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Will Prospective Home Buyers Pay More for Architecturally Designed Solar? Evidence from a Survey-Based Discrete Choice Experiment

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Will Prospective Home Buyers Pay More for Architecturally Designed Solar? Evidence from a Survey-Based Discrete Choice Experiment

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INTRODUCTION

Is residential solar an aesthetic amenity or dis-amenity? This white paper reports the results of a preliminary investigation into the price premiums for traditional rooftop and architecturally-designed solar implied by the survey responses of a large market research panel. The aesthetics of residential solar panels are often a sticking point in state and local jurisdictional debates over solar policy. Yet a robust academic literature has emerged in recent years showing that the likelihood of an individual home installing solar increases when nearby homes have also installed, suggesting that not all market participants are turned off by solar appearance (e.g., Dastrup et al., 2012, Bollinger and Gillingham, 2012, Gillingham and Graziano, 2015).

With aesthetic concerns in mind, the University of Wyoming Building Energy Research Group (UW BERG) created a catalogue of Zero Net Energy homes with "architecturally designed" solar, meaning homes with solar panels integrated into the architectural character and regional context of the designs. In order to more rigorously evaluate the demand for such improved designs, and for solar homes in general, we administered a survey-based discrete choice experiment to a large market research panel of homeowners and potential homebuyers in Mountain West states. The survey asks respondents to compare images from the UW BERG catalogue, modified to have different solar designs, and offered at different hypothetical price points and energy efficiency levels. From these comparisons we estimate an average price premium for various design features including solar appearance and energy efficiency levels.

We find that the price premium for architecturally-designed solar exceeds that of traditional rooftop solar for the average respondent by several thousand dollars. However, this additional "design premium" does not change much across market segments. Budget-focused buyers are willing to pay less than average for solar panels of any type, while luxury- and environment-focused buyers are willing to pay more.

SURVEY METHODOLOGY

The aesthetic preference results we will describe were part of a larger effort to test the hypothesis that social image affects neighborhood sorting in the green home market. For this effort we created a "discrete choice experiment," which is a standard tool used in marketing and economics to assess demand. In our survey, respondents were asked a set of general questions on demographics, public policy opinions, knowledge about energy efficiency, and home purchase priorities. They were then put through a sequence of hypothetical choices between different versions of the homes in the BERG catalog of Zero Net Energy homes in an exercise designed to "reveal" the strength of their preferences for various home attributes. These attributes included solar appearance, up-front costs, long-run energy bill savings, and energy efficiency rating. We were able to manipulate the solar appearance through altered versions of the photorealistic images from the BERG catalogue. During the hypothetical choice task, respondents were first asked to choose from four homes with differing floor-plans, exteriors, and base prices. Respondents were then asked to compare a standard version of their favorite model against two or three versions of the same model with energy efficiency and solar upgrades, and to choose which of these versions they would most want to purchase. Figure 1 shows one example of a choice task that a typical respondent would face. Each respondent completed this task six times, with a different set of choice options in each round. The internet-based survey tool was designed to mimic, to the extent possible, the shopping experience one would have visiting a major home builder's web site or a third-party site like Zillow.com or Realtor.com. The Home Energy Rating System was used to specify the energy efficiency level. Before the choice tasks, respondents were given a short informational primer on the HERS rating, time-discounting of energy bill savings, and environmental impacts of electricity production.

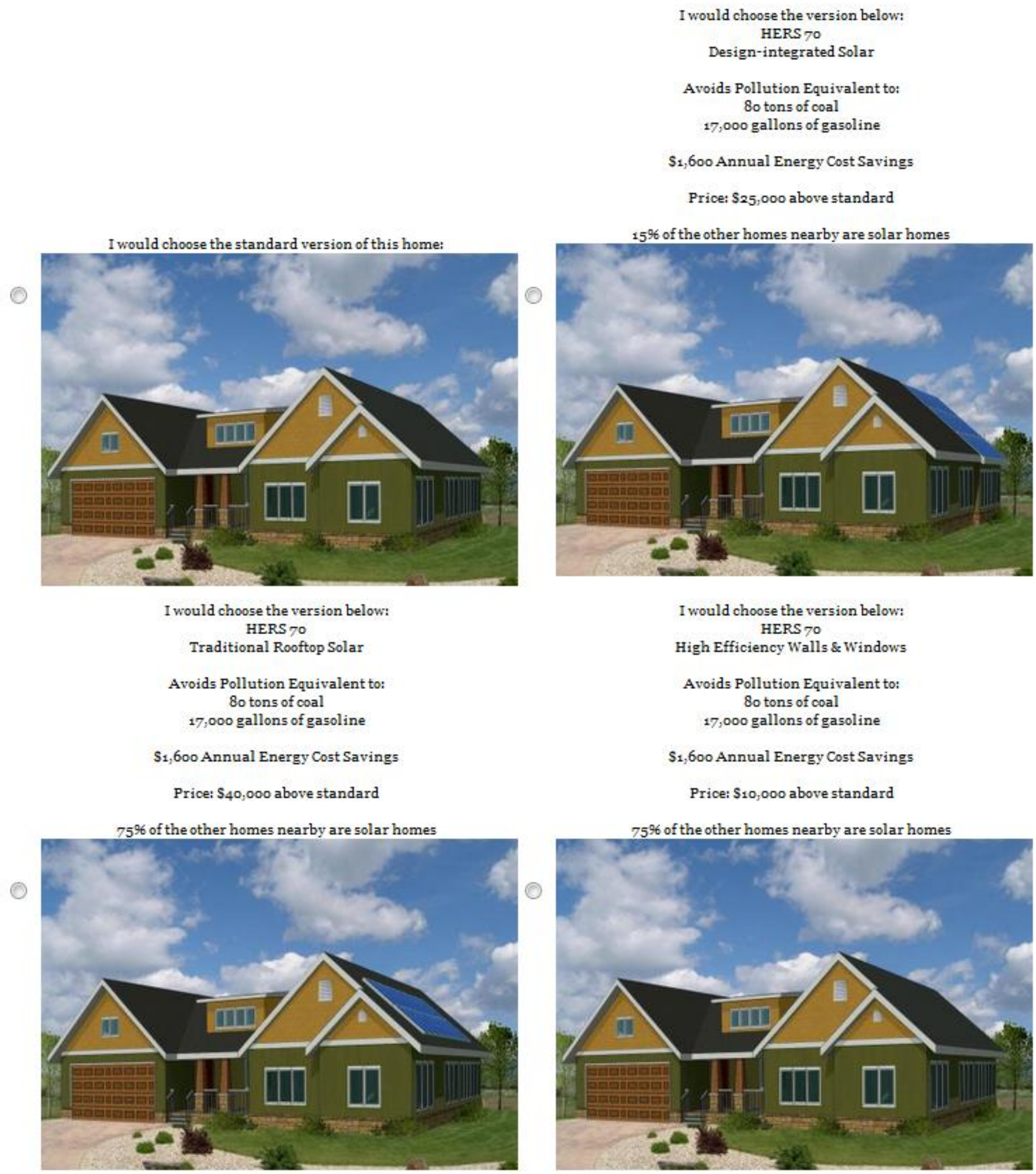

Figure 1: An example choice task from the online survey

We administered the survey online through a survey research panel service provided by a large market research firm to 1,077 homeowners and potential home buyers in Mountain West states. Respondents were divided in to two groups with slightly different survey designs. In Group 1, the effective "price" displayed for each solar or energy efficiency upgrade was a hypothetical "net" price calculated as the difference between potential up-front costs and the present value of potential energy bill savings, discounted at an interest rate of five percent. In Group 2, the up-front price of the upgrade and the energy bill savings were presented as separate attributes so that we could value the respondents' importance of each component separately. The energy efficiency options for Group 1 were HERS 100 (a standard home), HERS 50, and HERS 0 (a Zero Net Energy home), whereas Group 2's options were HERS 100, HERS 70, HERS 40, and HERS 0. For both groups, the solar options included no solar panels, a standard rooftop design, and an architecturally-integrated design in which the form and/or roofline was slightly altered to provide a rooftop location where the solar panels visually fit. For these options, photo-realistic images for each design were shown, using several home designs from the BERG catalog of Zero Net Energy homes. Figure 2 shows the three image variations for two example home designs. Each respondent performed the choice task six times, and each time they were shown a slightly different combination of energy efficiency and/or solar upgrades in addition to the standard version of the home. Respondents were also given a hypothetical market share of solar and high-energy efficiency homes in the neighborhood where their candidate homes would be located.

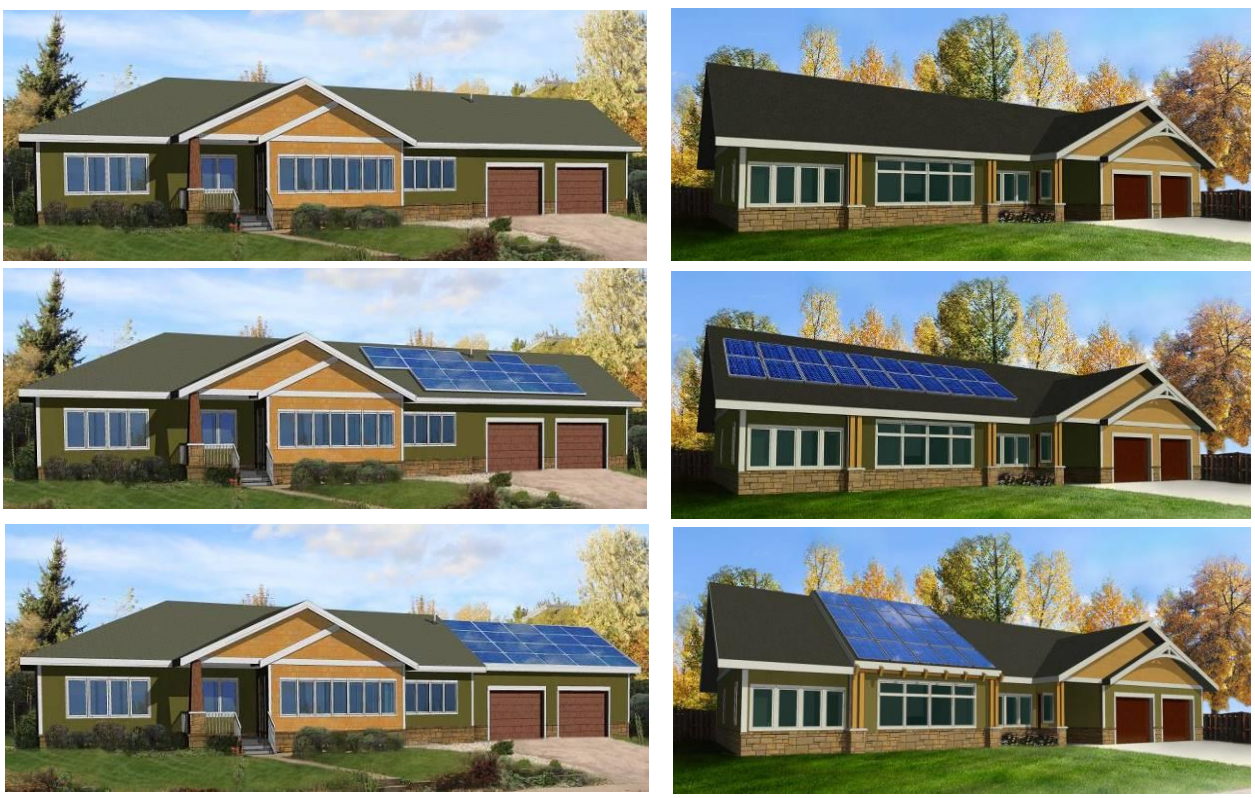

Figure 2. Image variations on "Thunder Basin" and "Red Desert" used in the survey.

Table 1. *Summary Statistics*

	Survey Group 1		Survey Group 2	
	Mean	Std. Dev.	Mean	Std. Dev.
State of residence:				
Arizona	0.27	0.44	0.28	0.45
Colorado	0.23	0.42	0.27	0.45
Idaho	0.09	0.29	0.08	0.27
Montana	0.08	0.27	0.05	0.23
Nevada	0.05	0.21	0.05	0.22
New Mexico	0.08	0.27	0.06	0.24
Utah	0.18	0.38	0.16	0.37
Wyoming	0.03	0.16	0.04	0.19
Respondent characteristics:				
Male	0.34	0.47	0.37	0.48
Age	45.43	16.15	46.88	16.46
Income ($1,000's)	75.60	50.23	77.80	51.15
HH Size: Adults	1.97	0.79	2.00	0.70
HH Size: Children	0.79	1.13	0.74	1.13
Homeownership experience:				
Bought in Last Year	0.13	0.33	0.16	0.37
Plan to Buy This Year	0.35	0.48	0.28	0.45
Owned More Than One Year	0.53	0.50	0.55	0.50
Have Owned Previously	0.59	0.49	0.60	0.49
First Time Owner/Buyer	0.41	0.49	0.40	0.49
Familiarity with energy efficiency ratings:				
Heard of HERS	0.04	0.18	0.04	0.20
Heard of Energy Star	0.51	0.50	0.58	0.49
Heard of HERS & Energy Star	0.09	0.29	0.07	0.26
Heard of Neither	0.36	0.48	0.31	0.46
Experience with energy efficiency technologies:				
None	0.10	0.30	0.09	0.29
Low-E Windows	0.49	0.50	0.55	0.50
Energy Star Appliances	0.71	0.46	0.68	0.47
Solar Photovoltaic	0.08	0.28	0.09	0.28
Solar/Geothermal Heating	0.07	0.25	0.07	0.25
Advanced Insulation	0.36	0.48	0.41	0.49
CFL/LED Lighting	0.67	0.47	0.72	0.45
Passive Solar	0.09	0.29	0.11	0.31
Natural Ventilation	0.30	0.46	0.28	0.45
Audit w/ Blower Door Test	0.06	0.25	0.08	0.27
Owned Hybrid Car	0.09	0.29	0.10	0.30

Opinions on building codes, zoning, and neighborhood character:				
Codes Too Strict	2.82	1.09	2.76	1.11
Codes Help Efficiency	3.92	0.98	3.96	0.97
Zoning Helps Character	3.86	0.90	3.93	0.88
Local Share of Green Homes	2.71	1.29	.	.
Importance Weights for homeownership priorities:				
Home Price	0.11	0.03	0.11	0.02
Interior Finishes	0.08	0.02	0.08	0.02
Maintenance Costs	0.09	0.02	0.09	0.03
Monthly Mortgage	0.10	0.03	0.10	0.04
Monthly Utilities	0.09	0.02	0.09	0.02
Home Size	0.09	0.02	0.09	0.02
Exterior Appearance	0.09	0.02	0.09	0.02
Neighborhood Character	0.09	0.03	0.09	0.03
Floor Plan	0.10	0.02	0.10	0.02
Green Footprint	0.06	0.03	0.06	0.03
Comfort	0.10	0.02	0.10	0.02

Notes: There were 540 respondents in Group 1 and 537 in Group 2. Only 263 in Group 1, and none in Group 2, were asked about the importance of the local market share of green homes; this question was measured on a 5-point scale, with 5 being very important. Opinion questions about building codes and zoning were rated on a 5-point Likert Scale, with 5 indicating strong agreement with the statement given. The majority of the remaining variables are reported as the fraction of respondents meeting a given criteria, with the exception of Age, Income, Household Size, and Importance Weight categories. The Importance Weights are calculated as fractional weights between 0 and 1; for each respondent, the sum across the categories sums to 1.

Table 1 presents summary statistics from the two groups, including the fraction of respondents from each state in the Mountain West and the gender, age, income, and household size breakdown. Although slightly more than half of the respondents had owned their current home for more than a year, about a third planned to buy a home in the coming year and the remainder were recent homebuyers, so the sample is relevant to the market. Although over half of the sample had heard of the Energy Star rating for homes, familiarity with HERS was much lower and a substantial share (about a third) had never heard of either rating system. However, a large portion of the sample had experience with Energy Star appliances, as well as energy efficient lighting and windows.

Respondents were asked to rate their agreement on a 5-point scale with the following statements: “Building energy codes are too strict”, “Building energy codes can help improve energy efficiency”, and “Zoning rules can help improve neighborhood character”. Although responses were given across the agreement/disagreement range for each question, agreement was generally stronger with the second two statements than the first, suggesting a general if mild acceptance (on average) of rules-based interventions in the housing market. Respondents were also asked to rate the importance for their home choice of the local green home market share on a 5-point scale; interestingly, responses are spread out and the mean is close to the middle of the range. Respondents were also asked to rate general homeownership priorities on a 100-point scale, which we then used to calculate relative ratings called “importance weights" for each category (so that each respondent's ratings summed to one). These “importance weights" are fairly evenly distributed among the categories, although notably the price and mortgage are most important and the green footprint of the home is by far the least important on average.

Table 2. *Market Shares, Average Prices, and Average HERS Ratings*

	Survey Group 1		Survey Group 2	
	Mean	Std. Dev.	Mean	Std. Dev.
HERS Rating	46.62	42.43	47.04	35.07
HERS 0 (Net Zero)	0.40	0.49	0.27	0.45
HERS 40			0.29	0.46
HERS 50	0.28	0.45		
HERS 70			0.27	0.44
Integrated PV	0.28	0.45	0.35	0.48
Rooftop PV	0.32	0.47	0.26	0.44
Energy Efficiency Only (No PV)	0.07	0.25	0.23	0.42
Net Present Value Costs of Upgrade	-1059.14	4894.13	-11994.10	16772.66
Monthly Payment Difference	-5.69	26.27		
Up Front Upgrade Price			16534.76	12815.23
Annual Bill Savings			1426.44	870.92

Notes: Each of the 540 respondents in Group 1 and 537 respondents in Group 2 made 6 home choices, so there are 3,240 choice observations in Group 1 and 3,222 in Group 2 from which to calculate market shares and average choice outcomes. HERS options differed between the groups. Group 1 presented the options of HERS 50 and HERS 0, while Group 2 faced options HERS 0, HERS 40, and HERS 70. Pricing options differed between Groups 1 and 2. In Group 1 only the net savings or costs for each option were shown to respondents, unlike in Group 2 where the Up Front Upgrade Price and Annual Bill Savings varied independently across choice options presented. The Net Present Value Costs of Upgrade calculate the difference between the up-front costs of the upgrade and the present value of expected bill savings, discounted at a 5% interest rate. A negative number implies that on average, respondents chose to upgrade more often when it was financially beneficial. The Monthly Payment Difference calculates the difference between the increased mortgage payment to cover the up-front cost of the upgrade, and the decreased energy bills. Again, a negative number indicates financial savings.

Table 2 presents the average “most preferred” choices selected by respondents during the hypothetical choice sequence. Respondents in general preferred to add solar and energy efficiency upgrades to their favorite home model; the average chosen HERS rating was less than 50 (less than 50 percent energy use of a standard new home), with a substantial share of respondents choosing a Zero Net Energy home. About 30 percent of respondents chose a solar upgrade. Offering a broader range of HERS options to Group 2 reduced the market share of Zero Net Energy, but also reduced the market share of standard HERS 100 homes by offering consumers at the margin an energy efficient option in HERS 70. It should be noted that HERS 70 is approximately the energy efficiency achieved by homes given the EPA’s Energy Star home rating. However, the majority of respondents preferred to choose upgrades when they were “in the money” – when the net costs to their household would be negative, although a substantial fraction still chose to upgrade when a net cost was incurred. We can see this by noting that the mean values of “Net Present Value Costs of Upgrade” for chosen homes are negative but the standard deviations are large, which indicates that many respondents chose the energy efficiency and/or solar upgrade models at a net cost.

MODELING SOLAR AESTHETIC VALUE

Among the choices given and the questions asked was enough information to derive the added value consumers saw in the architecturally integrated panels. To do this, we analyzed the choice data using a conditional logistic regression model. The regression model is motivated by a conceptual framework known as the "Random Utility Model" (see Chamberlain, 1980 or Greene, 2012, Ch. 17 for a full treatment of the model described here). Suppose that after taking into account their budget constraints, a typical consumer receives "utility" (subjective benefit) from their home choice that depends on a bundle of attributes of the home $(Z_1, \ldots, Z_m)$ and the price of obtaining that particular bundle, P, which also represents other consumption goods the consumer must forgo in order to afford this bundle. In our setting, for Group 1 the attributes include the solar option and the HERS level, and the price is the net present value or cost of the solar or efficiency upgrade. For Group 2 the attributes include the solar option, HERS level, and annual expected bill savings, and the price is the up-front cost of the upgrade. If we assume the utility received by the consumer is a linear function of attributes and prices, then the utility for person *i* from choosing home option *j* in choice round *k* is

$$U_{ijk} = \beta_0 X_i + \beta_1 Z_{1jk} + \cdots + \beta_m Z_{mjk} + \beta_P P_{jk} + \epsilon_{ijk},$$

where ϵ_{ijk} is a part of person *i*'s utility from choice *j* in round *k* that is unobserved by the researcher, X_i is a set of characteristics that are specific to the person (e.g., income, age, etc.) and the β's are coefficients that we estimate using the conditional logistic regression. In the economics literature, these β's are sometimes called the "marginal utilities" of a particular attribute, or the "part worths" in the marketing literature. In either parlance, the idea is that they measure the increase in subjective well-being from increasing the level of a particular attribute. Because the "units" of subjective well-being or utility are meaningless in real terms, one way to measure the implied consumer's demand or market value of a given attribute is to calculate the increase in price the consumer would be willing to bear in order to increase the level of that attribute. We can do this by applying the implicit function theorem to the utility function written above:

$$\frac{dP}{dZ} = -\frac{\partial U / \partial Z}{\partial U / \partial P} = -\frac{\beta_Z}{\beta_P}$$

This provides a convenient formula to calculate the average "Willingness to Pay" for an increase in any particular attribute as the ratio of the estimated coefficient of the attribute over the estimated coefficient of the price.

Under certain standard assumptions about the statistical distribution of the unobserved component of utility ϵ_{ijk}, it has been shown that the probability of choosing option *j* in round *k* is given by the logistic function:

$$\Pr(c_{ik} = j) = \frac{e^{\beta_0 X_i + \beta_1 Z_{1jk} + \cdots + \beta_m Z_{mjk} + \beta_P P_{jk}}}{\sum_j e^{\beta_0 X_i + \beta_1 Z_{1jk} + \cdots + \beta_m Z_{mjk} + \beta_P P_{jk}}}$$

We can then use the observed choices in each round to estimate the parameters (the β's) of this expression for choice probability by using standard maximum likelihood routines in statistical regression packages. Notice, however, that the $e^{\beta_0 X_i}$ term can be factored out of the summation in the denominator and cancelled with the same term in the numerator. In other words, parameters for how respondent characteristics that don't change between choice rounds (e.g., demographics or general attitudes) affect actual choices cannot be directly estimated in this model. We can, however, estimate the impact of consumer characteristics on home choice by modeling the coefficients on the attributes (the β_Z's) as functions of consumer characteristics X_i. In particular, because we are interested in how preferences for solar aesthetics vary among housing market participants, we estimate a modified version of the utility function written above:

$$U_{ijk} = \beta_0 X_i + (\beta_1 + \beta_{1X} X_i) \cdot IntegratedPV_{jk} + (\beta_2 + \beta_{2X} X_i) \cdot RooftopPV_{jk} + \cdots + \beta_m Z_{mjk} + \beta_P P_{jk} + \epsilon_{ijk},$$

where for X_i we use the respondent's importance weights for various homeownership priorities, such as monthly utility costs and mortgage payments, maintenance costs, exterior appearance, interior comfort, neighborhood amenities, and environmental footprint. *IntegratedPV* and *RooftopPV* are dummy-coded variables indicating whether option *j* includes design-integrated PV or standard rooftop PV. If both of these variables are equal to zero, then option *j* had no solar panels, and it is never the case that both variables are equal to one. While β_0 cannot be estimated for the reason described above, β_{1X} and β_{2X} give us a measure of how the marginal utility, or part worth, of having design integrated solar or traditional rooftop solar is different for people who place high or low relative weight on different homeownership priorities. For example, appearance-motivated buyers may value a particular solar aesthetic design differently than buyers who are income-constrained and therefore place a lot of importance on monthly expenses like mortgage payments.

SURVEY RESULTS

Tables 3 and 4 present the regression coefficients for Groups 1 and 2, respectively. Column 1 in each table reports results from the basic model that does not explore how values change among respondents with different motivations. Columns 2 through 8 in each table report how the valuation of solar options differs among respondents with different importance weights. Coefficients that are individually statistically significantly different than zero have stars next to them, and t-values for the estimated coefficients are given in parentheses below each coefficient.

Focusing on column 1 for the moment, we can see that the marginal utilities (the coefficients) for design-integrated solar are greater than standard rooftop solar in both survey groups, but that they are positive for both types of solar – indicating that the average respondent prefers some kind of solar panels to none. Using the simply formula derived above that gives the Willingness to Pay for a given attribute as the ratio of the attribute coefficient to the price coefficient, we can calculate the Willingness to Pay for design-integrated and standard rooftop solar for the average respondent in each survey group. For Group 1, the average Willingness to Pay for adding design-integrated solar to a home, holding all other attributes constant, is 0.849/0.0704 = 12.060, or about $12,060. For standard rooftop solar, this value is 0.335/0.0704 = 4.759, or about $4,759. This amounts to a premium of about $7,300 for design integrated solar over standard rooftop solar. In Group 2, using the parameters from column 1 of Table 4, we can calculate the average Willingness to Pay for design-integrated solar as 0.437/0.0517 = 8.453 or about $8,453, versus

0.115/0.0517 = 2.224 or about $2,224 for standard rooftop solar. There is once again a premium for design-integrated solar, here of about $6,200.

One reason that the magnitudes of estimated Willingess to Pay for either type of solar differs between the two groups is that the "price" variable is measured differently in the two surveys. So the values produced from the Group 1 sample ($12,060 and $4,759) represent the total increase in the lifetime cost of the solar asset the respondent is willing to incur to have it, whereas the values from Group 2 sample ($8,453 and $2,224) represent the increases in one-time up-front costs the respondent is willing to incur, leaving aside the flow of benefits and costs over time. Another reason for the discrepancy may be how respondents perceive and cognitively respond to the difference this representation of prices. It is a well known psychological fact that consumers have a hard time conceptualizing the flow of costs and benefits over time relative to immediate costs and benefits. In either case, however, the flow of benefits over time in terms of bill savings is either already captured in the price variable (Group 1) or valued separately as its own attribute (Group 2), so the solar coefficients (and Willingness to Pay estimates) represent positive preferences and values for the technology itself, above and beyond the preference of value of the financial investment. These technology preferences may occur for social, environmental, ideological, or aesthetic reasons.

We now investigate how these technology preferences vary among respondents with different priorities in homeownership. Considering column 2 of Table 3, the negative coefficients in the last two rows indicate that respondents who place a greater importance weight on monthly utility costs in their homeownership decision have a lower marginal utility (and Willingness to Pay) for solar technology than people who place less relative weight on utility costs.[1] At first glance, this seems counterintuitive since solar investments reduce utility bills. However, the technology coefficients represent the subjective preference or value of the technology itself – not the flow of bill reductions, as discussed above. Further, when we consider the last two rows of columns 3 and 4 of Table 3, the consumers' marginal utility of solar technologies is also lower for people who place high importance on monthly mortgage payments and maintenance costs. These three variables describe a market segment that is likely cash-constrained and potentially unable or unwilling to afford an up-front investment in a solar upgrade.

The last two rows of columns 6 and 7 indicate that respondents with a greater importance weight on more "luxury" attributes like neighborhood amenities and interior comfort also place a greater value on solar technologies. Because the coefficients on "Integrated PV X Importance Weight" and "Rooftop PV X Importance Weight" do not differ greatly or in a consistent pattern, the design-integrated premium over standard rooftop solar does not seem to grow or shrink in an obvious way across consumer types. In column 5 of Table 3, we see that respondents who place a high importance on exterior appearance have a lower value of design-integrated solar and a higher value of standard rooftop solar. However, "exterior appearance" is poorly defined and open to subjective interpretation by different respondents, so it is not surprising that there is a conflicting result. Lastly, column 8 suggests a very strong positive relationship between

[1] Although many of the coefficients in the last two rows of Tables 3 and 4 are not individually statistically significantly different than zero, they are jointly statistically significant, meaning that as a group they improve the explanatory power of the models and therefore belong in the regression; the estimated coefficients are therefore relevant for analysis.

respondents who consider the environmental footprint of their home ownership decision and their preference for solar technologies. These patterns are largely consistent in Group 2 (Table 4), with the exception of the "Neighborhood Amenities" importance weight (column 6). In Group 2, respondents with a high importance weight on neighborhood amenities place a much lower value on solar technology. This is again due to differences in the design of the survey between the two groups; the survey for Group 2 also included a hypothetical neighborhood market share of green homes as an attribute in each choice, so respondents in this group also valued the number of solar homes nearby their candidate home. An analysis of that relationship, presented and discussed in Gilbert, et al (2015), found evidence of a market segment who is willing to pay less for their own solar panels but more for the opportunity to live in a solar neighborhood – in other words, a tradeoff between the costs of installing PV on one's own home versus buying a more expensive home in a neighborhood with many solar homes.

DISCUSSION

This white paper represents a first step in understanding consumer preferences for residential solar and home design aesthetics. The study has advantages and limitations. The major limitation is that the choices made in the survey are inherently hypothetical. However, we have used state-of-the-art survey design and analysis techniques that help elicit the most realistic preferences we can, given the hypothetical nature of the activity. An advantage of the "stated preference" environment over an empirical study using observational data is that we can control the set of tradeoffs that we ask the respondents to make, through the design of the survey. Our research can therefore be more focused on a particular attribute, such as design variations. Additionally, our results are consistent with the empirical literature studying the solar home price premium using observational data (e.g., Dastrup et al. 2012, Hoen et al. 2015). We find a solar price premium of several thousand dollars, which is significantly larger for architecturally-designed solar than for standard rooftop solar.

These findings suggest that a substantial portion of the market for residential solar is potentially as yet untapped. If the homebuilding industry is able to transition its offerings in order to satisfy this latent demand for better solar aesthetics, by incorporating solar into home options in a purposeful way at the design stage, our findings suggest that market for residential solar would accelerate.

Table 3. *Choice coefficients (Marginal Utilities) for each attribute: Group 1*

	(1)	(2) Utilities	(3) Maint.	(4) Mortgage	(5) Exterior	(6) Neighbor hood	(7) Comfort	(8) Green Footprint
Net Present Value Costs	-0.0704***	-0.0704***	-0.0703***	-0.0704***	-0.0703***	-0.0704***	-0.0704***	-0.0706***
of Upgrade	(-14.90)	(-14.89)	(-14.88)	(-14.90)	(-14.88)	(-14.90)	(-14.90)	(-14.92)
HERS 0 (Net Zero)	-0.334***	-0.334***	-0.336***	-0.334***	-0.335***	-0.334***	-0.334***	-0.333***
	(-3.30)	(-3.29)	(-3.31)	(-3.29)	(-3.30)	(-3.30)	(-3.29)	(-3.28)
HERS 50	-0.623***	-0.623***	-0.623***	-0.623***	-0.623***	-0.623***	-0.623***	-0.621***
	(-7.67)	(-7.66)	(-7.66)	(-7.66)	(-7.67)	(-7.67)	(-7.66)	(-7.64)
Integrated PV	0.849***	1.113***	0.967***	1.159***	0.977***	0.624***	0.408	0.517***
	(8.92)	(5.15)	(4.62)	(6.10)	(4.40)	(3.02)	(1.63)	(3.60)
Rooftop PV	0.335***	0.610***	0.591***	0.582***	0.313	0.157	-0.00230	-0.0504
	(3.43)	(3.13)	(3.09)	(3.37)	(1.57)	(0.85)	(-0.01)	(-0.37)
Integrated PV X		-2.977	-1.340	-2.953*	-1.496	2.482	4.326*	5.187***
Importance Weight		(-1.36)	(-0.63)	(-1.88)	(-0.64)	(1.23)	(1.90)	(3.07)
Rooftop PV X		-3.108	-2.902	-2.353*	0.260	1.961	3.310*	5.999***
Importance Weight		(-1.63)	(-1.56)	(-1.74)	(0.13)	(1.13)	(1.71)	(4.03)
Observations	3240	3240	3240	3240	3240	3240	3240	3240

t statistics in parentheses

The first column reports coefficients from the basic model, while the remaining column reports coefficients on solar type that vary depending on the value of a particular Importance Weight. The Importance Weight used in each model is given in the column headers.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4. *Choice coefficients (Marginal Utilities) for each attribute: Group 2*

	(1)	(2) Utilities	(3) Maint.	(4) Mortgage	(5) Exterior	(6) Neighbor hood	(7) Comfort	(8) Green Footprint
Up Front Upgrade Price	-0.0517***	-0.0518***	-0.0518***	-0.0518***	-0.0518***	-0.0518***	-0.0517***	-0.0523***
	(-24.82)	(-24.84)	(-24.83)	(-24.83)	(-24.83)	(-24.83)	(-24.82)	(-24.89)
Annual Bill Savings	0.0414***	0.0414***	0.0414***	0.0414***	0.0414***	0.0414***	0.0414***	0.0417***
	(10.84)	(10.85)	(10.85)	(10.85)	(10.85)	(10.85)	(10.84)	(10.88)
HERS 0 (Net Zero)	1.059***	1.060***	1.059***	1.060***	1.061***	1.058***	1.059***	1.068***
	(10.11)	(10.12)	(10.11)	(10.12)	(10.12)	(10.10)	(10.11)	(10.17)
HERS 40	0.838***	0.839***	0.838***	0.840***	0.839***	0.839***	0.838***	0.850***
	(8.44)	(8.44)	(8.44)	(8.45)	(8.44)	(8.44)	(8.44)	(8.52)
HERS 70	0.649***	0.650***	0.649***	0.649***	0.650***	0.650***	0.650***	0.655***
	(6.55)	(6.56)	(6.55)	(6.55)	(6.56)	(6.55)	(6.56)	(6.59)
Integrated PV	0.437***	0.247	0.512***	0.703***	0.367**	0.819***	0.357*	-0.229**
	(8.44)	(1.48)	(3.30)	(5.62)	(2.05)	(5.31)	(1.65)	(-2.20)
Rooftop PV	0.115**	0.368**	0.277*	0.322**	-0.337*	0.484***	-0.126	-0.493***
	(2.12)	(2.12)	(1.67)	(2.41)	(-1.73)	(2.94)	(-0.54)	(-4.43)
Integrated PV X		2.165	-0.870	-2.630**	0.788	-4.229***	0.801	10.45***
Importance Weight		(1.20)	(-0.51)	(-2.34)	(0.41)	(-2.63)	(0.38)	(7.43)
Rooftop PV X		-2.911	-1.869	-2.033*	5.044**	-4.077**	2.396	9.578***
Importance Weight		(-1.53)	(-1.03)	(-1.68)	(2.42)	(-2.36)	(1.07)	(6.37)
Observations	3222	3222	3222	3222	3222	3222	3222	3222

t statistics in parentheses

The first column reports coefficients from the basic model, while the remaining column reports coefficients on solar type that vary depending on the value of a particular Importance Weight. The Importance Weight used in each model is given in the column headers.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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