Supplementary Information

Residential solar hot water adoption behaviour: A review of economic and technical predictors and their correlation with the adoption decision

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1. Search keywords

Table 1 lists a total number of 46 applied keywords and how the search was performed in Web of Science and Scopus in three categories (household, behaviour, and solar).

Table 1. Keywords categorized into three categories.

Area	Keywords	Search scope	
Household	House* OR home* OR resident* OR dwelling* OR domestic OR public OR social OR Users OR Consumer OR agent* OR Regional OR citizen OR person*	Topic	AND
Behaviour	Adopt* OR diffusion OR behavio* OR knowledge OR uptake OR "take up" OR intention OR attitude* OR aware* OR willingness OR acceptance OR knowledge OR risks OR values OR motiv* OR promotion OR install OR distribut* OR choice OR purchas* OR interest OR perception OR tendency OR incentive OR perspective OR perception OR preference	Topic (title-abstract-keywords)	AND
Solar	Microgeneration* OR "Solar hot water" OR "solar thermal heating" OR "solar thermal hot water" OR "solar heating water" OR "solar water heat*"	Topic	AND

Note that, in Table 1, the applied keywords resulted in some papers that hinted only renewable energy and microgeneration technologies in the title, but their focus was either on solar water heater (SWH), at least a section was devoted to SWH, or it was discussed as the main system at home solar systems. As stated in the paper, broader topics were considered if they discuss the residential adoption of solar technology systems. This was captured in the last two rows of the table, to first include all these papers, and second, to avoid irrelevant studies. The search was not limited to a certain period of time.

2. Four-phase assessment approach

A four-phase assessment approach [1, 2] was employed to facilitate the screening and eligibility evaluation (Fig. 1). The title, keywords, abstract, and full text of the remained articles from the first screening step was investigated. If the article passed these four steps and was not delete, it was deemed relevant to the scope.

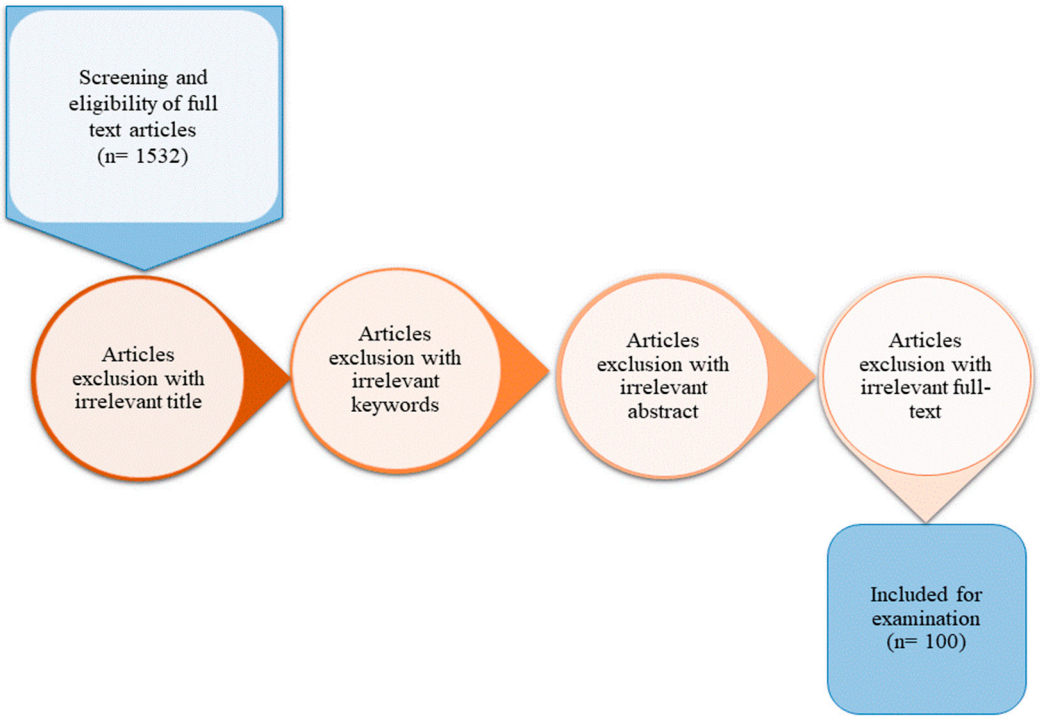

Fig. 1.Four-phase assessment approach. Darker colour = includes more articles.

3. Temporal distribution of published researches

The time series of 100 published research in residential SWH acceptance is illustrated in Fig. 2.

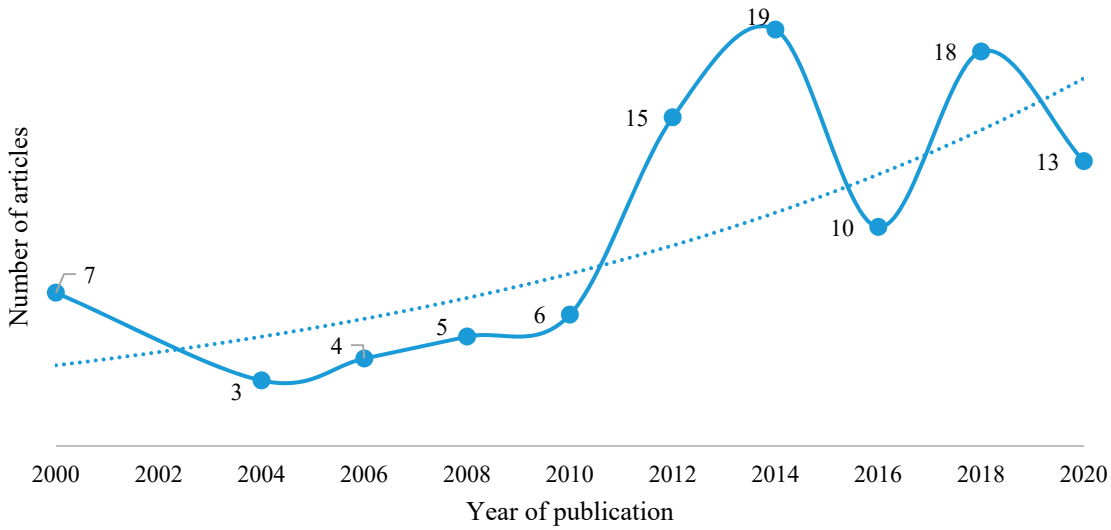

Fig. 2. Temporal distribution of reviewed articles focused on residential SWH adoption.* Papers for 2020 are restricted to the period (7 January 2021) that the research is conducted.

4. Reviewed articles

Table 2 illustrates information of all 100 articles reviewed in research, including the year of publishing, title and author(s) of the article and the source of publication.

Table 2. Entire list of articles reviewed on the adoption behavior of residential SWH systems.

No.	Year	Title	Author(s)	Source
1	1978	Speeding solar energy commercialization: A Delphi research of marketplace factors	Cesta & Decker	Journal of Business Research
2	1981	Exploring the Consumer Decision Process in the Adoption of Solar Energy Systems	Duncan G. Labay & Thomas C. Kinnear	Journal of Consumer Research
3	1983	Consumer Response to Information that Presents a Range of Possible Performance Levels for a New Product: The Case of Solar Water Heaters	Scott A. Neslin & Gert Assmus	The Journal Of Consumer Affairs
4	1985	Incentives For Solar Water Heating Systems	E. Tasdemiroglu	Energy
5	1993	Solar Water Heating In Queensland: The Roles Of Innovation Attributes, Attitudes And Information In The Adoption Process!	John Foster	Prometheus: Critical Studies in Innovation
6	1998	The technical and behavioural potential for solar energy - A case study for the town of Lusk/Ireland	Berger	Renewable Energy
7	2000	Consumer Concern, Knowledge, Belief, and Attitude toward Renewable Energy: An Application of the Reasoned Action Theory	Bang, H.K. et al	Psychology & Marketing
8	2004	Renewable energy policies in Italy	Ugo Farinelli	Energy for Sustainable Development
9	2004	Solar systems diffusion in local markets	D.K. Sidiras, E.G. Koukios	Energy Policy
10	2004	Diffusion of renewable energy technologies—barriers and stakeholders' perspectives	Sudhakar Reddy & J.P. Painuly	Renewable Energy
11	2005	Solar water heaters in Taiwan	Chang, K.Ch., et al	Renewable Energy
12	2005	Effect of financial and fiscal incentives on the effective capital cost of solar energy technologies to the user	Chandrasekar, B. et al	Solar Energy
13	2006	Consumer attitudes towards domestic solar power systems	Adam Faiers, Charles Neame	Energy Policy
14	2006	Solar water heating in Lebanon: Current status and future prospects	Ahmad Houri	Renewable Energy
15	2007	Social acceptance of renewable energy innovations: The role of technology cooperation in urban Mexico	Alexandra Mallett	Energy Policy

16	2007	An opinion survey based assessment of renewable energy technology development in India	B. Chandrasekar & Tara. C. Kandpal	Renewable and Sustainable Energy Reviews
17	2007	Household Solar Water Heating System Investment Modelling and Risk Analysis	Lugarić, L. et al	The International Conference on "Computer as a Tool"
18	2008	Improving the energy performance of UK households: Results from surveys of consumer adoption and use of low- and zero-carbon technologies	Sally Caird & Robin Roy & Horace Herring	Energy Efficiency
19	2008	Outlook for solar water heaters in Taiwan	Chang, K.Ch., et al	Energy Policy
20	2009	Profits or preferences? Assessing the adoption of residential solar thermal technologies	B.F.Mills,J.Schleich	Energy Policy
21	2010	Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies	Scarpa & Willis	Energy Economics
22	2010	Testing Residential Solar Thermal Adoption	Chelsea Schelly	Environment and Behavior
23	2010	Adoption and Use of Household Microgeneration Heat Technologies	Sally Caird, Robin Roy	Low Carbon Economy
24	2010	Assessment of public acceptance and willingness to pay for renewable energy sources in Crete	N. Zografakis et al.	Renewable and Sustainable Energy Reviews
25	2010	Consumer awareness in the adoption of microgeneration technologies: an empirical investigation in the Republic of Ireland	Claudy et al.	Renewable and Sustainable Energy Reviews
26	2011	Prediction of photovoltaic and solar water heater diffusion and evaluation of promotion policies on the basis of consumers' choices	Yamaguchi et al.	Applied energy
27	2011	Will non-owners follow pioneer consumers in the adoption of solar thermal systems? Empirical evidence for northwestern Germany	J.S. Woersdorfer & W. Kaus	Ecological Economics
28	2011	Selection of renewable energy technologies for a developing county: A case of Pakistan	Muhammad Amer, Tugrul U. Daim	Energy for Sustainable Development
29	2011	Social acceptance of solar energy technologies in China—End users' perspective	Yuan, X. et al	Energy Policy
30	2011	Renewable energy adoption in an ageing population: Heterogeneity in preferences for microgeneration technology adoption	Willis.,K. et al	Energy Policy
31	2011	The diffusion of microgeneration technologies – assessing the influence of perceived product characteristics on home owners' willingness to pay	Claudy et al.	Energy Policy
32	2011	Residential Property Development Professionals Attitudes Towards Sustainable Development In Australia	S. G. Bond	Int. J. Sus. Dev. Plann.
33	2011	Dissemination of solar water heaters in South Africa	Chang, K.Ch., et al	Journal of Energy in Southern Africa
34	2012	Financial measures Serbia should offer for solar water heating systems	Sanja Stevanovi´c & Mila Pucar	Energy and Buildings
35	2012	Can premium tariffs for micro-generation and small scale renewable heat help the fuel poor, and if so, how? Case studies of innovative finance for community energy schemes in the UK	Saunders, R.W. et al	Energy Policy

36	2012	Adoption of technology by the low-income population segment: The low-cost hot water heater case	Marina S. de Oliveira Ilha, Marília Ferraz Ribeiro	Habitat International
37	2012	Economic and environmental analysis of solar water heater utilisation in Gauteng Province, South Africa	Özdemir, E.D. et al	Journal of Energy in Southern Africa
38	2012	Why is renewable heat in the UK underperforming? A socio-technical perspective	Noam Bergman	Proc IMechE Part A: J Power and Energy
39	2012	Policy pitfalls of SWH	Ernst Uken	SHC 2012
40	2012	Evaluating intervention options to achieve environmental benefits in the residential sector	Andrew Higgins • Greg Foliente	Sustainability Science
41	2013	Study of Consumer's Willingness to Use Solar Water Heaters in DSM Program	Sangamesh G. Sakri, G. V. Jayaramaiah	7th International Power Engineering and Optimization Conference
42	2013	Rural public acceptance of renewable energy deployment: The case of Shandong in China	Liu,W. et al	Applied Energy
43	2013	Farmers' willingness to convert traditional houses to solar houses in rural areas: A survey of 465 households in Chongqing, China	Li et al.	Energy policy
44	2013	Assessment of government support for the household adoption of micro-generation systems in Korea	Gicheol Jeong	Energy Policy
45	2013	Solar thermal market in Taiwan	Chang, K.Ch., et al	Energy Policy
46	2013	A public perspective on the adoption of microgeneration technologies in New Zealand: A multivariate probit approach	Baskaran, R. et al	Energy Policy
47	2013	Motivational factors influencing the homeowners' decisions between residential heating systems: An empirical analysis for Germany	C.C. Michelsen, R., Madlener	Energy Policy
48	2013	Analysis of social acceptance of rural Solar Water Heater projects in South Africa	Geoffrey Mukwada	International Conference on Renewable Energy Research and Applications
49	2013	Which factors affect the willingness of consumers to adopt renewable energies?	Sardianou & Genoudi	Renewable energy
50	2013	Residential energy efficient device adoption in South Africa	Blommestein, K., et al	Sustainable Energy Technologies and Assessments
51	2014	Investigating the importance of motivations and barriers related to microgeneration uptake in the UK	Balcombe et al.	Applied Energy
52	2014	Diffusion of solar water heaters in regional China: Economic feasibility and policy effectiveness evaluation	Ma, B. et al	Energy Policy
53	2014	Solar heating in Taiwan	Chang, K.Ch., et al	2013 ISES Solar World Congress
54	2014	Pathways toward whole community transformation: a case study on the role of school engagement and environmental education	Mitchell, K.I. et al	Environ Dev Sustain

55	2014	Cleaning the energy sources for water heating among Nanjing households: barriers and opportunities for solar and natural gas	Lingyun ZHU et al	Front. Environ. Sci. Eng.
56	2014	Towards a UTAUT-Based Model for the Intention to use Solar Water Heaters by Libyan Households	M. Saleh, A. et al	International Journal of Energy Economics and Policy
57	2014	Why Social Acceptance in South African Solar Water Heater Projects Should Shape National Energy Policy: The Case of Bluegumbosch	Mukwada,G. et al	Mediterranean Journal of Social Sciences
58	2014	Do incentives work?: An analysis of residential solar energy adoption in Miami-Dade County, Florida	Varela-Margolles & Onsted	Southeastern Geographer
59	2014	Identification of the barriers for the slow uptake of solar water heaters in Australia	Djordjevic, S. et al	The 52nd Annual Conference of the Australian Solar Council
60	2015	Household preferences for energy saving measures: Approach of discrete choice models	JRID, O., et al	Energy and Buildings
61	2015	Enhancing public acceptance of renewable heat obligation policies in South Korea: Consumer preferences and policy implications	Lim, S. et al	Energy Economics
62	2015	The emperor and the cowboys: The role of government policy and industry in the adoption of domestic solar microgeneration systems	Genevieve Simpson & Julian Clifton	Energy policy
63	2015	“Let′ s do it ourselves” Individual motivations for investing in renewables at community level	Dóci & Vasileiadou	Renewable and sustainable energy reviews
64	2015	Consumer attitudes towards renewable energy in China—The case of Shanghai	Hast, A. et al	Sustainable Cities and Society
65	2015	An exploratory of residents’ views towards applying renewable energy systems in Saudi dwellings	Farajallah Alrashed, Muhammad Asif	The 7th International Conference on Applied Energy
66	2016	Who wants solar water heaters and alternative fuel vehicles? Assessing social–psychological predictors of adoption intention and policy support in China	Chen, C. et al	Energy Research & Social Science
67	2016	Humanitarian engineering opportunities and challenges in rural Dominican Republic: A case study of El Cercado	Blair, S., et al	GHTC 2016 - IEEE Global Humanitarian Technology Conference: Technology for the Benefit of Humanity
68	2016	Household Income Structure and Electrical Appliance Ownership: Evidence from Japanese National Household Survey	Shigeru Matsumoto	International Journal of Energy Economics and Policy,
69	2016	Installation of Residential Energy Systems: Local Conditions and Residents' Willingness	Kazuhiro Yuasa and Mai Yata	Journal of Asian Architecture and Building Engineering
70	2017	Development of Customized Formulae for Feasibility and Break-Even Analysis of Domestic Solar Water Heater	Rout. A. et al	International Journal Of Renewable Energy Research
71	2017	Assessment of Solar Water Heating In Cyprus: Utility, Development and Policy	Bamisile, O. et al	International Journal Of Renewable Energy Research
72	2017	Solar energy adoption in rural China: A sequential decision approach	Wang, X. e al.	Journal of Cleaner Production
73	2017	Consumer renewable energy technology adoption decision-making; Comparing models on perceived attributes and attitudinal constructs in the case of solar water heaters in Lebanon	Elmustapha, h. et al	Journal of Cleaner Production

74	2017	The 'Reduce and Save' Project: An Island- Wide Resource Management Awareness Initiative	Refalo, p. et al	Mediterranean Green Buildings & Renewable Energy
75	2017	Financial attractiveness of decentralized renewable energy systems e A case of the central Himalayan state of Uttarakhand in India	Yaqoot, M. et al	Renewable Energy
76	2018	The Economics of Residential Solar Water Heaters in Emerging Economies: The Case of Turkey	Aydin, E. et al	Energy Economics
77	2018	Green transition of energy systems in rural China: National survey evidence of households' discrete choices on water heaters	Ma, B. et al	Energy Policy
78	2018	Social ties, homophily and heterophily in urban sustainability transitions: User practices and solar water heater diffusion in China	Zhen Yu and David Gibbs	Energy Research & Social Science
79	2018	Potential of renewable energy system utilisation at decentralised level in the state of Uttarakhand in India	Mohammed Yaqoot & Tara C. Kandpal	International Journal of Ambient Energy
80	2018	An Agent-Based Model of Residential Energy Efficiency Adoption	Moglia, M. et al	Journal of Artificial Societies and Social Simulation
81	2018	Valuating renewable microgeneration technologies in Lithuanian households: A study on willingness to pay	Su. W. et al	Journal of Cleaner Production
82	2018	How Households Adopt Sustainable Innovations? A Free Decision Enforced by Others	Ingo Kastner and Sebastian Bobeth	Journal of Energy
83	2018	Measuring public acceptance of climate-friendly technologies based on creativity and cognitive approaches: Practical guidelines for reforming risky energy policies in Iran	Fetanat, A. et al	Renewable Energy
84	2018	Public Perceptions and Willingness to Pay for Renewable Energy: A Case Study from Greece	Ntanos, S. et al	sustainability
85	2018	A lesson learned from the long-term subsidy program for solar water heaters in Taiwan	Chang, K.Ch., et al	Sustainable Cities and Society
86	2018	Solar water heaters uptake in Australia – Issues and barriers	Urmee., T. et al	Sustainable Energy Technologies and Assessments
87	2018	Effectiveness and Prospects of Implementing a Solar Water Heating System in Astana, Kazakhstan	Absemetov, A. et al	The Role of Exergy in Energy and the Environment. Green Energy and Technology
88	2019	The Impact of Subsidy Programs for Solar Thermal Applications: A Case Study for a Remote Island	Lin, W. et al	energies
89	2019	Factors affecting Sustainable Market Acceptance of Residential Microgeneration Technologies. A Two Time Period Comparative Analysis	Karytsas, S. et al	energies
90	2019	Drivers of renewable technology adoption in the household sector	Jacksohn, A. et al	Energy Economics
91	2019	Social psychological predictors of adoption intention for solar water heaters in rural China	Wang, X. e al.	Social Behavior and Personality
92	2019	Barriers and solutions of solar water heaters in Mexican household	L. Salgado-Conradoa and Areli Lopez-Montelongo	Solar Energy
93	2019	Forecasting of advertising effectiveness for renewable energy technologies: A neural network analysis	Sharifi, M. et al	Technological Forecasting & Social Change

94	2020	Market diffusion of household PV systems: Insights using the Bass model and solar water heaters market data	Batista da Silva, H. et al	Energy for Sustainable Development
95	2020	Problems of engineering entrepreneurship in Africa: A design optimization example in solar thermal engineering	Kanyarusoke, K.	Engineering Science and Technology
96	2020	The socio-economic impacts of solar water heaters compared across two communities: A case study of Cato Manor	Naidoo, A.	Renewable and Sustainable Energy Reviews
97	2020	Solar water heating technical-economic potential in the household sector in Brazil	Cruz. T. et al	Renewable Energy
98	2020	A structural equation modeling analysis of factors driving customer purchase intention towards solar water heater	Kumar, V. et al	Smart and Sustainable Built Environment
99	2021	Towards carbon free economy and electricity: The puzzle of energy costs, sustainability and security based on willingness to pay	Balezentis, T. et al	Energy
100	2021	Public perception and adoption of Solar Water Heating systems in Chile: The role of supply side income tax credits	Nasirov, S. et al	Renewable and Sustainable Energy Reviews

5. Full details of vote counting

The following Table 3 and Table 4 provide the outcome of the vote counting technique on the economic and technical predictors, respectively. Of the full 123 predictors identified in this study, those 99 predictors that were tested in the vote-counting exercises are listed.

Table 3. Full lists of votes on the Economic determinants of residential SWHs.

Category	Subcategory	Predictors (n=50)	Positive		Negative		No. of Study voted	% of Sig.
			Sig.	Nonsig.	Sig.	Nonsig.		
Financial knowledge		System cost	4	0	6	2	12	83%
		Upfront cost	0	0	4	3	7	57%
		Installation cost	1	0	6	0	7	100%
		Fossil fuel cost	3	1	2	0	6	83%
		Energy cost	0	0	5	0	5	100%
		Bill saving	2	2	0	0	4	50%
		Affordability	2	0	1	1	4	75%
		O&M cost	1	1	2	0	4	75%
		Energy saving	3	0	0	0	3	100%
		Utility rebates or incentives	1	0	1	0	2	100%
		Electricity price	1	0	1	0	2	100%
		Revenue	1	0	0	0	1	100%
		Energy rationing	0	0	1	0	1	100%
		Financial support for other sources	0	0	1	0	1	100%
		Loan	1	0	0	0	1	100%
		Switching cost	0	0	1	0	1	100%
		System cost per Watt	0	0	1	0	1	100%
		permissions & insurance	1	0	0	0	1	100%
	Financial metrics	Payback period	3	3	1	0	7	57%
		Benefit-Cost Ratio	0	1	0	1	2	0%
		NPV	0	1	0	0	1	0%
		IRR	0	1	0	0	1	0%
	Government incentives	Financial incentives reducing purchase or installing costs	21	9	0	1	31	68%
		Financial incentives reducing RoI by FiT	3	0	0	0	3	100%
Perceived attitude towards financial aspects		Perceived attitude of government policies and incentives	16	3	3	2	24	79%
		Perceived system price	1	0	10	0	11	100%
		Perceived bill saving	7	1	0	0	8	88%
		Perceived maintenance cost	0	1	4	2	7	57%
		Perceived benefit	4	3	0	0	7	57%
		Perceived energy price	2	0	4	0	6	100%

	Perceived energy saving	6	0	0	0	6	100%
	Perceived upfront cost	0	0	5	1	6	83%
	Perceived costs	1	0	4	1	6	83%
	Perceived payback period	1	0	4	0	5	100%
	Perceived affordability	1	1	2	1	5	60%
	Perceived electricity price/ cost	3	0	1	0	4	100%
	Financial motivation	1	2	0	0	3	33%
	Economical Obstacles	0	1	2	0	3	67%
	Increasing home value	1	2	0	0	3	33%
	Perceived installation costs	0	0	3	0	3	100%
	Willingness to pay more	1	0	1	0	2	100%
	Investment opportunity	0	1	0	1	2	0%
	Obtaining best possible price	0	0	0	1	1	0%
	Perceived fossil fuel price	1	0	0	0	1	100%
	market conditions	0	1	0	0	1	0%
	Perceived switching cost	0	0	1	0	1	100%
Common financial knowledge	Knowledge of incentives	2	0	0	0	2	100%
	Knowledge of net-billing	1	0	0	0	1	100%
	Knowledge of financial metrics used for calculating investment	0	1	0	0	1	0%
	Security of investment	1	0	0	0	1	100%

Table 4. Full lists of votes on the technical determinants of residential SWH.

Category	Subcategory	Predictors (n=49)	Positive		Negative		No. of Study Voted	% of Sig.
			Sig.	Nonsig.	Sig.	Nonsig.		
Common technical knowledge		Knowledge (awareness) of SWH systems	6	2	4	0	12	83%
		knowledge on renewable energy	4	3	0	0	7	57%
		Knowledge of pros and cons of SWH	1	1	3	0	5	80%
		Knowledge of installation and maintenance	1	1	0	0	2	50%
		Knowledge of presence of solar energy service provider	0	0	1	0	1	100%
		Availability of technical support	1	0	0	0	1	100%
		Knowledge of operation	0	0	1	0	1	100%
Technical knowledge		Efficiency of SWH	3	0	2	0	5	100%
		SWH lifespan	2	0	0	0	2	100%
		Technical risk and services	0	0	2	0	2	100%
		plumbing systems	0	0	1	0	1	100%
		Solar collector	1	0	0	0	1	100%
		Warranty and Garranty	1	0	0	0	1	100%
Perceived attitude towards technical aspects		Lack of knowledge	0	1	7	1	9	78%
		Perceived maturity of local market	1	1	2	1	5	60%

		Quality of solar installations and installers	0	1	2	1	4	50%
		Complexity	1	1	2	0	4	75%
		Technical support and customer service	1	0	1	1	3	67%
		Perceived complexity of information	0	0	1	0	1	100%
	Perceived features of SWH	Perceived reliability	2	0	2	2	6	67%
		Perceived efficiency	1	4	0	0	5	20%
		Perceived Installation and operation	1	0	3	1	5	80%
		Perceived appearance of SWH	0	0	0	5	5	0%
		Perceived warranty and guarantee	2	1	1	0	4	75%
		Equipment and storage space	0	0	1	2	3	33%
		Perceived Ease of use	1	0	1	1	3	67%
		Perceived maintenance concerns	1	0	1	1	3	67%
		Perceived Accessibility	0	1	1	0	2	50%
		Perceived quality	0	2	0	0	2	0%
		Perceived system life	1	1	0	0	2	50%
		Perceived Intermittency	1	0	0	1	2	50%
		Safety	1	0	1	0	2	100%
		Perceived concerns of the structural damages	0	0	2	0	2	100%
		Perceived durability	0	1	0	0	1	0%
Dwelling characteristics	Physical features of house	House type	9	3	2	0	14	79%
		House size	4	3	1	0	8	63%
		Roof type	2	0	0	0	2	100%
		Roof insulation	0	1	0	0	1	0%
		Roof quality	0	1	0	0	1	0%
		Suitability of house	1	0	0	0	1	100%
	Non-physical features of house	House ownership	5	1	0	1	7	71%
		Solar radiation	3	2	0	0	5	60%
		Temperature	3	0	1	0	4	100%
		Weather condition	0	0	3	1	4	75%
		Geographical location	2	1	0	1	4	50%
		Sunshine hours	3	0	0	0	3	100%
		energy efficiency	1	0	0	0	1	100%
		House age	0	0	1	0	1	100%
		Home/ House value	1	0	0	0	1	100%

References

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