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Stakeholder values and platform wars: smart meters in the Netherlands

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Abstract

The interconnected nature of the different components of smart grids is a prime example of complexity in technological systems. Developing such systems is highly dependent on the wishes and needs of end-users and other stakeholders. We argue that stakeholder values should be taken into consideration during the design and standardisation of complex infrastructures, and illustrate this with a case of smart meters and home energy management systems. We base our argument on the literature in the technology management fields, particularly those strands related to standardisation. We conduct a case study of the acceptance of smart meters (standards) in the Netherlands, based on stakeholder interviews. We use q-methodology to analyse the most salient values in this case. The Dutch smart meter case arguably demonstrates that a lack of consideration for stakeholder values led to the postponed roll-out of smart meters in the Netherlands. By not addressing privacy issues, economic advantages, and the need for informed consent, the roll-out of smart meters was delayed for several years. This lead to a more gradual approach and increased stakeholder involvement. This case may serve as an example for other European countries who also face public concern regarding the impact of advanced metering infrastructures.

Keywords: smart meter; smart grid; values; responsible innovation; case study; Netherlands; home energy management

Introduction

Modern society is highly dependent on a number of infrastructures. The electricity infrastructure is the most critical (Luiijf and Klaver, 2006). The desire to move towards a more sustainable energy system – with more decentral, renewable energy sources such as solar and wind power – requires adjusting the existing, centralised electricity infrastructure. The concept of such a new system is known as the smart grid. It implies a number of changes

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at various system levels (national transmission grid, local distribution grid, and residential connections; Morgan et al. (2009)) with a high importance for information and communication technologies (ICTs; Mulder et al. (2012)). However, the precise technological constellation of smart grid systems is yet unknown and a matter of discussion for politicians and policy makers, (systems) engineers and standardisation bodies, energy providers and distributors, knowledge institutes and consultants, and citizen representatives. Moreover, to date it is unclear what policy and regulatory measures will have to be defined and established as the institutional requirements for the implementation of smart grids are largely unknown.

Even when limiting ourselves to the residential realm the number of interrelated issues is vast. A case in point is the smart meter. This improved version of an electricity meter is seen as an important element of the smart grid that also allows for end-user efficiency through insight into consumption patterns (EC, 2011; Faruquiet al., 2010). The most comprehensive version of such a device provides an overview of energy use in households (accounting for decentral generation). The meter transmits this information to energy providers and/or distributors to improve their systems, and control electric devices remotely, for example to optimise the load of the distribution grid, or to switch off consumers who have not paid their bills. At the end of 2013 it became clear that the switch function is going to be removed from the smart meters for security reasons. In practice, smart meter deployment is guided by various motives (e.g. fraud detection, improved billing) that have different technical requirements (Faruqui et al., 2010; AlAbdulkarim, 2013). At the same time, it has become clear that the roll-out of smart meters can only be successful if the end-users in households also recognise their benefits (Cuijpers and Koops, 2013; Hierzinger et al., 2013; Balta-Ozkan et al., 2013; Krishnamurti et al., 2012). Until recently this has not been the case and citizens have voiced concerns about issues including privacy (McKenna et al., 2012; McDaniel and McLaughlin, 2009) and health effects (Verbong et al., 2013; Hess and Coley, 2012).

In this paper we take the position that technology development is driven by the needs and requirements of a wide range of stakeholders. Among these, technology developers and their competitors play an important role in shaping and standardising technologies. Policy makers can be considered stakeholders, as they need to devise regulation that can be upheld at acceptable costs, hence to minimise transaction costs. Other stakeholders, such as households, may have a less prominent role in determining the development of technologies, but at times play a significant role in the acceptance of the technology (Mitchell et al., 1997). It is important to identify all the stakeholders involved and to understand their motives and values so that the technology development can be adjusted in a timely fashion. The Dutch smart metering history provides a cautionary tale as the needs of household end-users, one of the main groups of stakeholders, were not sufficiently taken into account. This was one of the main reasons that the Dutch Senate rejected the new Energy Bills in 2008 (Cuijpers and Koops, 2013), which consequently delayed the roll-out of smart meters for several years.

We aim to shed light on the development process and examine to what extent value sensitive design could have avoided this delay. We employ a case study analysis of the standardisation of smart metering in the Netherlands. We add insights from overlapping standards discussions in household automation and show that the interlinked nature of ICT and home automation does not allow a strict delineation of technological artefacts and leads to an oversimplification of the issues at stake. We discuss to what extent earlier analysis of this information could have led to earlier adjustments of standards such as the Dutch smart metering requirements (DSMR).

Home energy management as a complex product system

A smart meter could be seen as an artefact that, like a pair of scissors, can be designed or bought on the market in relative isolation. However, literature on technology management has long conceptualised technological artefacts as subsystems that are linked together, as well as being a component of even larger systems (Clark,1985; Suarez, 2004). Tidd (1995) calls these complex product systems, that have three distinctive characteristics:

- Systemic; the systems consist of numerous components and subsystems.
- Multiple interactions take place across different components, subsystems, and levels.
- Nondecomposable; the systems cannot be separated into their components without degrading performance.

This means that technologies, components, and interfaces incorporated in products are interdependent, and thus rely on standard interfaces, but also depend on different market segments and the range and specificity of performance criteria within these markets. This also means that technological designs and interface formats, sponsored by different actors, compete for dominance (in so called 'platform wars').The literature on platform wars has focused on economic, technological, and socio-political factors that influence market acceptance of platforms (Rosenkopf and Tushman, 1998; van de Kaa et al., 2011; Suarez, 2004). Little empirical research has been devoted to factors that affect the societal acceptance of platforms. However, societal acceptance is increasingly recognized as an important factor that influences market acceptance (Huijts et al., 2007). In this paper, we explicitly take this aspect into account. The more complex the product system, the greater the number of market segments and the variety of stakeholders involved (McHenry, 2013). For example, in the home network industry, various market segments such as information technology, consumer electronics, and telecommunications are involved and each of these include different actors (Van de Kaa et al., 2009). Recent research has shown that when stakeholders from these industries are aligned, the chances that the technological standard achieves market dominance increases (Van den Ende et al., 2012).

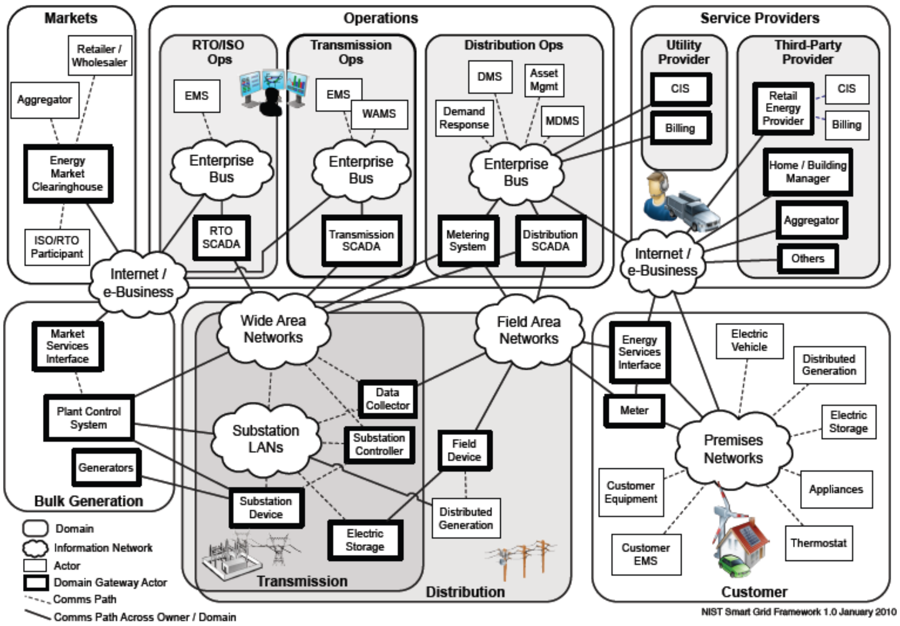

Figure 1: An overview of the components and sub-components of smart grids, according to NIST10. In the lower right corner the home environment is visible ('Customer'), in which a (smart) meter and Home Energy Management System ('Energy Services Interface') provide the gateway to the energy production chain.

Logically, there is a trade-off between an isolated analysis of one component that is simple but misses the interconnections of the larger system on one hand, and an analysis that is all-encompassing but unmanageable. The complexity of smart grid components and their interaction is displayed by (2010) in figure 1. At the lower layer of figure 1 we see the energy production chain from generation via transmission and distribution to the end user. The higher layer represents markets, services, and operations that facilitate the working of the physical chain. We see information and communication technology (represented by the clouds) connect to different grid components (represented by squares). Many of these components only operate because of their connections to other components in the grid, beyond the boundary of one organisation.

A full analysis of smart grids goes beyond the scope of our study, but a sole focus on smart meters would miss relevant interactions and (future) technical requirements. Therefore, we analyse the smart meter, but also look one level higher: at home energy management (in figure 1 this is called the customer level).

Value Sensitive Design

Before describing our case, we expand on the notion of values and value sensitive design. Values are mentioned in a wide array of disciplines (e.g. philosophy, sociology, economics) and generally denote what something is worth, opinions about that worth, and/or moral principles (Dietz et al., 2005). Values are also described as "enduring beliefs that a specific mode of conduct is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1968). In decision-making science, values, which can be described as an abstract set of principles, allow us to resolve conflicts by suggesting which preferences are better. When fully quantified, a set of values determines an objective function which allows us to distinguish options. Values not only provide guidance

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in evaluating alternatives, they also influence information collection, exploration of alternatives, and focus discussion (see e.g. Keeney, 1994, 1988).

Values also play a role in the design and use of technological artifacts. Whereas historically technology may have been considered purely instrumental and value-free (Manders-Huits, 2011), it has become clear that technological artifacts exhibit moral and political choices and consequences, even though the moral and political dimension may not be perceived by their designers and users. A stream of research that focuses on moral and political dimensions of technology is value sensitive design (VSD) (Friedman et al., 2002; Borning and Muller, 2012).

Many of the technological examples addressed in VSD relate to information and communication technologies (ICTs) (Friedman et al., 2008; Van den Hoven, 2007; Friedman, 1996), which is why we expect the approach to be pertinent to smart meter/home/grid technologies. VSD started from the recognition that when designing information technologies, the predominant, traditional focus of engineers is on functionality, i.e. the usability, efficiency, reliability, and affordability of (new) technologies. The prime point of reference is the designer's own experience. For example, it has been shown that software designers sometimes unknowingly design software that is more aligned with males than with females. Friedman (1996) also mentions an example of educational software that is geared towards the American competitive education system which is less successful in foreign classrooms, where cooperation is considered more important.

Although it is embedded in moral philosophy, VSD uses a broad sense of values. Values refer to what persons, either singularly or collectively, consider important to their lives. The Schwartz Value Survey, commonly used in social science (Dietz et al., 2005), identifies 56 personal values. However, this full range of values might not relate to technological artifacts and technology use. For this study, we therefore focus on a subset that is often mentioned in VSD literature. Next to the already mentioned functional values (accountability, controllability, correctness, efficiency, environmental sustainability, legitimacy, reliability, responsibility, safety), we address social values (cooperation, democracy, freedom from bias, identity, participation, politeness, privacy, trust) and individual values (autonomy, calmness, economic development, informed consent, ownership, universal usability, welfare). Most of these values are defined in Friedman (2008). Section 5 describes the most relevant values for this research. In the following case study, we highlight values related to home energy management systems. By identifying them, we gain insight in the acceptance of these technologies which, in turn, may influence their design.

Smart meters in the Netherlands

Early scholarly mentions of intelligent or smart meters suggest their (technical) development took place in the 1980s and 1990s (see e.g. Peddie, 1988). As we are interested in official standardisation, we provide an overview of Dutch policies regarding smart meters (see also the timeline in figure 2), its standardisation, and the stakeholders involved in this process.

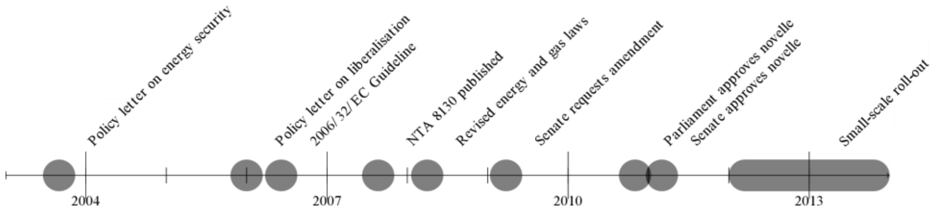

Figure 2: Timeline of the smart meter policy process in the Netherlands.

Following a letter about the security of energy supply from the Ministry of Economic Affairs to Dutch Parliament in 2003 (MinEZ, 2003), SenterNovem, a ministry agency, was requested to investigate the standardisation, stakeholder involvement, and conduct a cost-benefit analysis, in the roll-out of a smart meter infrastructure (Dijkstra et al., 2005). Demand side response was seen as a major contribution to security of supply during peak electricity consumption. The Dutch standardisation institute NEN was commissioned to formulate and describe a national standard for smart meters. The societal cost-benefit analysis proved to be positive (a net gain of 1.2 billion Euros) with the citizens as main beneficiaries of the roll-out. Interestingly, in the ensuing stakeholder consultation, consumer representatives were not heavily involved: "The point of view of the consumer, individually as a household, or collective via housing corporations, Home Owners Association or Consumers Association was not a key issue" (Dijkstra et al., 2005). The other stakeholders – energy producers, energy suppliers, grid operators, metering companies, telecom, energy regulator – requested the Ministry to clearly identify meter functionalities, expedite meter roll-out by setting a time-frame, and provide regular consumption overviews (to make smart meters the only affordable solution).

Anticipating the EU Directive (2006/32/EC) on energy end-use and energy services, the Ministry of Economic Affairs provided more information on smart meters requirements, citing billing administrative problems and the energy savings goals of the Commission as main arguments in favour of smart meters (MinEZ, 2006). In 2007, NEN published the technical agreement NTA 8130, which set out a minimum set of requirements for smart metering. The organisation of grid operators (Netbeheer Nederland) took the lead in specifying these requirements, known as the Dutch Smart Meter Requirements (DSMR).

In 2008, the Ministry of Economic Affairs revised the electricity and gas bills that implemented the European directive. Grid operators became responsible for meter deployment, and energy providers were appointed point-of-contact for consumers. This was supposed to increase clarity for consumers, efficiency, and create a level playing field for market parties. Consumers were required to cooperate in installing smart meters; not doing so, would constitute an economic felony. After several rounds of reviews and discussions about privacy, and amendments as a response to the Dutch Data Protection Authority (CBP), the bills were passed by the Lower House of Parliament in July 2008. By that time, the smart meter and its privacy issues had gained wider public interest. Technical experts assessed possible security and privacy breaches of the meter, and legal experts deemed the proposed solution irreconcilable with the European Convention on Human Rights (Cuijpers and Koops, 2013). When the bills were scrutinised by the Senate in 2009, it proposed amendments regarding the mandatory character and revisions concerning consumer privacy. The smart metering bill was amended into a voluntary roll-out of smart meters and reintroduced for political consideration in September 2010. The customer could now decline a smart meter and energy suppliers were required to give customers bi-monthly statements with specified

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information. The network operators set up uniform authorisation and authentication procedures to ensure that individual measurement data was only used for specific purposes and only after customer consent. The revised bills was passed by the Lower House of Parliament in November 2010 and approved by the Senate in February 2011 (Hierzinger et al., 2013).
The Ministry of Economic Affairs agreed on a ‘small-scale’ deployment of smart meters in 2012 and 2013. This two-year period was used to test the practical implications of roll-out in approximately 400,000 households and to assess consumer response. A mid-term review of the roll-out did not identify any major issues, with only 2%-3% of households rejecting the smart meter. At the end of 2013, there is still a political debate about whether the smart meter should be coupled with the functionality to switch off electricity and gas. In other countries this ability to avoid network overload or to cut off non paying customers was the main reason to install smart meters, but the Dutch Consumers’ Association argued that remote-controlled switches would constitute a cyber-threat on a nation-wide scale. In its latest consultation round at the end of 2013, the Ministry seems to share this view.
Meanwhile, several stakeholders (notably hardware providers) argue that the Netherlands with its eight million households and 750,000 small and medium enterprise connections is not large enough to make a customised smart meter financially feasible. They emphasise that the Dutch Smart Meter Requirements should be abandoned in favour of European standards.

Importance of values in smart meters

The case description indicates that smart meter development is indeed a complex process involving many stakeholders, standpoints, and solutions. One problem is that future users cannot express their needs and desires about products that they know very little about. In this case, we clearly see *technology push* rather than *demand pull* (Tidd, 1995). However, (1997) argue that stakeholders may have a latent or potential relationship with the technology, still requiring their input in the design process. This clearly did not happen in the Netherlands for the design of the smart meter.
We have attempted to identify the values that played a role in the development of smart meters. To do so, we subjected a group of experts to the q-methodology: an exercise plus associated statistical analysis used in social sciences to discover sets of perceptions about a particular topic (Stephenson, 1953; Brown, 1980). Q-methodology consists of four steps: a selection of statements about the topic to be analysed, the sorting and ranking of these statements by a group of respondents, the statistical (factoral) analysis of the data, and the interpretation of the resulting perspectives (Van der Lei, 2009; Van Exel and de Graaf, 2005).

We gathered statements about values related to technological systems from the VSD literature. This yielded 23 statements which our respondents ranked from +3 (‘very pertinent to the acceptance of smart meters’) to -3 (‘totally irrelevant for the acceptance of smart meters’), as much as possible according to a normal distribution (where the value 0 receives 5 statements and the extremes +3 and -3 each receive 2 statements). The distribution that a single person makes is called a q-sort and represents the perspective of that person on the research topic.

Based on the q-sorts of our expert panel, our analysis indicates that the five most important values associated with smart meters are:

1. *Privacy*: the system allows users to determine which information about them is used and communicated;
2. *Correctness*: the system provides correct data or performs the correct function;
3. *Reliability*: the system fulfils its function without the need to monitor/control it;
4. *Informed consent*: the system allows its users to voluntarily agree to its activation, based on comprehensible information;
5. *Economic development*: the system is beneficial to its users' economic or financial status.

These results very closely match the general impression of the smart metering debate in the Netherlands. *Privacy* is a very important value that was virtually ignored at the start of the implementation process. As could be expected for a device that is designed to measure, the functional values of *correctness* and *reliability* are also ranked high. The individual values of *informed consent* and *economic development* emphasise that end-user's needs should be taken into consideration.

An advantage of the q-methodology is that the sorting generates discussion, especially when performed in a group (Brown, 1980). An interesting and unexpected finding of our expert group discussion was that these values depend on the delineation of the system. The experts indicated that the important values actually shift when the smart meter is not only seen as a connected measuring device, but more as an energy management nexus for households. This remark urged us to perform a second set of q-sorts, which generated a new ranking of values for home energy management systems:

1. *Economic development*: the system is beneficial to its users' economic or financial status;
2. *Universal usability*: the system can easily be operated by all users;
3. *Privacy*: the system allows users to determine which information about them is used and communicated;
4. *Autonomy*: the system allows its users to make their own choices and pursue their own goals;
5. *Reliability*: the system fulfils its function without the need to monitor/control it.

Here we see a shift towards the individual and social values of users and slightly less emphasis on the functional values of the technology. We believe that this corresponds with findings of Krishnamurti et al. (2012) and Balta-Ozkan et al. (2013). Compared with stand-alone smart meters, a clearly higher score was given for *participation* and *well-being*, again emphasising the user experience. Also, the values of *legitimacy* and *freedom from bias* were ranked significantly lower. In the discussion, it became clear that home energy management systems are seen as a commercial consumer product, for which consumers are personally responsible.

Discussion

From values to design requirements

Value sensitive design purports to be a holistic approach that combines theory with empirics (Manders-Huits, 2011). The identification of values should be linked to the formulation of design requirements for complex product systems, in our case smart meters and HEMS.

The need for (elements of) *privacy* was addressed in the NTA8130 standard and an encryption protocol was added. Functional requirements of *correctness* and *reliability* were already covered by the Dutch measurement code and no further requirements were necessary. *Informed consent* is not easily addressed from a technological standpoint, but it did prove important in the debate in the Senate. The solution was not a technical, but a procedural one. The end users were given four options: no smart meter but an ordinary one, a smart meter that does not communicate, low-frequency communication, or high-frequency communication. The *economic development* was addressed by several cost-benefit assessments and a restriction of the metering tariff.

Given the nature of HEMS (i.e. more like a consumer product), the values associated with it should also be addressed in a slightly different way. The focus on *economic development* suggests a restriction in the price of the system. It also emphasises the need for a clear indication of how much can be saved by installing such a system and, for the user interface, a focus on Euros instead of kilowatt hours. *Universal usability* emphasises the need for easy-to-use interfaces: end-users should not require an engineering degree to operate the system. *Privacy* remains an issue and requires communication channels to be secured – similar to (mobile) telecommunication and computing requirements. *Autonomy* suggests that the users should be in charge of their home energy management and automation: this is closely linked to ease-of-use. And finally, the system should be *reliable* like other consumer products.
We acknowledge that the current research has performed an *ex post* analysis of values and identified issues that were already resolved in the course of history of the Dutch smart meter (standard and requirements). The proof of the pudding would be an *ex ante* assessment and monitoring of the upcoming issues.

Smart meters, smart governance?

Should the function to reduce gas and electricity flows be removed from the Dutch smart meter requirements, which at the time of writing seems most likely, it is questionable whether the smart meters in the Netherlands could still be deemed *smart*. In effect, they would be reduced to communicating measuring devices. From a metrological perspective this would be a positive outcome: the less components in the meter, the easier it is to certify that the meter meets the requirements of the Dutch measurement code. It would also appease the critics that emphasise privacy and security threats. It should however be noted that removing the switching capability from the meter does not remove all privacy and security threats. Specifically the interval information may still be abused. Moreover, when external apparatus is to be controlled via the smart meter this threat is still present. Therefore, adequate regulation to secure the system integrity around smart meters and the often associated (home) energy management systems needs to be devised.

From a technology innovation standpoint and from the view of a smart grid that allows full control of its components, the outcome of the Dutch case may be disappointing. The process of installing smart meters in other countries, e.g. Italy and Sweden, was not hampered by public opinion. On the other hand, the meters that were installed in those two countries do not support demand side management or home automation. So the question remains whether the Dutch postponement can be considered a costly delay or an opportunity to improve the meter from the start.

Other countries, e.g. Austria (BGB, 2013), seem to follow the Dutch example of rejecting mandatory roll out for security and privacy reasons. In Austria's case, this entails a reversal of a 2010 bill. This at least indicates that the Dutch case is not unique and that some of the values identified may play a role in other institutional arrangements. It would be interesting to find out whether the interests of the Austrians are exactly the same, or whether some ideas may differ. Furthermore, it leads to further search for technical innovations that are more in line with requirements of *all* stakeholders.

Multidisciplinary approach

Our research contributes to the literature on innovation management and standardisation (e.g. Suarez, 2004; Schilling, 1998, 2002; Sheremata, 2004). Scholars in the area of innovation management and standardisation have attempted to explain standard dominance and draw from various areas of research including network economics and institutional economics (Van de Kaa et al., 2011). They have come up with technology, firm, and environmental level factors that explain standard dominance (Suarez, 2004). In this paper we shed light on another level of analysis that is neglected in the literature: the end user (although we acknowledge the critique that we used *expert assessment* of end user needs). We provide a first illustration of the notion that societal acceptance of a platform will grow if a technological design is modified to changing user requirements related to ethical and societal values surrounding the technology. *Privacy* is the most salient value for the Dutch smart meter case, but *informed consent* also played an important role. Combining literature on value sensitive design on the one hand and technology management on the other hand, we provide a clearer view on the influence of factors relating to the end user. Future research could further explore the *ex-ante* translation from identified values to actual design requirements.

Conclusion

Our case study of the development of smart metering and smart metering standards in the Netherlands shows the complexity of introducing such technology in an existing socio-technical system. Current technological development is often so complex that stakeholders are unable to fully assess new technologies. Furthermore, people's opinions and beliefs change because of new information, insights, and experiences. Whereas the introduction of the smart meter started off from technical requirements, several non-technical issues (values) were introduced by the consumers' organisation and other stakeholders. We believe that the outcome of our values elicitation is a more balanced representation of the interests of the end-users: it is a combination of functional, social, and personal values.

On one hand the focus on values may help designers in their search for better specification of smart meters. However, the design process is complicated by the fact that smart meters form an important part of home energy management systems. As we have shown the related values are somewhat different and there still may be some discussion to what extent the meter should adhere to 'meter'-values or to 'HEMS'-values. This is certainly an area in which value sensitive design could provide more guidance. This not only pertains to the designers of the smart metering system, but also to the design of institutional arrangements, hence the policy and associated regulation.

Although the Dutch example shows that public influence can have a frustrating effect on technical innovation and in this particular case the vision of a smart grid, we would contend that a focus on end user requirements and values leads to a higher rate of acceptance of new technologies in complex socio-technical systems.

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