Public Acceptance of Smart Meters: Integrating Psychology and Practice

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ABSTRACT

Public acceptance of utility programs and initiatives is vital for efficient deployment. Consumer complaints, protests, and lawsuits, can significantly impede progress and cost utilities, cities, and taxpayers money. One recent area where this has become clear is the deployment of smart meters. While the advantages of smart meters are widely accepted by utilities, academics, and governments, some communities have experienced backlash and disapproval from customers. Many of these concerns have been rebutted by scholars and this backlash seems to vary between regions, suggesting that backlash may be incited by issues related to deployment, rather than the technology itself. It is hypothesized that much of the backlash can be prevented by greater attention to public communication; how to do so is being explored, but is as yet undetermined. This paper presents a model of technology acceptance drawn from psychological theory and a framework of potential strategies for increasing acceptance. Through analysis of 20 U.S. smart meter rollouts, a list of 56 public communication strategies was compiled and subsequently organized into a framework of 24 key strategies based on temporal (upstream, midstream, downstream) and functional (involve, inform) characteristics. This framework, which integrates key psychological theories on technology acceptance, provides utilities with initial guidance on developing successful smart meter communication campaigns.

Introduction

The United States and many other countries throughout the world are undergoing a significant change to their electricity infrastructure, replacing the current electric grid with what is referred to commonly as the "smart grid”. The smart grid is defined as the modernization of electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth (EISA, 2007). One important aspect of the smart grid is the replacement of traditional electricity meters with advanced metering infrastructure, or “smart meters.” Smart meters allow for wireless two-way communication between customer and utility as well as the provision of real-time data. These capabilities can be used to provide different rate structures, improve energy forecasting, and encourage conservation behavior. This is in contrast to traditional meters that provide little data to the consumer on their energy usage, require physical meter readings and make different rate structures impossible.

Currently, less than 10% of the world’s meters are considered “smart”, but this number is expected to change rapidly. In the United States, smart meters have already been installed in over 25 million homes and an estimated 65 million will be installed by 2020, serving over 50% of U.S. Households (Institute for Electric Efficiency, 2011). The government is trying to accelerate the adoption of smart grid through programs like the Recovery and Reinvestment Act, which

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allocated $4.5 billion in grants for smart grid programs, and the White House Green Button Initiative, which encourage utilities to provide consumers with real-time access to their energy information. Likewise, Canada is on its way to meeting mandates for 100% coverage and the European Union has a goal of 80% coverage by 2020 (Gohn & Wheelock, 2009).

While the advantages of smart meters are widely accepted by academics, government officials, and utility companies, several regions have experienced significant backlash and disapproval from customers when installing smart meters. It is crucial for utility customers to accept this new technology in order for smart grid development to continue. It is costly for companies to address customers concerns after installation and some utilities have even been confronted with protests and lawsuits – hindering progress toward a fully connected smart grid.

This report presents and applies a psychological model of technology acceptance to the case of smart meters and presents a framework of suggested strategies for improving public communications in future deployments. Through analysis of 20 U.S. smart meter rollouts, a list of 56 public communication strategies was compiled and subsequently organized into a framework of 24 key strategies based on temporal (upstream, midstream, downstream) and functional (involve, inform) characteristics. This framework, which integrates key psychological theories on technology acceptance, provides utilities with guidance on how to develop successful communication campaigns to switch to smart meters with greater public acceptance.

Literature Review

Dual Process Theory

One of the most influential theories in information processing is dual process theory, which posits that humans operate two parallel systems of receiving and processing information: a conscious, explicit (analytic) system and a subconscious, implicit (affective) system (see Chaiken & Trope, 1999 or Kahneman, 2011 for review). The analytic system evokes logical, deliberative thought; the affective system, however, is holistic, intuitive, and emotion-driven. In a series of experiments that eventually earned them a Nobel Prize in economics, Tversky and Kahneman (1974, 1981) revealed a series of heuristics, or cognitive shortcuts, that people engaged in consistently and predictably. They concluded that humans are able to engage in logical reasoning, but also have an intuitive mode that can take precedence in decision-making, especially under uncertainty. Dual process theory identifies three important processes: (1) how people process information intuitively; (2) how people process information attentively; and (3) the conditions under which the former or latter are more likely (Chaiken & Trope, 1999). Thus, dual process theories provide significant evidence that intuition and emotion can play just as large a role in informing decision-making as thoughtful analysis.

Perceiving Risk and Benefit

In a seminal *Science* paper on public acceptance of new technology, Starr (1969) found that perceived benefits often outweigh perceived risks to individuals when evaluating new technologies. Following this, several studies investigated further and found an inverse relationship between risk and benefit judgments, such that the higher the perceived benefit, the lower the perceived risk (see Slovic, 1987). This effect was attributed to an innate human desire for cognitive constancy; since people have a natural desire for consistency among diverse beliefs, they tend to reduce their perception of risk for technologies they find to be beneficial (Alhakami & Slovic, 1994).

Relating this to dual process theory, the initial affective response to a stimulus influences later cognitive judgments about it; thus, favorable attitude towards a technology and its benefits may result in reductions in risk perception. Remarking on this finding, Frewer et al. (1998) state that "'given the inverse relationship between risk and benefit, it may be possible to change perceptions of risk by changing perceptions of benefit, and vice versa" (p. 13). They also note that, although such effects are not likely for technologies in which the public already has a great deal of information (regardless of its accuracy), there is great potential "for technologies which are relatively unknown and poorly understood… where there is little *a priori* public knowledge regarding the risks and benefits of technology" (p. 13). Recent research by the Boston Consulting Group (2010) suggests that smart meter is, in fact, a technology that is still relatively unknown and poorly understood. In a survey of 1,678 U.S. consumers, they found that over 50% have never heard of a smart meter and only 15% reported being very aware of smart meters, both in area where smart meters had not been deployed as well as areas where they had. This suggests that smart meter is a technology with great potential for consumers' initial affective response to have a large impact on their subsequent cognitive judgments about its benefits and its risks.

The Role of Trust

Expanding on this relationship, subsequent research identified trust as an important variable that may impact consumers' affective response towards new technology. Trust is defined as "a willingness to make oneself vulnerable to the views, decisions or actions of another person or an organization." (Harvey & Twyman, 2007, p. 2). Without sufficient information, people are unable to properly assess either the risks or benefits of a technology and often rely on trust to assist with decision-making (Siegrist & Cvetkovich, 2000). Trust in the people and/or institutions involved in a new technology has been shown to impact both perceived benefits and risks as well as indirectly impact technology acceptance (e.g., Siegrist, 2000).

Within the literature on risk communication, a few key factors have been found to influence trust. Frewer Hedderly, and Shephard (1996) investigated sources of information as a predictor of trust and found that people have less trust, for example, in their governments than in consumer organizations or family and friends. Their full list ranked 15 information sources, finding tabloid newspapers to be the least trustworthy and doctors/scientists to be the most trusted sources. Other studies have measured specific features of information sources that determine trust, finding the most significant to be ability, benevolence and integrity (Mayer, Davis & Schoorman, 1995). As previously mentioned with benefits and risk perception, trust effects were strongest when individuals lacked knowledge about the technology; this effect was stable across 25 different technologies and activities (Siegrist & Cvetkovich, 2000).

These findings have significant implications for how utilities choose to conduct public communication and outreach with regard to smart meters. Engaging the opinions of independent researchers to present information is likely to be more effective than information coming straight from utility sources. In addition, utilities that engage in both long-term and short-term efforts in promote a sense of ability, benevolence, and integrity are likely to provoke greater trust from consumers, both in general as well as specific to their smart meter deployment efforts.

Informal Risk Communication

While most of the research on risk communication has focused on formal messengers such as scientists and journalists, a great deal of information about risk is conveyed to the public through "informal messages and unofficial carriers" (Rickard, 2011, p. 642). Some research has focused on "naturally occurring" conversations within social networks such as parenting groups (Tardy & Hale 1998), religious congregations (Agadjanian & Menjivar, 2008), and friends (Southwell & Yzer, 2009). As one study found, "These mundane conversations ... are important in the sense of revealing how consumers sift through various alternatives, determine their paths of action, and make choices." (Tardy & Hale, 1998: p. 168). Although much current discussion of "social networks" revolves around social media websites such as Twitter and Facebook, it is also important for utilities to recognize the importance of offline social interaction within communities. Consumers will likely talk about smart meters within their local neighborhoods and community groups; efforts targeting these existing networks may enable utilities to leverage these connections to support, rather than undermine their smart meter efforts.

Rickard (2011) also introduced the idea of *informal risk communicators*, service workers in fields that convey elements of risk (e.g, tattoo artists, pesticide applicators). As she describes, "these individuals serve as unofficial sources of risk information; they are routinely called upon to discuss risk with the public often as a secondary, and not necessarily formally recognized part of their job." (p. 643). Smart meter installers and service workers informally communicate with the public in their daily work; involving them in education efforts is a potential source of public communication that is often over-looked. Rickard highlights the potential of engaging such employees in an organization's formal communication strategy. "Recognizing and documenting this tension between multifaceted and even "invisible" job responsibilities holds considerable promise in contributing to both applied and theoretical risk communication." (p. 654).

The Role of Participation

Much like trust, the concept of participation has received a great deal of attention in the study of technology acceptance (see Rowe & Frewer, 2000); individuals much more likely to accept the outcome of a decision if they are made to feel they were somehow involved in it. Research suggests two primary aspects of successful public participation: "acceptance criteria, which concern features of a method that makes it acceptable to the wider public and process criteria which concern features of the process that are liable to ensure that it takes place in an effective manner” (Rowe & Frewer, p. 3). Participation is not limited to decision-making – other participation methods include tours and informational events. Zoellner et al. (2011) identified three primary factors that influenced public acceptance of biogass plants - technology, location, and the planning process. They found four key variables in this process: information (e.g., I find it important to be informed), consultation (e.g., people should be consulted in process), cooperation (people should be involved in process), and self-responsibility (I feel responsible for the project). “Transparency and trust not only constitute relevant aspects of the relationship between involved stakeholders like residents, local initiatives, operating companies, grid operators and local authorities but also in the planning and decision making process.” (p. 1)

Although involving the public in government or utility affairs is a daunting idea, there are a multitude of options that can increase actual and/or perceived involvement in the process of smart meter adoption. Informing the public an important part of the planning process but information alone may not lead to public acceptance – people also want to feel as if they were consulted, involved, and responsible in some way. Strategies to do accomplish these goals may include public comment or vote, opt-in or opt-out programs, community partnerships and events, and the provision of smart-grid enabled feedback to involve consumers in the benefits of their new meters.

Modeling Risk Communication

Theories of risk communication based on this research have suggested a two-route model that divides trust into a competence, or cognitive, component and a relational, or affective component (Harvey & Twyman, 2007). Therefore, a dual process model of trust is comprised of a cognitive route, that processes information about the competence and reliability of the source and an affective route focused on emotion response (McAllister, 1995; Rousseau, et al., 1998). One such model, the Trust-Confidence-Cooperation (TCC) model suggests that features of benevolence, honesty, and integrity (e.g., affective) relate to trust in the *motives* of the source and that features of knowledge and ability (e.g., analytical) correspond to *confidence* in the source (Earle et al., 2007). As such, there are two forms of trust: social trust (trust in motives), which is influenced by how similar a person judges the source’s values to be to their own, and confidence (trust in competence), which is influenced by past performance, both personal and via reports from others. Social trust, as an affective response, can also serve to filter performance information, as suggested by the dual process model. Thus, people who trust an institution are more likely to assess mistakes or poor performance generously, whereas those with lower social trust are more likely to judge the behavior much more harshly. It is the combination of these two factors, TCC proposes, that lead to cooperative intention and ensuing cooperative behaviors (e.g., accepting advice or services, acting on the basis of information provided).

Such models integrate much of the previously discussed research as well as their implications for smart meter communication. Establishing social trust is taken to be of equal importance as demonstrating technical competence and can even affect how technical competence is evaluated. Personal characteristics of information sources are emphasized, as is the establishment of shared values between communicators and receivers of information. Likewise, the importance of informal networks are reiterated in the inclusion of secondary information (e.g., from peers) in the establishment of confidence.

Taken together, this body of work provides a significant base with which to apply to the case of smart meter technology. Although there has been little research conducted to date on public acceptance of smart meters, theory and research on technology acceptance in other fields provide a rich canvas from which we can draw theories, hypotheses and models. The rest of the paper draws heavily from this research to analyze 20 cases of smart meter deployments for their use of public communication strategies. Using this rich theoretical background and data collected from the cases, it concludes with the presentation of a novel framework of public acceptance strategies for current and future smart meter deployments to consider.

Methods

Sample

The study utilized the method of content analysis, which is a technique of compressing large amounts of text into a manageable data set by creating and coding the text into categories based on a set of specific definitions (Stemler, 2001). The sample of 20 utilities was drawn from a report of smart meter deployments that were either undergoing or in the planning phase as of September 2011 (The Institute for Electric Efficiency, 2011). All five California utilities from the list were included and a random sample of 15 additional utilities was chosen (see Table 1).

Data Collection

Data for each utility was collected by visiting the official websites of each utility, specifically looking for information on their smart meter program. Searches were conducted for published materials (e.g., reports, brochures) as well as for information about notification, installation, marketing, social media, and subsequent billing or rate changes. In addition, general internet searches were performed with the query terms: (utility company name) and “smart meter”. These searches revealed additional information on the smart meter programs from media sources and independent groups as well as customer complaints and informational videos about both the benefits and risks of smart meters.

Table 1. Utilities Included in Study Sample

Utility Company	State	Meters Installed (as of 9/11)	Target Number of Meters
Austin Energy	TX	410,000	410,000
Black Hills Energy	CO	93,300	93,300
CPS Energy	TX	35,000	700,000

Dominion – Virginia	VA	110,000	2,400,000
Entergy New Orleans	LA	4,500	7,400
FirstEnergy Corp	OH, PA		58,000
Kansas City Power & Light	MO	14,000	14,000
Los Angeles DWP	CA		76,500
Louisville Gas & Electric	KA	2,000	2,000
NSTAR	MA	400	2,800
NV Energy	NV	400,000	1,300,000
Oncor	TX	2,000,000	3,400,000
Pacific Gas & Electric	CA	4,419,000	5,250,000
Portland General Electric	OR	816,000	816,000
Progress Energy	NC, SC, FL	72,000	155,000
Sacramento Municipal Utility	CA	270,000	615,000
San Diego Gas & Electric	CA	1,350,000	1,400,000
Southern California Edison	CA	3,000,000	5,300,000
Tacoma Public Utilities	WA	17,000	152,000
Texas New Mexico Power	TX	10,000	240,000

Institute for Electric Efficiency (2011)

Results

A coding sheet was developed to document and analyze findings. Code development was iterative and utilized the constant comparison method and multi-phase coding (Corbin & Strauss, 2007; Creswell, 2009). An initial set of codes was developed based on previous literature (e.g., training employees, community meetings, public comment, addressing risks and benefits – see above for discussion); additional codes were added, as needed through open coding, and then grouped into categories through axial coding. Finally, themes were constructed from analysis of the codes and categories in conjunction with a review of the literature.

Individual data (e.g., website pages, documents, archival records, and news articles) from the 20 utilities in the sample were reviewed and initial coding resulted in over a hundred distinct codes. Axial coding distinguished those related to the primary goal of the study (e.g., public communication strategies) from others related to the causal conditions, context, or consequences of these activities (Corbin & Strauss, 2007); codes for 52 specific actions related to smart grid deployment were then grouped into 11 primary categories (See Table 2).

Table 2. Strategies Identified During Coding

Category	Strategies (# of utilities)	Category	Strategies (# of utilities)
Research	Pilot Program (12) Focus Groups (8) Customer Survey (6) Published research report (5) Report from independent source (3)	Marketing	Hired PR Firm (3) Printed material (brochure, flyer) (10) Newspaper (3) Radio/Television (3) Smart Meter Demo (3)

Decision	Decision process publicly announced (6)	Website	Smart Meter information (16)
	State-appointed committee (2)		Discussed/addressed benefits (16)
	Public Comment Period (3)		Discussed/addressed concerns (11)
Notification	Mail (11)		Comment/question form (10)
	Door hangers (8)		Installation schedule and/or map (8)
	Email (2)		Smart Meter Video (7)
	Door-to-Door (3)	Installation	Post-installation door hanger (11)
	Phone (2)		Interaction with installer (7)
	Multiple notification strategies (7)		Post-installation feedback/survey (5)
	Staged messaging strategy (4)		Opt-in installation (1)
	First notification > 30 days prior (3)	Feedback/ Billing	Enhanced billing/website (9)
Outreach	Community Presentations (8)		Provided/offered feedback device (7)
	General community events (5)		Feedback device assistance (4)
	Notified community organizations (4)	Rate Structure	New rate/pricing structure (10)
	Neighborhood Association Meetings (2)		Information about rate changes (8)
	Energy Fair (1)		Information provided in advance (4)
	Formal community partnerships (1)		Information via door hangers (2)
Social Networks	Twitter (5)	Customer Service	Trained employees on smart meter (6)
	Facebook (4)		Offered/provided energy audits (6)
	YouTube (2)		Increased customer service reps (4)
	LinkedIn (1)		Increased in-field reps (4)

Although the focus of this preliminary study was on identifying smart meter deployment strategies consistent with psychological theory on technology acceptance, data collection also revealed signs of smart meter "backlash" consistent with the psychological model of technology acceptance presented in the literature review. In at least three of the regions where customers were not invited by their utility or municipality to participate in public comment or voting, residents created their own websites to provide information on how to contact utilities or share public comments. One even gave specific details on how to voice opposition and contact the state public utility commission. In addition, many of the stated risks associated with smart meter on several "backlash" websites are also associated with other technologies in which most consumers perceive greater benefit and therefore seem less concerned with risk (e.g., radiofrequency radiation, which is also emitted from cell phones, privacy issues related to wireless data transmission, which is similar for email). One quote from an anti-smart meter website nearly perfectly encapsulates the issues of social trust and technology acceptance:

> *"I first heard the term 'smart meter' when a postcard came … to inform us "In the coming weeks, we will be in your neighborhood to replace your meter with a smart meter." This is the only notice provided – and I know that some here never even received this postcard. Next, installers just show up and turn your power off to switch meters without even knocking on your door first – even while you are home. There are reports of computers getting shut off abruptly while in use, and appliances (fish tanks!) not powering back on when the owner is not home to reset switches and the like."*

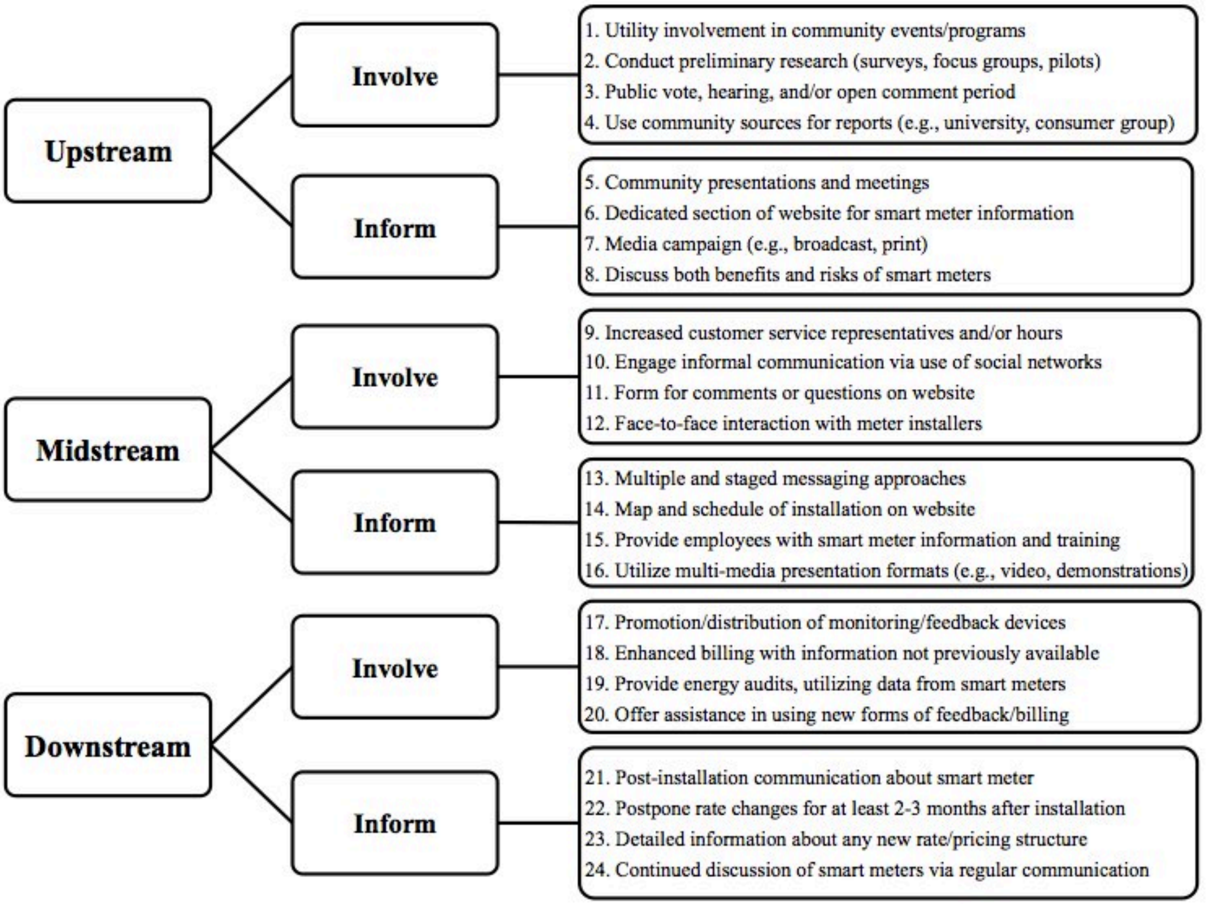
It seems much of the frustration of this person comes from not being notified sooner about the technology rather than the technology itself. This sentiment is reflected in data collected from several other utilities within the sample. Based on these preliminary findings, a follow-up study is currently being conducted to analyze the relationship between the strategies identified in this paper with the level of backlash within each region.

Discussion

Analyzing the strategies identified in light of previous research highlights three key points. First, the most commonly deployed strategies by utilities involve traditional information provision, focusing on the competence of smart meters rather than establishing trust with the administering agency. The most frequent strategies included pilot programs, mail and door hanger notification, printer material, and smart meter information on utility websites. Second, the most frequent strategies took place immediately prior to or during installation. By this time, it is possible that either initial impressions had already been formed from other sources or that notification of installation was the first information received about smart meter, which could decrease social trust. Finally, the presence of innovative practices among a small handful of utilities suggest new avenues for public communication that may leverage psychological insights for increasing acceptance. Provision of energy feedback in the form of devices and websites, involvement with community groups and events, and the use interactive media all show promise for both increasing social trust and demonstrating competence.

Based on these findings, strategies were integrated into a suggested framework, or protocol, for public communication regarding smart meter deployment (see Figure 1). The framework distinguishes communication strategies both functionally (involve and inform) and temporally (upstream, midstream, and downstream).

Figure 1. Multi-level Smart Grid Public Communication Framework



Functions of Smart Meter Communication

Strategies were divided into two functional groups, referred to as involve and inform. Involvement strategies are those activities designed to engage the community with smart meters and/or the utility company as well as create opportunities for public input regarding decisions about smart meter deployment and use. Involvement strategies included those which actively promoted shared values, demonstrated to be vital for social trust, as individuals who feel they are able to become involved in the decision-making process (even if they elect not to do so) are more likely to trust the institution. Strategies include utility support of community organizations and events, hosting public meetings, inviting public comment or vote on smart meter initiatives, and the use of enhanced billing and/or feedback to engage people with their energy information.

Information strategies included both the provision of general information about both smart meter risks and benefits and specific information about installation schedules and policies. The provision of thorough and unbiased information is especially important for new technologies such as smart meters, in which there is little previous knowledge on the part of consumers. Strategies includes information on the utility website, community meetings, and mass media campaigns. Since smart meters are installed in the home and have direct impacts on home residents, notification is also a vital step, as trust can quickly be eroded if customers feel like changes are being made to their home's electricity system without their knowledge.

Stages of Smart Meter Communication

Analysis also identified three core "stages" of smart meter deployment in which utilities can engage in public communication strategies: upstream (during the decision-making process), mid-stream (during implementation/installation), and downstream (after the initial transition to smart meters has taken place).

Upstream involvement has great potential for increased public engagement and is also vitally important according to dual process models of information processing, in which immediate, affective impressions can significantly impact subsequent cognitive processing of information. At this stage in smart meter deployment, strategies identified included preliminary research, public comment periods, demonstrations and public presentations about smart meter, and general utility involvement in community events (which can serve to build social trust and can occur far prior to the actual planning of smart meter installation).

As utilities move towards installation, the focus of communication strategies moved from general (affective) impression formation to notification of the actual installation process (analytical). It is suggested that notification involve multiple formats and be provided in advance of installation, so that residents are well informed and not taken by surprise when installers arrive. Another midstream strategy reinforced by the literature is training installers (and all utility staff) as informal risk communicators and ensuring that they have the tools and knowledge to respond to customer inquiries. Involvement is also possible midstream through increased attention to customer service inquiries, web forms, and the use of social networks that allow for two-way communication between utilities and their customers.

Downstream is another stage where many utilities seem to have room for improvement. Informing and involving consumers through provision of tangible benefits like real-time feedback and disentangling smart meter installation from rate changes can serve to highlight benefits of feedback and create shared value between consumer and utility for smart meters. In these times of tight economies, consumers are sensitive about government spending and continued information about what the smart grid has to offer consumers is highly valuable for maintaining public trust and acceptance in the long-term.

Conclusion

By reviewing past literature and connecting it to data drawn from actual utility deployments, this paper sought to develop a simple, yet effective framework for public communication strategies related to smart meter deployment. Public acceptance is crucial to smart grid development, as complaints and backlash delay development and hinder progress. Despite similar technological construction, public reception of the smart meters differs widely across regions and service areas, suggesting some differences may be attributed to rollout strategies. It is hoped that this basic framework can be built upon and tested to further develop our understanding of how people are responding to and living with the new grid infrastructure. Regardless of the specific strategy, integrating psychology and practice suggests that a communication approach built on establishing trust through both information and involvement of the public across temporal phases of deployment should increase public acceptance of smart meters within communities, both domestically and throughout the world.

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