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The British public's perception of the UK smart metering initiative: Threats and opportunities

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HIGHLIGHTS

- We examine consumer acceptance of smart metering initiatives using focus groups.
- Consumers perceive both threats and opportunities in smart metering initiatives.
- Threats include; autonomy issues, privacy concerns and mistrust of suppliers.
- Opportunities include: accurate billing and enablement of future ICT services.
- Consumers responded positively to the idea of automated energy management.

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ABSTRACT

Consumer acceptance of smart meters remains crucial in achieving the potential carbon emission reductions offered by advanced metering infrastructures. Given this, the present research used deliberative focus groups to examine what is needed to secure acceptance and engagement from domestic consumers with services, products and 'offers' in smarter power systems. Our findings suggest that consumers are able to identify not just threats relating to smart metering initiatives but opportunities as well. In particular, our focus group participants responded positively to the idea of an automated system that could be used to achieve energy savings in combination with time-of-use tariffs. We conclude by outlining suggestions for policy recommendations that may help consumer acceptance of smart meter enabled services be more readily achieved.

1. Introduction

The installation of smart meters into millions of homes across Europe, the USA, Canada, New Zealand, and Australia is one of the biggest energy industry change programmes in history (Darby, 2010). The advanced metering infrastructure afforded by smart meters, including the proposed development of a"smart grid', offers considerable scope for new offerings in smarter energy management services and may also help reduce environmental impact via lowering consumption and/or load shifting (Darby, 2009). However, in order for these benefits to be realised, it is crucial to secure consumer acceptance of smart meters and the associated services that they may enable. Indeed, as Smart Energy GB, the body responsible for promoting smart meters in the UK, observes, "Smart meters aren't mandatory – consumers can choose not to opt in. This means the rollout is not something happening to us – it will only work if we all actively and enthusiastically opt in."[1] Yet, current research has predominantly focused on the technical and system configurations involved with smart metering with non-technological topics, such as consumer acceptance of"smart services', attracting considerably less attention from researchers (Solaimani et al., 2015; Wilson et al., 2014). Moreover, the research that has examined consumer acceptance and engagement with smart meter enabled services (SMES) has tended to focus on the use of smart meters to provide feedback to consumers about their energy usage via an in-home display (IHD;

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[1] Extract taken from http://www.smartenergygb.org/.

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Table 1
A Summary of the New Economic Foundations Five Ways to Well-Being Framework.

Ways to well-being	Descriptive Explanation
Connect	Connect with the people around you. With family, friends, colleagues and neighbours. At home, work, school or in your local community. Building these connections will support and enrich you every day.
Be Active	Go for a walk or run. Step outside. Cycle. Play a game. Garden. Dance. Exercising makes you feel good.
Take notice	*Take notice*. Be curious. Catch sight of the beautiful. Remark on the unusual. Notice the changing seasons. Savour the moment. Be aware of the world around you. Reflecting on your experiences will help you appreciate what matters to you.
Keep Learning	Try something new. Rediscover an old interest. Sign up for that course. Take on a different responsibility at work. Fix a bike. Learning new things will make you more confident as well as being fun.
Give	Do something nice for a friend, or a stranger. Thank someone. Smile. Volunteer your time. Seeing yourself, and your happiness, linked to the wider community can be incredibly rewarding and creates connections with the people around you.

e.g., Buchanan et al., 2014; Hargreaves et al., 2010; Hargreaves et al., 2013; Snow et al., 2013). While such research is needed in light of the UK government's imminent plans to provide 53 million households with an IHD as part of the smart meter roll out (DECC, 2013), there is also a need to explore consumer acceptance of SMES that may emerge in the longer-term. This is especially pertinent, given that other SMES may succeed in attracting consumers for whom the IHD alone has failed to engage.

Given this, in the present research we examined the British public's responses to (i) smart meters and (ii) three'smart service' concepts: automation, community rewards, and gamification.[2] Notably, in keeping with our emphasis on consumer acceptance the three SMES we presented to focus groups were derived from a stakeholder workshop in which participants developed service concepts using inspiration from the New Economic Foundation's 'Five Ways to Well-being framework' (Aked et al., 2009). This framework identifies five factors that past research has extensively demonstrated are related with higher quality of life (ibid, 2009): connecting with others, being active, taking notice of experiences and surroundings, learning and giving to others (see Table 1 for further details). The rationale behind applying this framework was to appeal to a wider set of motives that consumers may have (e.g., to learn, to contribute to the community, etc.) rather than narrowly targeting SMES at either consumers' financial and/or environmental motives. To the best of our knowledge, we are the first to utilise a well-being framework to derive concepts for future SMES and to examine consumer acceptance of the services that arose out of this novel approach. Accordingly, we aimed not only to contribute to the existing literature concerning consumer acceptance of future SMES but also, in placing consumer well-being at the foundation of our investigation, hoped to highlight some key facets that should be considered in the design and marketing of SMES.

In the following paper, we briefly outline how smart meters are likely to affect UK consumers in the short- and long-term, before providing an overview of existing research into consumer acceptance of smart meters and prospective SMES. We then provide an overview of the present research and explain how and why the three SMES (automation, community rewards, and gamification) we presented to focus groups were derived using a well-being framework. Finally, we present a thematic analysis of consumer responses to the three SMES and more generally to smart meters, before concluding with the implications that our findings may have for policy.

1.1. How will smart meters affect consumers?

In the short-term, it is anticipated that smart metering will put an end to estimated billing and give UK consumers control over their energy bills by equipping them with an IHD that provides real-time information about their consumption, thus enabling them to switch suppliers more easily to secure better tariffs (DECC, 2014a, 2015). The installation of smart meters will also mean that consumers who fail to pay their bills could be 'remotely disconnected' or switched to a pre-payment mode[3] by their energy supplier; although the UK's utility regulatory body Ofgem has introduced rules to ensure this step is taken only as a last resort (National Consumer Council, 2008).

In the longer term, smart meters provide the infrastructure needed for the development of smart grids and smart appliances, as well as other home energy management services (DECC, 2014a, 2015). It is envisioned by the government that this will "play a key role in transforming how consumers buy and use energy" (DECC, 2015). For consumers, this is likely to mean that their energy providers will introduce new time-of-use (TOU) tariffs to incentivise them to consume energy during off-peak hours. Static TOU tariffs will charge customers more for their consumption at fixed times of the day, while dynamic tariffs will see customers paying different rates at different times, which may vary from day to day. Such tariffs may be used in tandem with direct load control (DLC), which will see customers give control of their 'smart' appliances to energy providers so that they can be operated during off-peak periods. Evidently then, smart meters may have considerable impact on consumers' lives both in the short- and long-term, and there is a clear need to ascertain whether these changes are perceived by the British public as opportunities or threats and, thus, if consumer acceptance is likely.

1.2. Existing research: consumer acceptance of smart meters and associated services

While existing literature into smart meters tends to be dominated by research concerned with technicalities (Solaimani et al., 2015; Wilson et al., 2014), more recently research has started to explore consumer attitudes toward smart meters and SMES. Although much of this research has focused on the use of smart meters to provide feedback to consumers (e.g., Buchanan et al., 2014; Burchell, et al., 2016; Hargreaves et al., 2010; Hargreaves et al., 2013; Snow et al., 2013), there is some research that has used both quantitative and qualitative methodologies to explore other smart-meter related topics, including the public's perception of smart meters (DECC, 2014b; Forsa, 2010; Krishnamurti et al., 2012) and smart houses (Balta-Ozkan et al., 2013; Paetz et al., 2012), as well as consumer acceptance of various demand-side response options, including static TOU, dynamic TOU, and DLC[4] (Annala

[2] Gamification refers to the process of enhancing services with (motivational) affordances to invoke gameful experiences and prompt desired behavioural outcomes (Hamari, 2013; Huotari and Hamari, 2012).

[3] A prepayment mode will ensure that consumers are required to purchase credits for their meter before being able to consume energy. Should consumers run out of credits the meter will have a limited amount of credits to the value of £10. However, should a consumer use these emergency credits they will need to replace them when they next purchase credits.

[4] Variously referred to as remote demand control, automation or enabling "smart appliances".

et al., 2013; Darby and Pisica, 2013; Fell et al., 2014; Lopes et al., 2014; Mert et al., 2008; Mert et al., 2009; Murtagh et al., 2014; Spence et al., 2015).

Research examining public acceptance of smart meters suggests neither overwhelming support nor opposition. Instead, the British public appear to be either apathetic or ambivalent, with 53% indicating that they are undecided about whether they should be installed in every UK home (DECC, 2014b). Moreover, where smart meters have been installed in domestic homes, this has primarily been the result of customers being contacted by energy suppliers rather than consumers proactively requesting one (84% vs. 5%; DECC, 2015). Part of the problem appears to be that consumer knowledge of smart metering is relatively low (Smarter Energy GB, 2015[5]) with 76% of British consumers reporting knowing either nothing or very little about smart meters (DECC, 2014b).

Although the SMES examined by research have varied, it is possible to extrapolate some key themes regarding the threats and opportunities perceived by consumers. Some of the benefits identified include greater accessibility of information and greater levels of control over energy costs, the opportunity to save money, and the maintenance/enhancement of personal comfort (Annala et al., 2013; Darby and Piscia, 2013; Mert et al., 2008; Paetz et al., 2012; Smarter Energy GB, 2014). In contrast, the threats identified include privacy violations, issues of security, loss of control and autonomy, mistrust of energy suppliers, and disruption to daily household routines (Balta-Ozkan et al., 2013; Fell et al., 2014; Krishnamurti et al., 2012; Lopes et al., 2014; Mert et al., 2008; Murtagh et al., 2014; Paetz et al., 2012; Rodden et al., 2013).

2. The present research: exploring consumer acceptance

The primary objective of the present research is to understand what is needed to secure acceptance and engagement from domestic consumers with (i) smart meters and (ii) prospective SMES. To achieve this objective, we first ran a workshop to develop concepts for SMES and then conducted deliberative focus groups to explore consumers' perceptions of smart meters and the three prospective SMES that arose out of the workshop.

Notably, we employed a novel framework to design the concepts for the prospective SMES that, to the best of our knowledge, has not previously been utilised in this capacity. Specifically, the SMES were derived using inspiration from the framework provided by the 'Five Ways to Well-being'. This framework was developed in 2008 by the New Economic Foundation (NEF) as part of the UK government's Foresight Project on Mental Capital and Well-being, and constitues a set of five evidence-based actions associated with the promotion of people's well-being (Aked et al., 2009); namely connect, be active, take notice, keep learning, and give (see Table 1 for further informtion).

The rationale behind utilising the 'Five Ways to Well-being' framework to design the smart meter service concepts was twofold. First, we aimed to target a wider range of motives, rather than simply appealing to either financial and/or environmental motives, which consumers may not necessarily have (Buchanan et al., 2015). In particular, we saw value in targeting consumers collective motives. This is because a key opportunity afforded by smart meters is the potential for consumer load shifting. This reduces strain on the grid through enabling distribution network operators to match demand with the availability of supply, which in turn reduces the need for grid reinforcement, and improves the overall efficiency of the grid. However, given the existing infrastructure of energy systems, such benefits can only be realised if households within the same geographical community act cooperatively to reduce their energy use during the specified time intervals. Second, it is possible that by placing consumers' well-being at the heart of these services the public may be more likely to accept them. Indeed, consumers have observed that if mass adoption of smart home technologies is to occur then householders must be convinced that they will have a positive impact on general well-being (Balta-Ozkan et al., 2014).

2.1. Deriving concepts for future smart meter enabled services

To design the concepts for future SMES we arranged a stakeholder workshop comprised of senior professionals and decisions makers from the energy industry, including experts from both commercial and academic sectors. In total, 18 individuals attended, including device manufacturers, smart data analysts, energy providers, policy makers and practitioners. To ensure 'balanced' group discussions we pre-allocated seating at one of three tables so that each group had a good mix of skills/interests.

At the workshop, delegates first sat through a brief presentation in which we introduced ourselves, outlined the purpose of the workshop, and gave an overview of the 'Five Ways to Well-being'.[6] We then asked participants to work in pairs to generate ideas for SMES that would help reduce environmental impact either through load shifting, storage or demand reduction. To ensure ideas were related to the well-being concepts we provided delegates with a handout that summarised the 'Five Ways to Well-being' and gave examples describing how each concept might link to energy (e.g., 'Notice: when I'm at my neighbour's I really notice what they do about energy use. We're sharing tips so we can top Smartpower's league table of neighbourhoods!'). Following generation of these initial SME concepts, participants were asked to share their ideas with the rest of the delegates at their table and consider to what extent they would be easy to implement and involve consumer engagement that was passive (i.e., the action takes places without end-user input) or active (i.e., user-controlled service where action is required from the end user).

After these discussions, ideas from all three tables were collated and participants were asked to consider the merit of all the options presented. Each delegate then voted for the three ideas that they personally considered to be the best based on the feasibility of the concepts, both in terms of consumer acceptance and reducing environmental impact. This voting process was used to identify the three concepts that, overall, our stakeholders collectively considered to be the strongest. One out of the three concepts was then assigned to each of the three groups, which they were then asked to further develop into a market pitch. After the workshop, the information recorded from these pitches was provided to a designer who created concept boards for us to use as a visual aid for the focus groups (See Figs 1–3).

2.2. Three smart meter enabled services and their links to well-being

The three SMES derived from the stakeholder workshop were automation, community rewards, and gamification. A summary of each service concept including an illustration is provided below, while Table 2 details the links between each service design concept and the 'Five Ways to Well-being'.

[5] A large scale (N=10,071) nationally representative survey commission by Smarter Energy GB found that just under 1 in 5 of the British population knows what a smart meter is.

[6] The 'Five Ways to Well-being' were introduced by Mike Zeidler, who has considerable knowledge about this framework, given his post at the Happy City Initiative, a small not-for-profit organisation that helps people and their communities to focus on happiness.

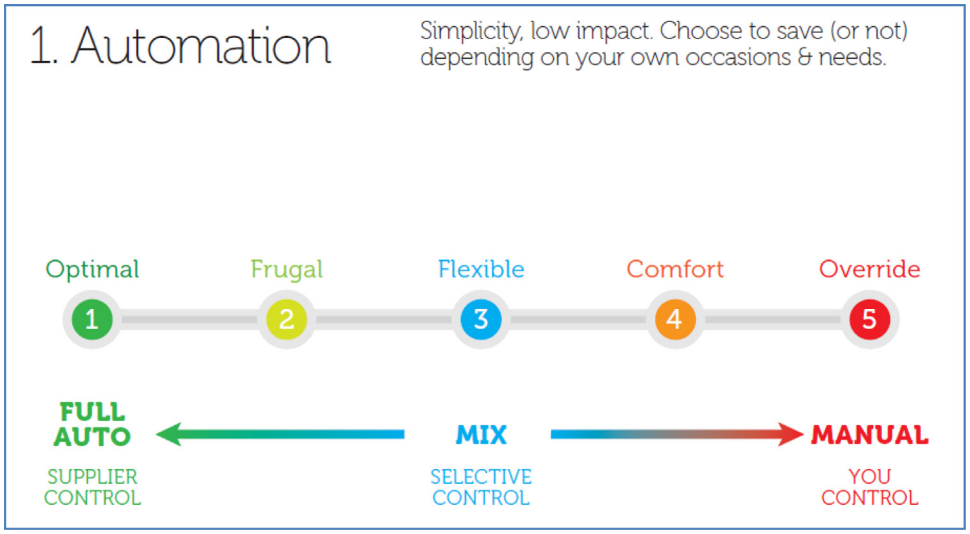

Fig. 1. The concept board shown to focus groups depicting the automation service.

2.2.1. Automation

The first concept is based on the idea of automated electrical household appliances and is comparable to DLC, where consumers allow energy suppliers control over their appliances and are rewarded for using them during off-peak intervals. The user will be offered a high-end interactive display (see Fig. 1) that allows them to choose from several levels of automation, i.e. from 'optimal' (full automation) to 'override' (least system control). This gives the user the feeling of control when actually it is the system that has an automated level of control over household appliances. The optimal end would effectively mean that if a consumer's energy is billed according to a demand side response tariff the system will save them money by reducing their usage at peak times. The override end would effectively mean that the householder is in sole charge of controlling their energy use and reacting to signals on their smart meter. Both extremes have different levels of convenience, inconvenience, and reward.

Participants in this scheme could be rewarded financially for taking part; for example, a one-off payment per year depending upon the average level of automation they allowed. The well-being reward aspect of this service is related to the choice of system control that is inherent in the dial, a report providing positive feedback on their behaviour, as well as knowing that allowing this automation is a benefit for the system and subsequently the energy that is available to them now and in the future.

Notably, due to the capacity for the service to reduce consumers' energy bills and provide them with financial rewards, this concept was the weakest in terms of tapping into non-financial motives.

2.2.2. Community rewards

Community members will be able to sign up for a web-supported service that enables them to gain community points for their personal household energy behaviours, on an opt-in basis. Members have the choice to be identifiable by other members of the community or remain anonymous. These communities would

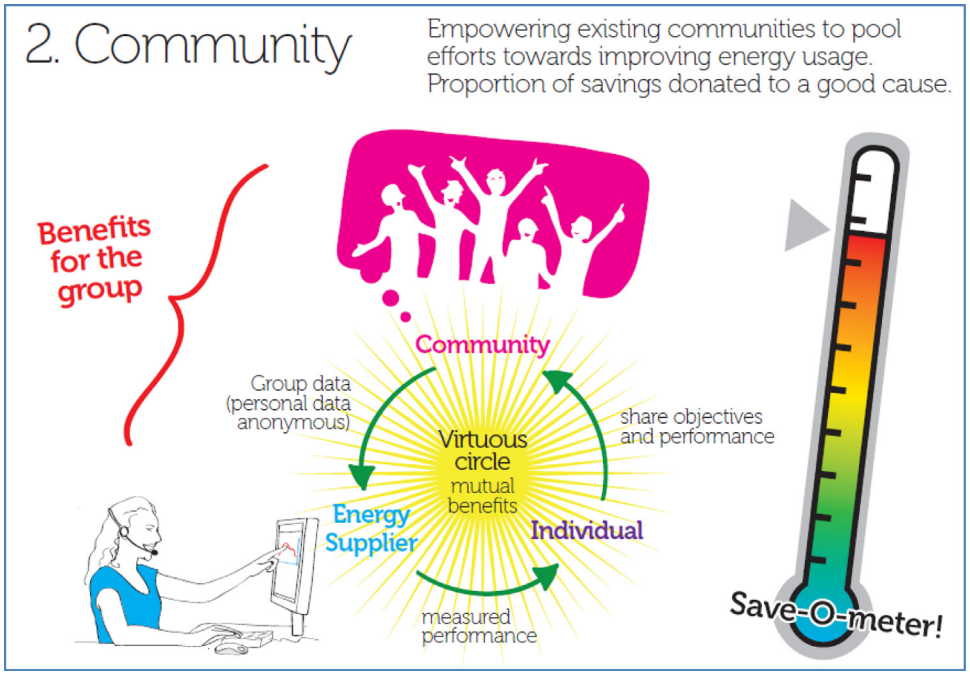

Fig. 2. The concept board shown to focus groups depicting the community rewards service.

Fig. 3. The concept board shown to focus groups depicting the gamification service.

be formed of pre-existing groups, and could be geographical (e.g., a local primary school) or virtual (e.g., Mumsnet). The communities' energy saving webpage could also be linked to social media for those community members that would like to be involved in this way, and members could access and share their performance online via these forums. The community collectively identifies a reward they would like to collect points for (e.g., new playground equipment for their nursery) and are eventually rewarded with this by the energy supplier(s) when they meet their target. Progress towards the target would be updated automatically on the website and community group members could offer each other energy-saving tips and encouragement.

Participants in the scheme would see savings on their energy bills by changing their energy behaviour and reducing their consumption. The well-being reward aspect of this service is related to increasing community spirit, connecting with others, being part of a bigger cause and giving to that cause, as well as learning how to be more energy efficient.

2.2.3. Gamification and data sharing

This service includes the use of an online gaming platform to compare household energy use against others in the game and to receive 'rewards' in the form of points or unlocking new aspects or levels of the game. These points could remain in the game or could be used online as part of schemes that offer consumer discounts. The game would have elements of subversive learning to it. The user's profile might develop as their score and experience grows, much like other online games on Facebook. We expect the competitive aspect of it to appeal to certain types of consumers, as well as to children as a learning tool. Participants could compete against friends in their social network and/or random users. They could also explore energy-saving behaviours in a virtual house.

Participants will see a reduction in their energy bills by changing their energy behaviour and reducing consumption. The well-being aspect of this service includes the sense of satisfaction from personal improvement, connecting with friends more frequently, and improvement against others' behaviour, individually or as a group.

3. Method: deliberative focus groups

To examine consumers' perceptions of smart meters and the three SMES designed by stakeholders we conducted deliberative focus groups. Deliberative focus groups involve the provision of detailed information in order that participants are able to develop a clear understanding of the issues under discussion. As such, they provide the perfect forum for exploring views on issues of which the public may have little or no knowledge, or where they will be

Table 2
The Links between each Service Design Concept and the New Economic Foundation's Five Ways to Well-Being.

Well-Being Aspects	Service Design Concept		
	Automation	Community	Gamification
Connect	Automation dial could be a talking point among friends/colleagues.	Be an active member of the community and make new friends.	Connect with others taking part in the game and gain a sense of community.
Be Active	N/A	You may be able to help with installing/fitting the community reward	–
Take Notice	Be aware of how reducing your energy use can have a positive impact on the environment	See what other communities are doing and what you can do to improve your own	Enjoy the gaming experience of reducing your energy.
Keep Learning	Learning how to reduce energy use	Learn how to reduce energy usage.	Learn how to reduce your energy usage & play a new game.
Give	Giving back to the system and reduce environmental impact	Give back to the community and to the system and reduce environmental impact.	Give back to the system and reduce environmental impact.

Table 3
Socioeconomic Classifications.

Classification	Description
A	High managerial, administrative or professional
B	Intermediate managerial, administrative or professional
C1	Supervisory, clerical and junior managerial, administrative or professional
C2	Skilled manual workers
D	Semi and unskilled manual workers
E	State pensioners, casual or lowest grade workers, unemployed with state benefits only

given information to reflect on (Marsden and King, 2009). Moreover, data generated by the interaction between participants aids spontaneity, thus creating a more "naturalistic and socially contextualized environment" (Finch et al., 2014, p.240).

3.1. Sample

We used a professional research agency[7] to recruit eight individuals for each of the four focus groups that were conducted. Participants were segmented by age and socio-economic class in order to capture diversity and facilitate interaction among participants. Socioeconomic groups were derived using the National Readership Survey social grades, whereby a household is classified according to the occupation of the Chief Income Earner (see Table 3). The socioeconomic categorisations of each focus group were as follows: Group 1=ABC1 (under 40), Group 2=ABC1 (41+), Group 3=C2DE (under 40) and Group 4=C2DE (41+).

3.2. Conduct of fieldwork and approach to qualitative analysis

The focus group discussions were moderated by Nick Banks (Centre for Sustainable Energy) and Mike Zeidler (Happy City Initiative) and followed a consistent structure. During the 90-minute session, each group was introduced to smart meters and the different types of services they can be associated with, such as TOU tariffs and DLC. The 'Five Ways to Well-being' were also briefly explained, before each of the three proposed smart services (automation, community rewards and gamification) were introduced with the aid of concept boards (see Figs. 1–3), with time allotted for a discussion of their advantages and disadvantages. Following a discussion of all three prospective SMES, participants were asked to indicate which of these they favoured. Aside from serving as a crude measure of general consumer receptiveness to each service concept, the voting process was used to prompt participants to share any final thoughts they had about the service concepts before discussions were concluded. All of the focus group sessions were audio recorded and transcripts were produced by an outside agency.[8]

We performed thematic analysis using the process outlined by Braun and Clarke (2006). An inductive approach was adopted whereby the themes that we identified were strongly linked to the data to ensure that the results were not unduly influenced by our pre-existing ideas and knowledge of existing research in this area.

4. Findings

In the following section, we first report on consumers' responses to the three proposed SMES and then reflect on the key themes that emerged both in response to (a) the idea of smart meters and (b) throughout discussions of the three service concepts.

4.1. Consumers' responses to three proposed smart meter enabled service concepts

4.1.1. Automation

Initial reactions to the automation concept were mixed, with some participants declaring that it was a "*good idea*" that was "*quite sensible*" and "*straightforward*", and others denouncing it as "*horrible*" and requiring a lot of (mental) "*energy*", as well as having the "*potential to be wrong a lot of the time*". Despite these initial mixed opinions, a poll taken towards the end of the session revealed that, among all of our focus groups, automation was consistently the most preferred concept of the three proposed SMES. This likeability appeared to arise out of participants' realisation that the proposed system offered them different choices about *if* and *when* they would like the system to control their household appliances. It was clear that users appreciated this, with one participant commenting, *"I think it's a good idea. You have control, I mean you might not have control at that minute, because you've chosen not to have control, but it's still up to you."* Such observations illustrate the crucial importance of control and autonomy in gaining users acceptance. Indeed, control and autonomy emerged as key themes throughout focus group discussions (see Section 4.2.6.1).

Within each focus group, participants showed an awareness that "*everybody's different… everybody's got different kinds of need-usage*" and that "*a lot depends on your lifestyle*". Indeed many of our participants were quick to identify circumstances in which they or others would welcome the option to have different 'automated' settings (e.g., "*I think it's quite good for when you're not at home,[on] holidays or at work…*"). Interestingly, the circumstances in which the automation was considered positive appeared to depend on occupancy and the appliance under consideration.

There was some discussion about whether or not people would notice if small changes were implemented when an automated setting was selected. For example, one respondent commented, "*obviously some people might not notice it but some people will*". Curiously, participants expressed different opinions about whether they would like to notice any changes that were implemented. For instance, while one respondent observed that, "*If I didn't notice then I think I'd probably be quite grateful actually*", another worried that the energy supplier would gradually implement more energy-saving measures without their consent until "*they decide without you being aware*". These differences in desires for 'seamless' technology likely stem from the extent to which participants were primarily concerned with levels of service (i.e., potentially being inconvenienced) versus losing their autonomy (in a similar vein, see also Fell et al., 2014).

It was important for people that if they welcomed the system into their home it worked as expected. In one respondent's words, "*you're trusting it to get it right*". Some participants even went as far as to say that they would be "*suspicious*" or "*sceptical*" until "*they've done some sort of study*". It is also clear that for people to accept an automated system then it has to been seen as benefitting them or compensating them for the inconvenience of not being able to use energy as and when they wanted to. As for the type of compensation, in line with prospect theory (Tversky and Kahneman, 1991), consumers were primarily interested in benefiting from reductions to their bills by going on lower tariffs rather than receiving rewards or incentives. Such findings are also in line with survey data, which found that savings in electricity costs acted as a key driver for consumer acceptance of DLC (Annala et al., 2013; Lopes et al., 2014). However, our participants noted that such an arrangement was only acceptable as long as the inconvenience

[7] QFRS: www.qfrs.co.uk.
[8] FingertipsTyping Services UK: http://www.fingertipstyping.co.uk/.

suffered was *fairly* rewarded. We suspect that this is because by suffering this inconvenience they were not only providing a social benefit through alleviating environmental impact, but importantly were also providing value to both the grid and the supplier that would benefit these parties financially. Given, that their actions were providing a financial benefit to suppliers, they expected a fair exchange for their part in the transaction (i.e., retribution in the same metric-financial). Interestingly, when the contract was framed in this way, consumers appeared more likely to trust the providers, presumably because it is a commercial arrangement and aligns with the ways in which the public perceive energy providers – as commercial entities.

4.1.2. Community rewards

The idea of community rewards inevitably raised issues regarding what was meant by 'community' and if such a thing even still existed, or the mechanisms via which the proposed scheme could be achieved (see also section 4.4.2, 'Practicalities'). From the discussions that ensued, it appeared that participants did not necessarily form communities based on their geographical locations ("*I don't see my neighbours, I don't chat to them*") but instead were more likely to identify with communities based around their own personal interests/hobbies.[9] This presented a fundamental threat to the proposed service as it became problematic to reach an agreement about which charitable or community-based cause should be rewarded that would collectively benefit everyone. This was further complicated by the participants need to feel as though they had choices, both to opt into the scheme ("*What's important to me is it should be my choice*") and to decide how much they wanted to give and to whom ("*You could choose where you want it to go to specifically*".) Ultimately, this led participants to suggest that each household should select their own preferred cause or charity. However, this solution was met with further issues about whether the donations would amount to much and queries about how long it would take to reach donation targets individually. Moreover, typically community action was not perceived as a reward in and of itself, and it was clear from participants' comments that they would rather receive money off their energy bills than contribute toward paying for a collective benefit. This was somewhat disappointing given that to achieve the benefits offered by load shifting cohesive community action will be required. However, we suspect our findings may in part be a product of the uncertain economic climate (E.g., *"In all honesty I think a lot of people are so hard up… they want the money back to put in their purse to spend in their home, not give it away").*

4.1.3. Gamification

The feedback we got from our focus groups suggests that on the whole gamification of energy was not something that would personally interest them ("*I wouldn't have any interest in it whatsoever*"). A variety of reasons were given for this, including that "*people were too busy*", that the competition aspect was distasteful and invasive ("*Personally I can't think of anything worse than my neighbour trying to like beat my thing.*"), and that it simply was not engaging for adults and could not compete with existing console games ("*You're never going to compete with a console game […] It's not engaging, it's not fun, it's not real time"*). There also appeared to be a social stigma associated with adults gaming, with comments that it might appeal to "*the weak-willed*" and that it was "*for people who've got time on their hands*".

When the groups were asked who the game might appeal to, the general consensus was that while not for them or the elderly, it could be a powerful learning tool for children, particularly in schools, with one respondent stating, *"children are, their future. […] Now in schools I can imagine playing games and seeing how well the schools are doing and you're driving it into them"*. There was less appetite for this learning to occur in a home environment with comments such as "*I'm not being funny but why would I let my kids play with my energy?*" and objections that out of school hours were deemed more important for other activities. A concern was also raised that engaging with a game such as this would actually require electricity use, which seemed contradictory to the energy-saving purpose of the game (e.g.,*"Doesn't that kind of defeat the object of energy saving, because you're putting them on the computer to play a game?"*).

4.2. Emerging themes throughout discussions

The following subsection refers to findings that emerged throughout discussions, both in response to the idea of smart meters and to the three proposed service concepts.

4.2.1. Initial awareness of and reactions to smart meters

In each of the focus groups, approximately half of the respondents reported that they had heard of smart meters. One respondent commented that they heard of them because "*they try and advertise them everywhere*", whereas another respondent knew of them through his work as a letting agent. However, despite having heard of smart meters, there appeared to be some confusion about the details as illustrated by the following response: "*I'm not sure exactly what they are*." Indeed, the latter response is in line with survey findings showing that the majority of the British public does not know what a smart meter is (DECC, 2014b). When asked if they thought smart meters were a good or a bad thing, participants appeared cautiously optimistic noting that they "*should*", "*could*" or were "*probably*" a "*good idea*".

4.2.2. Practicalities

The focus group participants responded to the idea of smart metering and the concepts boards with an emphasis on practicalities. These seemed to revolve around the following implicit questions: how does it all work? How will it affect me? And how will it affect others? Indeed, such findings are in line with research which has outlined similar types of questions that should be addressed by energy suppliers to help alleviate consumers concerns about demand response services (Annala et al., 2013).

4.2.3. How will it work?

In each of the focus groups, participants asked the moderators several questions. Typically, these centred on the equipment involved, the installation process, and the purported functionality. Questions were also asked about a series of *what if* scenarios. These constituted a range of queries such as, "*What happens if you change energy supplier?*" and "*What happens if people haven't got a computer?*" The content of these questions indicates that participants were attempting to formulate an understanding of the proposed scenarios and to gain some assurance that the suggested ideas could feasibly work.

4.2.4. How will it affect me?

Just as past research has found that householders are eager to identify what smart meters might mean for them (DECC, 2012), we also found that participants were keen to ascertain how their daily lives would be affected by smart meters and the services we were proposing. While some respondents had difficulty envisaging the changes (e.g., "*It's so different, we can't imagine it really*") others tried to contextualise the changes by interpreting them in line

[9] While one may expect that identifying with interest-based rather than geographical-based communities is associated with age or demographics, further examination of the data suggests that this is not the case.

with existing systems. For example, in response to the idea of static TOU tariffs, a respondent observed: "*Because we do it for the telephone don't we, perhaps make a phone call on a weekend; it's cheaper in the day so we're into that concept already.*"

In considering how they might be affected by the changes, participants questioned what this might mean for their current lifestyle and various practices, including cleaning, eating, heating, and entertaining (e.g., "*if you've say set to record something at three o'clock in the morning will it* [the smart meter] *know that and not turn the appliance off?*"). Although the majority of the activities that participants mentioned might be perceived as mundane and ordinary, when the threat of disruption was presented it became clear just how valued these everyday commodities were. For instance, in response to the idea of TOU tariffs, one participant proclaimed, "*…Sometimes it's essential that you have a bath, something happens and you're absolutely filthy, you need it then, you can't wait an hour!*" Such comments suggest that it is vital for marketing communications to make it clear to consumers that TOU tariffs will not prevent them from being able to consume energy at a time of their choosing, but that it will simply mean that the energy consumed during that time will cost more.

4.2.5. How will it affect others?

Aside from wondering how the proposed concepts would affect them, our focus group participants also questioned how it would affect others. In particular, three out of four focus groups voiced concerns about how the more vulnerable members of society might cope with the proposed changes (e.g., "*Elderly people, disabled people, how are they supposed to get their heads round it*?"). Part of this concern appeared to stem from a general feeling that it was unfair to place the responsibility for environmental problems entirely with consumers (see also Section 4.2.6.3), and in particular vulnerable consumers, especially given that in many cases some technological capability or 'know-how' may be required in order to realise the benefits offered by the SMES.

4.2.6. Doubts and concerns

4.2.6.1. Issues of control and autonomy. Issues of control and autonomy emerged as a key theme throughout discussions in each of the focus groups. This was evident not only from the words that participants used in their discussions ("*choice*", "*option*", "*power*", "*control*", "*consent*") but also because participants openly expressed their displeasure about the idea of energy suppliers managing their energy consumption for them (e.g., "*I wouldn't want them to decide, oh we're gonna just do whatever, 'cause that would make me feel uncomfortable*"). Such findings replicate previous research which has found that consumers voice concerns about losing control when presented with the concepts of remote disconnection, smart appliances, DLC and/or TOU tariffs (Darby and Pisica, 2013; Fell et al., 2014; Lopes et al., 2014; Mert et al., 2008; Paetz et al., 2012; Rodden et al., 2013). Indeed, Krishnamurti et al. (2012) found that the more consumers believed that smart meters would "let their electricity company control their energy use" the less likely they were to desire one.

Both our data and findings from related literature suggest that objections to this loss of control stem from people's feelings that it would be "*invasive*" for an external institution to prevent them from using energy as and when they wanted, as it may lead to a decline in comfort and/or disrupt time dependent household routines (e.g., Darby and Pisica, 2013; Fell et al., 2014; Mert et al., 2008; Murtagh et al., 2014). Yet, curiously, automation remained a popular concept with our focus groups, providing they were rewarded appropriately and equipped with some means of overriding the system (see also Fell et al., 2014). In this vein, many of our participants were quick to declare that the proposed ideas would be more attractive if they could "*retain some level of control*" or to have the opportunity to override "*if you need to do something urgent*". Similarly, some participants expressed a preference to be given the information so that they could play an active part in making decisions about their energy management. Evidently, choices were clearly of great importance to our participants and respondents raised questions about whether they actually had a choice in the smart metering initiative (e.g., "*But is it really an option? You said it's going to 2019, is that right? Everyone will have to have one, so it's like you're basically telling us get ready for it. It's like a dictatorship*"). The latter point reiterates findings from a previous study where participants' own self-directed research into smart meters led them to form the perception that they were mandatory for consumers (DECC, 2012). Further confusion may be exacerbated by the underlying tension inherent in the government's smart metering policy, which on the one hand states that "suppliers are required to roll out 53 million smart meters by 2020", but on the other says that "smart meters are not mandatory" for domestic energy consumers.

4.2.6.2. Suspicious minds/mistrust of energy suppliers. All of our focus groups expressed some suspicions about smart meters and the proposed concepts. They were keen to establish where the initiative was coming from (e.g., "*You said it's passed by law…What is the reasoning behind it?*") and which parties were likely to benefit from it (e.g., "*What do the energy companies get out of this?*"*).* Generally, participants felt that they were unlikely to be the ones to benefit from the smart metering initiatives (e.g., "*In some way or another it's gonna cost us*"). From the explanations given it was clear that participants found it difficult to comprehend how an energy provider would profit if they were encouraging consumers to use less energy. Indeed, several participants formulated theories about how the energy companies would ensure that they profited from the smart metering initiative. In particular, consumers mentioned: the suppliers bolstering their reputation by donating customers' savings on their energy bills to charity, charging consumers for the cost of the new meters in their bills, profiting from the interest on consumers' energy savings, and implementing new TOU tariffs that would cause energy to be more expensive when consumers were most likely to need it. Many of these "*concerns*" appeared to stem from a deep mistrust of energy suppliers acting in ways that did not seem to serve them as commercial entities, for instance acting in apparently 'charitable' ways through donating customers energy savings to charitable causes ("*they've not been very open and transparent if you look at what's happening…. So why would I think they're suddenly going to turn over a new leaf*".) Such distrust is not uncommon with findings from a large-scale nationally representative sample showing that 51% of the British public does not trust any energy suppliers (Smarter Energy GB, 2015). Moreover, our findings replicate existing research which has often found that consumers mistrust of energy suppliers may act as a barrier to consumers' willingness to shift demand and/or adopt demand responsive enabling technologies (Balta-Ozkan et al., 2013; Fell et al., 2014; Lopes et al., 2014; Paetz et al., 2012; Rodden et al., 2013).

4.2.6.3. Worries: marketing influx, privacy and spiralling costs. Participants expressed a number of issues that concerned them. While some respondents were worried about being "*bombarded with different energy suppliers*" trying to compete for their custom (see also Balta-Ozkan et al., 2013), others expressed concerns about their privacy. Indeed, the latter appears to be a common concern in relation to smart services (e.g., Krishnamurti et al., 2012) as in both our own findings and in other qualitative studies participants have uttered the phrase "*Big Brother*" to invoke a comparison of being watched by an unseen and invasive presence (e.g., Balta-Ozkan et al., 2014; Fell et al., 2014).

Another concern that emerged was that the smart-metering initiatives and their associated services would be used to place the responsibility for spiralling energy bills with householders through enabling 'better' decisions to be made about energy management, thus negating supplier obligations to ensure that householder bills are kept as low as possible. For example, one of our focus group respondents commented, "*That worries me again, because again it feels like the onus keeps on being pushed back on the individual somehow that if you get this right you can reduce your energy consumption and somehow save money*". Indeed, in other studies scepticism about whether energy savings really could be achieved was a concern for participants (e.g., Forsa, 2010; Lineweber, 2011).

4.2.7. Benefits and opportunities

As the focus group drew to a close, we asked our participants if their initial reactions to smart meters had changed. Their responses indicated that many of them had warmed to the ideas around smart metering (e.g., "*It's nice. I can see there's lots of advantages*", "*It's got potential*" and "*It's just a bit unsettling but there's some good ideas.*"). This change in heart appeared to be attributable to participants' recognition of the benefits that could be obtained from smart metering. Indeed, Paetz et al. (2012) noted that consumers saw many advantages for themselves in smart-home offerings, including the chance to reduce their energy bills, while Krishamaturi et al. (2012) found survey respondents' perceptions of tangible benefits increased their desire for a smart meter. In our data, the benefits that met with participants' approval were accurate billing, avoiding the "*hassle*" of meter readings, and the chance to save money.

As well as these benefits, focus group respondents speculated about the additional opportunities that smart metering could offer in terms of superior communications with the utility companies. One respondent commented that she would like to receive text alerts from her supplier when they identified surges in energy so she could have the "*opportunity to contact them and say 'I'm not at home, there's a problem, can you turn it off?'* Similarly, another respondent said it would be helpful "*if you could text someone… if you've left something on… It'll send a message to your meter that you're out and it can turn off*".

In addition to the aforementioned, participants also noted some other ways in which smart meters could be used to benefit society, suggesting that altruistic as well as individual concerns may have some bearing on consumers' responses to smart meters. For instance, one participant noted that if suppliers were able to disconnect electricity when they detected potential hazards then it might "*potentially lower insurance premiums*", while another noted that smart meters could be used to "*make sure old people's homes don't go below a certain temperature*". Some respondents also welcomed the suggested concepts from an "*ecological point of view*", recognising that "*there are other reasons other than money that you should switch it off*".

5. Discussion

Consumer acceptance of smart meters and the services they may afford is crucial to ensuring that the potential they have to reduce carbon emissions is realised. In the present research, we placed consumer acceptance at the heart of our investigation and, for the first time, used the 'Five Ways to Well-being' framework to derive three varied SMES before conducting focus groups to examine consumers' responses to them and more broadly to smart meters themselves. Overall, consumers found both threats and opportunities inherent in smart-metering initiatives. Threats included: loss of autonomy/control, privacy concerns, and mistrust towards profit orientated energy suppliers and concerns about how it would affect their own and other peoples' daily lives. Opportunities included avoiding the hassles of meter readings, more accurate billings, the chance to reduce their energy bills, and the enablement of future smart-meter services, including text alerts and smarter controls that would allow consumer to switch off 'unused' appliances remotely. While our focus group participants were initially weary of smart meters, there is some indication that the benefits they may offer may go some way to promoting consumer acceptance.

In the following section, we provide a brief discussion about which concept for SMES was preferred before considering the strengths and weaknesses of our research. We conclude by reflecting on the policy implications our research has with regards to securing consumer acceptance of smart meters and SMES.

5.1. Three smart-meter services

In the present research we employed the novel approach of designing SMES through encouraging experts in the energy industry to derive concepts using the framework provided by the NEF's 'Five Ways to Well-being'. This led to the development of three varied SMES, automation, community rewards, and gamification. Of the three services proposed, our focus group participants indicated a greater preference for automation. Gamification and community rewards encountered resistance due to a lack of consumer appeal. Both services were not seen as rewarding with participants struggling to see how each service would personally benefit them, while also questioning the practicalities surrounding both concepts. For instance, respondents questioned why it was necessary to use electricity in a game to demonstrate how to conserve energy and how the community rewards scheme would work given that people vary in how they conceptualise and identify with the concept of 'community'.

We suspect that there are a number of explanations as to why respondents in our focus groups appeared fairly receptive to the automation concept. First, unlike with the other concepts presented, in this scenario the contract between energy providers and consumers may have been easier for people to comprehend and thus trust. This is because both energy providers and consumers are receiving benefits in exchange for a commodity. Specifically, consumers are receiving a reduced bill, at a fair level, due to the inconvenience of handing control of their appliances to the energy suppliers while suppliers are equipped with the tools needed to reduce strain on their grid, thus reducing the need to invest in reinforcing existing energy infrastructures. This eradicated one of the oft-encountered barriers to smart meters and SMES: mistrust of energy suppliers. It also had the advantage of realising a benefit that consumers identified as important to them: reduced energy bills.

Second, through giving participants the ability to (a) opt in to the scheme and (b) override the system, the automation concept enabled participants to perceive that their needs for control and autonomy were not violated. Thus, the system would avoid disrupting householders through impinging on any consumption self-identified as 'essential'.

Finally, we speculate that the automation concept presents a medium of interacting with energy that is not dissimilar to the present way of using energy. That is, for most UK consumers the rarity of TOU tariffs mean there is no need to actively manage their consumption to ensure it coincides with off-peak periods. Indeed, while this may be manageable if consumers were on a static TOU tariff, it becomes impractical for dynamic TOU tariffs. The automation concept we proposed, although utilising TOU tariffs, allows consumers to benefit from cost reductions while still maintaining the same mode of 'passive' energy management. This appears to

be important to consumers and was particularly evident in our data when participants voiced concerns about being held accountable for their spiralling energy costs, rather than the responsibility being placed with providers to reduce the unit cost of their energy supply. Similarly, other research has also found that consumers may resist actively becoming involved in their energy management. For example, Rodden et al. (2013) found that although consumers felt an obligation to engage with energy issues they were disinterested in actively managing their energy consumption, while a participant from Darby and Piscia's study (2013, p.233) stated, "We all want to save money, but we don't actually want to have to do a whole lot".

In summary, it appears that the automation concept, allowed people a mode of interacting with energy that was relatively effortless but still enabled them to receive financial benefits (achieved via reduced consumption in the' optimum' automated savings mode) while simultaneously providing environmental benefits to wider society through reducing the need for grid reinforcement. Importantly, such a system seemed to strike the right balance for people between active and passive energy management and in doing so appeared to increase the likelihood of consumer acceptance.

5.2. Strengths and weaknesses of the present research

5.2.1. Using a novel framework focused on consumer well-being to derive concepts for SMES

In the present research, for the first time, we utilised the 'Five Ways to Well-Being' framework to derive concepts for SMES and then presented the derived SMES to consumers in a focus group to gain insight into their market appeal. A critical evaluation of the use of this framework suggests that while it worked well in some aspects, it fell short in others. This is because, on the one hand, applying this framework led our stakeholders to develop three diverse SMES that theoretically succeeded in targeting a broader set of motives beyond consumers' own financial and/or environmental concerns. However, on the other hand, the five aspects of well-being used to influence the design of the three SMES did not feature in participants' discussions regarding the acceptability of each service concept. Instead, consumers prioritised other aspects more indirectly related to general well-being as being important, such as autonomy, convenience, control, and the need to feel as though smart meters and the proposed SMES would personally and directly benefit them. Often the direct benefits mentioned by consumers alluded to reductions in their energy bills. This was disappointing given that our aim was to move beyond targeting consumers' financial motivations, but perhaps unsurprising given that financial rewards tend to be the dominant paradigm used to incentivise consumers.

5.2.2. Focus group methodology

Notably one of the key critiques of focus group based research is that the results obtained may represent only the groups that were sampled and as such may not be representative of the general population. Nonetheless, there is some indication that our findings may have some generalisability, as in many cases the issues that we identified as pertinent for promoting consumer acceptance of SMES also emerged as key issues in other research (e.g., mistrust of energy providers) examining various SMES. Evidently, such replication is important, not only as it provides confirmation of the elements that need to be considered in the design and marketing of SMES, but also because our findings provide further knowledge surrounding these issues. For example, our results uncovered a much more nuanced relationship between consumers and suppliers than plain mistrust. Rather the mistrust stemmed from suspicions that arose when SMES or offerings were made that appeared incongruent with the consumers' awareness that energy providers are commercial and profit-orientated entities.

6. Conclusion and policy implications

In the present research we used focus groups to collect data on the British public's perception of smart meters and three SMES. Evidently, given the small sample sizes involved, our results may not necessarily be representative of the general UK population. Accordingly, our data can be used to guide the design of surveys to collect data from a large and nationally representative sample. Furthermore, larger-scale survey data would need to be supplemented by further research (potentially including a cost-benefit analysis) before conclusive policy recommendations can be made. However, on the basis of our initial findings we provide some recommendations for aspects that we propose need to be considered in the future design of smart meters and their practical applications within the home, particularly if the UK government wants the rollout of smart meters to have an impact on domestic energy demand.

We propose that in order to secure consumer acceptance it is vital to communicate with the general public as clearly and as transparently as possible. Accordingly, communications should clarify what consumers can expect as a consequence of smart metering, both in the short-term and the longer-term. At present, campaigns have almost exclusively focused on the short-term benefits and, in particular, the chance for consumers to take control of their energy bills through utilising the information provided by their IHD.[10] Yet, a lack of knowledge about the 'bigger picture' and an awareness of the future vision regarding smart grids may be contributing to consumers' suspicion about whether the smart-metering initiative is intended to benefit them or energy suppliers. Indeed, our data suggests that consumers found it difficult to comprehend why profit-motivated energy suppliers would want them to reduce their consumption. Worryingly, such confusion could act as a barrier to encouraging behavioural changes in energy reduction. Yet, had the longer-term vision of a smart grid and demand side response been marketed to consumers as a future benefit, both to themselves and for wider society, this may have gone some way toward removing this suspicion barrier. Moreover, given that consumers do not readily trust energy suppliers, introducing smart meters for a one set of purposes (e.g., more accurate billing) and then introducing other purposes at later date (e.g., load shifting) may further jeopardise the quality of the relationship between consumers and providers.

In order to attract a broad audience of consumers, smart-metering services should aim to fit into the fabric of people's everyday lives and not require excessive management in order to reap benefits. There should be some recognition that whatever goes into people's homes must benefit them in some way, whether this involves providing them with greater security, safety, control or even leisure applications (Balta-Ozkan et al., 2014). To optimise their appeal, both the individual and societal benefits of adopting smart meters should be made salient from the outset and a broad range of motives targeted in communication campaigns. While for some consumers, reduced energy bills may serve as key motivator for engaging with their smart meters, for others those who lack financial motives there must be another hook to encourage the adoption of smart meters. Such hooks could employ innovative new technology services to maximise consumer comfort and

[10] E.g., http://www.smartenergygb.org/what-are-smart-meters, https://www.gov.uk/smart-meters-how-they-work

safety, or could target collective motivations. Indeed, with respect to the latter point, if distribution network operators are to avoid spending money reinforcing local networks and substations then they will need to target collective motivations to ensure that local communities collectively sign up for demand side response programmes.

Finally, any smart-metering services must place consumer well-being at the heart of its proposal. Our data shows that regardless of the concept we presented, participants consistently reported the need to experience a sense of volition and control and that this was particularly important to them within the sanctity of their own home. This need is akin to autonomy, a component identified by self-determination theory as being essential for sustaining people's sense of well-being (Deci and Ryan, 2000). The dominance of this theme throughout our data and the literature in this area suggests that it is of fundamental importance to consumers and that any initiative or service that threatens consumers' autonomy (and thus their well-being) is likely to be rejected. It is clear from the UK government's policy that there is some recognition of the importance of consumers' autonomy as legalisation states that smart meters are not mandatory and that consumers may have them removed once installed, providing they do so before a year has elapsed. While such information may provide reassurance to consumers with autonomy concerns, unfortunately many energy suppliers have failed to successfully communicate this information in their nationwide campaigns.

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