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Perspective

# When the lights go out: Californians' experience with wildfire-related public safety power shutoffs increases intention to adopt solar and storage

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ABSTRACT

As wildfire risk in the western U.S. grows due to climate change, the frequency and duration of public safety power shutoffs (PSPSs) are expected to increase. Surveying California residents (n = 804), we identify four respondent groupings based on PSPS experience and concern about future power outages. We find that those with higher levels of experience/concern express higher levels of intention to adopt solar and/or storage, even after controlling for factors such as socio-demographics, climate change concern, and existing adoption of smart technology within the home. Such findings have implications for areas where residents have experienced and/or are concerned about future power outages, suggesting that motivations for solar and storage adoption can go beyond financial considerations and environmental attitudes, and may include a desire to lessen impacts from power disruptions. In this *Perspective*, we argue that experience with and concern about extreme events, especially those that have the potential to result in power disruptions, should be incorporated into research about residential solar and storage adoption, and will likely become more important as extreme weather, climate change, and other aspects of an evolving electricity grid impact future power system reliability.

## 1. Introduction

With wildfire risk looming large in the American West and after the revelation that downed power equipment was responsible for the devastating 2018 Camp Fire in California [1], utility companies have increasingly used public safety power shutoffs (PSPSs) to reduce ignition hazards when fire risk is high [2]. When a utility initiates a PSPS, they de-energize sections of the electrical grid as a preemptive measure to reduce the risk of ignitions from power equipment during extreme fire conditions, such as high wind speeds accompanied by low humidity and/or dry vegetation or hazards observed by ground crews [3,4]. PSPSs are now routinely employed across California and have either been applied or planned in other areas of the Western U.S., including Oregon and Washington [5,6], as well as in other countries with high fire risk, such as Australia [7]. While electricity infrastructure is estimated to cause only 1% of ignitions in California, to date, these ignitions were responsible for half of the most destructive fires in the state [8,9], indicating a clear role for PSPS in wildfire prevention [10]. However, there is an active debate about the conditions under which PSPSs should be deployed, with some research suggesting that utilities in California have initiated PSPS events beyond objective criteria [8], all of which is happening under the backdrop of on-going wildfire litigation involving utilities [11]. Ensuring that PSPS events are appropriately applied is of critical importance as the consequences can be severe for those who are impacted. PSPSs can result in the loss of power to millions of households for consecutive days, as was the case in California in October 2019 [12], and can present grave threats to vulnerable populations, such as those who rely on medical equipment [13]. As climate change is anticipated to increase fire risk conditions in the western U.S. [14,15], more of the population will likely be impacted by outages from PSPSs in the future [8].

Policymakers have also recognized that a primary component for addressing future climate change will be the responsibility of the energy sector, requiring transformations that include the wider integration of renewable generation and the expansion of electrification in the transportation and residential sectors, which in turn could introduce additional uncertainties into the power system [16]. For residential consumers, these uncertainties, coupled with the potential for more frequent and longer-lasting PSPS events, higher energy prices, as well as a desire to reduce carbon emissions, may have households looking for

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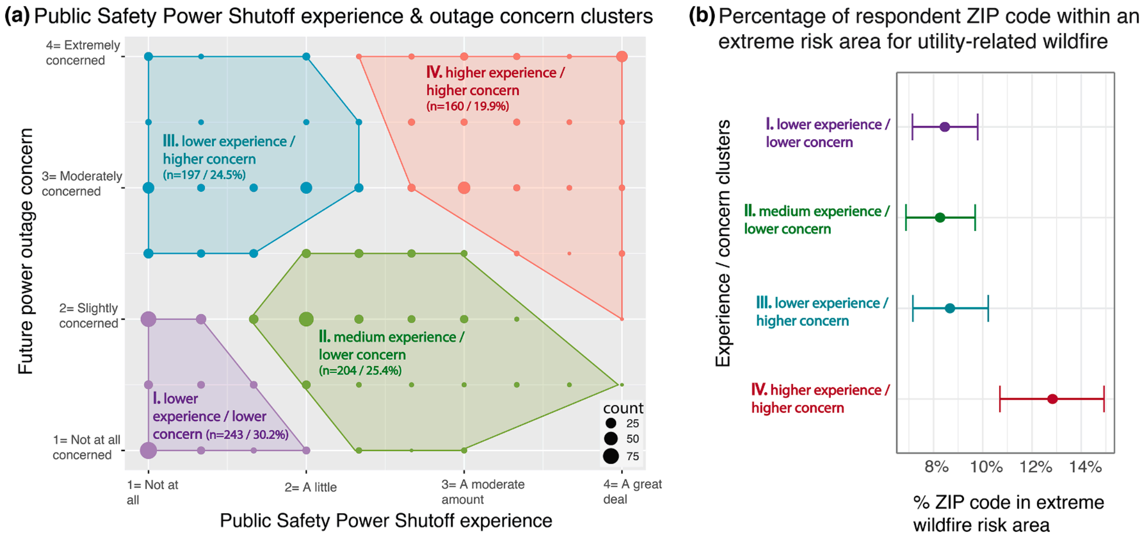


**Fig. 1.** (a) Four clusters describing PSPS experience and outage concern; (b) percentage of respondent ZIP code containing areas designated as having extreme utility-related wildfire risk, summarized by experience/concern clusters. Points represent means and lines 95% confidence intervals.

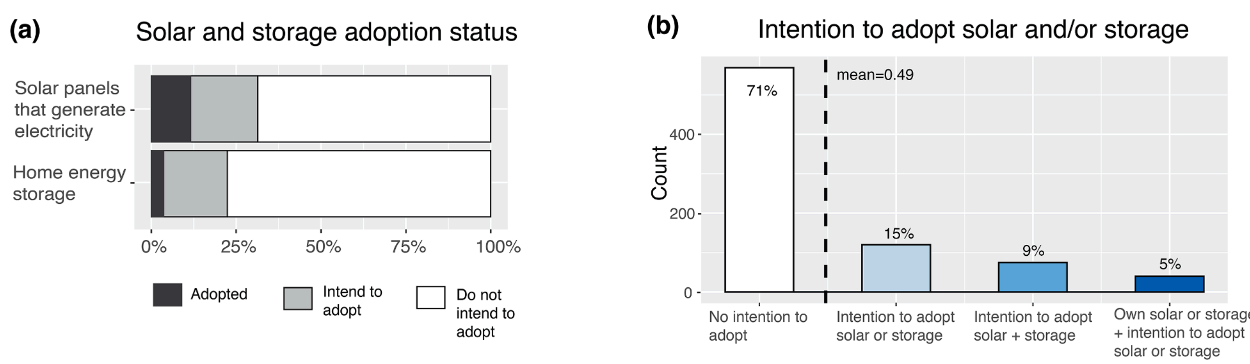


**Fig. 2.** Summaries of (a) Solar and storage resources by adoption status and (b) Intention to adopt solar and/or storage.

new ways to increase control of their electricity use and generation through smart home technologies [17].

For households seeking to reduce electricity disruptions from PSPSs and other outage events, solar generation and home battery storage systems, two Behind the Meter (BTM) resources, are emerging as increasingly viable technological solutions for residential users. This is especially true in places like California, with comparatively high year-long solar irradiance, time of use electricity pricing, and energy efficiency rebate programs [18]. While residential energy storage systems may afford some independence from the grid during times of brief disruption, when combined with rooftop solar into a single system, solar plus storage systems have the potential to enable power availability during longer, multi-day disruptions, dependent on the size of these systems, home characteristics and appliances, and the energy use patterns of inhabitants [19]. Residential adoption of solar and storage also may benefit the power system overall [20], lessening strains on the grid during high use periods and reducing the need to bring online nonrenewable sources of electricity generation (e.g., natural gas power plants) to meet this demand. However, increased adoption of solar and storage resources can also introduce new challenges for grid operators, such as more pronounced peaks in residential load profiles and increased complexity in grid planning [20].

Previous research has considered sociodemographic, behavioral, and attitudinal factors related to solar and other smart home technology adoption (though explorations of storage adoption are rare) [21,22]. Overall, adopters of smart home technologies are more likely to be male, have higher incomes, be homeowners (vs. renters), and cite motivations related to environmental concern, cost and energy savings, and interest in new technology [23,24]. While the characteristics of smart home technologies and solar adopters are similar, influence of peers, as well as household income, have been noted as particularly important for solar adoption [25,26]. At the same time, other literature has explored the role that personal experience with the impacts of extreme weather has had in influencing assessments about future climate change concern and support for climate change policy, with some linking this experience with greater intentions to make adaptation decisions [27–29]. However, we are unaware of research examining the role of PSPS experience and concern on the adoption of residential solar and storage, which, under the specter of a changing climate, and increased wildfire and outage risk, could be viewed as a type of individual or household adaptation behavior. Therefore, we seek to answer the following question: How does PSPS experience and concern for future power outages shape intention to adopt residential solar and storage?

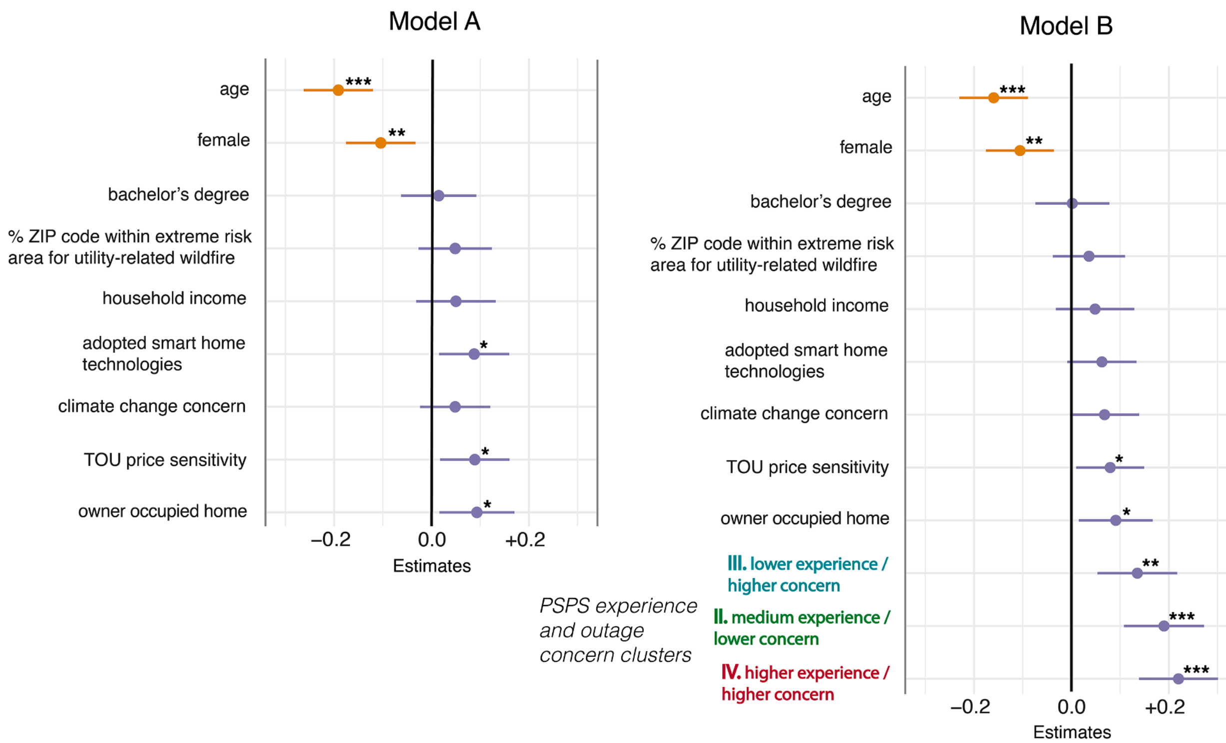


**Fig. 3.** Linear multilevel models predicting intention to adopt solar and/or storage with utility provider fixed effects and ZIP code random intercepts. Coefficients are standardized by two standard deviations with statistical significance levels at *p < 0.05, **p < 0.01, ***p < 0.001. Utility provider fixed effects were not statistically significant and removed from Model A and B for brevity (see Appendix A.3 for full model summaries).

## 2. Materials and methods

We fielded an online survey to a sample of 804 California residents recruited by Qualtrics, an internet survey research firm, from May 5–18, 2020. Respondents were quota sampled based on gender, age, and education-level and matched to estimates in the American Community Survey (ACS) for California [30]. While this survey was not designed to be representative of the California population, differences between the survey sample and California ACS estimates did not exceed +/-1% for matched demographic categories or ±7% for unmatched demographic and household characteristics (see Appendix A.1).

To characterize recent experience with PSPSs, we asked respondents "How much have recent public safety power shutoffs (when utility companies shut off electricity to limit wildfire risk) affected…?": (1) "You personally"; (2) "Other members of your family,"; and (3) "Your community." Response categories for these three items were situated on the same four point scale from 1 = "Not at all" to 4 = "A great deal." Responses to these items were combined into a single mean index, *PSPS experience*, which had acceptable reliability (Cronbach's alpha = 0.903). To assess respondent concern about outages, we formed the measure *Future power outage concern* from the question "How concerned are you about the following…?": (1) "My family's ability to cope with future power outages" and (2) "My community's ability to cope with future power outages", with these two items oriented on a four point scale from 1 = "Not at all concerned" to 4 = "Extremely concerned" (Cronbach's alpha = 0.869). We then used k-means clustering to identify four groups of respondents using *PSPS experience* and *Future power outage concern* indices as inputs. Cluster means were used to uniquely identify groups of respondents and were assigned names based on their relative position on the *PSPS experience* and *Future power outage concern* continuum.

For the primary dependent variable, *Intention to adopt solar and/or storage*, we combined responses from a multi-item question: "Which statement best describes your household's intentions to purchase the following items?" with items "Solar panels that generate electricity" and "Home energy storage battery (Tesla Powerwall, etc.)." Response categories were recoded to Do Not Intend to Adopt, Intend to Adopt, and Adopted. Using these responses, we formed a composite variable with the following categories: 0 = No intention to adopt; 1 = Intention to adopt solar or storage; 2 = Intention to adopt solar and storage; and 3 = Own solar or storage and intend to adopt the other resource. Category 3 therefore represents those who already own a single resource and intend to complete the system by adopting the second resource, signaling a higher level of intention to complete a solar plus storage system than Category 2. See Appendix A.2 for more information.

For independent variables, we included respondent demographic characteristics (age, gender, and education) as well as respondents' sensitivity to time of use pricing, where electricity rates vary during different times of day corresponding to grid demand (*TOU price sensitivity*), and level of concern about climate change (*climate change concern*). Additionally, household income, whether the respondents' residence is owner-occupied, and a count of already-deployed smart technology in the home (*adopted smart home technology*) were included as independent variables.

To explore the relationship between an objective measure of fire risk and respondent assessment of experience and concern, we measured the percentage of a respondent's ZIP code that is within an extreme risk area for utility-related wildfire, including potential impacts on people and property, by spatially summarizing Tier 3 zones from the California Public Utilities Commission Fire-Threat Map [31] within ZIP code Tabulation Areas (ZCTAs). We also modeled experience/concern clusters as dependent variables and found that our utility-related wildfire risk measure is positively associated with PSPS experience and future power outage concern, suggesting that objective fire risk assessment aligns with respondent self-reporting (Appendix A.5). All of the above model covariates are described in detail in Appendix A.2.

Multilevel linear regression models predicting *Intention to Adopt Solar and/or Storage* were estimated using the R package lme4 [32]. Individual-level predictors (i.e., Level 1) include the independent variables described previously (socio-demographics, household characteristics, behavioral response and attitudes, utility-related fire risk) and binary variables indicating the respondent's utility provider. Our group-level predictor (i.e., Level 2), respondent ZIP codes, are modeled as random effect intercepts. This modeling approach accounts for the hierarchical structure of our data, where households are nested within ZIP codes [33]. Main findings are robust to multiple alternative model formulations (e.g., binary logistic multilevel regression, see Appendix A.4).

## 3. Results

Results from our survey indicate that many Californians have experienced recent PSPS events and are concerned about future outages. On average, respondents reported being "a little" affected by recent PSPS events (mean = 1.95; SD = 0.91) and "slightly concerned" about future outages (mean = 2.38; SD = 0.91). When PSPS experience and outage concern responses are combined into a single analysis (Fig. 1), we uncover four clusters of respondents: I. lower experience/lower concern (n = 243/30.2%); II. medium experience/lower concern (n = 204/25.4%); III. lower experience/higher concern (n = 197/24.5%); and IV. higher experience/higher concern (n = 160/19.9%). On average, we find that respondents in the higher experience/higher concern cluster reside in ZIP codes that contain larger percentages of areas designated as being at extreme risk for utility-related wildfires (+4.35%; $t = 2.45$; $p < 0.05$).

We next turn to summaries of solar and storage (Fig. 2). For existing installations of solar and storage, 11.6% of respondents reported owning a solar system, 4.6% a home energy storage system, and only 1.2% owned solar plus storage. However, 15% of respondents reported intending to purchase either solar *or* storage, 9% solar plus storage, and 5% of respondents who owned either solar or storage reported intending to purchase the other resource to complete a solar plus storage system.

We extend this analysis by predicting intention to adopt solar and/or storage using multilevel regression modeling (Fig. 3). In our baseline model (Fig. 3: Model A) we find that older, female respondents expressed lower intentions to adopt solar and/or storage, which is consistent with previous literature about smart home technology adoption. Additionally, living in an owner-occupied home, more willingness to shift energy activities outside a time of use pricing window (TOU price sensitivity), and higher counts of adopted smart technologies in the home were all associated with greater intentions to adopt solar and/or storage. We do not, however, find education, income, climate change concern, or percentage of respondents' ZIP code within an extreme utility-related wildfire risk area to be related with intention to adopt solar and/or storage.

We next consider a model that includes PSPS experience and outage concern clusters (Fig. 3: Model B). Overall, our model findings demonstrate that PSPS experience and outage concern are positively related to intention to adopt solar and/or storage. Compared to the lower experience/lower concern cluster, the higher experience/higher concern cluster has the strongest association with increased solar and/or storage intention, followed by medium experience/lower concern and lower experience/higher experience clusters. Notably, among all the included model factors, the higher experience/higher concern cluster has the largest effect on intention to adopt solar and/or storage.

## 4. Discussion

We observe a strong connection between greater intention to adopt two BTM resources, solar and storage, and our higher PSPS experience/concern clusters, suggesting that California residents are likely already incorporating these considerations into purchasing decisions. While reasons for solar and storage adoption intention are multifaceted, many of which we were able to explore here, lived experience appears critical, particularly the experience of notable high impact events like PSPSs. Such personal, concrete, disruptive experiences need to be incorporated into our theoretical and empirical models of solar and storage adoption in ways they have not previously. Our results indicate that PSPSs may be serving as another type of personal experience associated with extreme weather events and climate change, potentially altering the calculus for individuals in terms of technology adoption in areas where they are happening. We therefore argue that power disruption experience and concern should be recognized as important determinants of BTM technology adoption, operating alongside, or in concert with, other social-psychological and economic motivations for BTM adoption.

The combination of experience of and concern about harm and potential impacts evokes cognitive appraisal models whereby appraisals of threat—especially those threats not under personal control (such as PSPSs and wildfires)—bring about a desire to limit threat via finding efficacious actions such as adoption of technologies that aim to preserve the safety of the household. One such model is that of *looming vulnerability*, which expands cognitive appraisals to those that are perceived as moving or looming [34,35]. Media depictions and community warnings add to the looming nature of wildfire and PSPS events. To the extent that individuals know of BTM technologies and have sufficient resources to adopt these technologies, BTM resources, in particular solar plus storage, offer a means of countering, or at least preparing for, the looming threat of wildfire-driven PSPS events. Only time, and additional data sources, will tell if this intent to adopt turns into actual adoption—a challenge identified by other research exploring solar adoption intention [36] as well as stated preferences for purchasing bundled BTM resources [22].

Our findings suggest that there could be opportunities for further catalyzing this intention into adoption via policy [37]. Our survey was fielded in May 2020, prior to California's record breaking 2020 wildfire season [38], and as we did not employ a research design that surveyed respondents before and after the 2020 wildfire season or repeatedly sampled Californians across multiple years [39], we can only postulate how these devastating wildfires may be influencing intentions to adopt BTM resources. Our expectation, however, is that in the wake of the 2020 wildfire season and associated PSPS events, even more households will be considering adopting solar plus storage systems than what we report in this study, with recent rapid growth in storage deployment only bolstering this claim [40]. Policy makers should use this as an opportunity not only to incentivize solar and storage, as well as other BTM resources such as electric vehicles, through rebates and other mechanisms but also consider how to address potential long-term equity concerns. This is especially important given the high upfront costs associated with purchasing and installing technologies that are often contingent on home ownership and certain levels of income. Such adoption challenges may make these technologies out-of-reach for lower income households and the vulnerable populations who may benefit from them the most. If disparities in access to reliable energy resources during outage events are not addressed, potentially through alternative mechanisms such as community solar and/or microgrids, residential solar plus storage adoption patterns may only reinforce existing social, environmental, and energy justice issues [41–43]. This is particularly relevant given how the coronavirus pandemic is both stretching household finances [44] while at the same time making households more reliant on electricity to fulfill a variety of functions within the home [45]. Such policy actions would benefit both individuals and the grid, while easing the transition to a smarter, cleaner energy system that can meet California's goal of zero-emission energy sources by 2045 [46]. Still other policies and investments could be aimed at minimizing the need for PSPS events altogether – e.g., through enhanced detection, aggressive clearing of vegetation around power lines, burying power lines, utilizing power diverters, etc. [47,48]. Yet, all of these potential solutions come with their own combinations of costs and benefits—and public perceptions of these costs and benefits—which will likely continue to shape policy and household decisions now and in the future and deserve continued scholarly attention.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgement

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## Appendix

Tables A1–A5

**Table A1**
Demographic measures and household characteristics.

| Measure | Survey Respondents | California ACS 2018 (5-year Estimates) |
|---|---|---|
| Gender | Male: 50.0%<br>Female: 49.9%<br>Other: 0.1%<br><br>*Item summary, Female (=1)* vs. *Male (=0)*<br>Mean = 0.499<br>n = 803 | Male: 49.7%<br>Female: 50.3% |
| Age | 18–34: 31.8%<br>35–64: 50.4%<br>65 and over: 17.8%<br><br>*Item summary, Age*<br>1 = 18–24; 2 = 25–34; 3 = 35–44; 4 = 45–64; 5 = 65 or older<br>Mean = 3.208<br>SD = 1.310<br>n = 804 | 18–34: 32.5%<br>35–64: 49.9%<br>65 and over: 17.7% |
| Education | High school or less: 37.8%<br>Some college: 29.1%<br>Bachelor's or higher: 33.1%<br><br>*Item summary, Bachelor's degree (=1)* vs. *Not Bachelor's degree (=0)*<br>Mean = 0.471<br>n = 804 | High school or less: 37.7%<br>Some college: 29.1%<br>Bachelor's or higher: 33.3% |
| Income | Median household income category: $60,000 - $69,999<br><br>*Item summary, Household income 16 categories from* 1 = Less than $10 K to 16=$500,000 or more<br>Mean = 6.706<br>SD = 3.56<br>n = 748 | Median household income: $71,228 |
| Owner occupied household | 56.1% owner-occupied<br><br>*Item summary, Owner occupied home (=1)* vs. *Not owner occupied (=0)*<br>Mean = 0.5609<br>SD = 3.56<br>n = 804 | 50.3% owner-occupied |

California ACS 2018 estimates for age were adjusted for comparison to the survey sample which did not include participants under 18 years old. Adapted from Zanocco et al. [31].

**Table A2**
Attitudes, perceptions, and derived measures.

| Measure | Survey question/ Description | Item information | Summaries |
|---|---|---|---|
| TOU price sensitivity | If the price of electricity were to double from 3 pm to 9 pm on weekdays, how likely would you and/or members of your household be to move this activity to a different time?<br><br>-Do laundry using the washing machine or dryer<br>-Cook with stovetop/range or oven<br>-Run the dishwasher<br>-Use electric heating when it's cold or fan/AC when it's hot<br>-Use a computer, game console, tablet, or TV | 1 = Very unlikely<br>2 = Unlikely<br>3 = Likely<br>4 = Very likely<br>5 = I don't do this in my home from 3 to 9 pm on weekdays | Recoded response items<br>1 = 1;2 = 2;3 = 3; 4 = 4; 5 = NA<br><br>Mean composite index with at least 2 response items without NAs.<br><br>Mean = 2,74<br>SD = 0.764 |
| Climate change concern | How much do you, personally, care about the issue of climate change? | 1 = Not at all<br>2 = Not too much<br>3 = Some<br>4 = A great deal | Mean = 3.24<br>SD = 0.854 |
| Adopted smart home technologies | Which statement best describes your household's intentions to purchase the following items?<br>…Smart Thermostat (Nest, Ecobee, etc.)<br>…Smart light bulbs (Philips Hue, etc.)<br><br>…Smart speaker (Amazon Echo/ Alexa, Google Home, etc.)<br>…Smart plug or power strip<br>…Home Energy Monitoring System (HEMS) (Sense, CURB, etc.)<br>…Robotic vacuum (Roomba, etc.) | 1 = We have already purchase<br>0 = Else | Summation of 6 items<br><br>Mean = 1.221<br>SD = 1.301 |
| % ZIP code within extreme risk area for utility-related wildfire | Percentage of ZIP code area that is located within Tier 3 fire-threat area as designated by the California Public Utilities Commission | Percentage of ZIP code | Mean = 9.348%<br>SD = 21.907 |
| Electricity utility provider | Self-reported utility provider | Pacific Gas and Electricity Company (PG&E)<br>Southern California Edison (SCE)<br>San Diego Gas and Electric (SDG&E)<br>Los Angeles Department of | PG&E; N = 275<br><br>SCE; N = 245<br><br>SDG&E; N = 60<br><br>LADWP; N = 149<br><br>Other; N = 75 |

(continued on next page)

**Table A2** (*continued*)

| Measure | Survey question/ Description | Item information | Summaries |
|---|---|---|---|
| | | Water and Power (LADWP) | |
| Public Safety Power Shutoff experience | How much have recent public safety power shutoffs (when utility companies shut off electricity to limit wildfire risk) affected…?<br>…You personally?<br>…Other members of your family<br>…Your community | 1 = Not at all<br>2 = A little<br>3 = A moderate amount<br>4 = A great deal | Items combined into a mean index<br><br>Mean = 1.954<br>SD = 0.906<br>Cronbach's alpha = 0.903 |
| Future Power Outage Concern | How concerned are you about the following…?<br>…My family's ability to cope with future power outages<br>…My community's ability to cope with future power outages | 1 = Not at all concerned<br>2 = Slightly concerned<br>3 = Moderately concerned<br>4 = Extremely concerned | Items combined into a mean index<br><br>Mean = 2.381<br>SD = 0.908<br>Cronbach's alpha = 0.869 |
| I. Lower experience/ lower concern | Clusters identified using Public Safety Power Shutoff experience and Future Power Outage Concern | Public Safety Power shutoff experience mean = 1.14<br>Future Power Outage Concern mean = 1.46 | N = 243 |
| II. Medium experience/ low concern | Clusters identified using Public Safety Power Shutoff experience and Future Power Outage Concern | Public Safety Power shutoff experience mean = 2.28<br>Future Power Outage Concern mean = 2.01 | N = 204 |
| III. Lower experience/ higher concern | Clusters identified using Public Safety Power Shutoff experience and Future Power Outage Concern | Public Safety Power shutoff experience mean = 1.52<br>Future Power Outage Concern mean = 3.06 | N = 197 |
| IV. Higher experience/ higher concern | Clusters identified using Public Safety Power Shutoff experience and Future Power Outage Concern | Public Safety Power shutoff experience mean = 3.31<br>Future Power Outage Concern mean = 3.41 | N = 160 |
| Intention to adopt solar and/or storage | Which statement best describes your household's intentions to purchase the following items?<br>…Solar panels that generate electricity<br>…Home energy storage battery (Tesla Powerall, etc.) | 1 = We have already purchased<br>2 = We intend to purchase in the next 12 months<br>3 = We intend to purchase after 12 months<br>4 = We have no intention to purchase<br>5 = This cannot be installed into our current home | Recoded response items:<br>0 = 1,4,5 for all items<br>1 = 2,3 for either Solar panels or Home energy battery<br>2 = 2,3 for Solar panels and Home energy battery<br>3 = 2,3 for Solar panels or Home energy battery AND 1 for Solar panels or Home energy battery<br><br>Mean = 0.485<br>SD = 0.858 |

**Table A3**
Multilevel regression models predicting intention to adopt solar and/or storage.

| | Intention to adopt solar and/or storage | |
|---|---|---|
| | Model 1A Std. beta (p-value[1]) | Model 2A Std. beta (p-value[1]) |
| ***Respondent characteristics*** | | |
| Age (categories) | -0.191*** (<0.001) | -0.160*** (<0.001) |
| Female (vs. male) | -0.104** (0.004) | -0.106** (0.003) |
| Bachelor's or higher (vs. less than bachelor's degree) | 0.015 (0.709) | 0.002 (0.963) |
| % ZIP code within extreme risk area for utility-related wildfire | 0.049 (0.206) | 0.036 (0.342) |
| Household income | 0.050 (0.229) | 0.049 (0.237) |
| Climate change concern | 0.088* (0.017) | 0.063 (0.085) |
| Adopted smart home technologies | 0.049 (0.186) | 0.068 (0.060) |
| TOU price sensitivity | 0.089* (0.014) | 0.080* (0.026) |
| Owner occupied residence | 0.093* (0.018) | 0.091* (0.019) |
| III. Lower experience / higher concern | | 0.135** (0.001) |
| II. Medium experience / lower concern | | 0.190*** (<0.001) |
| IV. Higher experience / higher concern | | 0.220*** (<0.001) |
| ***Electricity utility provider*** | | |
| PG&E (vs. other) | 0.027 (0.676) | -0.005 (0.938) |
| SCE (vs. other) | -0.012 0.853 | -0.024 (0.771) |
| SDGE (vs. other) | 0.005 (0.922) | 0.001 (0.981) |
| LADWP (vs. other) | 0.052 (0.375) | 0.041 (0.482) |
| **Random effects** | Std. Dev. | Std. Dev. |
| Zip codes (Intercept) | 0.2718 | 0.2682 |
| Intercept (unstandardized) | 0.159 (0.485) | -0.029 (0.892) |
| AIC | 1895.944 | 1878.473 |
| N | 730 | 730 |

[1] Coefficients are standardized by two standard deviations; statistical significance levels at *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

**Table A4**
Binary logistic multilevel regression models predicting intention to adopt solar/storage (0 = No intent to adopt; 1 = Intent to adopt solar, storage, or solar plus storage).

| | Intention to adopt solar/storage | |
|---|---|---|
| | Model 1B Odds ratio (p-value[1]) | Model 2B Odds ratio (p-value[1]) |
| ***Respondent characteristics*** | | |
| Age (categories) | 0.668*** (<0.001) | 0.701*** (<0.001) |
| Female (vs. male) | 0.576** (0.002) | 0.551** (0.001) |
| Bachelor's or higher (vs. less than bachelor's degree) | 1.191 (0.384) | 1.102 (0.633) |
| % ZIP code within extreme risk area for utility-related wildfire | 1.005 (0.228) | 1.004 (0.370) |
| Household income | 1.040 (0.162) | 1.041 (0.160) |
| Climate change concern | 1.351** (0.009) | 1.249 (0.058) |
| Adopted smart home technologies | 1.082 (0.232) | 1.138 (0.060) |
| TOU price sensitivity | 1.364** (0.009) | 1.317* (0.024) |
| Owner occupied residence | 1.413 (0.070) | 1.430 (0.070) |
| III. Lower experience / higher concern | | 2.978*** (<0.001) |
| II. Medium experience / lower concern | | 3.763*** (<0.001) |
| IV. Higher experience / higher concern | | 5.598**** (<0.001) |
| ***Electricity utility provider*** | | |
| PG&E (vs. other) | 0.844 (0.610) | 0.713 (0.328) |
| SCE (vs. other) | 0.710 0.312 | 0.663 (0.243) |
| SDGE (vs. other) | 0.567 (0.212) | 0.576 (0.233) |
| LADWP (vs. other) | 0.979 (0.954) | 0.902 (0.784) |
| **Random effects** | Std. Dev. | Std. Dev. |
| Zip codes (Intercept) | 0.2935 | 0.2107 |
| Intercept (unstandardized) | -1.590** (0.009) | -2.3448*** (<0.001) |
| AIC | 865.3359 | 824.8398 |
| N | 730 | 730 |

[1] Coefficients are standardized by two standard deviations; statistical significance levels at $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

**Table A5**
Binary logistic multilevel regression models predicting experience/concern cluster membership.

| | I. Lower experience/ lower concern Model 1C Odds ratio (p-value[1]) | II. Medium experience/ lower concern Model 2C Odds ratio (p-value[1]) | III. Lower experience/ higher concern Model 3C Odds ratio (p-value[1]) | IV. Higher experience/ higher concern Model 4C Odds ratio (p-value[1]) |
|---|---|---|---|---|
| ***Respondent characteristics*** | | | | |
| Age (categories) | 1.275*** (<0.001) | 0.847* (0.013) | 1.067 (0.359) | 0.840* (0.016) |
| Female (vs. male) | 0.964 (0.832) | 1.095 (0.601) | 0.917 (0.634) | 1.010 (0.957) |
| Bachelor's or higher (vs. less than bachelor's degree) | 0.705 (0.085) | 0.930 (0.717) | 1.194 (0.391) | 1.371 (0.144) |
| Household income | 0.980 (0.454) | 1.048 (0.080) | 1.043 (0.145) | 0.927* (0.012) |
| Owner occupied residence | 1.143 (0.477) | 1.279 (0.197) | 0.562** (0.004) | 1.199 (0.377) |
| % ZIP code within extreme risk area for utility-related wildfire | 0.996 (0.333) | 0.996 (0.395) | 0.997 (0.550) | 1.011** (0.007) |
| ***Electricity utility provider*** | | | | |
| PG&E (vs. other) | 0.446** (0.009) | 1.502 (0.239) | 1.299 (0.466) | 1.385 (0.378) |
| SCE (vs. other) | 0.622 (0.121) | 1.237 (0.547) | 1.637 (0.176) | 0.928 (0.844) |
| SDGE (vs. other) | 1.041 (0.918) | 1.322 (0.525) | 0.664 (0.413) | 1.050 (0.920) |
| LADWP (vs. other) | 0.561 (0.087) | 1.282 (0.510) | 1.507 (0.287) | 1.073 (0.862) |
| **Random effects** | Std. Dev. | Std. Dev. | Std. Dev. | Std. Dev. |
| Zip codes (Intercept) | 0.3726 | 0 | 0.4335 | 2.424e-07 |
| Intercept (unstandardized) | −0.915* (0.015) | −1.110** (0.002) | −1.201*** (<0.001) | −1.440 (0.081) |
| AIC | 903.4815 | 853.278 | 841.3276 | 749.2984 |
| N | 747 | 747 | 747 | 747 |

[1] Coefficients are standardized by two standard deviations; statistical significance levels at $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

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