-to-use concept Plug&Play™ PV.

Results indicate no difference in calculated intention to purchase solar PV between participants primed with either concept, which reveals that despite of structural (and technical) differences, placing an adhesive module on the roof doesn't raise more objections than conventional PV. However careful examination of attitudes, social norms and perceived behavioral control indicates that participants that were exposed to the Plug&Play™ PV system concept perceived that they had more control over the decision making process.

The report outlines the foundation of the theory of planned behavior as it is applied to the intentions of purchasing PV systems. We review the methodology that was used to elicit the unconscious beliefs, in which the questionnaire was based, and we discuss the statistical procedures. The report will conclude with the results and final discussion

2. Introduction to the Theory of Planned Behavior

The original theory of planned behavior planned behavior (TPB) has been used to study the motivational factors towards target behaviors. We find applications of the TPB in studying pro-environmental behaviors (recycling; Tonglet *et al*., (2004), engagement in environmental activism Fielding *et al*., (2008), natural reforestation Karppinen, (2005)), predicting the adoption of electronic commerce (Pavlou *et al.,* 2006), public health (Albarracín *et al.*, 2001) and energy conservation (Peters, J. *et al.*, 1999).

The theory of planned behavior evolved as a model to understand and predict human behavior to account for behavior that is not under complete volitional control. One advantage of the TPB is its relative parsimony, offers a simple model of the proximal influence on intentions and behavior.

According to the theory of planned behavior, people act in accordance with their intentions and perceptions of control over the behavior, while intentions in turn are influenced by attitudes toward the behavior, subjective norms, and perceptions of behavioral control. "The relative importance of attitude, subjective norm, and perceived behavioral control in the prediction of intention is expected to vary across behaviors and situations." (Ajzen, 1991). In this model, intentions are the primary antecedent to behavior and indicate the amount of effort an individual is willing to exert to perform the target behavior.

Behavioral beliefs are a person's estimation of the probability that performing a certain action will lead to a particular outcome and produce a favorable or unfavorable (good or bad) attitude (Ajzen, 1991). For example: *For me, purchasing rooftop PV* (target behavior) *for my home would be beneficial* (positive outcome). These attitudes serve as behavioral guides to approach or avoid what is being evaluated (Overwalle & Siebler, 2005).

The attitude construct continues to be a major focus of theory and research in the social and behavioral sciences. According to the expectancy- value model, evaluative attitude arises spontaneously as we form beliefs about an object., people learn "expectations" that a given response will be followed by some event that is determined to be positive or negative and learn to perform behavior that they expect to be positively evaluated (Tolman, 1932). The evaluative attitude arises spontaneously as individuals form beliefs about target object/ behavior. Each belief associates the object with a certain attribute, and a person's overall attitude toward an object is determined by the subjective values of the object's attributes in interaction with the strength of the associations. Although, people can form many different beliefs about an object, it is assumed that only beliefs that are readily accessible in memory influence attitude at any given moment (Ajzen, 2001). To capture individual's attitude, the relevant beliefs have to be carefully selected as beliefs may vary among populations.

Normative beliefs are beliefs about the normative expectations of others (what others expect me to do or think) and if others would approve or disapprove of the target behavior. For example: *People who are like me would approve of my purchase of rooftop PV for my home in the next few years.* The strength of this belief is determined by the motivation to comply with these expectations. Normative beliefs also result in perceived social pressure to engage in behavior and establish a subjective norm.

"Drawing an analogy to the expectancy- value model of attitude toward behavior, it is assumed that the prevailing subjective norm is determined by the total set of readily

accessible normative beliefs concerning the expectations of important referents. Each normative belief is multiplied by the person's motivation to comply with the referent, and the resulting products are summed across all accessible referents." (Ajzen, 2005).

Control beliefs are beliefs about the presence of factors such as economic resources or physical effort that may enhance or impede behavior and the perceived power of these factors. Factors that affect performance may be external such as opportunities, resources, social support, and time, or internal such as skills, abilities, and emotional stability. The more people believe that they have capacity to perform an intended behavior, the more likely they are to persevere to succeed (Cialdini *et al.* 1998). For example: *If I wanted to, I could purchase solar PV for my home in the next few years*. Control beliefs also lead to a sense of self-efficacy to perform the desired behavior and also reflects the obstacles that one has encountered in past behavioral performances (Albarracín et al., 2001). Perceived self- efficacy is said to refer to "beliefs in one's capabilities to organize and execute the courses of action required to produce given levels of attainments" (Bandura, 1998).

Perceived behavioral control can influence behavioral performance indirectly by its effects on intentions to engage in the behavior and more directly by its effects on perseverance in the face of difficulties encountered during execution (Ajzen, 2005). The power of each control factor to facilitate or inhibit behavioral performance is expected to contribute to perceived behavioral control in direct proportion to the person's subjective probability that the control factor is present. Perceived power and subjective probability are multiplied , and the resulting products are summed across all accessible control factors (Ajzen, 2005).

By measuring these three predictors, one can predict the intention to perform a target behavior. Figure 1 outlines the relationship between the constructs that make the model of the theory of planned behavior.

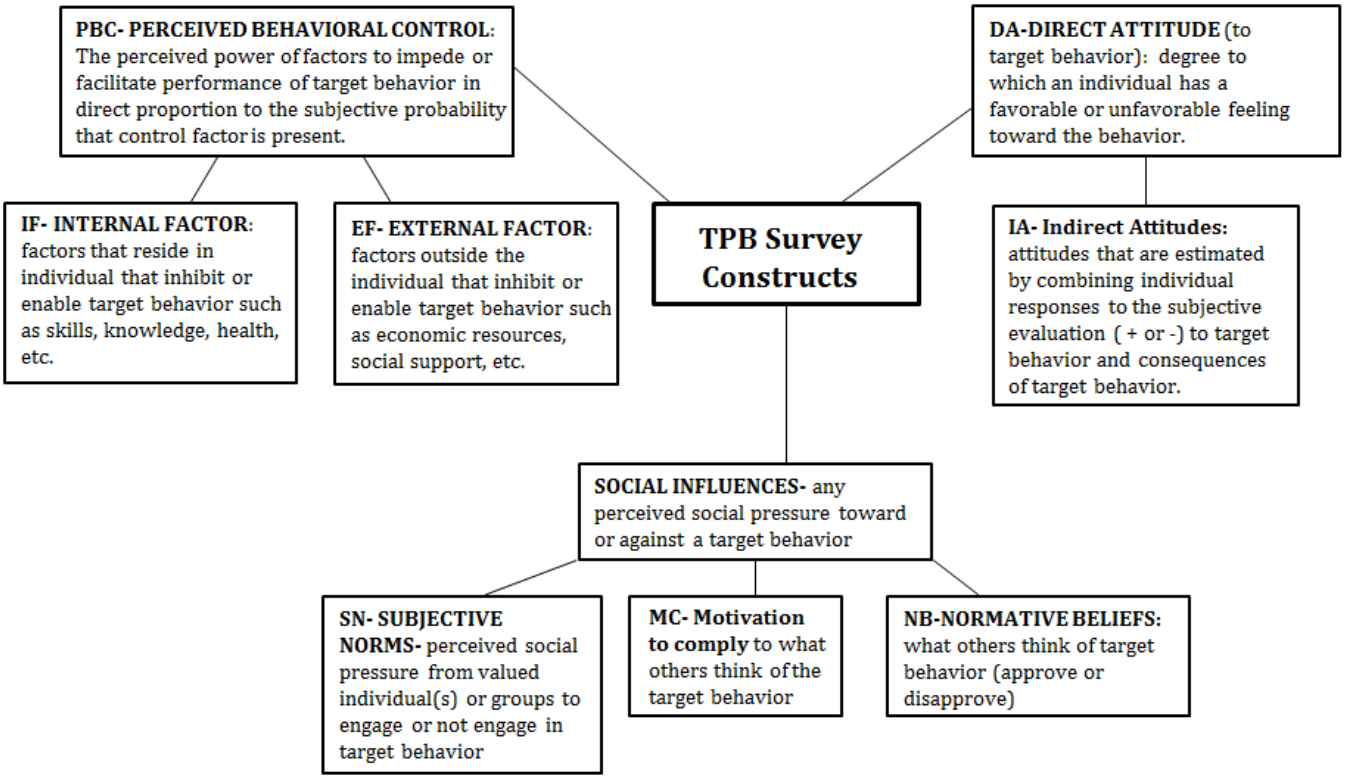


Figure 1: relationship between the constructs that make the TPB

As a general rule, the more favorable the attitude and subjective norm, and greater the perceived behavioral control, the stronger should be the person's intention to perform the behavior. Empirical support from numerous correlational studies, confirm the ability of this model to predict direct intentions of future behavior.

2.1. Computation of direct and indirect measures

Direct measures are computed by averaging the results of the questions that make a specific construct. An individual's indirect attitude measure is expected to derive from the beliefs regarding the possible outcomes of performing a behavior in conjunction with the evaluation of those outcomes. Indirect attitude is the summation of the strength of the behavioral belief multiplied by the subjective evaluation of the value of that belief (see Equation 1).

$$A_B \approx \sum_{i=1}^{p} b_i e_i \quad (1)$$

The indirect subjective norm measure is presumably influenced by one's beliefs regarding important referents (e.g., parents, friends) as well as one's motivation to comply with these referents. Indirect normative beliefs are the summation of the subjective norm beliefs multiplied by the motivation to comply with others' beliefs (see Equation 2).

$$SN_B \approx \sum_{j=1}^{q} nb_j m_j \quad (2)$$

Indirect perceived behavioral control measure accounts for the amount of control an individual may feel they have over performing or not performing a behavior. Pavlou & Fygenson (2006) suggest that this includes aspects of both self-efficacy and perceived power of the factors that may impede or enhance performance (controllability). Formally, this is represented by Equation 3.

$$PBC \approx \sum_{k=1}^{r} c_k p_k \quad (3)$$

Lastly, the intention to perform a behavior is a summation of direct intentions, attitude, subjective norm, and perceived behavioral control (see Equation 4).

$$I \approx A_B + SN_B + PBC \quad (4)$$

Where I[1] is intention, A_B is attitude toward the behavior, SN_B is the subjective norm toward the behavior, and PBC is the perceived behavioral control of performing the behavior.

3. Elicitation of beliefs

The core beliefs were obtained from the feedback provided by the interviews conducted with the Solarize Mass community leaders, and by the focus group participants, conducted in our research facility in Boston.

3.1. Focus Group

Behavioral intentions are determined by 3 motivational factors: attitudinal / behavioral, normative beliefs, and perceived behavioral control. The first step in constructing a TPB questionnaire is to elicit the individual beliefs regarding solar PV that drive or inhibit the intention to purchase solar PV. To do so, we ran a focus group (Francis *et al.*, 2004; Ajzen, 1991).

3.1.1. Recruitment and selection of participants

The desired participant owns a single family residence in the greater Boston area, is relatively unaware of solar energy, has not gotten a bid for solar PV, has an income greater than 50k per year and is between the ages of 35 and 65. A Survey Monkey questionnaire was created to screen participants. The following ad was posted to Boston Craigslist in All Jobs> et cetera jobs on April 2, 2014:

''We are looking for a people to join a focus group about solar power. The focus group location is in south Boston, MA, near South Station. You will spend no more than 90 minutes in a conference room sharing your thoughts and opinions with a facilitator and other group members on solar-related topics. All focus

[1] Indirect intentions because they are based upon the calculation of attitudes, perceived behavioral control and subjective norms, in opposite to direct intentions calculated by averaging the three questions that measure direct intention towards a behavior (I want…, I will…, I plan…).

group members will be compensated $75 for their time. Anyone is welcome to apply, just click on this link or copy and paste the following address into your browser: https://www.surveymonkey.com/s/N9998R6. You will be asked to fill out a short survey and we will contact you within seven days to tell you if you have been selected.''

The cost for the job posting was $25.00. Within 3 hours, 79 people had completed the survey. On April 3, 2014, the job posting was closed at 10 AM with 176 responses. We were able to access 100 of the completed responses; an upgrade was necessary to view all participants. The following list is a compilation of all respondents who met the aforementioned selection criteria. From this list 6 candidates were withdrawn to participate in the focus group. In order to quantify the participant qualifications for participating in the focus group, all responses were first itemized in terms of their frequency. Then, the percentage of individuals that should be selected from each category was calculated based on the percentage of total responses in each category.

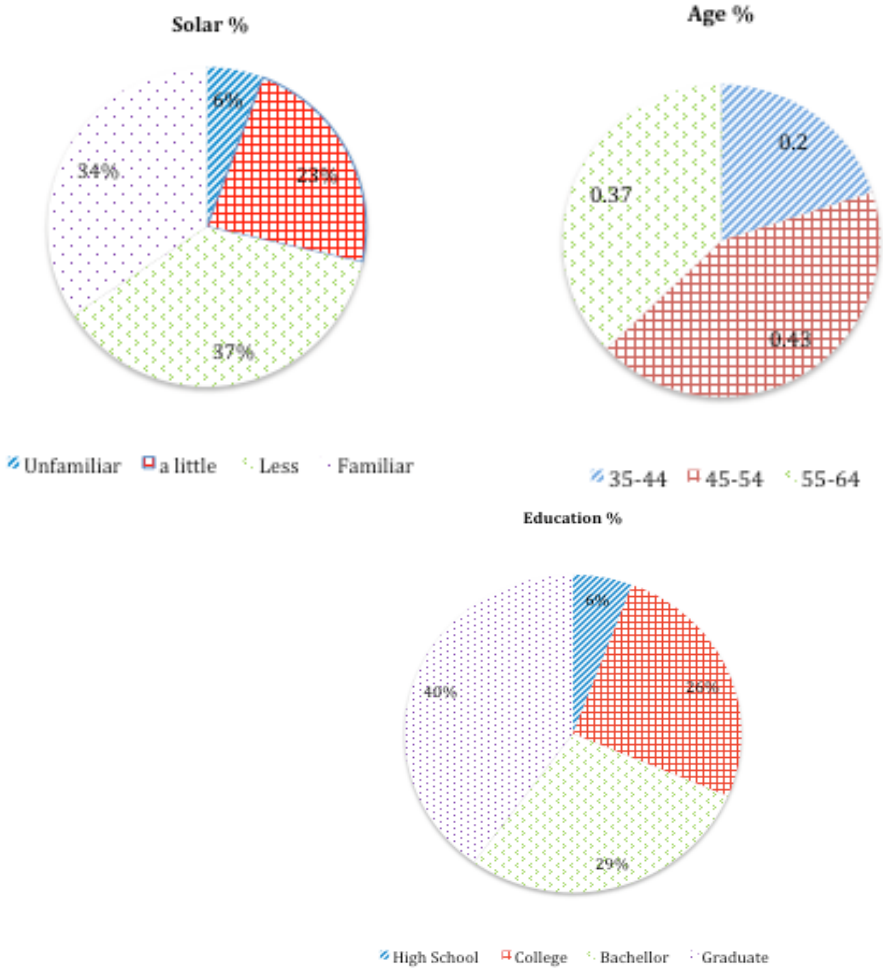


Figure 2: Demographics of respondents

3.1.2. Conducting the focus group

We divided the focus group in three sessions: an (1) introductory section that includes ice breaker and brainstorming activities, (2) a generic PV section which focuses on individual beliefs regarding current PV technology, and (3) a PnP PV section which focuses on how consumers perceive the new PV systems and any additional barriers that still exist regarding this improved technology. The beliefs and feelings elicited in section 2 were the basis for the questionnaire.

Section One serves several purposes: it gives the facilitator an opportunity to build rapport with the participants, and allows participants an opportunity to offer input without being burdened by any preconceived notions. It is extremely important not to bias the participants by giving them the impression we want them to only say positive things about sustainability or PV. To begin, asked participants to introduce themselves and share the top three words they associate with solar PV. This activity is intended to help participants understand that they do not need to have a positive attitude or extensive knowledge toward solar PV in order to contribute to the discussion.

Next, we pursued these perceptions of solar PV by sharing images about solar PV. In preparation, we have asked participants to collect at least three images that represent their current perceptions of solar PV and bring them to the focus group. We grouped these images according to topic – it may be that a lot of them are about environmental sustainability, or perhaps the appearance of solar PV. Whatever the case, these images allowed us to begin to understand what barriers individuals have toward PV and perhaps also what opportunities there are for PV.

Section Two allowed us to bring a unique approach to our focus group by asking questions based on the Theory of Planned Behavior (TPB; Ajzen, 2001). According to TPB, individual's actions are guided by three types of beliefs: beliefs about the effect of one's behavior (e.g., behavioral beliefs), beliefs about what others think, and the desire to comply with what others think (e.g. normative beliefs), and beliefs about one's efficacy to enact changes/make choices (e.g., control beliefs).

Those questions were asked in the form of open-ended questions, and they can be seen in appendix A. The formulation of those questions was also inspired the literature. For example, Faiers et al., (2006) found that consumers judged PV systems to be unattractive and unaffordable and there was not enough incentive (rebates, grants, etc.). Others found that consumers wanted assurance that the system wasn't too visually obvious, required little maintenance, will add value to the property, and that the installation process was simple and non-disruptive. In addition, we interviewed some Solarized mass community leaders, and have learned of other barriers individuals experience regarding PV, such as:

- Location/roof orientation issues such as living in heavily (tree) shaded areas or having a roof that is not adequately exposed to the sun.
- Complexity inherent to PV systems such as long and confusing proposals, complicated terminology and jargon.
- Investment cost a large barrier; homeowners are uncertain whether the life of their roof is adequate or if they will be in the house long enough to recoup their investment.

We used the focus group to uncover not just what the barriers are but also why they are barriers (e.g., what are the underlying beliefs and attitudes that lead to the barriers. By doing this, we can learn more about clients views of this technology and also probe them for

ways that they think the technology can or should be improved. The focus group affords us an opportunity to elicit salient beliefs from our target demographic. That is, the belief that comes first to mind when individuals are asked about their instrumental or affective beliefs toward a behavior (Sutton, et al., 2003).

Instrumental beliefs are more objective assessments of the advantages or disadvantages of a behavior while affective beliefs represent more subjective beliefs regarding a behavior (e.g., dislike or like). Salient beliefs regarding the costs or benefits of performing a behavior, the views others have regarding a behavior, and the reasons that an individual believes they can or cannot perform a behavior are thought to determine real attitudes, subjective norms, and behavioral control, respectively (Sutton, et al., 2003). As such, we seek to elicit these beliefs in order to establish the modal salient beliefs to be used as the foundation for a quantitative experiment of solar PV beliefs. The following eight questions are the key to eliciting salient beliefs from the focus group and are based on questions used by Ajzen and Fishbein (1986) and Ajzen and Driver (1991).

- What do you think would be the advantages of adopting rooftop solar PV?
- What do you think would be the disadvantages of adopting rooftop solar PV?
- What would you like or enjoy about having a rooftop solar PV system?
- What would you dislike or hate about having a rooftop solar PV system?
- Are there any groups or people who would approve of you having a rooftop solar PV system?
- Are there any groups or people who would disapprove of you having a rooftop solar PV system?
- What do you think would make it difficult for you to have a solar PV system?
- What do you think would make it easy for you to have a solar PV system?

Sutton et al., (2003) found that there were more beliefs elicited when the affective questions were listed first so we will first ask the affective question, followed by the instrumental question, from the focus group.

In **Section Three** of the focus group, we introduced the concept of Plug&Play PV product. Our objective with this part was to understand what first comes to mind when being exposed to Plug&Play. We were generally looking for hints towards answering the following questions.

- What first comes to mind when being exposed to Plug&Play?
- Does Plug&Play circumvent some of the barriers and beliefs elicited in **Section Two**?
- What are the most appealing aspects of Plug&Play?
- Overall, would Plug&Play PV increase the interest in purchasing a residential solar PV system?

To this end, we intended to again focus on eliciting focus group participants' salient beliefs regarding PnP rooftop solar PV. The wording of the elicitation questions was therefore adjusted to the following:

- What do you think would be the advantages of adopting a Plug&Play rooftop solar PV system?
- What do you think would be the disadvantages of adopting a Plug&Play rooftop solar PV system?
- What do you like about the Plug&Play rooftop solar PV system?
- What do you dislike about the Plug&Play rooftop solar PV system?

- Are there any groups or people who would approve of you having a Plug&Play rooftop solar PV system?
- Are there any groups or people who would disapprove of you having a Plug&Play rooftop solar PV system?
- What do you think would make it difficult for you to have a solar PV system?
- What do you think would make it easy for you to have a solar PV system?

For better overall understanding of the scope of the focus group refer to Appendix A, focus group script. The full list of responses organized topic is shown in appendix B.

4. Experimental design

The experiment was designed to respond to the following questions: are people more willing to purchase rooftop solar PV if they are primed with a brochure that depicts the simplicity of the Plug&Play system? In the context of the TPB theory, we measure the direct and indirect intentions toward the target behavior that is defined as purchasing solar rooftop PV in the few years.

In this experiment, we measured the differences in direct and indirect intentions between groups of participants that were randomly assigned to a brochure about Plug&Play or to a brochure about the installation of generic PV (see the brochures in appendix D).

We relied on the service "Panels" provided by Qualtrics to achieve a spatially distributed representative sample of 400 American homeowners. This sample was randomly assigned to one of two online brochures, each explaining what it is to install generic PV or Plug&Play PV (these brochures are depicted in appendix D). The survey questions were randomized.

After scrolling through the brochure, the participants were asked to respond to a survey. The instructions explained that there were no right or wrong answers and participants were supposed to say what they feel about each question. An outline of the TPB survey questions can be found in Appendix C.

5. Questionnaire development

We followed the guidelines provided by Ajzen (1991) and Francis *et al.* (2004) to build the questionnaire.

5.1. Target behavior

We start by specifying the target behavior. This needs to be explicit according object, situation and time. In this study we specified target behavior as the **"intention to purchase (target behavior) rooftop PV (object), for my home (situation) in the next few years (time)".**

5.1. Direct measurement of intention

The first set of questions assessed the direct intentions of the participant with a Likert- type scale ranging from 1 to 7. Participants responded to three items: "I (expect/intent/want) to purchase solar PV for my home in the next few years."

5.2. Measuring attitudes

5.2.1. Direct measurement of attitude

Participants responded to 5 items that assessed direct attitudes. Participants were asked: "For me, purchasing solar PV for my home in the next few years would be (+1 Enjoyable/+7 Unenjoyable, +1 Unpleasant/ +7 Pleasant, +1 Valuable/ +7 Worthless, +1 Harmful/ +7 Beneficial, +1 A good idea/+7 A bad idea)."

5.2.1. Indirect measurement of attitude: measuring behavioral beliefs and outcome evaluations

Indirect attitudes were assessed with 8 items. Participants were asked: "If I purchase solar PV for my home in the next few years, it will (+1 raise the value of my home/ +7 not raise the value of my home, +1 help me keep the environment clean/ +7 not help me keep the environment clean, +1 increase my self- sufficiency/ +7 not increase my self- sufficiency)" and "If I purchase solar PV for my home in the next years, it will (+1 be cheap/ +7 expensive, +1 be attractive/ +7 be unattractive, +1 waste less money on electric bills/ +7 waste more money on electric bills, +1 will be dependable for at least 15 years/ +7 will not be dependable for at least 15 years)" and "If I purchase solar PV for my home in the next few years, I believe the modules (+1 will require low maintenance/ +7 will require high maintenance)." The evaluation of the strength or the importance to self of the attitudinal beliefs that were described above was measured with 8 items (one question per attitudinal belief).

Participants were asked to rate how likely or unlikely each statement is to you. "I would pay a little more for a house that has solar PV already installed (+1 Very Likely/ +7 Very Unlikely) and I believe the environment needs to be protected (+ 1 Very Likely/ +7 Very Unlikely)." Participants were asked to rate how much you identify with the following statement: "Self- sufficiency is an essential aspect of well-being (+1 Just like me/ +7 Not at all like me)." Participants were also rate how likely or unlikely this statement is for you: "I worry about cost first when making home improvement decisions (+1 Very Likely/ +7 Very Unlikely). In general, I am concerned about long term reliability of my home infrastructure

(+1 Very Displeased/ +1 Very Pleased)." Participants were then asked to rate the importance of the following statements: "The appearance of my home exterior (+1 Extremely Important/ +7 Not at all important). Spending bills on electric bills is wasteful (+1 Very Likely/ +7 Very Unlikely)." Participants were finally asked to rate how much they believe in the following statement: "When I have to perform maintenance to the home exterior I am (+1 Very Displeased/ +7 Very Pleased)."

5.3. Measuring subjective norms

5.3.1. Direct measurement of subjective norm

Direct measurement of subjective norms was assessed with 2 items. Participants were asked to rate how much they agree or disagree with the following statement: "Most people who are important to me would approve if I purchase solar PV in the next few years (+1 Strongly Agree/ +7 Strongly Disagree)", and were asked to rate the following statement: "People who are like me would approve of my purchase of solar PV in the next years (+1 Very Likely/ +7 Very Unlikely).

5.3.2. Indirect measurement of subjective norm: measuring normative beliefs and motivation to comply

Normative beliefs were measured with 3 items. Participants were asked to rate how likely or unlikely they think the following statements are: Most of my friends who own homes will purchase solar PV in the next few years (+1 Very Likely/ +7 Very Unlikely). My neighbors would approve if I purchase solar PV in the next few years (+1 Very Likely/ +7 Very Unlikely).

The motivation to comply with the referents was assessed with 3 items. The first item asked: "When it comes to investing in your home, how important are the experiences of your homeowner friends? (+1 Extremely Important/ +7 Extremely Unimportant)." The following two items asked to rate how much the participant agrees or disagree with the following statements: "My neighbor's approval of my home is important to me (+1 Strongly Agree/ +7 Strongly Disagree). What my family thinks I should do matters to me (+1 Strongly Agree/ +7 Strongly Disagree)."

5.4. Measuring perceived behavioral control

5.4.1. Direct measurement of perceived behavioral control

Perceived behavioral control was assessed with 2 items. Participants were asked: "If I wanted to, I could purchase solar PV in the next few years (+1 Extremely confident/ +7 Not at all confident)" and "It is entirely up to me if I purchase solar PV in the next few years (+1 Completely agree/ +7 Completely disagree)."

5.4.1. Indirect measurement of perceived behavioral control: measuring control beliefs and their perceived power to influence behavior

Indirect measurement of perceived behavioral control was assessed with 5 items. Participants were asked: "I expect that the up front cost of purchasing solar PV will not be an issue (+1 Strongly Agree/ +7 Strongly Disagree), I will be able to find a reliable contractor if I install solar PV in the next few years (+1 Extremely Likely/ +7 Extremely Unlikely), I believe that solar technology is reliable (+1 Strongly Agree/ +7 Strongly Disagree), I expect that government incentives will help my purchase of solar PV in the next

few years (+1 Strongly Agree/ +7 Strongly Disagree), and I am confident that solar PV doesn't require much maintenance (+1 Extremely confident/ +7 Extremely Unconfident)."

The evaluation of the power of the referents to influence behavior was assessed with 5 items. Participants were asked: "In general, do upfront costs make you more or less likely to make investments in your home? (+1 Very Likely/ +7 Much less Likely), Being able to hire a reliable contractor makes it (+1 more likely that I will do home improvement projects/ +7 less likely that I will do home improvement projects), I am (+1 more likely to purchase electronic items if they are reliable/ +7 less like to purchase electronic items if they are reliable), Government incentives will make it (+1 easier to purchase solar PV/ +7 harder to purchase solar PV), and I am (+1 more likely to purchase equipment that will require little maintenance/ +7 less likely to purchase equipment that will require little maintenance)." See appendix C for the complete list of questions.

6. Characteristics of the sample

Target respondents were American homeowners. The survey was closed as soon as we gathered a sample of 399 evenly geographically distributed responses representative of all of the geographic locations (Northeast, South, Midwest, West) in the U.S.

According to the 2010 Census Bureau, the population was 308.7 million people. 74.2 million people were under the age of 25 , 112.8 million people were between the ages of 18 and 44, 81.5 million people were between the age of 45 and 64, and 40.3 million were over the age of 65. We had a sample size of 200 people in the Generic PV condition (25- 34 = 1%; 35- 44 = 18%; 45- 54 = 35%; 55- 64 = 42%; and 65+ = 3%) and 200 people in the Plug and play condition (25- 34= 1%; 34- 45= 19%; 45- 54 = 23%; 55- 64 = 56%; and 65+= 2%; figure 3).

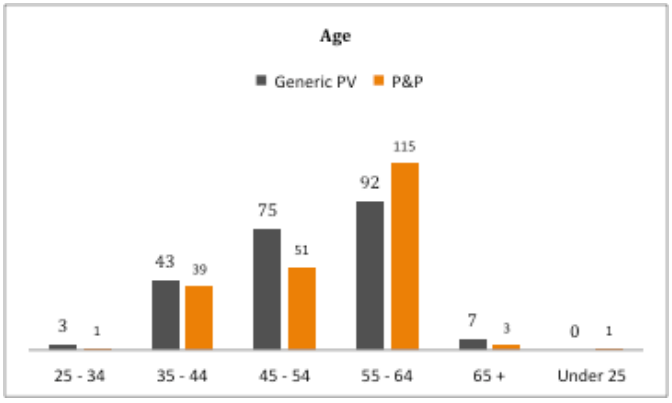


Figure 3: Distribution of age between groups of participants

According to the 2012 Census Bureau, the median household income was 51, 107. We had a sample of 400 individuals representative of the wider population. We had a sample of 200 individuals who reported their annual household incomes assigned to the Generic PV condition (Under 20K= 3%; 20K- 39K= 14%; 40K- 59K= 24%; 60K- 79K= 25%; 80K- 99K=

13%, <100K= 20%) and 200 individuals assigned to the Plug and play condition (Under 20K= 1%; 20K- 39K= 13%; 40K- 59K= 27%; 60K- 79K= 26%; 80K- 99K= 9%, <100K= 24%; Figure 4).

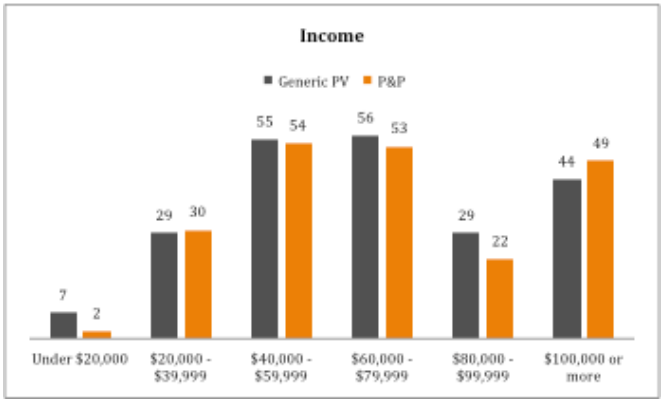


Figure 4: Distribution of income

According to the Census Bureau in 2009, 85% over the age of 25 had obtained at least a high school degree, 8% had an Associate's degree, and 28% had a Bachelor's degree. We had a total of 400 participants that reported their education background. We had a sample of 200 individuals who reported their educational background assigned to the Generic PV condition (0%= Less than high school degree; High school/GED= 18%, Some college/Associates degree= 28%; 4- year college degree= 39%; Master's degree= 13%; Doctorate or professional degree= 3%) and 200 individuals assigned to the Plug and play condition (1%= less than high school degree; 19%= High School/ GED; Some college/Associates degree= 37%; 4- year college degree= 27%; Master's degree= 14%; Doctorate or professional degree= 3%; Figure 5).

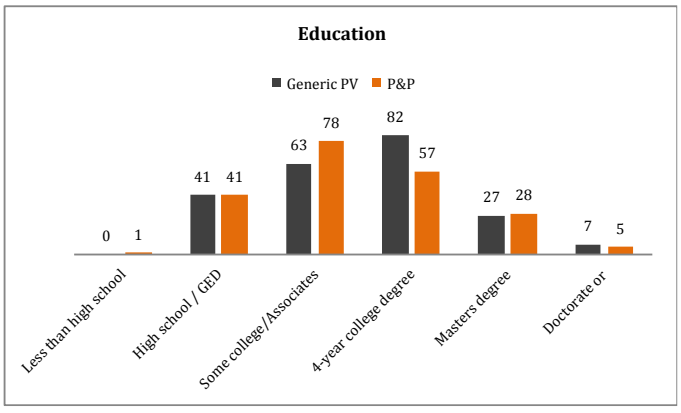


Figure 5: Education

7. Analysis

Reliability

We subdivided the response matrix in two groups: generic PV and Plug&Play PV. The first step of the analysis was to calculate the internal consistency between the questions that make each dimension of the theory of planned behavior, using the Cronbach alpha. Acording to Churchill *et al.* (2006) a Cronbach's alpha value of .7 is an acceptable measure of consistency. The statistics for direct measures was a high reliability value for direct intentions, attitudes and subjective norms, and a moderate value for perceived behavior control (table 1). For indirect measures, the statistics was consistently better, ranging from .808 to .906 across all measures (table 1).

Table 1: Measure of internal consistency between questions and respective dimension

	Generic	***Plug&Play***
	Cronbach's α	Cronbach's α
Direct measures		.687
Direct intentions – 3 items	.921	.909
Direct attitude – 5 items	.914	.944
Direct subjective norm- 2 items	.900	.882
Direct behavioral control- 4 items	.505	.528
Indirect measures		
Indirect attitude (belief X strength)- 14 items	.850	.906
Indirect subjective norm (norm X magnitude)-6 items	.866	.805
Indirect behavioral control (belief X strength)-10 items	.808	.860

Direct measures were calculated by averaging the results of the questions that pertain to each dimension. The Cronbach's Cronbach's α is high for direct intentions, direct attitudes and direct norms, and is moderate for perceived behavioral control. It appears that the participants feel that the decision to purchase rooftop PV less in their immediate control.

According to Ajzen (1991), direct measures of social norms, attitudes, and perceptions of control predict direct intentions. Cronbach's α was calculated between the averages of the direct measures (social norms, attitudes, and perceptions of control) and direct intentions to perform the behavior (4 items, Generic PV- Cronbach's α= .845; Plug&Play- Cronbach's α= .882).

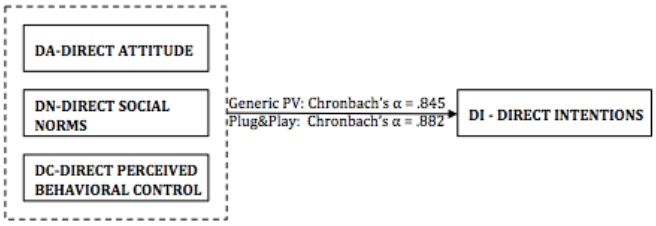


Figure 6: Evaluation of the consistency between direct measures

The next question will be to determine if the groups, primed by a technology-specific brochure, were responding the same way or if the difference in responses was statistically significant. We measured this effect looking at first at the measures of direct intentions towards the behavior. We performed the non-parametric Mann-Whitney U Test (SPSS) to assess difference between two independent groups, a procedure that is justifiable when there's a violation of (Ajzen, 2002).

The null hypothesis is that there is no difference between the groups. Inferential statistics show that there is a statistical difference between the groups, U(1)= 4.00, p=.047. Therefore, we can reject the null hypothesis. The test for independent samples demonstrated that the participants exposed to the Plug&Play brochure favored a **higher** direct intention to purchase solar PV (figure 7, where AVE_DI is Direct Intentions)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The medians of AVE_DI are the same across categories of Block_score.	Independent-Samples Median Test	.047	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 7: Statistically significant difference between groups for direct intentions

7.1. Indirect measures

To compute the scores for each indirect measure construct (indirect attitudes, indirect norms and perceived behavioral control), we followed the procedure described in section 2.1. In brief, we multiplied behavioral belief by the score for the relevant outcome evaluation to create a new variable that represents the composite score.

7.1.1. Indirect attitudes: model reliability

We looked first at principal components analysis to analyze the distribution of the dimensions that form an attitude towards our target behavior. To do so we performed principal components analysis, which helps group the variables in axis and reduce the number of variables that explain the majority of the variability in the dataset (KMO_{gen}=0.881 and $KMO_{P\&P}$=0.908).

We found that the drivers for PV installation are part of the same vector: direct attitudes, the belief that PV increases the value of a home in the market, the belief that PV is "clean" and an environmentally sound option, self sufficiency and that spending on electrical bills is wasteful, and therefore the perception that PV contributes to save money on electrical bills. While the barriers to PV installation appear clustered in the second dimension PV installation cost, reliability, and maintenance. There are no significant differences for attitudes towards purchasing PV between the technologies (figure 7).

However there is a slight tendency for ranking the drivers slightly higher for Plug & Play, with relevance to self sufficiency and environmental benefits, and for ranking the barriers slightly lower, in comparison with generic PV (in this respect, plug and play seems to be perceived as a slightly more attractive system than generic PV).

Figure 7: Behavior belief dimensions

7.1.2. Indirect measures: normative beliefs

Factor analysis applied to the questions pertaining normative beliefs, (KMO_{gen}=.881 and $KMO_{P\&P}$=.908) place all variables in a single factor. Major differences between technologies show very little difference in the indirect social norm dimension between technologies. The difference appear with direct norms with respondents exposed to Plug and Play perceiving very favorably that other like them or most people important to them would approve of their decision to purchase Plug and Play (figure 8) .

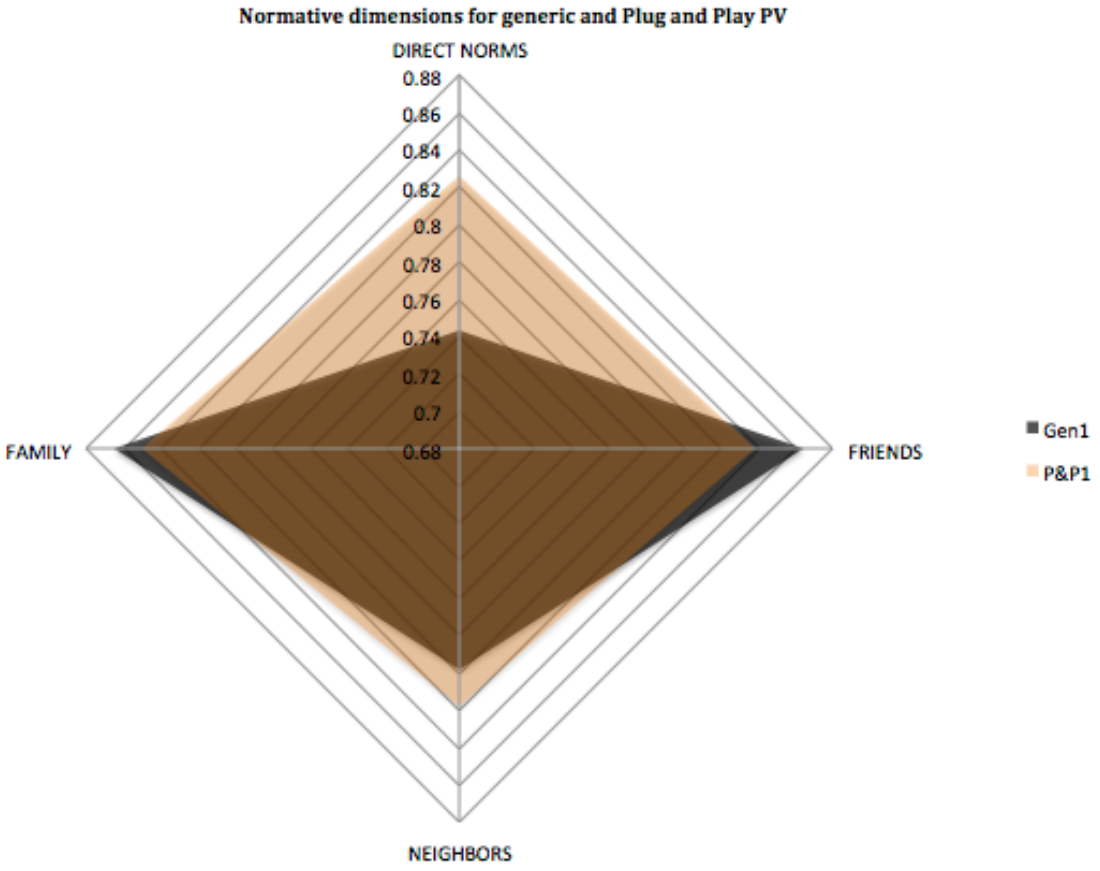


Figure 8: Normative belief dimension

7.1.3. Indirect measures: perceived behavioral control beliefs

Finally we applied factor analysis to the composite questions pertaining to perceived behavior control (KMO_{gen}=.805 and $KMO_{P\&P}$=.823). We didn't find a second salient dimension, but again we found Plug and Play to rank slightly higher than generic PV, for the majority of the variables.

Since the questions were posed in a positive way, (it is easy to find a new contractor, it is easy to maintain, I am sure government incentives will be in place) in general it appears that the participants that were exposed to Plug and Play brochure appear to be more optimist that the right circumstances will be in place if they opt for installing a Plug & Play solar PV system (figure 9).

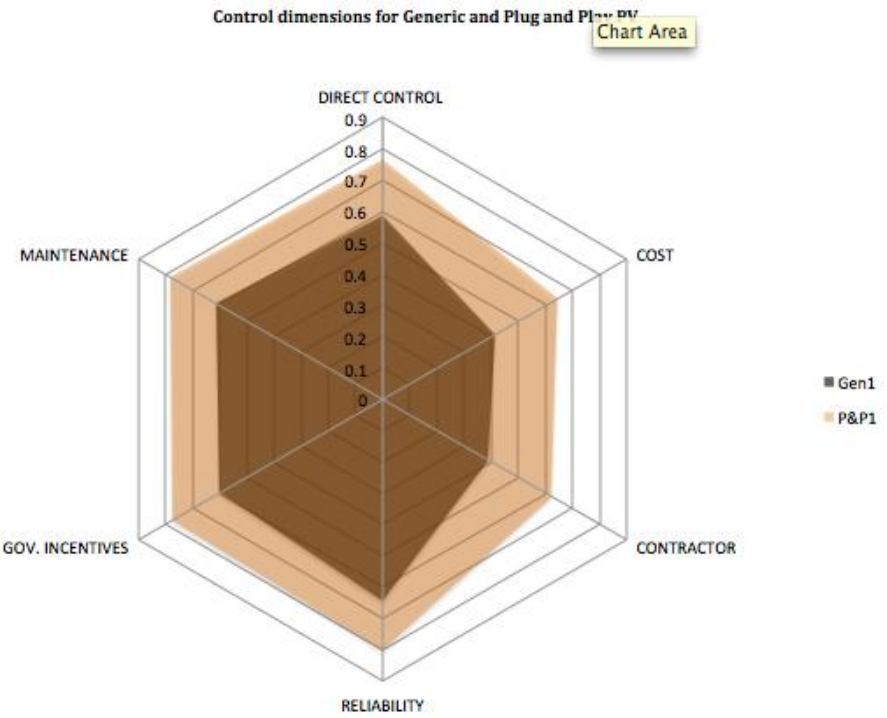


Figure 9: Perceived behavioral control dimension

7.2. Prediction of intentions

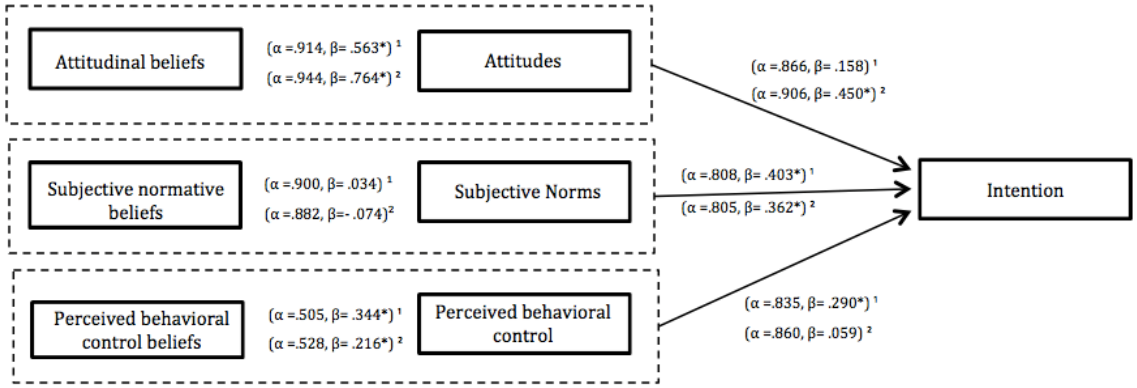
We used a multivariate regression model to establish the predictive power of indirect constructs and intentions toward the behavior[2]. The predictive power for both technologies are moderate $R^2_{aGeneric\ PV}$ =0.603 and $R^2_{aPlug\&Play}$ = 0.629. The difference between groups is not statistically significant (figure 10).

Table 2: PREDICTION OF DIRECT INTENTIONS TO PURCHASE PV SYSTEM

	Generic PV		***Plug&Play***	
	β	R^2a	β	R^2a
Indirect measures				
Indirect attitude (belief X strength)- 14 items		.603		.629
Indirect subjective norm (norm X magnitude)-6 items	.158		.450*	
Indirect behavioral control (belief X strength)-10 items	.403*		.362*	
	..290*		..059	

*Significant regression coefficient (p<.01);

[2] Both Kolmogorov and Durbin-Watson statistics are conducive to perform parametric analysis, , which means that the residuals are normally distributed and are not auto-correlated.



*Significant regression coefficient (p<.01)

[1]= Generic PV System

[2]= Plug&Play PV System

8. Discussion

In this study we have found that the direct intentions toward the behavior, i.e. to purchase solar PV in the next few years, was statistically significantly more favorable for those respondents that were primed with the Plug & Play brochure. Significance, however, was not sustained across the study.

It could be that the effect of the brochures was not sufficiently strong to deeply influence the responses. The two brochures were designed to look the same to make sure that the differences if they exist are attributable to intrinsic differences between the technologies, instead of the differences in communicating those differences. For the common resident, unfamiliar with PV technology, it could be that Plug & Play is perceived as the standard.

That being said, when we analyze the distribution of the beliefs regarding the technology we see a few differences. The analysis of the drivers and barriers shows that first, drivers are group in the same vector (environmental responsibility, improving the value of the home). Results indicate that those variables correlate more with direct attitudes for plug & Play, than for generic PV, which should be acknowledged as a general trend, that is sustained across the survey. For example, for barriers, such as upfront cost, maintenance and attractiveness (commonly perceived as a disadvantage for PV technologies), it appears that vector is stronger for Plug&Play, which means that those variables not perceived as barriers as much for Plug and Play, because the questions are formulated in a positive way. Although, the effect of perceived social norms is not different between the groups, the opposite happens with perceived behavioral control, where the weights of the vector

appear to have a stronger impact for Plug&Play. Again because of the way the survey questions were formulated a stronger response seems to indicate that Plug&Play respondents appear to feel more confident that the participant will decide to purchase solar PV in the next few years (ex.: government incentives, finding a reputable contractor, among others). The study indicates a slightly more favorable appeal of Plug&Play when compared with Generic PV.

9. Further steps

Since it is not possible to measure the behavior, the theory of planned behavior gives an indication of the intentions of individuals to perform a behavior. Intentions are not the sole predictors of actual behavior, and therefore this study was not designed as a predictor of how successful the technology will be in the market.

Alternative methodologies could provide a better gauge for user acceptance. An example those methodologies is a preference study where participants could compare the features of the two technologies at the same time and choose the one they would prefer the most.

The study provides a benchmark for user appeal and creates a baseline for PV acceptance, against which other studies could be benchmarked. By doing so, it will be possible to monitor the appeal of solar PV for American residents in the following years.

References

Ajzen, I. & Madden, T.J. (1986). Prediction of goal- directed behavior: attitudes, intentions, and perceived behavioral control. Journal of Experimental Social Psychology, 22, 453- 474.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

Ajzen, I. (2001). Nature and operation of Attitudes. Annual Review Psychological, 52, 27- 58.

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behavior. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Eds.), The handbook of attitudes (pp. 173-221). Mahwah, NJ: Erlbaum.

Albarracín, D., Johnson, B., Fishbein, M., Muellerleile, P. (2001). Theories of reasoned action and planned behavior as models of condom use: a meta analysis. CHIP Documents. Paper 8. http://digitalcommons.uconn.edu/chip_docs/8.

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. Psychology and Health, 13, 623- 649.

Cialdini, R.B. & Trost, M.R. (1998). Social influence: social norms, conformity, and compliance in D.T. Gilbert, S.T. Fiske, & G. Lindzey (Eds.), The Handbook of Social Psychology Vol 2.(pp. 151-192). New York City, NY: Oxford University Press

Costanzo, M., Archer, D., Aronson, E., & Pettigrew, T. (1986). Energy conservation behavior: The difficult path from information to action. *American Psychologist*, *41*, 521-528.

Faiers, A., & Neame, C. (2006). Consumer attitudes towards domestic solar power systems. *Energy Policy, 34*, 1797-1806.

Fielding, K.S., McDonald, R., & Louis, W.R.(2008). Theory of planned behavior, identity and intentions to engage in environmental activism. Journal of Environmental Psychology, 28, 318- 326.

Francis, J., Eccles, M., Johnston, M., Walker, A., Grimshaw, J., Foy, R., Kaner, E., Smith, L. and Bonetti, D. (2004). Constructing questionnaires based on the theory of planned behavior. A manual for health service researchers. Center for Health Services Research. University of Newcastle, UK. 42p.

Karpinnen, H. (2005). Forest owners' choice of reforestation method: an application of the theory of planned behavior. For. Policy. Econ, 7(3), 393- 409.

Overwalle, F.V. & Siebler, F. (2005). A connectionist model of attitude formation and change. Personality and Social Psychology Review. 9(3) 231- 274.

Pavlou, P. and Fygenson, M. (2006). Understanding and predicting electronic commerce adoption: an extension of the theory of planned behavior. MIS Quarterly, 30(1) 115-143.

Sutton, S., French, D. P., Hennings, S. J., Mitchell, J., Wareham, N. J., Griffin, S., Hardeman, W., Kinmonth, A. L. (2003). Eliciting salient beliefs in research on the theory of planned behaviour: The effect of question wording.Current Psychology: Developmental, Learning, Personality, Social, 22, 234-251.

Tolman, E.C. (1932). Purposive behavior in animals and men. New York: Appelton-Century- Crofts.

Tonglet, M., Phillips, P.S., Bates, M.P. (2004). Determining the drivers for householder pro-environmental behavior: waste minimization compared to recycling. Resoures. Conserv. Recylc. 42, 27- 48.

APPENDIX A: Focus Group Script

Anonymous data of focus group participant's

Participant code	Name
C	Alicia, J.
D	William, K.
J	Marshall, G.
K	Karen, B.
N	Kenneth, M.
O	Karen, C.

Welcome, filling out forms, signing and collecting consent forms (10 minutes)

(Begin at 4:30)

Welcome to Fraunhofer CSE. Fraunhofer is a leading applied contract research and development laboratory supporting our society with the transition to a sustainable energy future. Fraunhofer CSE focuses on two main areas: renewable energy and building energy efficiency. The purpose of this focus group is to collect your thoughts about solar photovoltaic modules, which we will refer to as solar PV or PV modules throughout this session.

I am Joana – I will be your facilitator today- and this is Natasha – who will assist me and take notes. Before we begin, we would like to explain the payment procedure. A check for 75 dollars will be mailed to you from Fraunhofer's USA headquarters in Michigan. In order to do this, we need you to fill in the W9 form which is in the envelope in front of you. If your mailing address is different from your taxpayer address – for example, if you have a PO Box – we have a separate sheet that you can fill out in the envelope. Once you fill out the form, you can place it inside the envelope.

Also inside the envelope are two informed consent forms. One of these is for you to keep, and the other is to sign and place inside the envelope with the W-9. If you have any questions about these forms I would be happy to answer them now. If you think of questions later, my contact information is on the informed consent form that you will keep.

(Collect forms)

Ground rules

We will be here together for approximately 90 minutes, including our break, so let's establish a couple basic rules. First, there is no right or wrong answers and each of you will likely have differing points of view. Although you don't need to agree with others, please listen and respond respectfully during the discussion.

Lastly, please silence or turn off your cell phone.

The restrooms are located out the door to the left. We will take a ten-minute break at 5:15, but if you need to excuse yourself, please do so quietly.

Before we begin, does anyone have any other questions that I haven't answered?

Section One

Introductions (30 minutes)

Let's begin by learning more about each other. Please introduce yourself, tell us how long you have been a homeowner, and then share your pictures and explain why those pictures are associated with your perception of solar energy.

(Place pictures next to comments, write comments next to pictures)

(Cover the glass board with the other screen)

Section Two

Okay, next we are going to have you do a little writing.

(Hand out Worksheet 1) 8 mins

In response to the questions on this worksheet, please list the thoughts that come immediately to mind. Write each thought on a separate line. There is no right or wrong responses as we are only interested in your personal opinions.

When it comes to your personal decision about acquiring solar PV modules for your roof in the next few years:

What would you **like or enjoy** about having solar PV modules?

What would you **dislike or hate** about having solar PV modules?

What do you think are the **advantages** of having solar PV modules?

What do you think are the **disadvantages** of having solar PV modules?

(Collect Worksheet 1)

(Distribute Worksheet 2) 8 mins

In response to the questions on this worksheet, please list the thoughts that come immediately to mind. Write each thought on a separate line. There are no right or wrong responses as we are merely interested in your personal opinions.

When it comes to your decision to acquire solar PV modules for your roof in the next few years, there might be individuals or groups that think you should or should not purchase PV.

Name or give examples of **people**, and their relationship to you, who would **support** your decision to acquire solar PV modules for your roof:

Person *Relationship*

Name or give examples of **people**, and their relationship to you, who would **disapprove** of your decision to acquire solar PV modules for your roof:

Person *Relationship*

Name or give examples of **groups of people** and their relationship to you who would **support** your decision to acquire solar PV modules for your roof:

Groups Relationship

Name or give examples of the **groups of people**, and their relationship to you, who would **disapprove** of your decision to acquire solar PV modules for your roof:

Groups Relationship

(Collect Worksheet 2)

(Distribute Worksheet 3) 5 mins

In response to the questions on this worksheet, please list the thoughts that come immediately to mind. Write each thought on a separate line. There is no right or wrong responses as we are merely interested in your personal opinions.

When it comes to your decision to acquire solar PV modules in the next few years, there might be certain circumstances or events that would make it easier or more difficult for you to do so.

What circumstances or events **would make it easy for you to acquire** solar PV modules?

What circumstances or events **would make it difficult for you to acquire** solar PV modules?

(Collect Worksheet 3)

(Break for 10 minutes)

Section Three

We would like to show you two different types of solar PV modules. This is an image of a traditional PV installation. The solar PV module are installed by attaching a racking system to the roof using bolts which are inserted through the roof (show image 1). The solar modules weigh between 20 and 50 pounds each and are placed within the racking system. (show image 2) In general, these systems are installed by professionals and the permitting and installation process can take up to two months. The components of the solar PV system include the solar modules, DC connections, a DC to AC inverter, an AC connection, AC isolation switch, a credit meter, consumer unit, AC power control unit and dedicated electricity meter. Some of these components are wired inside the home and some of them are wired outside the home (show image 3).

(Collect generic PV flyer)

(Distribute Plug&Play flyer)

Now, we would like to show you a different type of solar PV technology, which is called Plug&Play. This technology uses solar modules that are less than 15 pounds and are about a quarter inch thick which attach directly to the roof using an adhesive. They can be installed in ten hours or less by a homeowner or an installer and they plug into an adaptor, which is installed on the existing electric meter of a home. This technology does not require roof penetrations and the permitting process can be automated. In the next section, we will be going through a similar set of questions as before, but this time the focus is on the Plug&Play solar PV modules.

(Place both images in front of participants)

In response to the questions below, please list what comes immediately to mind. Write each thought on a separate line. There is no right or wrong responses as we are merely interested in your personal opinions.

(Distribute Worksheet 4) 8 mins

When it comes to your personal decision about acquiring Plug&Play solar PV modules for your roof in the next few years:

What would you **like or enjoy** about having Plug&Play solar PV modules?

What would you **dislike or hate** about having Plug&Play solar PV modules?

What do you think are the **advantages** of having Plug&Play solar PV modules?

What do you think are the **disadvantages** of having Plug&Play solar PV modules?

(Collect Worksheet 4)

(Distribute Worksheet 5) 8 mins

(Read aloud): In response to the questions below, please list the thoughts that come immediately to mind. Write each thought on a separate line. There are no right or wrong responses as we are merely interested in your personal opinions.

When it comes to your decision to acquire Plug&Play solar PV modules in the next few years, there might be individuals or groups that think you should or should not purchase PV.

Name or give examples of **people**, and their relationship to you, who would **support** your decision to acquire Plug&Play solar PV modules for your roof:

Person Relationship

Name or give examples of **people**, and their relationship to you, who would **disapprove** of your decision to acquire Plug&Play solar PV modules for your roof:

Person Relationship

Name or give examples of **groups of people** and their relationship to you who would **support** your decision to acquire Plug&Play solar PV modules for your roof:

Groups Relationship

Name or give examples of **groups of people** and their relationship to you who would **disapprove** of your decision to acquire Plug&Play solar PV modules for your roof:

Groups Relationship

(Collect Worksheet 5)

(Distribute Worksheet 6) (5 min)

In response to the questions below, please list the thoughts that come immediately to mind. Write each thought on a separate line. There are no right or wrong responses as we are merely interested in your personal opinions.

When it comes to your decision to acquire Plug&Play solar PV modules in the next few years, there might be certain circumstances or events that would make it easier or more difficult for you to do so.

What circumstances or events **would make it easy for you to acquire** Plug&Play solar PV modules?

What circumstances or events **would make it difficult for you to acquire** Plug&Play solar PV modules?

(Collect Worksheet 6)

Closing Questions and Debriefing (5 minutes)

APPENDIX B: Summary of the beliefs elicited by the Focus Group

Table: Attitudes towards purchasing a PV system

Like/Enjoy	*Dislike/Hate*	*Advantages*	*Disadvantages*
I would like to save money	I would dislike the cost but w/ tax rebates it all works out in the end.	Clean	Work it would take to install
Energy cost savings	Neighbors complaining about panels	Cleaner energy	Up front costs
Reduce carbon footprint	Initial cost of installation	Reduce carbon footprint	Initial cost
Ease of installation	The look	Lower energy bills	Maintenance?
Long term cost saving	Initial investment although I understand that anything worth doing has a price.	To generate cheaper heat & hot water & electricity.	Unless it is a DIY thing, the only disadvantage to me is the cost initially.
I would like the idea of using clean energy for my home.	I would probably dislike the upfront cost of installing and purchasing the solar PV modules.	I think the advantages would be saving money	The disadvantages would be the up front costs of installing the solar PV modules.
Keep environment clean	Downtime during stormy weather	Go green	Can't rely on them for electronics
Environmentally responsible	Finding reputable installation contractor	Cost savings	Still considereably more expensive per kw
Start reducing electricity $	The cost	Save $ over the long term	Replacement?
Ease of maintenance	I do not think that I would hate anything.	No power outages	Don't want to be "off the grid"
Clean environment	Upfront costs	The way it looks on house	Long term maintenance
I would enjoy the savings in my utilities bills that using solar energy would save for me.		Helping the environment	Finding a reputable contractor
Good for the planet		Controlling usage	The technology will improve a lot in next few years: will I be able to upgrade at reasonable cost?
Increases re-sale value of my home		Helping the environment	
The ability to add more panels			
Not paying so much to the oil, gas, & utility companies.			
It's a "cool" thing to do			

Table : Subjective norms – referents

People - Support	*People - Disapprove*	*Groups - Support*	*Groups - Disapprove*
Husband	Neighbors	Cousins	Cousins
Next door neighbor	Friend	Friends	Neighbors who don't like the way they look
Various friends	No one	Younger generation/ child & friends	Members of historic districts
Daughter	Spouse	Sustainable "green" energy groups	Oil, gas & Utility Execs.
Sustainable "green" energy groups	Members of historic districts	Anyone that could tie in & save $ from your panels	
Family	My utility companies	Family	
Neighbors	Friend	Neighbors	
Sisters	Neighbor	Local, state, federal gov'ts	
Parents	Oil, gas & Utility Execs.		
Anyone that could tie in & save $ from your panels			

Table: Perceived behavioral control - belief and strength of the belief

Easy to acquire	*Difficult to acquire*
Hiring & Buying	The difficult would be to find & install & get a permit w/ city of Boston
Time - if I live long enough in house for return on investment	If I knew I were moving within 3 years
Gov't subsidies	Ending of subsidies
Grant or low interest loan	Price
Residential grants/	High cost
If they came free	The price and cost of the solar PV modules
Overall affordability	Time to install
Low interest financing	Local government not on board
Further reduction of panel cost	Retrofitting equipment
Contractor availability	Find Contractor
Tax credits	Contractor certification

APPENDIX C: TPB Questionnaire

Theoretical constructs and beliefs		Survey questions	Scale
Direct Intpoentions		I expect to purchase solar PV for my home in the next few years.	Strongly agree : Strongly disagree
		I intend to purchase solar PV for my home in the next few years.	Extremely likely : Extremely unlikely
		I want to purchase solar PV for my home in the next few years.	Strongly agree : Strongly disagree
Direct Attitudes	Attitudes	For me, purchasing solar PV for my home in the next few years would be	Enjoyable : unenjoyable
		For me, purchasing solar PV for my home in the next few years would be	Unpleasant : pleasant
		For me, purchasing solar PV for my home in the next few years would be	Valuable : worthless
		For me, purchasing solar PV for my home in the next few years would be	Harmful : beneficial
		For me, purchasing solar PV for my home in the next few years would be	a good idea : a bad idea
Indirect Attitudes - beliefs		If I purchase solar PV for my home in the next few years, it will	raise the value of my home : not raise the value of my home
		If I purchase solar PV for my home in the next few years, it	it will help me keep the environment clean : not help me keep the environment clean
		If I purchase solar PV for my home in the next few years, it will	increase my self-sufficiency : not increase my self-sufficiency
		If I purchase solar PV for my home in the next few years, it will	be cheap : be expensive
		If I purchase solar PV for my home in the next few years, it will	be attractive : be unattractive
		If I purchase solar PV for my home in the next few years, I will	waste less money on electric bills: waste more money on electric bills
		If I purchase solar PV for my home in the next few years, I believe the modules	will be dependable for at least 15 years : will not be dependable for at least 15 years
		If I purchase solar PV for my home in the next few years, I believe the modules	will require low maintenance : will require high maintenance
Indirect Attitudes - strength of the belief		Rate how likely or unlikely this statement is you	I would pay a little more for a house that has solar PV already installed.
		Please rate how likely or unlikely this statement is you.	I believe the environment needs to be protected
		Please rate how much you identify with the following statement:	Self-sufficiency is an essential aspect of well-being
		Rate how likely or unlikely this statement is for you.	I worry about cost first when making home improvement decisions
		Please rate the importance of the following to you.	The appearance of my home exterior
		Please rate the importance of the following to you.	Spending on electric bills is wasteful
		Rate how likely or unlikely this statement is to you.	In general, I am concerned about long term reliability of my home infrastructure
		Rate how much you believe in the following statement.	When I have to perform maintenance to the home exterior I am

Theoretical constructs and beliefs	Survey questions	Scale
Direct norms	Rate how much you agree or disagree with the following statement	Most people who are important to me would approve if I purchase solar PV in the next few years.
	Rate how likely or unlikely you think the following statement is.	People who are like me would approve of my purchase of solar PV in the next few years.
Indirect Norms - normative beliefs	Rate how likely or unlikely the following statement is for you.	Most of my friends who own homes will purchase solar PV in the next few years.
	Rate how likely or unlikely the following statement is for you.	My neighbors would approve if I purchase solar PV in the next few years.
	Rate how likely or unlikely the following statement is for you.	My family thinks that I should purchase solar PV in the next few years.
Indirect Norms - strength of normative belief	When it comes to investing in your home, how important are the experiences of your homeowner friends	
	Rate how much you agree or disagree with the following statement.	My neighbors' approval of my home is important to me.
	Rate how much you agree or disagree with the following statement.	What my family thinks I should do matters to me.
Direct Perceived Behavioral Control	If I wanted to, I could purchase solar PV in the next few years.	Extremely confident : Not at all confident
	It is entirely up to me if I purchase solar PV in the next few years.	Completely agree : Completely disagree
Indirect Perceived Behavioral Control - Belief	I expect that the up front cost of purchasing solar PV will not be an issue	
	I will be able to find a reliable contractor if I install solar PV in the next few years.	
	I believe that solar technology is reliable.	
	I expect that government incentives will help my purchase of solar PV in the next few years.	
	I am confident that solar PV doesn't require much maintenance.	
Indirect Perceived Strength of belief - Behavioral Control	In general, do upfront costs make you more or less likely to make investments in your home?	
	Being able to hire a reliable contractor makes it	more likely that I will do home improvement projects : less likely that I will do home improvement projects.
	I am	more likely to purchase electronic items if they are reliable : less likely to purchase electronic items if they are reliable
	Government incentives will make it	easier to purchase solar PV : harder to purchase solar PV
	I am	more likely to purchase equipment that will require little maintenance : less likely to purchase equipment that will require little maintenance

APPENDIX D: Generic PV Brochure


INSTALLING A RESIDENTIAL SOLAR SYSTEM
Once racks are securely installed, solar modules are fastened to the racks.


HOW DOES A RESIDENTIAL SOLAR SYSTEM WORK?

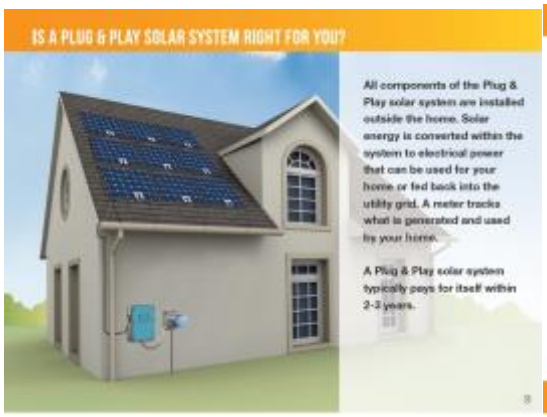

IS A RESIDENTIAL SOLAR SYSTEM RIGHT FOR YOU?


GET STARTED
Solar modules are a smart investment. Explore how much you could save with an online solar estimator and visit your local hardware store to get started.

APPENDIX E: Plug&Play PV Brochure


HOW DOES THE PLUG & PLAY SOLAR SYSTEM WORK?
The Plug & Play solar system plugs directly into a PV-ready socket. Once connected the system performs a self test to ensure safety and reliability. The utility interconnection process is automated.


HOW DOES THE PLUG & PLAY SOLAR SYSTEM WORK?
The system provides information to the jurisdiction and utility, automating permitting and inspection


IS A PLUG & PLAY SOLAR SYSTEM RIGHT FOR YOU?
All components of the Plug & Play solar system are installed outside the home. Solar energy is converted within the system to electrical power that can be used for your home or fed back into the utility grid. A meter tracks what is generated and used by your home.
A Plug & Play solar system typically pays for itself within 2-3 years.


GET STARTED
A Plug & Play solar system is a smart investment. Explore how much you could save with an online solar estimator and visit your local hardware store to get started.

APPENDIX F: Principal Component's Analysis -

	Generic PV*		Plug&Play*	
KMO	.881		.908	
Variables	Component		Component	
	1	2	1	2
Direct Attitudes (enjoy, good, pleasant, valuable, beneficial)	.817	.224	.860	.337
PV will raise value of the home x I would pay more for a house with PV installed	.732	.365	.701	.515
PV helps keep environment clean x the environment needs to be protected	.766	.106	.886	.105
Increase self-sufficiency x Being self sufficient is an essential aspect of well being	.790	.224	.870	.220
PV will be inexpensive x I worry about cost first when making home improvements	-.009	.893	.014	.795
Be attractive for my home x The appearance of my home exterior is important	.583	.604	.518	.700
I will waste less money on electrical bills x spending on electric bills is wasteful	.741	.084	.740	.295
I believe the modules will be reliable x I am concerned about long term reliability of my home infrastructure	.589	.374	.488	.547
Will require little maintenance x when I have to perform maintenance to my home exterior I am pleased : displeased	.439	.659	.329	.699

KMO	0.748	0.805
Components	Gen1	P&P1
DIRECT NORMS	0.743	0.826
FRIENDS	0.864	0.838
NEIGHBORS	**0.798**	0.818
FAMILY	**0.865**	0.851

KMO	0.805	0.823
Components	Gen1	P&P1
DIRECT CONTROL	0.59	0.768
COST	0.416	0.645

CONTRACTOR	0.389	0.623
RELIABILITY	**0.646**	0.804
GOV. INCENTIVES	**0.598**	0.773
MAINTENANCE	**0.614**	0.784