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SPECIAL FEATURE: ORIGINAL ARTICLE

Citizens' Attitudes, Preferences, Willingness-to-pay for Climate Change Mitigation Options in Asia

Public perceptions on net zero energy houses in Japan

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Abstract
For Japan, which has not operated nearly all of its nuclear power plants since 2011 and is dependent on thermal power generation, the introduction of renewable energy into homes is extremely important for the future formation of a sustainable society. However, the introduction of net zero energy house (ZEH) in detached houses, which account for 55% of all dwellings in Japan, has not progressed. To promote the introduction of ZEH, this study clarified the awareness of owners of detached houses regarding ZEH. We analyzed factors that influence such perception of solar photovoltaics (PV) technology using a 1000-sample online survey questionnaire. The survey was conducted in late January 2020 and included questions examining the public perception of solar installation and factors that were found to be important in previous research. We found that Japanese respondents who live in detached houses generally lack an understanding of renewables and that the level of interest in installing solar PV for the ZEH is low. We also found that awareness of renewables, such as knowing new energy policy and searching information on solar PV, is the critical factor of installing renewables. At the same time, most socio-demographic and neighborhood variables seem not to influence installing solar PV or other technologies for ZEH. This research will contribute to the Japanese government's goal of strengthening education on renewable energy to promote ZEH.

Keywords Net zero energy houses · Public perceptions · Solar photovoltaics · Renewables · Japan

Introduction

It is generally believed that climate change has become one of the significant threats posed to human beings, with severe and urgent effects on the environment, human health, and society. All sectors must contribute to deep emission cuts to achieve the long-term temperature goals of the Paris Agreement of 2015. About the same time this agreement was forming, citizens around the world started to take a high interest in green energy. Chaikumbung (2021) found that citizens in more democratic and capitalistic countries were willing to pay higher prices for renewable energy through meta-analysis from over 90 renewable energy studies. Soon and Ahmad (2015) calculated the summary willingness-to-pay (WTP) estimates from 30 studies and found that US and Canadian households have higher WTP than Chinese and Korean ones.

In 2017, energy consumption by the building sector constituted 28.6% of Japan's total final energy consumption. In Tokyo, the building sector, including commercial and residential, accounted for 77% of greenhouse gas (GHG) emissions. Like many other countries which have developed policies to promote new high-performance buildings to address climate challenges under the Paris Agreement, the Ministry of Economy, Trade and Industry of Japan (METI) established a ZEH roadmap in December 2015 to promote ZEH (METI 2015). In 2020, Japan declared "Carbon Neutrality by 2050," and the METI and other

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ministries formulated the "Green Growth Strategy through Achieving Carbon Neutrality in 2050" (METI 2021). However, although Japan's government is currently determined to move toward carbon–neutral living and achieve net zero energy building (ZEB) by 2050, the cost involved in constructing ZEH is generally higher than an ordinary house. The incremental cost of building a ZEH is estimated to be around 6.7–8.1% higher compared to ordinary houses in the USA (Petersen et al. 2018). Apart from the USA, several studies show the prospect and importance of ZEB/ZEH in the EU (Nematchoua et al. 2021), China (Liu et al. 2019), and Saudi Arabia (Alrashed and Asif 2015). To suggest recommendations to policymakers for promoting the construction of ZEH in Japan, more research on public perception and WTP of ZEH is required.

Public acceptance and perception of renewable energy adoption are prerequisites for successfully achieving energy goals and promoting ZEB/ZEH policies. Wu and Skye (2021) reviewed residential ZEB and summarized that solar energy had been the mainstream renewable energy source for residential ZEBs. Understanding the acceptance and perception of solar PV is critical because residential rooftop PV is a creditable energy-efficient building technology used in Japan (Murakami et al. 2006). However, most research on the social acceptance of solar energy has focused on the context of large solar installation projects. Therefore, interviews and survey questionnaires are the most used method in such research. For example, Van Veelen and Van Der Horst (2018) have conducted face-to-face interviews with the residents of Morocco on the acceptance of large-scale solar energy installations. They found reasonably high acceptability of solar energy, mainly because of the environmentally friendly image of solar PV, but very low perceived level of knowledge about the solar installation project. Similarly, a highly positive image of solar PV was also revealed in Moroccan residents (Sütterlin and Siegrist 2017).

On the other hand, there is less discussion on public acceptance and perception of small solar home systems such as a rooftop PV system and examination of factors that influence households' interest in PV installation (Sauter and Watson 2007). This solar microgeneration system requires more active acceptance by the homeowners willing to install solar PV systems in their houses. Solangi et al. (2015) employed a survey questionnaire to examine the social acceptance of residential solar systems. They suggested that solar PV has gained a lower public acceptance and awareness than solar water heater energy in Shandong, China. Simpson (2018) indicated that both financial incentives and social interactions in the communities contributed to solar installation. The critical factors of social acceptance of rooftop solar PV in Thailand were examined by Suppanich and Wangjiraniran (2015), and they suggested that global warming concern was a primary factor for the accepters, while installation cost was the main factor for the rejecters.

Studies in Japan have extensively discussed renewables such as nuclear power and wind power (Rehdanz et al. 2017; Maruyama et al. 2007) and public perception of solar energy, especially on small solar home systems (Mukai et al. 2011; Yamaguchi et al. 2013). Chen et al. (2020) found that technology anxiety about home energy management systems reduces WTP in Tokyo, but overall, there is little literature that reveals Japanese attitudes toward ZEH/ZEB. An international survey conducted during the World Wide Views on Climate and Energy (WWViews) revealed that though Japanese are as concerned about climate change as those from other countries, they feel less positive about climate action than counterparts in other countries (e.g., JST 2015). A survey with undergraduates confirmed that even the young generation, the so-called Z generation, which is usually found to be a force for climate action, has fairly negative attitudes about decarbonization (Kihara and Matsubara 2018). Similarly, individuals do not perceive their personal actions as impactful on climate change unless others also engage in the same actions; the share of such a response was the third highest among the surveyed countries in the 2020 Intertional Social Survey Programme (Murata 2021). Japan has been actively promoting solar PV through various support policy instruments, most notably with the full-fledged feed-in tariff (FIT) scheme since 2012. Despite the generous support, the deployment has been rather slow. As of 2020, about 7% of the detached houses have solar PV on their roofs, while the share is up to 30% in Australia.

The Green Growth Strategy for Carbon Neutrality by 2050 aims to promote the spread of ZEH and ZEB further. According to the METI, the use of next-generation photovoltaic cells will make it possible to install solar PV on the roofs, walls, and windows of homes and buildings, which has been difficult in the past, and increase the generation of renewable energy (METI 2021). The government also aims to reduce or eliminate the burden of utility costs on consumers by making more than half of new custom-built detached houses ZEH. In addition, the government plans to add housing and small-scale buildings to the list of mandatory compliance with the Act on the Improvement of Energy Consumption Performance of Buildings by 2025. However, at present, only 13% of all custom-built houses are ZEH due to a lack of knowledge about ZEH among small- and medium-sized builders, the high cost of installing solar PV in detached houses, and a low level of consumer awareness and understanding of the benefits of ZEH (METI 2021). At the local government level, the Tokyo Metropolitan Government is aiming to achieve a "Zero-emission Tokyo" by standardizing the installation of PV power generation equipment in new buildings. In May 2022, the Tokyo Metropolitan Government's panel of experts compiled a draft report

recommending that new buildings, including single-family homes, be required to install PV panels.

Such a contradiction of high construction cost while promoting low-carbon buildings in Japan, as well as the lack of literature discussing small solar home systems, led to the following research question:

- What factors may affect the public perception of solar PV technology in Japan?

By conducting a household survey, this paper investigated the factors that affect public perception of solar PV technology. Thus, it fills in the gap in previous research on public perception and WTPs of renewables in the context of ZEHs from the perspective of Japan. We conducted a survey to investigate the acceptance of households from an economic perspective and to analyze factors influencing their preference from a social psychology perspective. The present study on the perspectives of actual residents of detached houses regarding ZEH is expected to provide crucial insights for future ZEH policies in Japan and the achievement of a carbon–neutral society. Furthermore, it is likely to offer valuable insights for other countries, particularly those where the promotion of ZEH is increasingly necessary.

Methodology

In this study, we describe the survey conducted to investigate the awareness of energy-related issues, environmental concerns, electricity costs, and PV systems among residents of single-family dwellings in Japan. Notably, no prior information was provided to the participants in this study. This approach was employed to obtain an authentic understanding of the current awareness regarding PV installations and ZEH among real-world occupants of detached houses. The entire survey questionnaire was conducted online by My Voice Inc., a private consulting firm based in Japan. In consideration of insights into optimal sample sizes in consumer surveys by Tonsor et al. (2009), we utilized Myvoice Inc. to obtain 1000 valid responses. A total of 1166 Japanese were recruited for this online survey in late January 2020, and 1000 survey responses were collected on the same day. This 1166-respondent sample was selected through a stratified random sampling method, and the 47 prefectures in Japan defined the strata. Meanwhile, all respondents live in a detached house by design since we planned to ask about house rooftop PV. All respondents were not informed of the content of this survey and did not receive any other instructions. Based on the survey results, linear and logistic regression analyses were conducted to examine how socio-demographic variables, interest, views on the environment, and neighbors influence interest in installing solar PV and plans to install solar PV.

Questionnaire and data collection

The survey instrument employed in this research encompassed various dimensions designed to comprehensively capture respondents' perspectives. Firstly, socio-demographic profiles were outlined using eight questions (q1–q8). To gauge the influence of attitudes toward global warming on the outcomes, nine questions (q9–q17) were incorporated, addressing respondents' views on global warming and rankings of environmental issues, drawing inspiration from the work of Curry et al. (2007). Recognizing the pivotal role of energy awareness, seven questions (q18–q21, q24–q26) were dedicated to exploring respondents' awareness and understanding of energy, leveraging content from the household energy questionnaire survey and renewable energy survey questions. This addition was motivated by the hypothesis that a general interest in energy issues might correlate with the propensity to install solar PV or a battery system. Two questions (q22–q23) delved into respondents' WTP preferences for environmentally friendly products. Finally, nine questions (q27–q35) were directed at assessing attitudes toward solar PV, partially drawing from the framework proposed by Curry et al. (2007). This multifaceted survey instrument facilitated a nuanced exploration of the diverse dimensions underpinning respondents' perspectives and preferences.

Questions to examine public perception of solar installation

Socio-demographic variables include age, gender, education level, and other socio-economic variables. Several variables of interest in climate change and energy were implemented, including concerns about global warming and energy saving, level of understanding, awareness of renewables, and interest in installing solar PV and batteries. For analysis, q19 and q24 were combined to become q19 + q24, as these two variables have relatively high consistency (Cronbach's alpha $\alpha = 0.78$). Similarly, q27 and q28 were combined to become q27 + q28 (Cronbach's alpha $\alpha = 0.84$), and q34 and q35 were combined to become q34 + q35 (Cronbach's alpha $\alpha = 0.87$). Variables of views on the environment were implemented, including opinions on the current environmental situation, WTP for ecofriendly products, and projection on energy scarcity. For analysis, q22 and q23 were combined to become "q22 + q23", as these two variables have relatively high consistency (Cronbach's alpha $\alpha = 0.87$). Neighborhood variables include the number of neighbors (q32) and the number of family and friends who installed solar systems previously (q33).

Table 1 Descriptive statistics of socio-demographic features of all respondents

Description	Frequency	Percentage (%)
Gender		
Male	498	49.8
Female	502	50.2
Age		
Below 40	442	44.2
40 and above	558	55.8
Marriage		
Married	460	46.0
Unmarried	540	54.0
Education		
High school or below	498	49.8
College or higher	502	50.2
Household Income		
Below 5 million yen	402	40.2
5 million yen and above	598	59.8
Electricity bill		
Below 9 thousand yen	440	44.0
9 thousand yen and above	560	56.0

Results

The descriptive summary of the socio-demographic features of all 1000 respondents is shown in Table 1.

Descriptive results of perception on climate change and energy

In general, the Japanese respondents strongly agreed that human-caused global warming was occurring (Fig. 1). About 90% of all respondents believed there was an increase in the global average temperature since 1900 (q10), and about 60% of all respondents believed it was primarily caused by human activities (q12). On average, Japanese respondents were concerned about the environment, especially global warming. Around 90% of all respondents indicated that our environment was at least in some trouble or in lousy shape and needed effort to save it (q14), and more than half of the respondents answered that they were worried about global warming very much or somewhat (q11). Moreover, nearly 40% of the respondents in Japan regarded global warming as the worst environmental problem facing the planet (q15).

The degree of concern toward energy was also high (Fig. 2). Approximately, 50% and 70% of the respondents assumed that energy would be scarce in Japan sometime within 30 years and 50 years from now, respectively (q20). Also, above 60% of the respondents expressed strong or somewhat moderate concern about expected future price rises (q19). Moreover, around two-thirds of the respondents expressed a high interest in saving energy in their homes (q24).

In this study, the current understanding of residential attitudes toward solar PV installation was assessed by investigating homeowners without providing any prior information, serving as an overview of the current situation regarding the adoption of solar PV. Interestingly, respondents showed a low level of interest in installing solar PV themselves (Fig. 3). For example, only one-third of all respondents had thought of installing solar PV for their home (q34), and more than half of them were not interested in installing a household storage battery to store the electricity generated for their home (q35). Also, about 75% of all respondents indicated no plan to install solar PV in 5 years (q30).

As shown in Fig. 3, the reason for this low interest in installing solar PV was probably financial. According to the data collected in q29, 41% of respondents chose installation cost and 20% chose maintenance cost as the primary factor preventing them from installing solar at home. There were different subsidies for solar PV at the national and local government levels. Since 2000, the annual reduction in initial PV installation costs has made it increasingly accessible for households to adopt PV systems. Additionally, the rapid growth in the adoption rate of PV systems was influenced by factors such as planned blackouts, following the impact of the Great East Japan Earthquake in 2011. As the PV adoption rate increased, the installation costs gradually decreased. Following the government's assessment that the 'threshold for adoption had lowered,' the national subsidy provided for stand-alone solar PV installations was discontinued in 2014. On the other hand, at the local government level, in Tokyo, for instance, there is a subsidy of 120,000 yen[1] per kilowatt (with a maximum of 360,000 yen) for installing solar panels in newly constructed homes (Tokyo Metropolitan Government 2023). Currently, some local governments such as Tokyo have their own unique subsidy programs for the installation of PV systems. Therefore, many homeowners tend to hesitate to adopt PV systems in the absence of such subsidies, highlighting the current lack of financial incentives for PV adoption in many residential areas.

This low interest in installing solar PV was also probably related to a lack of understanding of renewables, as shown in Fig. 4. Several questions were designed to measure the awareness and understanding of renewables. More than half of them did not know the difference between renewable and non-renewable energy as a concept (q18). 82% were not aware of promoting the ZEB policy in Japan (q25). Only 26% had ever researched about buying or investing in solar

[1] $1 = 145$yen (Jan. 2024). 120,000yen = US$825. 360,000yen = US$2476.

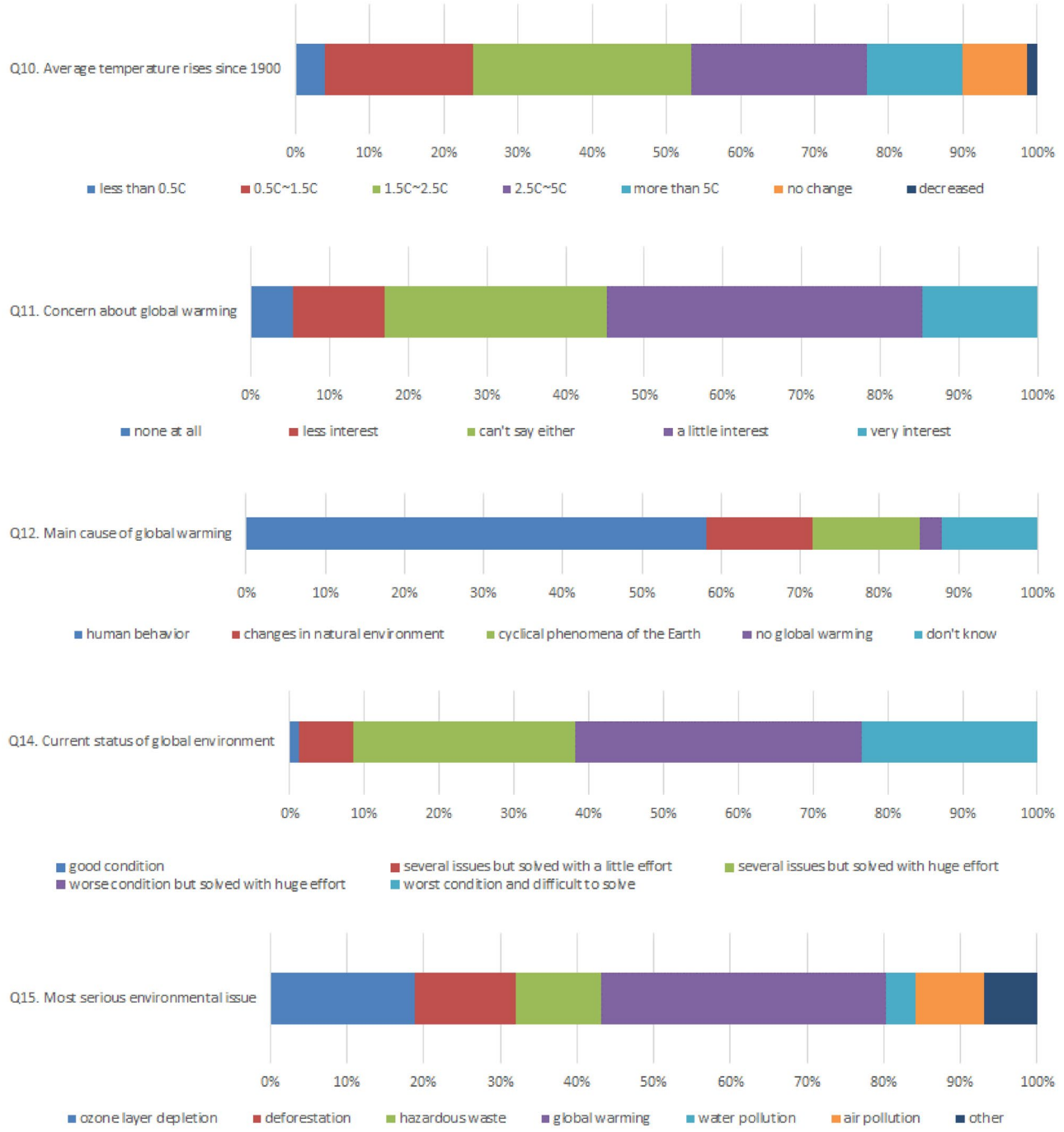

Fig. 1 Summary of responses to questions on perception and understanding of the Earth

PV (q28). Only 36% had ever researched about solar panels regardless of purchase intention (q27).

Overall, the descriptive results show that respondents held a broad concern about climate change and energy, as well as high confidence in human-caused global warming. Most of the respondents argued that the government should take action to mitigate climate change. However, respondents showed a low level of interest in installing solar PV themselves. They also exhibited a lack of awareness and understanding of renewables, suggesting a potential reason for the low level of interest in installing renewables.

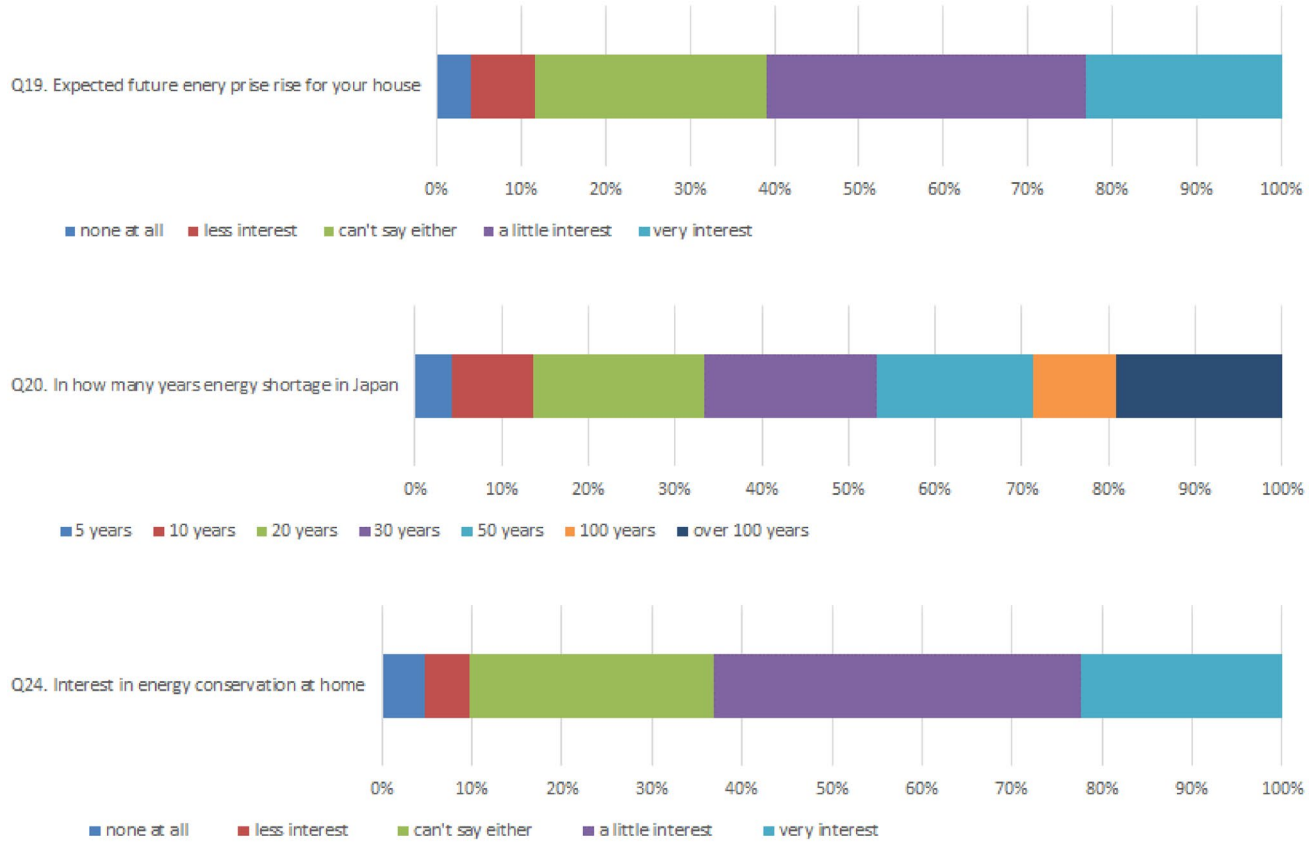

Fig. 2 Summary of responses to questions on perception and understanding of energy and renewables

Logistic regression results of the plan to install or invest in solar PV

Logistic regression analysis was conducted to investigate the separate and combined effect of socio-demographic variables, interest, views on the environment, and the influence of neighbors (independent variables) on the plan of Japanese households to install solar PV (dependent variable). Table 2 shows the logistic regression analysis results on the plan to install or invest in solar PV. We analyzed five models. Models 1–4 focused on specific attributes and themes, while Model 5 involved a comprehensive analysis encompassing all aspects.

In Model 1, age (q2), gender (q1), and marriage (q4) were the three socio-demographic variables that might significantly affect the plan of households to install or invest in solar PV. In contrast, the electricity bill (q9) and the number of people living together (q8) seemed not to influence the plan to install or invest in solar PV. Also, respondents with higher education levels (q6) or household income levels (q7) tend to have plans to install or invest in solar PV. However, the McFadden R^2 value (0.175) was too low.

In Model 2, concern toward future energy price rise (q19, q24), knowing new ZEB policy (q25), search about solar PV (q27, q28), and interest in installing solar PV (q34, q35) were the most significant factors of plans to install or invest in solar PV. Interest in global warming (q11) and knowing the difference between renewable and non-renewable energy would limitedly influence the plans to install or invest in solar PV. The McFadden R^2 value (0.529) indicated a good fit for this model.

In Model 3, the view on warming (q13) and a WTP value for eco-friendly products (q22, q23) may significantly affect the plan of households to install or invest in solar PV. Respondents who regarded global warming as a serious problem and were willing to pay for eco products were more likely to have plans to install or invest in solar PV. However, the low McFadden R^2 value (0.150) suggested a low fit of this model.

In Model 4, the number of family and friends who installed solar PV (q33) was a significant factor in installing or investing in it. However, the number of neighbors who installed solar PV (q32) did not significantly influence the plan. Therefore, the McFadden R^2 value (0.113) was too low to suggest a suitable model.

Finally, Model 5 combined the four models and was designed to examine which variables were significant factors of the plan to install or invest in solar PV. The

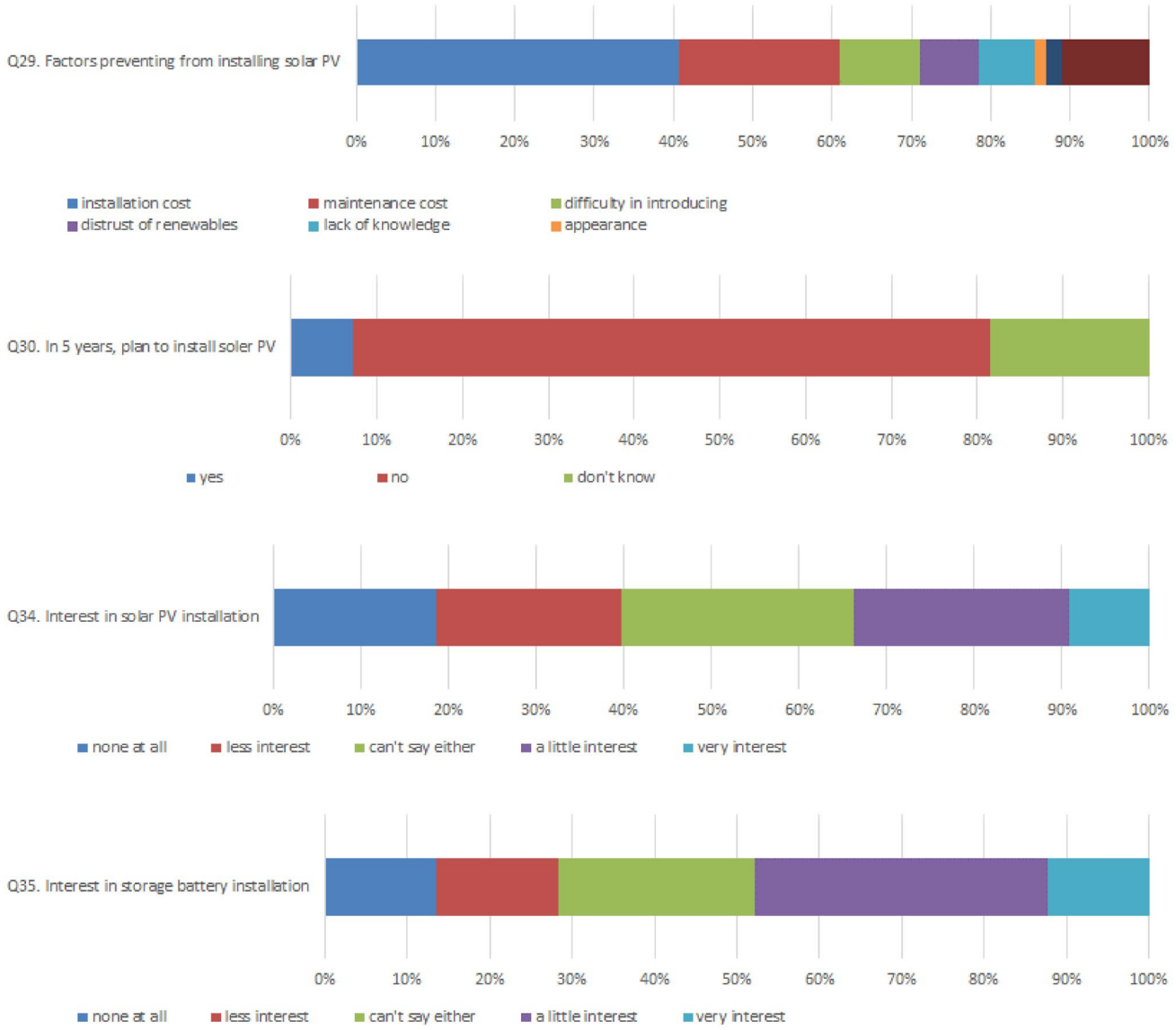

Fig. 3 Summary of responses to questions on perception and understanding of solar PV

McFadden R^2 value (0.611) indicated a good fit for this model. The results show that knowing the new ZEH policy (q25), search about solar PV (q27, q28), and interest in installing solar PV (q34, q35) were critical factors of the plan of households to install renewables. All these three factors were related to the level of awareness and understanding of renewables. These suggested that a high level of understanding of renewables was the key for people to have plans to install renewables at home. Moreover, the concern toward future energy price rise (q19, q24) and the WTP value for eco products (q22, q23) also positively affect the plan to install or invest in solar PV to some extent. Therefore, people who do not strongly conserve electricity for the sake of monthly power bills and are willing to purchase eco-friendly products, even at a slightly higher cost for the benefit of the environment, tend to be more proactive in adopting PV systems. Unlike the cases in countries such as the USA and Australia, in Japan, the installation of PV systems is not widely perceived as profitable through feed-in tariff (FIT). Instead, there seems to be a recognition that even with a slight increase in personal expenses, the installation of PV systems is viewed as a contribution to environmental conservation. Age (q2) was the only socio-demographic variable that affected the plan to install or invest in solar PV. Its negative coefficient indicates that young people tend to have plans to install or invest in solar PV. Other socio-demographic variables, along with the number of neighbors who installed solar PV (q32) and the number of family and friends who installed solar PV (q33), were not significant factors.

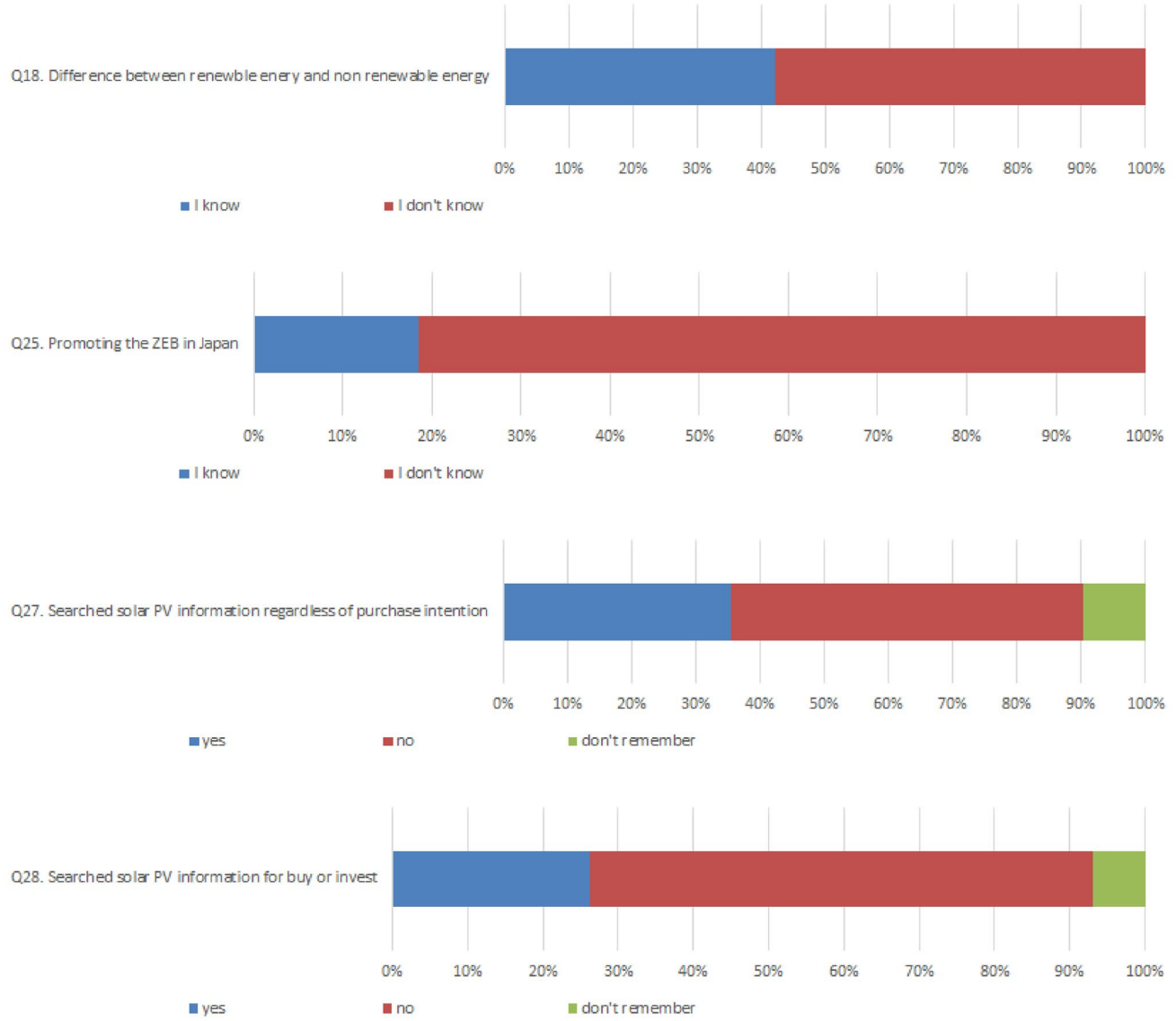

Fig. 4 Summary of responses to questions on perception and understanding of renewables

Discussion

Our results showed that Japanese respondents were moderately concerned about climate change and energy issues, and this vital concern significantly affected households' interest in installing renewable technologies. These findings align with those of Nakano et al. (2018). On the other hand, the data showed a contradiction in attitude toward climate change efforts. Although the majority of the Japanese respondents indicated strong support for the government to mitigate climate change and invest in renewables, they lack awareness and understanding of renewables and showed a low level of interest in installing solar PV and battery systems themselves. Similarly, Leiserowitz (2006) also observed this contradiction in policy attitudes in the USA. It appears that Japanese respondents are hoping that the government or someone else would solve the climate change problems with little change in their behaviors or lifestyle. This suggests that the Japanese public is in the 'wishful thinking' stage of the seven stages of public opinion forming (Yankelovich 1992).

This paper has filled in the gap in previous research on public perception for ZEH by analyzing from a Japanese perspective. It can be improved if the comparison of public opinions on ZEH and the differences in the determinants of public acceptance and opposition among multiple countries and regions are conducted in the future. Also, it is essential to analyze how socio-psychological factors such as political beliefs and cultural values could explain public acceptance and perception of ZEH. For example, Leiserowitz (2006)

Table 2 Logistic regression analysis on the plan to install or invest in solar PV

	Independent variables	Model 1 Socio-dems	Model 2 Interest	Model 3 Attitude	Model 4 Neighbor	Model 5 Full
q1	Gender	−1.180**				−0.409
q2	Age	−0.098**				−0.077**
q4	Marriage	1.369**				0.270
q6	Education	0.293*				0.230
q7	Income	0.365**				0.205
q8	No. of people living together	−0.072				−0.038
q9	Electric bills	−0.100				−0.124
q11	Interest in global warming		0.424			0.367
q19 + q24	Concern on energy price rise		−0.515**			−0.434*
q18	Diff. Btw renewable and non-renewable		0.212			0.225
q25	Zeh		2.480**			2.294**
q27 + q28	Searched about solar panel		1.291**			1.374**
q34 + q35	Interest in install solar PV		0.585**			0.575**
q13	View on warming			−0.373**		0.131
q22 + q23	WTP for eco products			0.334**		0.185*
q20	View on energy scarcity			−0.123		−0.036
q32	Neighbor's solar PV installation				−0.048	−0.203
q33	Family's solar PV installation				1.062**	0.377
McFadden R^2		0.175**	0.529**	0.15**	0.113**	0.611**
N		693	693	693	758	693

Dependent variable, plan to install solar PV in your own home or to invest in solar PV in 5 years (q30)

*Significant at $p = 0.1$; **significant at $p = 0.05$; ***significant at $p = 0.01$

found that value commitments like pro-egalitarian value were the strongest predictor of climate policy preferences. Furthermore, according to Devine-Wright (2007), personal variables (age, gender, income), socio-psychological variables (knowledge and awareness, environmental and political beliefs), and contextual variables (technology type and spatial context) are three major types of factors explaining public acceptance of renewable energy technologies. The influence of more potential socio-psychological and contextual variables should be investigated and compared for future perception studies on ZEH.

Conclusion

In this paper, a questionnaire survey of 1000 respondents was conducted, covering questions examining the public perception of solar installation. In addition, it investigated the factors of Japanese households for the ZEH that affect public perception of solar PV technology. Analysis of survey data discerns that factors such as age, monthly electricity expenditures, knowledge of ZEH, interest in PV, and eco-product consumption play pivotal roles in influencing the inclination toward PV adoption and investment. Focusing on demographic variables, it was found that only age was associated with the promotion of ZEH installation. The observation that younger single-family homeowners exhibit a more positive attitude toward ZEH installation aligns with past research (e.g., Nagasawa 2017) indicating a preference for new technologies among young people in Japan. While concerns about PV installation and maintenance costs pose significant challenges to PV adoption, no distinctions were observed based on household income. Therefore, it is imperative for the advancement of ZEH policies in Japan to encourage increased understanding of the cost burden associated with ZEH adoption and to promote initiatives such as the expansion of subsidies for ZEH installation costs offered by various local authorities.

We found that Japanese respondents generally lack understanding of renewables, and the level of interest in installing solar PV and WTP for ZEH is relatively low. Awareness of renewables, such as knowing new energy policy and searching information on solar PV, is the primary factor affecting the solar plan. Therefore, to move toward carbon–neutral living and promote zero-emission buildings in Japan, the government must strengthen general education on the environment and energy. We also found that most of the Japanese public relies on the government to solve climate change problems and is reluctant to act independently. Against this backdrop, there exists a

prevalent belief in Japan that eco-friendly activities require personal sacrifices in daily life, in contrast to countries like Australia where citizens are more enthusiastic about PV adoption due to the belief that eco-friendly practices are financially rewarding. An international comparative study, WWViews, also highlighted an anomaly specific to Japan, where 60% of respondents felt that climate change mitigation threatens their quality of life, as opposed to the world average of 27% (JST 2015). Similarly, it has been revealed that the Z generation in Japan tends to be more skeptical about climate change measures.

In Japan, consumers are highly cooperative when direct benefits are clearly outlined, such as eco-car tax reductions based on emission and fuel efficiency, and eco-points for purchasing energy-efficient air-conditioners, refrigerators, and televisions to promote energy conservation and economic stimulus. On the other hand, policies that enforce participation, such as the Cool Biz initiative for adjusting office air-conditioning temperatures to save energy, have been met with reluctance by office workers (Dowaki et al. 2010; Omori et al. 2014; Yamaura and Peterson 2019). Therefore, for the Japanese government to promote PV installation, it is crucial not only to educate consumers at the citizen level about the importance of solar power generation for maintaining a more sustainable society, but also to explicitly communicate PV installation incentives that surpass the current subsidies available.

Appendix

List of questionnaire:

q1 Gender (1 = male, 2 = female)

q2 Age

q3 Residence

q4 Marriage (0 = no, 1 = yes)

q5 Occupation

q6 Education (1 = other, 7 = grad school)

q7 Household income (1 = less than 3 million yen, 6 = over 15 million yen)

q8 Number of people living together

q9 Electric bills of last month (1 = less than 3000 yen, 7 = over 15,000 yen)

q10 How much do you think the Earth's average temperature has increased from 1900 to the present? (1 = less than 0.5C, 5 = more than 5C, 6 = no change, 7 = decreased)

q11 How concerned are you about global warming? (1 = none at all, 5 = a lot)

q12 In your opinion, what are the main causes of global warming? (1 = human behavior, 2 = changes in natural environment, 3 = cyclical phenomena of the Earth, 4 = no global warming, 5 = do not know)

q13 From what you know about global warming, which of the following statements best describes your view? (1 = serious problem, 5 = unwarranted)

q14 What do you think is the current state of our global environment? (1 = good condition, 2 = several issues, but can be solved with a little effort, 3 = several issues and can be solved with a huge effort, 4 = poor condition, but can be solved with huge effort, 5 = poor condition and difficult to solve)

q15 Among the environmental issues facing the Earth, which do you consider is the most serious? (1 = ozone layer depletion, 2 = deforestation, 3 = hazardous waste, 4 = global warming, 5 = water pollution, 6 = air pollution, 7 = other)

q16 If the government of our country were to spend one trillion yen, what do you think should be the top priority?

q17 If the United Nations were to spend one trillion yen, what do you think should be the top priority?

q18 Do you know the difference between renewable and non-renewable energy? (0 = no, 1 = yes)

q19 How concerned are you about the expected future price rises in energy for your house? (1 = none at all, 5 = a lot)

q20 Considering the current use of fossil fuels, in how many years do you think energy will be scarce in Japan? (Choose the closest answer) (1 = after five years, 7 = over 100 years)

q21 What is the primary heating system in your household? (1 = ac, 2 = kerosene stove, 3 = kerosene fan heater, 4 = electric stove, 5 = underfloor electric heating, 6 = gas fan heater, 7 = gas stove, 8 = other, 9 = no)

q22 How much more would you be willing to pay for the "detergent set that is considered to be good for the environment"? (1 = always buy cheaper, 6 = always buy eco products)

q23 How much more would you be willing to pay for the "product that is better for the environment"? (1 = always buy cheaper, 6 = always buy eco products)

q24 How much interest do you have in energy conservation for your household? (1 = none at all, 5 = a lot)

q25 Do you know that we are promoting the ZEB in Japan? (0 = no, 1 = yes)

q26 Developed countries provide development assistance to developing nations through financial and technological support. What are your thoughts on future development cooperation? (1 = actively implement, 5 = actively reduce)

q27 Have you ever searched for information on solar PV regardless of the purchase intention? (0 = no, 1 = yes)

q28 Have you ever searched for information on solar PV to buy or invest in? (0 = no, 1 = yes)

q29 What are the reasons for not installing solar panels in your household? (1 = install cost, 2 = maintenance cost, 3 = difficult to install, 4 = doubt renewable energy,

5 = less knowledge, 6 = appearance, 7 = rental agreement, 8 = installed)

q30 In 5 years, is there a plan to install solar PV in your own home or to invest in solar energy? (0 = no, 1 = yes)

q31 How many years earlier has your current residence been built? (1 = less than 10 years, 4 = over 30 years)

q32 How many homes have installed solar PV in your neighborhood?

q33 How many of your family members and friends have installed solar PV on their houses?

q34 How much thought do you give to installing solar PV in your own home? (1 = none at all, 5 = a lot)

q35 How much thought do you give to installing a household storage battery to store the electricity generated? (1 = none at all, 5 = a lot)

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