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LETTER

Diffusion into new markets: evolving customer segments in the solar photovoltaics market

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Abstract

The US residential solar market is growing quickly, and as solar adoption diffuses into new populations, later adopters may differ significantly from earlier ones. Using a unique household-level survey dataset including 1234 adopters and 790 non-adopters from San Diego County, California, we explore differences in attitudinal and socio-economic factors for three groups: (i) adopters and non-adopters; (ii) early and more recent adopters; (iii) consumers adopting via buying or leasing. Our results suggest that adopters overall have higher incomes, are more educated, live in larger homes, and expect to stay in their homes for longer than their non-adopting peers. They also differ in their expectations of electricity retail rate changes and the impact solar could have on their home resale value. When examining differences between early and more recent adopters, we find that recent adopters are more representative of general homeowners and more politically moderate. They are also increasingly installing solar to protect against future electricity price increases and to lower electricity costs as opposed to adopting strictly for environmental reasons. Furthermore, more recent adopters differ significantly from earlier adopters in the situations that prompted them to adopt. The findings demonstrate how solar markets are evolving, reflecting changes in the underlying drivers of consumer adoption as well as innovative solar marketing strategies.

Introduction

The US residential solar photovoltaics (PV) market is expanding quickly, with installed capacity more than doubling between 2012 and 2014 (SEIA 2015). Several trends point to a maturing market—consolidation of market share among solar installers, increased access to low-cost capital (particularly from institutional funding sources), and increased competition between market players. For example, California, the largest market for solar in the US, stopped issuing state-issued rebates for residential systems in the second half of 2013 in the Southern California Edison (SCE) and Pacific Gas and Electric service territories, yet residential installations in 2014 were 50% higher than in 2013 (SEIA 2015). The US Federal Investment Tax Credit, once an irreplaceable incentive for making installations economical, is expected to decrease from 30% to 10% in 2016—and the industry will live on.

However, the solar industry is not completely in the clear. Customers still need to be recruited, and costs for acquiring customers are high, estimated at \$0.49 W^{-1} per customer, or roughly 10–20% of a system's costs (GTM 2013). In part this is because rooftop solar is an unproven commodity for many households. Trusted contacts from social networks (friends, family, coworkers, and neighbors) combined with observations of existing systems contribute significantly to convincing unsure customers. In response, the industry has experimented with a number of innovative advertising and marketing methods to either develop new leads or improve their conversion rate for existing ones. These methods range from door-to-door canvasing, to partnerships with

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established retailers, to purchasing customer leads wholesale from third-party aggregators (GTM 2013). All of these factors point to a continued need for research that can help identify new market segments, predict areas ripe for adoption, and test effectiveness of marketing tactics (Davidson *et al* 2014).

Customer behavior and preferences have been at the forefront of recent research related to solar adoption. The main framework consists of the consumer as a decision-maker, drawing on the behavioral economics, diffusion of innovations, and value-based norms frameworks (Stern *et al* 1999, Rogers 2003, Faiers and Neame 2006 and Wilson and Dowlatabadi 2007) to understand the economic, informational, social, and behavioral factors that drive adoption decision-making. Some insights from this field are that social networks can help reduce customer uncertainty (Bollinger and Gillingham 2012, Rai and Robinson 2013, Noll *et al* 2014, Graziano and Gillingham 2014) and that customers are motivated to adopt for a variety of reasons—not strictly financial or environmental concerns alone (Zhai and Williams 2011, Schelly 2014). Nonetheless, a number of barriers may inhibit adoption including high upfront costs, inadequate access to financing options, lack of awareness of available products, concerns about required system maintenance, and the perceived risk of PV negatively affecting home values (Margolis and Zuboy 2006, Hoen *et al* 2011). Compounding this complexity is price variation, which is a function of PV system characteristics but also search costs, imperfect competition, installer experience, and public policy (Gillingham *et al* 2014). In light of this, Rai and Robinson (2015) present an agent-based model of technology adoption applied to solar PV, using household-level resolution to represent demographic, attitudinal, social network, and environmental variables that impact decision-making. Accounting for financial aspects as well as agent-level attitudes and social interactions is determined to be critical in the prediction of adoption (Robinson and Rai 2015).

Furthermore, third-party ownership, or leasing, has been instrumental both in the market's expansion and in mitigating some of the barriers outlined above. Most lease contracts guarantee both production and operational and maintenance of the system, thus reducing risk and hassle to the consumer (Shih and Chou 2011). More importantly, leasing fundamentally inverts the financial proposition to the consumer by eliminating the need to take on debt or make a potentially large up-front payment. As many households do not have sufficient free cash to make these payments, leasing has helped to grow the market and attract new demographics (Drury *et al* 2012, Rai and Sigrin 2013, Davidson *et al* 2015).

To better understand what prompts solar adoption and how those underlying motivations are changing, we fielded two household-level surveys in 2013 and 2014 in the San Diego metro area to explore: (i) differences between adopters and their non-adopting peers, and (ii) demographic and attitudinal variations within adopter populations and how they have changed over time. Our analysis presents novel statistical testing results that compare adopters and non-adopters along socio-demographic dimensions, expectations of electricity rate changes, and self-reported importance of various factors in the decision to adopt. We also compare responses from early adopters and more recent ones to explore how markets may be changing; to our knowledge, this is the first study to do so using recent adoption data. While we are not able to attribute causality, our findings provide new insights into how the underlying factors that contribute to the solar adoption decision-making process at the residential level are changing.

Data

Two surveys of San Diego households were conducted in 2013 and 2014 for: (1) homeowners that had adopted PV ($n = 1234$) and (2) homeowners that had not adopted PV ($n = 790$). The surveys were designed to elicit new data exploring the factors that drive households to adopt PV, including stated motivations (e.g., wanting to save money, wanting to stabilize electricity expenditures, etc), stated barriers (e.g., upfront costs, impacts on home value, etc), personal attributes (e.g., political beliefs, demographics), social network characteristics (e.g., how many neighbors/friends have adopted), and access to information. For both surveys, the sampling was limited to homeowners since these are the households that benefit from installing PV. The sampled populations were not intended to be representative of the entire San Diego population, however controlling for homeownership allows us to understand how PV adopters differ from their peers.

Adopter survey

The PV adopter survey was administered as an online survey using SurveyGizmo in late 2013. It was in the field for three weeks, and two reminders were sent at the end of weeks one and two. Invitations to complete the survey were emailed to 10 064 PV adopters in San Diego County who had applied for California Solar Initiative incentives from January 2007 through the first quarter of 2013. Of these, participation in individual sections of the survey ranged from about 880 to 1230. The final response rate was approximately 15%, defined as the ratio of fully or partially completed surveys by the number of successfully-delivered solicitations.

To ensure representativeness of survey respondents to the population of PV owners in San Diego, we looked at two factors: (1) whether the respondent pool represented the breakdown between third-party owned PV customers and host owned PV customers;

(2) whether respondents effectively represented adoption from early years (pre-2009) as well as more recent years (2012–2013). For (1), we find 29.7% of survey respondents leased compared to 30.6% of all PV adopters in San Diego (CSI 2014). For (2) we find a small bias towards over-representing recent installations—28.8% of survey respondents reported adopting in 2012 versus 25.3% of actual installations in 2012, and 2.3% versus 1.5%, respectively, for the first quarter of 2013.

Non-adopter survey

The survey for PV non-adopters, administered in early 2014, was fielded through Qualtrics and sent to single-family homeowners in San Diego County that had not adopted rooftop solar systems. Responses were solicited until reaching a pre-determined number of 790 completed survey responses.

The non-adopter's instrument used many of the same questions from the PV adopters survey so that responses could be compared across the populations. These include demographics, relative importance of factors in the adoption decision, and home characteristics. The non-adopter survey also included additional questions exploring any contacts that homeowners have had with solar installers to control for exposure to the solar industry.

Results

Our analysis focuses on understanding differences between adopters and non-adopters, motivations for adoption, and how the motivations and customer segments for adopters are evolving. We also briefly examine differences across adopters that decide to lease versus buy as this is another method of segmenting customers. We do not attempt to identify causal patterns; rather, we use various statistical difference tests to support our observations.

Differences in adopters versus non-adopters

We first examine the attitudinal and demographic differences between adopters and non-adopters, using Student's t-tests with the null hypothesis being the mean of adopters' responses equals that of the non-adopters, finding a number of statistically significant differences. Specifically, adopters tend to have higher incomes by \$50 100 on average and are more highly educated. Adopters also differ in that they live in larger homes, potentially a proxy for higher electricity costs, and also expect to stay in their current homes by nearly 6.5 years longer than non-adopters (table 1). As the income and education variables were initially solicited as ordinal categorical measures, we convert them to numeric responses by using the midpoint of income intervals and converting education to the number of years of post-secondary instruction.

For non-ordinal categorical variables, we use a Pearson's Chi-Squared test for differences in distribution of responses. Adopters were found to be significantly more likely to have children living in the household ($\chi^2 = 30.79$, df = 1, $p < 1e{-}05$), with 32.5% of adopters reporting at least one child living in their households compared to 19.5% of non-adopters. No difference was found in the likelihood of being retired with 43.0% of adopters retired relative to 42.7% of non-adopters. Adopters were also more likely to have air-conditioning (77.1% of adopters versus 63.9% of non-adopters) ($\chi^2 = 37.58$, df = 1, $p < 1e{-}05$) or a pool (37.3% of adopters versus 18.2% of non-adopters) ($\chi^2 = 79.05$, df = 1, $p < 1e{-}05$).

Concerns over high electricity bills, in addition to concerns about future rate changes, are often highlighted as a motivation for adopting solar—particularly in California, which has some of the highest retail rates in the US. In both surveys, households were asked how they thought electricity rates would change over the next 5 years. A majority of respondents in both populations expect electricity costs to increase substantially and at a faster pace than the long-term Consumer Price Index average (BLS 2014). Expectations between groups significantly differed ($\chi^2 = 106.3$, df = 7, $p < 1e{-}05$), with 'rates about 30% higher in the next five years' the most common expectation from adopters, and '20% higher' as the most common response for non-adopters. Specifically, almost half of adopters (45.2%) expect rates to increase by at least 30% over the next five years, whereas only a quarter of non-adopters (25.2%) hold the same opinion.

Table 1 presents statistical test results for the differences in factors adopters and non-adopters considered to be important when adopting solar as well as socio-demographic factors. Lowering one's bill and protection from future rate increases were considered the two most important factors for both groups, but we do not find there to be statistically significant differences in the importance of these factors between adopters and non-adopters. This, along with the observation that adopters expect higher electricity rate increases in the future, suggests that the relative importance of this expectation is not necessarily a factor in the adoption decision, but instead, expectations of electricity rate increases among non-adopters were not high enough to spur adoption. This is reasonable considering we have already observed that non-adopters have lower incomes and smaller home sizes, which likely translates into overall lower electricity consumption. This places these households in lower electricity rate tiers, and thus the matter of electricity price increases may be less salient to non-adopters. Adopters' concerns over rate increases either could have been a prior opinion that spurred initial interest or an outcome of the adoption process itself (i.e. personal research, conversations with installers, etc).

Table 1. Comparison of demographic and adoption factors for solar adopters and non-adopters.

H_0: $\mu_{adopt} = \mu_{nonadopt}$	Adopters	Non-Adopt			p-value	95% CI of difference	
Unequal var. assumed	Mean	Mean	t	df	2-Tailed	Lower	Upper
Edu (years post-secondary)	4.54	4.15	4.07	1666	5.0e−5***	0.13	0.67
Income ($1000)	164.9	114.8	10.4	1568	<1e−5***	40.6	59.5
Exp. remain in house (years)	21.3	14.9	13.1	1614	<1e−5***	5.39	7.30
Home size (sq. ft)	2653	2062	10.7	1834	<1e−5***	482	698
Imp. of lower elec. costs	4.56	4.59	−0.72	1684	0.472	−0.10	0.047
Imp. of protect increase in elec. prices	4.47	4.46	0.33	1816	0.745	−0.06	0.09
Imp. of protect environment	3.86	3.92	−1.05	1807	0.294	−0.164	0.050
Imp. of increasing home value	3.15	3.88	−13.39	1845	<1e−5***	−0.831	−0.619
Imp. of home easier to sell	2.50	3.64	−18.97	1780	<1e−5***	−1.26	−1.021

Significance codes: *** significant at 0.1% level or greater, ** significant at 1% level, and * significant at 5% level.

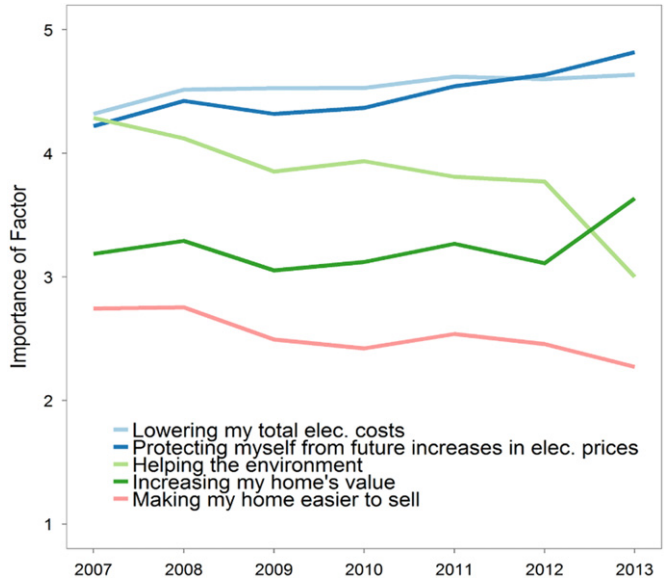

Figure 1. Evolution of important factors in adopting solar.

Non-adopters rated the importance of increasing home value and making the home easier to sell more highly than their adopting counterparts. It is logical for non-adopters to have greater concern about the impact of PV on their home's value and salability as they have indicated an intention to live in their homes for shorter periods. However, much of the current literature indicates that PV has a sizable positive impact on home resale value (Hoen *et al* 2015), which suggests non-adopters are either unaware or unconvinced of this effect. If the potential home resale value increase is enough of an incentive to motivate adoption, efforts to provide additional information could provide a low-cost opportunity to expand market size.

Motivations for adopting and how customer segments are evolving

As markets mature, they diffuse into new populations and locations to continue growing. A key prediction from the diffusion of innovations literature is that there are attitudinal and demographic differences between early-adopting individuals and the rest that follow them (Rogers 2003, Wilson and Dowlatabadi 2007). For example, while initial adopters are sometimes motivated to adopt based on the novelty of a new technology, the general populace requires a clearer degree of relative advantage between the old and new technology to consider adopting.

Figure 1 shows the relative importance of multiple factors in the decision to install solar for adopters from 2007 to 2013 (1 = 'not at all important', through 5 = 'very important'), where lowering total electricity costs and protecting one's household from future increases in prices were rated the two most important factors. Compounding this, importance of economic factors increase over time, whereas environmental concerns are decreasing in relative importance.

To further explore these observations, we tested differences between early adopters and more recent

Table 2. Comparison of importance factors for early (2007–2010) versus recent adopters (2011–2013).

$H0$: $\mu_{recent} = \mu_{early}$	Recent adopter	Early adopter			p-value	95% CI of difference	
Unequal var. assumed	Mean	Mean	t	df	2-tailed	Lower	Upper
Imp. of lower elec. costs	4.61	4.52	1.87	1045	0.062 (.)	−0.005	0.191
Imp. of protect increase in elec. prices	4.6	4.35	4.455	982	9.3e−6***	0.137	0.354
Imp. of protect environment	3.77	3.94	−2.207	1046	0.028*	−0.322	−0.019
Imp. of increasing home value	3.19	3.11	1.037	1052	0.3	−0.073	0.236
Imp. of home easier to sell	2.49	2.53	−0.465	1026	0.642	−0.205	0.127

Significance codes: *** significant at 0.1% level or greater, ** significant at 1% level, * significant at 5% level, and (.) significant at 10% level

adopters by conducting a series of Student's t-tests with the null hypothesis being that the means for early adopters (2007–2010) equal those of the more recent adopters (2011–13). While our primary intent is to demonstrate market changes over time, we acknowledge there is no obvious cut-off for what defines an early adopter in the solar PV market. As such, we conducted additional sensitivities on alternative definitions of early adopters to provide robustness to our results (see supplemental materials).

The results suggest that the importance of protecting the environment is less of a motivation for recent adopters relative to early adopters ($p = 0.028$) whereas protecting against future increases in electricity prices is more important for recent adopters ($p = 0.000$) (table 2). Lowering electricity costs is also more important for recent adopters ($p = 0.062$). While the changes are relatively small in magnitude considering their scaling and categorical framework, the differences are statistically significant, suggesting some level of change. These findings highlight how homeowners are increasingly installing solar because it is an economically attractive investment opportunity—not just because of the associated environmental benefits. This could be the result of market maturation, but it also could be driven by strategic marketing strategies that focus on communicating certain benefits of adoption. When defining more recent adopters as those that adopted in 2012–2013 and early adopters as those that adopted in either 2007–2011 or 2007–2009, the results hold except that we lose significance for the importance of lowering electricity costs (tables S1 and S2). Taken together, these findings demonstrate how recent adopters appear to be installing solar for different reasons than earlier ones.

Early and recent adopters are also compared along demographic and political identification. We find that recent adopters are less educated than early adopters and more centrist on political ($p = 0.019$), social ($p = 0.033$), and economic ($p = 0.026$) issues (table 3).[5]

Examining the actual distribution of responses for political identity is instructive as well, which demonstrates large increases in the percent of respondents that self-identify as slightly conservative or conservative (24.9–30.3%) along political issues for early and recent adopters and corresponding decreases in slightly liberal or liberal respondents (30.2–22.8%). Put another way, greater numbers of early adopters identified as liberal in some way (37.6%) than conservative (33.6%), whereas affiliations have inverted for recent adopters (27.9% liberal, 40.8% conservative), with similar trends along affiliations for economic and social issues (see table S5). Overall, broad trends in political identification provide another nuanced view into how PV markets are evolving and where framing considerations could help broaden the appeal of the product to a wider set of consumers. In fact, these observations could reflect the result of existing marketing strategies that aim to appeal to different consumer segments. See tables S3 and S4 for additional detail on the sensitivity of the political inferences to 'early' and 'recent' adopter cutoffs.

It is also often the case that specific events stimulate interest in PV. The most common events that adopters cited as leading them to serious consider solar were: increasing electricity rates (32%), planning for retirement (24%), talking to friends or family members with solar (21%), direct marketing by solar companies (16%), and planning a remodeling project (11%).[6] The top two events reflect a common theme from survey respondents expressing concern over rising electricity costs or economic concerns in general; influence from social groups is also strong overall (Bollinger and Gillingham 2012, Rai and Robinson 2013, Graziano and Gillingham 2014). A surprising observation is the relative importance of retirement planning in the decision to adopt rooftop solar systems in our sample. Although we did not observe higher rates of retirees in the adopter sample as compared to non-adopters, prevalence of

[5] Note that while survey takers identify as being liberal or conservative on a scale from 1 (very liberal) to 7 (very conservative), survey takers also could identify as libertarian. We did not wish to omit these responses because of the potential bias that would be introduced, so we classify libertarians as being the most conservative (an 8 on the scale) for our analysis.

[6] Since respondents were allowed to indicate more than one event, the percentages do not sum to 100%.

Table 3. Comparison of demographics and political views of early (2007–2010) versus recent adopters (2011–2013).

$H0: \mu_{recent} = \mu_{early}$	Recent adopter	Early adopter			p-value	95% CI of Difference	
Unequal var. assumed	Mean	Mean	t	df	2-tailed	Lower	Upper
Age at time of adoption (years)	56.9	56.4	0.664	931	0.507	−0.932	1.884
Edu (years post secondary)	4.18	4.44	−2.015	881	0.044 *	−0.516	0.007
Income ($1000)	129.0	141.4	−1.195	627	0.233	−32.8	7.994
Married (1 = yes, 0 = no)	0.875	0.87	0.243	944	0.808	−0.037	0.048
Retired (1 = yes, 0 = no)	0.41	0.444	−1.057	960	0.291	−0.096	0.029
Politics (1 = very liberal to 8 = very conservative)	4.54	4.23	2.347	879	0.019 *	0.052	0.578
Social issues (1 = very liberal to 8 = very conservative)	3.93	3.64	2.136	866	0.033 *	0.023	0.548
Economic issues (1 = very liberal to 8 = very conservative)	4.98	4.71	2.23	871	0.026 *	0.032	0.502

Significance codes: *** significant at 0.1% level or greater, ** significant at 1% level, and * significant at 5% level.

retirement planning as a trigger indicates potential as a significant market segment.[7]

As the market is evolving, however, we were also interested in whether more recent adopters were more heavily influenced by different prompts than their early-adopting peers, since this could reflect either changing motivations for adopting or more targeted marketing by solar companies. Recent adopters were more frequently prompted by electricity rate increases relative to their early-adopting peers ($p = 0.001$), again highlighting the increasing relative importance of economic factors in decision-making. In addition, we found that advertisements ($p = 0.0008$) and direct marketing ($p = 0.049$) were more significant drivers for recent adopters (2011–2013) relative to early adopters (2007–2010), which suggests that marketing efforts may have strengthened. On the other hand, early adopters were more likely to be prompted by other solar owners as part of a home tour ($p = 0.006$) (see supplementary material table S6). The results generally hold across our sensitivity checks as well (see tables S7 and S8). We did not find there to be a statistically significant difference in being motivated by upcoming remodeling projects, retirement plans, seeing neighbors with solar, or talking to neighbors or friends about solar over time.[8]

Differences in buy versus lease samples

Momentum in PV adoption has recently been heavily skewed towards third-party ownership (leasing), as opposed to host-ownership (buying), though host-ownership has made a resurgence in 2015 due to increased access to reduced cost capital (SEIA 2015, CSI 2014). Because our survey covers adoption from 2007 to 2013, it is demonstrative of this shift towards third-party ownership—overall, 26.3% of adopters leased their system, whereas for adoption in 2012–2013 only, leasing comprises 52.2% of the sample. Therefore, it is instructive to understand differences in the third-party owned sample as compared to the host-owned. Note that we do not control for time in this comparison, so while our analysis provides some descriptive insights into how buyers and leasers differ in general across the sample, it does not account for how those differences may or may not be changing.

Customers adopting via host-ownership reported that different situations or events prompted their initial interest in installing solar panels as compared to third-party adopters (figure 2). Specifically, for leasers, 'recent increases in prices', 'a conversation with a friend or family', and 'direct marketing by a solar company' were the three most likely events to prompt interest. By comparison, 'thinking about retirement planning' and 'conversations with friends or family' were the second and third most likely events for buyers. In general, leasers reported being more highly influenced by installer advertising (radio, TV) and marketing, whereas buyers were more influenced by personal contacts.

In regards to demographic differences between leasers and buyers, previous research has presented contradictory findings. For example, Drury *et al* (2011) found demographic differences in SCE territory at the zip code level, with adoption by leasers associated with areas with lower mean incomes and educational levels. In contrast, Rai and Sigrin (2013) found no significant difference between the groups in the nascent Texas market when surveying individual households.

To test differences in our sample, we conducted a series of Student's t-test with the null hypothesis that the mean of buyers' responses equals that of the leasers'. We find somewhat mixed results (see supplementary table S9) with some demographic and

[7] Despite having a sunny climate, San Diego County does not have a higher rate of retirees (12.3%) than the rest of California (12.5%) (US Census 2013).

[8] Note that we are not saying that these factors are not significant determinants of adoption, but just that their relative importance hasn't changed over time.

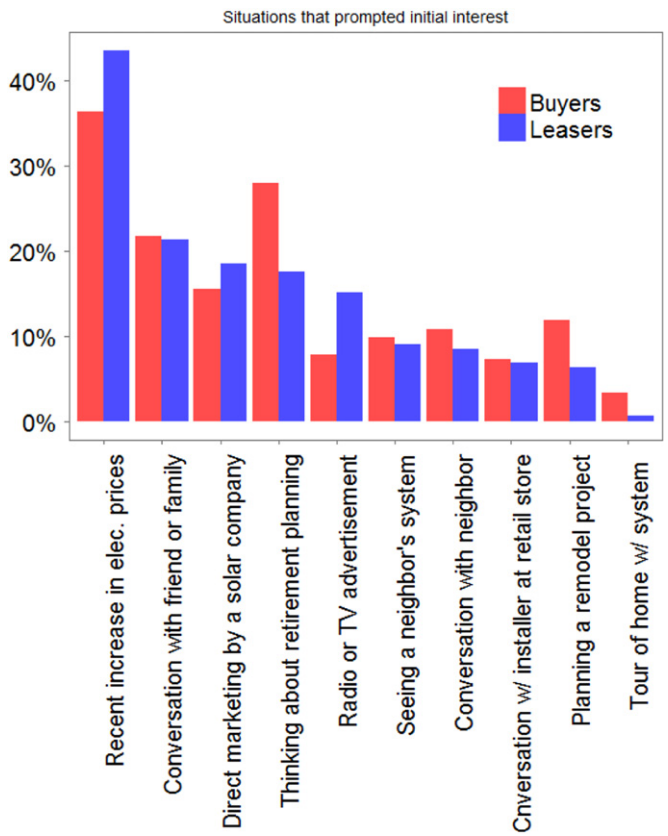

Figure 2. Buy versus lease differences in events that prompted adoption interest.

attitudinal differences between customers from the two business models. Specifically, buyers are found to have higher incomes by \$13 000 on average, though the result is not statistically significant. Buyers and leasers are roughly the same age, however buyers have nearly half a year of additional post-secondary education than leasers ($p = 4.9e{-}5$). In addition, leasers were less likely to be retired (38% of sample versus 45%) and more likely to have children living at home (37% versus 31%) though results are only significant at a 90% CI ($\chi^2 = 3.21$, df = 1, $p = 0.073$) and ($\chi^2 = 2.97$, df = 1, $p = 0.085$) respectively. For factors that adopters indicated were important in their decision to adopt PV, buyers rated 'lowering my total electricity costs' as being the most important, whereas 'protecting myself from future increases in electricity prices' was the most important factor for leasers (table S9). However, the only statistically significant difference is in the importance of protecting against future electricity prices. Aside from this difference, the two groups rated the remaining factors of decision-making with comparable magnitude of importance.

Lastly, adopters were asked how much they agreed with various statements related to their business model decision-making process (i.e., to buy or lease) with response options ranging from 1 (strongly disagree) to 5 (strongly agree). These perspectives included which business model seemed easier, would save more money in the long run, created more concern about signing a long-term contract, if selling the home would be easier, and whether those that the adopter knew had bought or leased their systems. We find there to be statistically significant differences in the importance of each of these priorities and perceptions across buyers and leasers at the 99.9% significance level (see supplementary material table S10). Specifically, buyers agree more with statements regarding the economics of the system—such as saving more money in the long run and ensuring that installing a solar system will not impede the ability to sell the home—suggesting that the long-run economics were more relevant to buyers relative to leasers than other features of the business model. Buyers are also more heavily influenced by the business model choice of their peers. In other words, they seem to be influenced by peer effects more strongly than leasers. On the other hand, leasers were more concerned with pursuing a simpler business model as they agreed more heavily with statements concerning the ease of the process and contract length.

While this analysis does not identify the causal drivers of the decision to lease or buy solar, it provides insights into how these customer segments differ. The findings have considerable implications for solar companies developing marketing campaigns and informational products that are specifically intended to motivate either leasing or buying options. Future work

will explore the determinants of the business model decision more robustly.

Conclusion

The US residential solar market is growing quickly, and to continue growing, it must expand into new populations. In the San Diego market, motivations for adopting are evolving, with environmental concerns decreasing in priority, replaced with greater interest in economic motivations and, particularly, reducing exposure to higher future bills. In other words, adopters appear to be increasingly pursuing solar installations not just in an effort to contribute to mitigating environmental challenges, but also because it is an economically attractive investment option. Furthermore, customers leasing their systems now constitute a majority of new installations in many markets—and these customers are more representative of the general population than early adopters. Buyers and leasers appear to differ on the importance of protecting against future electricity price increases in our sample. Taken together, the findings from this research could help to inform the development of a framework for segmenting customers. On the other hand, while our analysis provides insights into how the motivations for adopting solar appear to be changing more broadly, it is unclear whether this change is associated with actual beliefs and decision-making drivers or whether this is the symptom of targeted marketing strategies that highlight specific benefits of solar adoption in their communications. Future work could use this unique household level survey data to more robustly explore the causal determinants of adoption, considering the novel attributes consistently captured in our dataset across both adopters and non-adopters.

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