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Short communication

Understanding and beliefs about smart energy technology

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ABSTRACT

The smart grid has been hailed for its potential to address a wide range of problems with current electricity infrastructure, with improvements expected in consumer awareness of energy use, energy efficiency, renewable energy distribution, and reliability of service. Some estimates suggest that the smart grid could reduce global carbon dioxide emissions by more than 2%. However, a vocal minority has expressed concerns about the health, privacy, and cost impacts of the smart grid. Here we use a convenience sample of online respondents to quantitatively examine the American lay public's level of knowledge about smart meters and the smart grid and show that a majority of respondents are wholly unfamiliar with smart energy technology. Furthermore, we demonstrate that, in contrast to information-deficit model expectations, knowledge of and exposure to smart meters do not necessarily lead to acceptance. On the contrary, knowledge and exposure is associated with increased concerns about negative impacts of these technologies. Implications for smart grid policy interventions are discussed.

1. Introduction

The "smart grid"—a modernized electrical grid allowing for two-way digital communication about energy demand and availability [1]—is critical infrastructure for reducing cost and environmental impacts of electricity systems worldwide [2–4]. This technology has the potential to deliver improvements in transmission efficiency, integration of renewable energy, and demand reduction; and is a gatekeeper for expanding technologies such as electric vehicles and distributed solar power. Estimates suggest that the smart grid could reduce greenhouse gas (GHG) emissions by 0.9–2.2 gigatons per year [5], roughly 2–5% of global emissions.

The smart grid encompasses a wide range of technologies including advanced sensors and energy storage [6,7]. One critical component of the smart grid is smart meters (SMs)—digital electricity meters attached to homes and businesses that enable remote meter reading and two-way communication. This functionality can provide consumers detailed information about their energy use and the ability to program appliances to reduce energy consumption and cost per kWh. Utilities may also utilize SMs to moderate peak loads by interfacing with smart appliances or through variable pricing. Although aspects of the smart grid can be implemented without SMs, they are integral to realizing its full potential [1,5,8]. Consumer willingness to adopt and utilize SMs could greatly affect the scale and pace of smart grid deployment.

Qualitative research has shown that European consumers vary in their degree of engagement with smart energy technologies and in motivations for doing so [9–11]. Much theory on this topic criticizes the information-deficit assumption that providing consumers with energy feedback necessarily results in desirable behavior changes [12–15]. Social practice theory, for example, instead focuses on what people do, rather than what they think [9,10,16,17]. Yet consumer interpretation of—not just education about—smart technologies is an important and often overlooked component of SM success.

Already, consumer concerns about privacy, safety, and cost have slowed installation in some North American communities [18–20]. Utilities have faced protests [21,22] and class action lawsuits [23,24]. In response, some local governments have attempted to ban SMs [18,20]. Although this level of resistance is rare, consumer apprehension about smart technology, and government and industry reactions to those concerns, could significantly hinder smart grid expansion. Consumer anxiety about SMs is multi-faceted. Some have expressed concerns about the health effects of radiation emitted by wireless SMs [25] or about giving utilities control over home appliances [26]. The detailed household-level data that will be collected has also led to privacy concerns [16,25,27,28]. Some doubt that utilities will implement SMs in ways that will actually save consumers money or reduce GHG emissions [26,29]. Overall, this resistance suggests that consumers are unconvinced of the rel-

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ative advantages touted by industry and environmental advocates of SMs over analog meters [30].

Although, public concern about the social, economic, and health impacts of SMs are reasonable, evidence suggest that some concerns are rooted in misconceptions. Findings suggest that people who have not yet been exposed to SMs often have unrealistic expectations of the benefits of this technology and confuse SMs with related energy tools [31,32]. These overly optimistic expectations may turn to disillusionment after consumers gain experience with SMs. Furthermore, the source of SMs may affect reactions to them. Most meters are provided by utilities [31], so most research has focused on utility-provided meters [18]. Prior research suggests widespread distrust of utilities [26,33], which may contribute to SM resistance. Little is known about consumer trust of third-party SM providers (such as non-profits or technology companies), but it is possible that SMs provided or facilitated by non-utilities may be more palatable to consumers who are wary of utilities' motivations.

Given that US deployment of SMs and the smart grid is still at an early stage, there is value in understanding the public's beliefs and expectations as this technology achieves a greater footprint. In this study, we take a quantitative approach to understand current perceptions of smart technology by surveying US residents who live in states with relatively high or low SM penetration. Comparing knowledge and beliefs across these settings allows us to examine how exposure to the technology affects attitudes. Do people become more comfortable with smart technology as they become familiar with it? Or, does the introduction of SMs stimulate even greater concern over the associated risks? In this study, we address the following research questions:

(1) What do people believe are the impacts of smart technology on global warming, health, privacy, security, and affordability of electricity?
(2) Do perceptions of SMs differ from those of the smart grid as a whole?
(3) How do beliefs differ between those who have and have not been exposed to smart technology?
(4) How do beliefs about the risks and benefits of SMs affect willingness to adopt them? In answering this question, three hypothetical agents (electric utilities, environmental advocacy groups, and for-profit companies) were tested. Comparing consumer responses across agents allowed us to explore whether alternative providers could be a promising avenue for SM dissemination.

2. Methods

2.1. Participants

A convenience panel of American online respondents ($n = 305$) were enrolled through Amazon's Mechanical Turk (MTurk) in exchange for $0.75 in March 2014. Respondents were generally more educated, younger, and less wealthy and conservative than US averages (Table 1) [34–37]. Participants were recruited from states that, based on the percentage of all installed SM's in those states, were deemed high penetration (HP: at least 75%) or low penetration (LP: less than 25%) (Appendix A) [38]. This variable served as the measure of exposure to smart energy technology.

2.2. Procedure

Participants responded to an ad for research on consumer and policy issues. They reported demographics and state of residence before answering two blocks of questions: one about SMs and one about the smart grid. The order of these blocks was randomized. In each, participants indicated whether they had heard the term previously and wrote an open-ended definition. They were then given real explanations of the terms and indicated their awareness of any such technology in their community.

Participants rated each technology on how much it improves and threatens global warming mitigation, privacy, health, security, and affordability of electricity. Finally, they indicated their likelihood of adopting SMs if offered pro-bono by (1) their electricity utility, (2) an environmental advocacy group, or (3) a for-profit company. See Appendix A for all measures.

3. Results

3.1. Existing knowledge of smart energy technology

Fewer than half of participants had heard of either term (SMs = 36.1%; smart grid = 32.1%). Participant-written definitions of each term were scored for accuracy (see Appendix A). Over 64% demonstrated no understanding of SMs and 47% no understanding of the smart grid (Table 2). A one-way analysis of variance (ANOVA) showed that participants from HP states (M = 1.31, SD = 1.42) were more accurate in their SM definitions than those from LP states (M = 0.68, SD = 1.17), F (1,110) = 6.35, $p < .01$, but no such difference was found for smart grid accuracy. Common misconceptions were that SMs are intelligence tests (24.1% of respondents), parking meters (11.6%), smartphones/apps (6.3%), or health-monitoring devices (3.6%). Participants often thought the smart grid was an internet grid (9%), smartphone/app (7%), GPS system (5%), intelligence test (4%), or traffic system (3%).

Even after reading term descriptions, a majority of respondents were unaware of any such technology in their communities (Table 3). However, logistic regressions showed that participants from HP (vs. LP) states were more aware of both SMs and the smart grid in their community. Thus, as expected, actual prevalence of SMs affected participants' awareness of them and the related smart grid.

3.2. Smart meters

3.2.1. Smart meter perceptions

Three first stage moderated mediation models with bootstrapping (using PROCESS, Model 7) [39,40] tested the effects of exposure on participants' reported likelihood of adopting SMs if offered by a (1) utility, (2) advocacy group, or (3) for-profit company. Knowledge—measured via participants' definition-accuracy scores—was tested as a moderator of exposure, with beliefs about the effects of SMs on global warming, privacy, security, health, and affordability as mediators (Fig. 1; see Appendix A). Results are summarized in Tables 4 and 5.

Table 4 shows the direct effects of predictor variables on beliefs about SMs. The mean scores for each belief suggest that, overall, participants thought SMs had more benefits than risks for global warming, health, and affordability, but that costs outweighed the benefits for privacy and security. Knowledge was related only to health beliefs; more knowledgeable people thought the devices were more harmful to health. Residing in a HP state reduced some perceived benefits; these individuals thought that SMs were less affordable and helpful in global warming mitigation.

A significant interaction emerged between exposure and knowledge on estimates of security effects and a marginal interaction emerged for privacy estimates. Probing these interactions [41] revealed no significant simple effects, but non-significant trends showed that the greatest concerns about security and privacy were found among knowledgeable respondents living in HP states.

Table 1
Comparison of current sample to U.S. population.

Sample	Percent male	Median age	Percent holding bachelor's degree	Mean household income	Percent identified as democrats or democrat-leaning Independents
Current study	38	35.0	55.7	\$35,000–\$49,000	56
U.S. average[a]	49[a]	37.2[b]	31.7[c]	\$51,107[d]	48[e]

[a] US Average numbers as reported by Gallup and the U.S. Census Bureau.
[b] U.S. Census Bureau (2010) age and sex composition in the United States: 2010. (Washington, DC).
[c] U.S. Census Bureau (2013) current population survey: Educational attainment of the population 25 years and over, by selected characteristics: 2013. (Washington, DC).
[d] U.S. Census Bureau (2013) income, poverty, and health insurance coverage in the United States: 2012 (Report no. P60–245). (Washington, DC).
[e] Gallup (2014) baby boomers to push U.S. politics in the years ahead [Tables]. Retrieved from http://www.gallup.com/poll/167012/baby-boomers-push-politics-years-ahead.aspx.

Table 2
Accuracy of participant descriptions.

				Accuracy frequencies[a]			
Item	n[a]	Mean	(SD)[a]	Very accurate	Fairly accurate	Somewhat accurate	Inaccurate
Smart meter	112		0.93(1.31)	24.1%	8.9%	2.7%	64.3%
Smart grid	100		1.22(1.31)	29%	7%	15%	47%

[a] Descriptive statistics are for participants who were shown each block of questions first.

Table 3
Logistic regression and percentages of participants who were aware of devices in their community, by state condition.

	Awareness by exposure[a]					95% CI		
Item	HP	LP	B	SE	Odds ratio	Lower	Upper	Nagelkerke pseudo R^2
Smart meter	41.1%	16.6%	1.26	.27	3.51***,[b]	2.06	5.98	.10
Smart grid	16.1%	5.7%	1.15	.40	3.17**	1.44	6.98	.06

[a] Exposure is coded such that 0 = low-penetration state, 1 = high-penetration stateaExposure is coded such that 0 = low-penetration state, 1 = high-penetration state.

Table 4
Direct effects of state and smart meter knowledge on mediators from moderated mediation model.

					95% CI		
Mediator	Mean (SD)	Predictor	b	t	Lower	Upper	R^2
Global Warming	2.75(2.14)	State	−0.90	−3.56***,[a]	−1.40	−0.40	.05
		Knowledge	0.10	0.86	−0.13	0.34	
		Interaction	−0.32	−1.60	−0.72	0.07	
Privacy	−2.60(2.73)	State	−0.50	−1.52	−1.124	0.15	.03
		Knowledge	0.03	0.16	−0.28	0.33	
		Interaction	−0.49	−1.87†	−1.00	0.02	
Security	−0.57(2.56)	State	0.06	0.20	−0.54	0.67	.03
		Knowledge	−0.12	−0.82	−0.41	0.17	
		Interaction	−0.48	−1.99*	−0.96	-0.00	
Health	1.25(2.24)	State	−0.51	−1.85†	−1.05	0.03	.04
		Knowledge	−0.34	−2.57**	−0.60	−0.08	
		Interaction	0.19	−0.85	−0.25	0.62	
Affordability	1.61(3.04)	State	−1.12	−3.10**	−1.83	−0.41	.05
		Knowledge	−0.06	−0.38	−0.40	0.27	
		Interaction	−0.35	−1.22	−0.91	0.22	

[a] Degrees of freedom = (3, 298) $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

3.2.2. *Smart meter acceptance*

Direct and indirect effects on adoption likelihood were examined for each of the three sources of SMs (Table 5). Overall, respondents said they were slightly more likely than not to adopt SMs. The direct effect of exposure on adoption was not significant for devices from any source. However, the conditional indirect effects of exposure on meter adoption—as mediated by beliefs about the price effects of SMs—were significant for two of the three meter sources. Specifically, when the source was a utility or advocacy group, beliefs that SMs help affordability predicted increased adoption. However, residents of HP states with at least average SM knowledge were less likely to subscribe to those beliefs, making them less likely to adopt SMs than residents of LP states. The same (non-significant) trend emerged when the source was a for-profit company.

Beliefs about global warming effects of SMs mediated the conditional effects of state condition on adoption. The more people thought SMs mitigated global warming, the more likely they were to adopt them. However, knowledgeable people from HP states were less optimistic about the devices' effect on global warming, making them less likely to adopt meters compared to participants from LP states. This pattern was significant for both non-utility sources, and the results for utilities trended in the same direction.

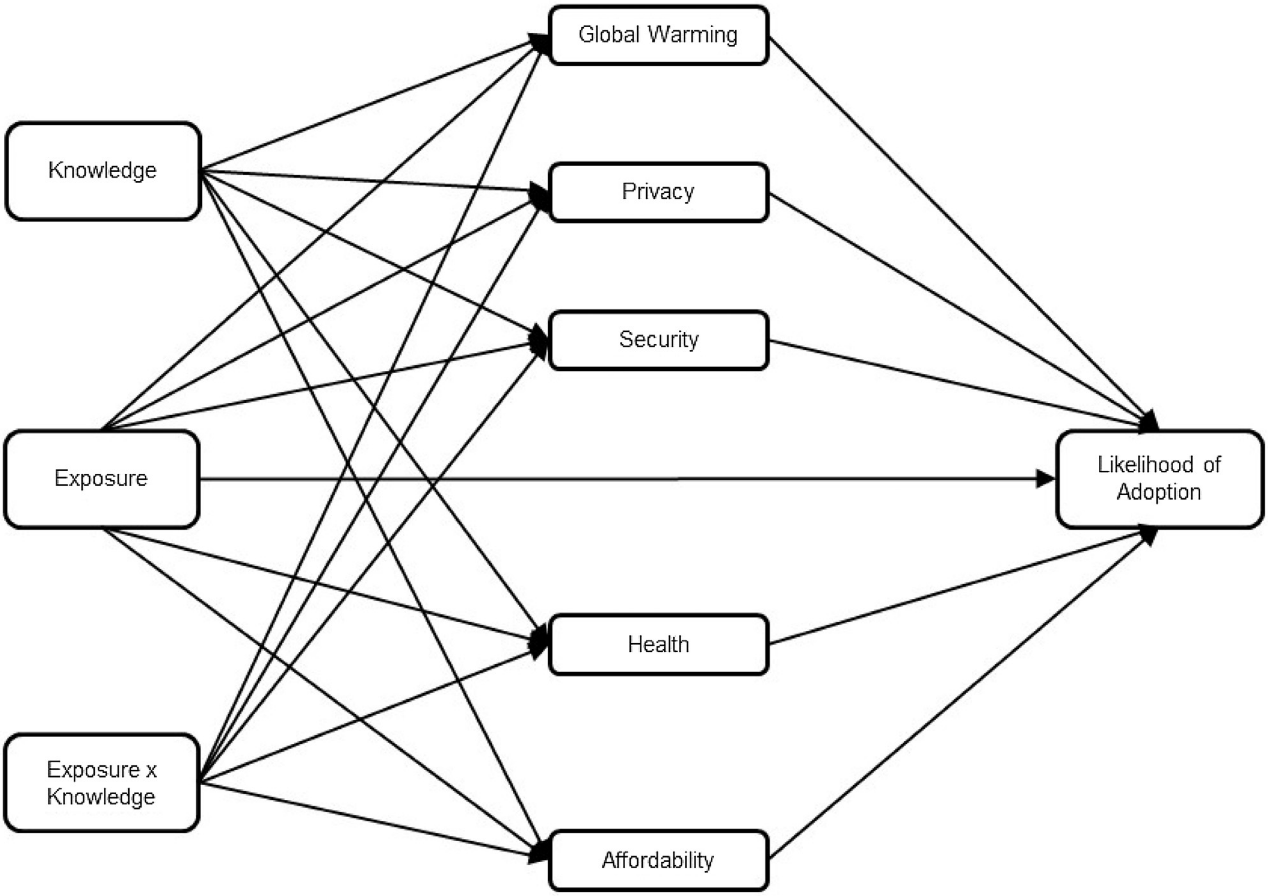

Fig. 1. Template of mediation models of exposure and knowledge as predictors of adoption, with knowledge mediated by beliefs about the effect of devices on global warming, privacy, security, health, and affordability of electricity.

Table 5
Least squares regression results for moderated mediation of smart meter adoption.

			Direct effect on adoption[a,c]			Conditional indirect effects of exposure on adoption at levels of knowledge b[b]		
Device source	Mean (SD)	Predictor/mediator	*b*	*t*	R^2	Low	Mean	High
Electricity utility	5.36(1.87)	Exposure	−0.23	−1.16	.25			
		GW	0.09	1.67†		−0.04	−0.08	−0.12
		Privacy	0.01	0.27		0.00	−0.01	−0.01
		Security	0.11	2.36*		0.07	0.01	−0.06
		Health	0.10	1.89†		−0.07	−0.05	−0.03
		Afford	0.16	4.41***		−0.11	−0.18*	−0.25*
Environment advocacy group	4.64(2.15)	Exposure	0.09	0.39	.26			
		GW	0.30	4.81***		−0.15	−0.27*	−0.39*
		Privacy	0.07	1.38		0.01	−0.03	−0.07
		Security	0.08	1.53		0.05	0.00	−0.04
		Health	0.05	0.85		−0.04	−0.03	−0.01
		Afford	0.11	2.61**		−0.07	−0.12*	−0.17*
For-profit company	4.04(2.09)	Exposure	−0.15	−0.64	.19			
		GW	0.16	2.52**		−0.08	−0.14*	−0.21*
		Privacy	0.06	1.28		0.01	−0.03	−0.07
		Security	0.10	1.81†		0.07	0.01	−0.05
		Health	0.12	1.97*		−0.09*	−0.06	0.03
		Afford	0.06	1.39		−0.04	−0.07	−0.09

[a] For direct effects † $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.
[b] For indirect effects: *95% confidence intervals did not include zero.
[c] Degrees of freedom = (6, 295)..

Finally, for meters offered by for-profit companies, respondents with the least knowledge in HP (vs LP) states were less likely to adopt SMs because they believed them to have less of an effect on health and thus were less swayed by the potential health benefits.

A repeated-measures ANOVA found that the source of SMs affected likelihood of adoption, $F\ (2,303) = 75.10$, $p < .001$.[1] Pairwise comparisons with Bonferroni adjustments showed that participants were more likely to accept devices offered by utilities (M = 5.46, SD = 0.11), than environmental advocacy groups (M = 4.64, SD = 0.12), and more likely to adopt devices from either of these groups than from for-profit companies (M = 4.04, SD = 0.13).

3.3. Smart grid perceptions

Hierarchical linear regressions tested smart grid beliefs. Whereas people can sometimes choose whether to allow SMs to be connected to their homes (through opt-out programs, etc.), residents have little control over whether their community is serviced by a smart grid. Therefore, we do not report likelihood of smart grid adoption.

As with meters, participants generally believed the smart grid to have slightly positive net effects on global warming, health, and affordability but negative effects on privacy and security (Table 6). Knowledge about the smart grid predicted relatively optimistic views about its effects on global warming, affordability, and security. However, exposure to the smart grid had an opposite effect: Those in HP states were relatively pessimistic about its effects on global warming and affordability. Neither knowledge nor exposure affected health or privacy beliefs.

4. Discussion

Our respondents were generally unfamiliar with smart technology, but believed it would have positive impacts on global warming, health, and affordability, and negative effects on security and privacy. Importantly, increased familiarity with smart technology (i.e., knowledge of it and exposure to it) did not translate into acceptance. Although those living in high-penetration states were more knowledgeable about SMs and the smart grid, they perceived less benefit from this technology than their counterparts in low-penetration states. Therefore, exposure to smart technology seems to result in skepticism about the benefits of this technology rather than positive attitudes or acceptance. This could be due to dissatisfactory experiences or increased exposure to the debates about smart technology that often accompany deployment. Understanding people's sources of technology information (and the risks they convey) will be a key factor in creating policy strategies that address these concerns.

Knowledge about smart technology was correlated with positive beliefs about its effects on global warming, security, and affordability. However, greater knowledge and exposure was also related to negative views of their health effects: a concern shared by technology opponents [18]. If increasing exposure and knowledge leads to ever greater health concerns, opposition may grow as deployment spreads. Residents of HP states also held more negative views of the effects of smart technology on energy affordability. This translated into lessened likelihood of SM adoption due to affordability concerns for people who were at least moderately knowledgeable and living in a HP state.

One might expect concerns to be ameliorated by beliefs that smart technology will mitigate global warming. Certainly, this is one way the smart grid has been promoted [42]. Participants echoed this assessment, reporting positive effects on global warming for both SMs and the smart grid, especially among those knowledgeable about the smart grid. Yet, exposure to these technologies was associated with lower perceived benefits. In fact, for meters offered by non-utilities, living in a HP state led knowledgeable people to say they were less likely to adopt SMs due to their pessimistic outlook about the effect on global warming. This could be due to consumer distrust of SM providers' stated climate-mitigation goals or about the efficacy of individual meters in large-scale climate solutions.

5. Conclusion

Negative reactions to smart technologies are more prevalent than industry or government would like and market research shows these unfavorable views are rising [43]. Adoption in this study was purely hypothetical, in reality consumers may have no choice whether to "adopt" SMs or may change their minds when confronted with a choice [18]. However, understanding the public's perceptions of and willingness to try smart technology provides useful information for decision makers in this arena.

The documented resistance to SMs may not be due to distrust of utilities, per se, but fears about the effects of the technology itself. Contrary to expectations that non-utility providers might facilitate acceptance, participants preferred devices from their utility to those from third-parties. Third-party sources of SMs are thus unlikely to overcome consumer wariness better than utilities. However, this preference for utility-provided meters may be due to limited information about alternatives. Participants are presumably familiar with their utility and may distrust motives of unknown third-parties for offering devices. Policy and communication efforts should focus on the point at which the smart grid becomes personal: smart meters. Our results showed consistently that, whereas knowledge predicted positive expectations about the smart grid, it had negligible or negative effects on SM expectations.

Differences in consumer perceptions of SMs and the smart grid have implications for policy. The distinction may reflect NIMBY (not in my backyard) tendencies to support projects or technologies in the abstract, but to oppose them when they are brought too close to home, or in this case, attached to one's home. Similar differentiation has been shown in qualitative SM research and in household energy consumption [28,44]. This does not mean that such responses are selfish, simply that although the benefits of these technologies are community-wide, the costs become apparent to consumers when smart technology is brought into their own home. For example, those with more knowledge had stronger health concerns (e.g., fears of wireless radiation) [18], which are directly applicable to SMs in homes and less so to the smart grid as a whole. This is particularly important given the vocal health-driven opposition to smart technology [18]. Efforts to systematically evaluate the health effects of SMs may lessen these concerns over time, but could create new frontiers for debate. Changing policies by offering the option of wired (rather than wireless) SMs and communicating the personal health benefits of the smart grid (via reduced coal-based air pollution) [45] is likely a more productive way to balance fears in this domain in the short-term.

Allowing customers to retain control over their home energy settings is also key. Familiarity with smart technology was associated with increased worry about security. Westerners perceive their home as private spheres over which they (not third parties) should have control [16] and security concerns about household SMs may be equated with privacy (indeed, privacy concerns followed the same pattern). This suggests that US consumers—like their UK counterparts [26]—may be unenthusiastic about remote control of residential energy systems. Providing guidelines to con-

[1] Including state condition and knowledge as covariates did not change these results, so only the more parsimonious model is described.

Table 6
Regressions of beliefs about the effects of smart grids on global warming, privacy, security, health, and affordability of electricity by exposure, knowledge, and their interaction.

Outcome	Mean (SD)	Predictor	b	SE	t	df	R^2 change
Global warming	2.79(2.32)	Exposure[a,b]	−1.06	0.27	−3.93***[a,b]	301	.05
		Knowledge	0.38	0.11	3.56***	300	.04
		Interaction	0.16	0.05	−1.96	299	.00
Privacy	−2.84(2.68)	Exposure	−0.23	0.32	−0.71	300	.00
		Knowledge	−0.05	0.13	−0.37	299	.00
		Interaction	0.22	0.26	0.84	298	.00
Security	−0.54(2.77)	Exposure	0.33	0.33	0.99	300	.00
		Knowledge	0.33	0.13	2.55**	299	.02
		Interaction	0.13	0.27	0.47	298	.00
Health	1.25(2.24)	Exposure	−0.32	0.27	−1.18	300	.01
		Knowledge	−0.13	0.11	1.27	299	.01
		Interaction	−0.02	0.22	−0.10	298	.00
Affordability	1.33(3.23)	Exposure	−0.96	0.38	−2.50**	300	0.02
		Knowledge	0.42	0.15	2.79**	299	0.03
		Interaction	0.32	0.31	1.03	298	0.00

[a] Exposure is coded such that 0 = low-penetration state, 1 = high-penetration state.
[b] *$p < .05$, **$p < .01$, ***$p < .001$.

sumers and utilities about what information meters may (and may not) record as well as rules for how personal data managed is are also important. Privacy efforts are underway: The U.S. DOE has called for a voluntary code of conduct on smart grid data privacy [46], and states are considering legislation to ensure SM consumer privacy. Yet, consumers are likely unaware of these efforts, just as they are unaware of the technology itself.

Control extends to costs as well. For example, knowledgeable people may know of possible system-wide cost benefits of smart technologies [1,42], yet think that measurement of their own household through SMs could increase their bills (due to improved accuracy or consumption during peak load hours). Being upfront with customers about this possibility may prevent disillusionment [31], and pairing SM installation with tools to help avoid peak prices—like in-home real-time feedback—is one way for SM providers to mitigate sticker-shock and give customers the necessary information to control energy spending.

Major policy initiatives, including new U.S. EPA regulations [47], and a variety of state programs, seek to spur smart grid deployment. Utilities and state regulators need to understand consumer perceptions of these technologies to develop support and participation in programs enabled by the smart grid. As they do so, they should clearly address consumer concerns about the personal effects of smart technologies in the home rather than simply system-wide benefits and risks.

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Appendix A. Materials shown to respondents

Materials shown to respondents

Explanations of devices

Smart meter. Smart meters are electronic devices that are used in a home or business to measure how much energy (usually electricity) is being used by the appliances, lights, heating, and cooling systems in the building. Smart meters are usually installed to see where and when energy is being used so that it can be used more efficiently. Some smart meters send this information to utility companies. Other smart meters show information to the residents of the buildings about their own energy consumption (either on the meter itself or on a website).

Smart grid. Smart grids are modernized electrical grids that use information and communications technology to gather and act on information, such as information about the behaviors of electricity providers and consumers. Smart grids often work by automatically sending information about a building or home's energy use to the electricity company. The electricity company can then control the amount of electricity sent back to that building or home accordingly, or it can adjust the price of electricity depending on the level of consumer demand at that time.

Adoption

How likely would you be to set up a smart meter in your home if was offered to you free of charge by: (1 = very unlikely to 7 = very likely).

1) your electricity utility company.

2) an environmental advocacy group.

3) a for-profit company other than your utility (such as a technology company or smart meter company).

Beliefs

All belief questions were measured on Likert scales ranging from 1 = not at all to 7 = very much

Global warming*

How much do you think that smart meters/smart grids will help prevent global warming?How much do you think that smart meters/smart grids will make global warming worse?*The response choices for these items included an additional option: NA–I don't believe in global warming. These were treated as missing data in the analyses.

Privacy

How much do you think that smart meters/smart grids help people's privacy?How much do you think that smart meters/smart grids threaten people's privacy?

Security

How much do you think that smart meters/smart grids help people's security?How much do you think that smart meters/smart grids threaten people's security?

Health

How much do you think that smart meters/smart grids help people's health?How much do you think that smart meters/smart grids threaten people's health?

Affordability

How much do you think that smart meters/smart grids help people's access to affordable electricity?How much do you think that smart meters/smart grids threaten people's access to affordable electricity?

Data coding

Exposure categ ories

Participants from six states (CA, MD, MI, NV, TX, VT) were assigned to the high penetration (HP) category (37% of participants).

Participants from 21 states (CO, CT, IA, KY, MA, MN, MT, NE, NH, NJ, NM, NY, ND, RI, SC, SD, TN, UT, VA, WV, WY) were assigned to the low penetration (LP) category (63% of participants).

Coding of participant-generated definitions

Two coders scored participants' written definitions of each term for accuracy from 0 (no knowledge/inaccurate) to 3 (very accurate). Inter-rater agreement was substantial (Cohen's Kappa = .63 for smart meters; .67 for smart grids). Raters discussed discrepancies until they reached consensus or averaged the scores (Cohen's Kappa scores = .92 and .90, respectively).

Creation of mediator composite scores

Composite scores for each mediator were created by subtracting participants' estimated threats to each outcome (health, privacy, etc.) from estimates of benefits. Possible scores ranged from −7 to 7, with positive scores indicating benefits outweighed risks and negative scores indicating the reverse.

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