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Original research article

Smart grids, smart users? The role of the user in demand side management

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ABSTRACT

Smart grids are a key feature of future energy scenarios, with the overarching goal of better aligning energy generation and demand. The work presented here considers the role of the user in such systems, and the contexts in which such roles might emerge. The data used is drawn from focus groups with 72 participants, using novel scenario techniques to contextualise smart grid technologies in domestic settings. Two contrasting visions of the smart grid are presented, a centralised system based on current institutional arrangements, and an alternative system in which decentralisation of generation and control is pursued. Using the concepts of 'energy consumer' and 'energy citizen', the paper considers what forms of engagement are likely to be generated by the two visions. We propose that smart grid designs must look beyond simply the technology and recognise that a smart user who is actively engaged with energy is critical to much of what is proposed by demand side management. We conclude that the energy citizen holds out most promise in this regard. The implications of this for policy makers are discussed.

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1. Introduction

Energy systems are undergoing enormous transformations around the world. Though loosely defined, the concept of the 'smart grid' entails power networks transmitting digital information as well as energy. The primary purpose is to allow (near) real time consumption and generation data to be transmitted between different nodes, but it also allows for possibilities such as remote activation of appliances. In combination with facilitating increased amounts of distributed generation, often from renewable sources with variable output, the goal is to optimise the balance of generation and consumption in order to achieve efficiencies [1].

More than just a grand technological project however, a smart grid has the potential to fundamentally change the social dynamics of the energy system. Two opposing visions of how the smart grid's potential might be realised are established [2], though they should be considered two poles of a continuum rather than a binary choice. The first, in keeping with the centralised, hierarchical paradigm which has defined the energy systems of the last century [3], entails centralised generators increasing monitoring and control of end-user consumption [4], as detailed in UKERC's '*Smart Power Sector*' scenario of smart grid futures [5]. Henceforth, we refer to this vision as 'centralised demand side management' (CDSM), as a specific form of the generic term 'demand side management' (DSM). The alternative involves blurring the distinction between generators and end-users, with the latter—whether as individuals or communities—increasingly independent through microgeneration and self-management, a model Wolsink calls 'DisGenMiGrids' (distributed generation micro grids) [2], and similar to UKERC's '*Groundswell*' scenario [5]. These contrasting visions share the same technologies, but differ radically in the social structures underpinning them.

In extending generator control of consumption, centralised demand side management targets the provision of accurate usage information to consumers, including dynamic pricing tariffs, and the remote control of electricity load and devices. Within these approaches there is considerable latitude in regard to the role envisaged for the user; however all require integration into daily routines and so some degree of user interaction. A 'weak' version of CDSM might simply entail a 'smart' implementation of dynamic pricing tariffs, in which certain white goods are remotely triggered to run during low demand periods. A 'strong' implementation could include using real-time pricing signals and new technologies

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to encourage and enable users to 'time shift'[1] energy-intensive behaviours away from periods of peak demand, or towards periods when fluctuating renewable energy generation is high. Such an approach would require energy to take a prominent role in the ordering of household activities (see [6] for a more detailed appraisal of what this range of options might look like).

To date, a considerable body of work has been generated from practice theory-based studies of energy use in domestic contexts, (e.g. [7,8]). Some of this work has called for a disassembling of the producer–consumer divide which has defined the energy systems of the last century, to be replaced instead by the kind of 'co-management' of resources [9] seen in DisGenMiGrids. Strengers extends this further, calling for 'co-management of practices' [10], a more ambitious vision which recognises the co-production of *demand*—that is the relationships in which wants and needs are formed—as well as supply. By contrast, much of the work to date on DSM specifically has been narrow in focus and concerned with individual users, disregarding the dynamics of the shared household as a deployment site [11,12]. Research that has explored this area is often limited to certain aspects of DSM, for example on smart metres (e.g. [13]), in home displays (IHDs) [14,15]; dynamic pricing [16]; or peer comparison feedback effects [17].

Researching the societal implications of smart grids faces similar problems to that of other new technologies (e.g. biotechnologies, nanotechnologies) in gaining insight into socio-technical systems that do not yet exist. The uncertainty of future technologies necessitates defining them for research participants. In doing so the context and framing used can have a large influence on responses. Despite this, the necessity of such research stems from the considerable benefit in upstream engagement with new technologies where lay perspectives help to direct research and development efforts [18], and smart grids are no exception in this regard [6].

The current research makes use of contravision scenario films [19] within a series of focus groups in order to engage members of the public with the range of potential smart grid technologies available within future energy systems. These enable us to probe people's understandings of, and engagement with, their own energy consumption, and explore interactions with current and future smart grid technologies. Recent work draws attention to the prominent role that the user is expected to play within smart grid systems [20]. Our core interest is what that role might look like, and the consequences of it. Two forms of public are identified—*energy consumers* and *energy citizens*—which in crude terms are distinguished by their orientation: as energy end-users and energy system participants respectively. It is argued that the energy consumer frame is a consequence of the same paradigm that drives CDSM, and yet it undermines the very thing CDSM hopes to achieve—namely a grid in which consumption adjusts to meet generation. We propose that energy citizens, aligning with DisGenMiGrids, hold out much greater potential in this regard. The implications of this for policy makers are discussed.

2. Methods

2.1. Theoretical framing

Exploring the role of end-users within smart grids requires an understanding of the context in which energy and associated devices are used within the home. In this section we will outline our implementation of practice theory, and explain the energy citizen and energy consumer concepts which structure our analysis.

Practice Theory is employed here as a means of unpacking the mundane, embedded use of energy in day-to-day life. Practice theory has a number of overlapping formulations [21,22], but as applied here it breaks down practices into four components: materials and infrastructures; rules and knowledge; embodied skills; and engagements and meanings [8].

Time-shifting showering for example, entails material technological changes to feed signals (e.g. electricity unit costs) to the user through the smart grid and associated display device, and incorporating new knowledge of how the system works. It also potentially entails changes in skills—for example the user altering their showering routine to complete it in five minutes instead of eight—and also possibly in meanings—as in the shower's symbolic purpose switching from a refreshing wake-up before work, to a relaxing destress after work. Changing the practice of showering is comprised then of multiple elements unique to it. Additionally, and importantly, showering practices as with most domestic practices, are often developed in a dynamic way through interactions both with other members of a household and wider society, through interaction and negotiation. These include powerful norms conferring proper behaviour, for example signifying not only suitable hygiene, but also achieving this with a rapidity appropriate for the contemporary time-poor adult (showers being faster than the baths they supplanted) [7, Ch. 5].

We use this perspective on energy use—embedded in the social and physical infrastructure of daily domestic life—to structure our analysis. The manner in which it is deployed might be characterised as 'weak' practice theory [23, p. 1279] as we do not adopt practices as our unit of enquiry. Instead, our overarching frame is that of energy consumer and energy citizen. This preference for maintaining the human actor as our focus stems from a desire to avoid reducing the individual to a mule-like 'carrier' of practices. Our hybrid approach is an attempt to recognise that energy use emerges from complex socio-technical landscapes, whilst still maintaining the agency of the human actor.

2.1.1. Energy consumer and energy citizen personas

The specifics of these twinned concepts will be given in Section 3, here though we wish to provide a background to their formation. The concepts emerged during data analysis, out of the necessity to reconcile the tensions inherent within individuals' accounts. One such tension was between a wish for energy to remain invisible and a demand for more knowledge about energy consumption and efficient usage.

These concepts exist as both personas and frames, which is to say they are both enacted from within and imposed from without, in a manner that is co-constructive. We deploy these personas as characters—roles that are performed, or in the case of frames *expected* to be performed, with a particular set of assumptions about their orientation to overarching social structures (in this case, the 'energy system' in its broadest sense). In this they differ somewhat from the typology of energy system users deployed by van Vliet [24], which is "defined by the kind of relationship between providers and consumers" [p. 3]. Van Vliet identifies three types: (i) customer; (ii) citizen–consumer; and (iii) co-provider. The latter two overlap with energy citizen as used here, however our formulation is less concerned with formal relations between actors, favouring instead the actor's *orientation* to the energy system—that is to say their knowledge, and meanings of the system and their role within it—reflecting this paper's interest in how to enrol smart grid participants most effectively.

Energy consumer and energy citizen personas should not be read as mutually exclusive. Many participants adopted one persona

[1] Time shifting involves the moving of energy-consuming practices away from times of peak electricity demand, in order to ease the demands placed on electricity generation.

more comfortably than the other, but nevertheless deployed both at different times and in different contexts. It is in the shifting, overlapping boundaries of the personas that tensions emerge.

2.2. Participants

The data is drawn from four focus groups, each of eighteen people, conducted in and around the city of Nottingham. The intention was to achieve a broadly representative demographic spread, whilst ensuring a high proportion had some existing experience of low carbon energy schemes, which contain elements of smart grids (e.g. distributed generation). The result was a wide range of participants with varying levels of knowledge and engagement with energy efficiency and reduction schemes.

An agency recruited participants based on demographic representativeness (age, gender, ethnicity, and income) of the recruitment areas (see Appendix). The first focus group was recruited to offer a spread of the urban city (C) population and had a modal income range of between £25,000 and £50,000. Subsequent groups were selected to offer different experiences of low carbon energy schemes and varying levels of urbanicity and socio-economic status. Bickton (B) is a rural village some twenty miles from the city with a modal income of <£25,000, where a wind turbine scheme was refused planning permission two years ago following local resistance. Lowell (L) is similarly rural but has a higher modal income of >£75,000, and has a wind turbine scheme run by a consortium of villagers, as well as several zero carbon housing developments. Weston (W) is an inner city estate with a modal income of <£25,000, which for the last decade has had its own community energy group, which among other activities runs a scheme installing PV on homes at no cost, in exchange for which it collects the Feed-In Tariff which is invested back into schemes to reduce the energy use of the community. In what follows, 'C', 'B', 'L' or 'W' designates which focus group a quote was drawn from.

2.3. Procedure and materials

Three short films[2] made by the research team were shown, interspersed with discussions structured around themes and technologies featured in the preceding film. Each focus group was sub-divided into three groups of six to facilitate in-depth discussion, with a researcher allocated to each. Discussion themes comprised existing energy practices; time-shifting and 'smart' energy technologies; understanding of energy and billing; and perceptions of the energy industry.

The films were intended to anchor abstract technologies in a domestic setting that might be meaningful to participants. Characters illustrated in the films were purposefully chosen in order to represent a broad spectrum of society and each showed a subset of smart grid technologies being used in a fictional home. The settings and range of smart grid technologies were developed through a multidisciplinary workshop ($N = 12$) incorporating experts within engineering, computer science, psychology and sociology with interests in energy technologies.

In an effort to avoid the narrative framings from biasing subsequent discussion, a 'contravision' approach [19] was used in which each film was split into 'light' and 'dark' versions of the same narrative. In one the technology and users operated in perfect harmony, in the other the discord was total. These intentionally extreme accounts were intended to open up as wide an imaginative space as possible in order to facilitate discussion, whilst simultaneously engaging participants with a recognisable setting.

3. Results

Transcriptions of the focus groups were analysed using a thematic approach, coded using Nvivo software. Our following analysis first discusses the question of how users are framed, and how this maps to the sociality of the shared home. We then introduce the concepts of energy consumer and energy citizen, with which we structure our subsequent analysis of user roles within smart grid systems. In particular we consider the idea of the energy consumer within CDSM approaches, and outline the challenges this creates. We then focus on developing the idea of the energy citizen, the intertwined roles of community and ownership in relation to this persona and what this means for smart grids.

3.1. Understanding the User

Contemporary policy makers commonly approach energy demand issues with an individualistic model of attitudes and choice [23]. Accordingly, incentives for shifts in energy behaviour are commonly framed in financial (lower bills) terms [11]. Our focus group participants were immediately responsive to such a framing, reflecting that the paradigm's influence is not limited to government. When presented with such a frame, participants affirmed financial reasons as the dominant incentive to adopt such technologies. Discussions quickly problematised such a simple framing however:

> L[owell]: I think unless your savings are dramatic... for the upheaval, the change of lifestyle for pennies then you've... would children sit there? [...] If you've got small children, what would I say? 'This is going to save you five pence, you can't have your dinner just yet', but they start crying...

The role of the child here demonstrates that motivations are far more diverse and complex than that captured by an individualistic framing of sustainable behaviour changes. There are multiple physical and psychological rewards triggered by energy-using practices which might, in any given situation, outweigh specific concerns (e.g. financial) that CDSM promotions might appeal to.

A situated appraisal of the user has been largely overlooked by previous research into the acceptance of smart grid technologies (a rare exception being Strengers' work [16,25] on dynamic pricing). Focus on individual users of such technologies neglects the complex social topography of shared households in which no one actor holds total control over energy practices and associated consumption. Rettie [26] identifies "practice domain owners" within households, who take ownership of a subset of the household's practices, and thus determine associated energy use. The picture from the focus groups suggested even greater intricacy. The quote above from a father pressed to schedule cooking at a time deemed acceptable by his children points to the fact that even domain owners are denied the liberty of a monopoly.

Paying for energy is one of the few instances when energy becomes surfaced in conscious decision-making. As such the bill payer could be expected to play an important role as an agent of change when implementing smart grid technologies. However, even here influence remains mediated by the complex, often gendered [27], distribution of practices amongst household members. Dad may pay the bill but if mum does the washing then who decides whether time shifting is implemented? For projects seeking to recruit smart grid participants, this should act as a warning

[2] Short films used during focus group hosted at http://horizonenergy.blogspot.co.uk/.

against reducing the household to the attitudinal responses of a single autonomous rational actor.

3.2. Energy consumers

Participants' responses during the focus group discussions took two contradictory forms, in accordance with what can be characterised as their orientation to energy. This engagement commonly developed as the discussion did, as participants moved from an immediate, unsituated perspective, in which energy-related practices were rather inflexible, and energy itself was of minimal presence, to a more reflexive, grounded one in which energy became salient and consequential. These conceptions were marked enough to suggest two different personas were being deployed by participants, which we label *energy consumer* and *energy citizen* respectively. For this we draw on Devine-Wright's concept of 'energy citizenship' [28] in which the public's role in energy is "*framed by notions of equitable rights and responsibilities across society for dealing with the consequences of energy consumption*" (p. 71). In contrast with the consumer, for whom energy is simply a good to be expended in pursuit of personal goals, the energy citizen engages with energy as a meaningful part of their practices.

The most immediately accessible persona for many was that of energy consumer. Here, discussions emphasised energy as just one of multiple contingences of daily life, e.g. work; family; finances; many of which are more pressing. Commonly, energy's desired role is to be neither seen nor heard, as in the first quote below. The second quote emphasises the subservient role of energy in the mundane activities of the household. The notion that it should structure them was alien to most participants' current understandings. Unlike the practices it makes possible, it is not "part of your life" and participants did not have, nor want to make, time to think about energy.

> C[ity] 1: Do people realistically have that much time in the day to think about their energy situations, 'cause to me, we're looking for easy solutions, that don't take any time to think about.

> C2: It's a necessity in the morning, having a shower, it's part of your life. I don't want to be thinking, oh, I can't have another two minutes in the shower because, heaven forbid, the meter's going to go over. I think it's one of those things that can potentially stress you out even more.

In accordance with these views, the notion, as advanced in the 'light' films and implicit in some accounts of future potential functions of smart grids, e.g. [4,11], that energy might be a 'surfaced' aspect of interaction within the household—that is a consciously perceived entity and an explicit topic of conversation and group planning—was met with considerable scepticism.

Reflecting energy's current background role, participants expressed a lack of knowledge about functional matters such as how pricing worked, and what the energy demand of different goods was. This coalesced around the issue of energy bills, a common complaint being their opaqueness. A clear tension existed here between the desire to not think about energy on the one hand, and on the other a concern that a lack of knowledge was costing money, either through inefficient use of energy or unsuitable tariffing. This was exacerbated by high levels of industry distrust.

3.3. The role of IHDs

Many participants appeared to read IHDs as a solution to this tension, by offering an undemanding means of becoming informed. However, some that had existing displays complained that the displays themselves were opaque in their presentation of information and relied on poorly understood metrics like kilowatt hours. Given the preference amongst many for energy to remain backgrounded, it is unsurprising that several participants expressed interest in IHDs that presented information in very simple terms, e.g. with a light indicating current electricity price through colour. This appeal speaks of a desire to understand and manage energy use through intuitive and undemanding means, summed up by one participant as "*A quick glance, if you've got the time*" [C].

However, even positive accounts from IHD owners indicated that used in isolation the surfacing of energy by IHDs tended to diminish after a matter of days or weeks, and become largely hidden beneath the patina of daily experience, leaving limited or no long term effect on practices.

It is clear from our work and that of others [29,30] that the utility of IHDs is limited if they are used in isolation purely for feeding back consumption data. Participants' accounts suggest that such approaches fail due to purely targeting a single element of practices—knowledge—in an abstract (e.g. poorly understood 'kw/h') form that fails to engage with actors' meanings. It also fails to address embodied actions in any clear way, which is to say, what is a user *to do* with this information? In contrast, focus group participants who used an IHD as but one element of a wider microgeneration scheme appeared to have a greater ongoing engagement, and studies of dynamic pricing schemes suggest that, as one element of such a scheme, a display can help achieve sustained reductions in energy use [31]. Participants in IHD trials have highlighted a desire for accompanying advice on energy saving [32]. In isolation however, their utility appears limited.

IHDs are a technology common to CDSM and DisGenMiGrid models, providing household consumption information in both. Beyond this their roles differ somewhat. For the former, they offer a means for the generator to manage demand by relaying pricing information to the user. In the latter, their primary role is in providing the user with data on their personal or community generation. As such, both integrate IHDs into a set of practices, in a manner supportive of ongoing engagement. The exception is weak versions of CDSM, which favour automation over user involvement. In such a system, IHDs are likely to quickly become an irrelevance, as they are currently for many focus group participants.

3.4. Automation and time shifting

IHDs are one element of the project of making the smart grid end-user supply-responsive. One key aspect of this may be to encourage people to time shift activities—for example showering at a different point in the day—by relaying signals to them from a network controller. Alternatively, the users' devices may be enrolled through automation—for example starting a pre-loaded white goods machine at a time of low demand. In the case of CDSM such interventions would rely on economic motivations. Difficulties for this approach emerged from the focus groups.

When evaluating concrete examples that might entail reordering practices, most participants were quick to adopt an energy consumer persona, a perspective from which other demands were seen as taking priority over the need to reduce or shift energy. Accordingly, changes that were easily accepted were those that did not require reconfiguring the practice in question.

Automating white goods was viewed favourably as long as these could fit within existing routines. One participant, for example, was happy for her washing machine to run overnight as long as she could delay its start long enough for her to fall asleep and so not be disturbed by it. Participants were highly positive about automation that ran their white goods whilst their solar panels were generating electricity—an example of the beneficial knock-on effects of microgeneration. Key to the popularity of these deployments of

automation is that energy consumption is not point-of-use during practices involving white goods, which is to say the user's involvement in loading and unloading of the machine can be separated from the running of it. As long as the programme completes within a window acceptable to the user it entails little or no reconfiguration of the user's role within the practice.

Exceptions to this generally stemmed from local circumstances, such as concern from those in terraced housing that the machine might generate too much noise for themselves or neighbours to run overnight. Such examples point to the danger that those with the least flexibility to shift their practices might be those with the greatest economic need to benefit. Whilst the un- or under-employed who are at home during (part of) the day have in theory the greatest flexibility with regard to conducting energy-using practices [33], the most vulnerable may have chaotic lifestyles or constrained abilities that negate any such opportunities. Deployments of domestic smart grid technologies require further research in this regard.

For energy consumption that *is* point-of-use, e.g. showering and cooking, reactions to time shifting were far less favourable. Participants would commonly point to the nexus of related actors and actions that made moving such practices impossible. This might be the demands of children to be fed, or the need to be showered before leaving for work at 8.00a.m. Suggestions of shifting such practices often generated emotive responses reflecting the degree to which they are woven into the repertoires of performance from which individuals construct notions of self [7]:

> B[ickton]1: I get up in the morning, I might get up earlier than most people but the first thing I do is take a shower.
> B2: Yes.
> B1: I don't want Big Brother dictating to me the time I get up.
> B3: No, no, that's how you start your day, it wakes me up and gets you going.

For these participants showering signified a process of gaining alertness at the start of the day. Two other meanings attached to showering were that of comfort and relaxation. Indeed participants reacted negatively to a device, portrayed in one of our films, which limited the amount of time that could be spent in the shower before the water turned cold. Both relaxation and comfort were threatened by this form of intervention. In a similar manner, there was more openness to the notion of using electric vehicles as a *personal* store and source for surplus microgenerated energy as opposed to a grid store and source for surplus energy, regardless of whether the user maintained an override. In this example it seems that the independence commonly signified by cars [34] was challenged by the technology, but less so if the participant maintained ownership of operations (even if only symbolically).

3.5. The implications of the energy consumer for CDSM

It is striking that the discourses upon which the energy consumer frequently draws are ones that render consumer-targeted interventions largely moot. When rejecting specific examples of CDSM, participants referenced obligations to other family members; or the requirements of their work life; or the everyday pressures that lead them to seek out convenience. They did not reference financial matters. As such, participants' accounts suggest that the only forms of behaviour change that might be achieved by targeting energy consumers are those that enable convenience, or at least are convenience-neutral (such as time-windowed white goods automation); or that are incentivised by financial inducements that are so significant they compel the consumer to consider them. Given the low cost of most practices when considered in isolation,[3] finding an economic basis for such an approach could be extremely challenging.

The demonstrated efficacy of dynamic pricing trials [31] could be seen to contradict this argument. Considerable variability of impact is apparent from such trials (figure in [31]), reflecting the interactions of specific trial designs with the context in which they are enacted. They nevertheless appear to be consistently successful of achieving (often significant) reductions in use. One could read their success as evidence that energy consumers *were* responsive to pricing signals, such that they would accept—at least for certain periods of peak demand—an extended surfacing of energy in which mundane practices might need to be reordered on a daily or hourly basis. However, we would argue that the fact that dynamic pricing schemes have been successful is likely to be an outcome of the self-selection of participants. We can hypothesise that those taking part are likely to be predominantly energy citizens who are already engaged with energy as a surfaced component of their practices. This is supported by Strengers' work, which found that those that took part in an Australian trial commonly cited "a sense of social responsibility" [16] rather than any individualistic motivations for their participation. Energy consumers may be unlikely to volunteer for such a trial in the first place given the changing orientation to energy it would require, and indeed reluctance to participate in such schemes has been noted previously [35]. Further support for this hypothesis comes from a study of a large trial in which participation was non-voluntary. This found that average use actually *increased* under the scheme [36].

This is not the only sense in which the energy consumer is problematic for CDSM. In Section 3.2 above, we noted that the energy consumer persona seemingly frees users from engagement with energy, whilst burdening them with a concern that they are not being efficient or getting the best deal. Further contradictions or tensions were apparent when participants appraised some of the technologies, skills and meanings embedded in their everyday consumer lifestyles. This is illustrated in an exchange discussing the role of younger generations in tackling climate change:

> W1: It's easier to educate children than it is to educate old codgers like us. . .. We try and do our bit but those kids are going to do more than us.
> W2: It's those same kids you're talking about, they think nothing of jumping on a flight and going around the world once or twice a year. So they learn how to turn a light off and then they go and jump on a plane and go and spend a month in Thailand.

We observed this phenomenon in several forms of response. Many participants could see a contradiction in the motives of energy companies in encouraging energy efficiency who, by the nature of their business, were seen to make money when individuals consume more, not less. At a household level, one participant recounted her successful efforts to convince her children to recycle. However, when it came to their energy consumption, which took the form of constant charging of "*the gadgets, their personal possessions*" [W], she held up her hands in surrender. Her children were consumers and this was healthy consumption. As such it was not something she had the right to challenge.

These responses highlight participants' awareness of the contradictions inherent in targeting sustainable behaviour through a consumer model. In encouraging individuals to simultaneously consume *and* to reduce their environmental impact there is considerable danger that recipients of these conflicting messages are liable to respond with cynicism and disengagement [37, p. 115, 38].

[3] At the standard UK rate of 13 pence/kW h, making a cup of tea costs less than a penny in electricity.

Combined with a distrust of the energy industry [39], it creates a potentially unfavourable environment for introducing CDSM.

3.6. Energy citizens

The shallow and inflexible engagement with energy began to diminish as the focus groups proceeded. Participants began to recount examples that showed their practices to be more plastic: learning to switch appliances off at the wall after finding out how much they used in standby; turning off lights in empty rooms at the insistence of the grandchildren (another example of the pluralistic setting). The energy citizen persona became increasingly apparent, leading some to self-critique their practices, even whilst defending them. This again suggests internal tensions between citizen and consumer personas:

> C: All of our negative reasons are quite luxury reasons really, aren't they? They don't hold any water, when you are talking about extremely high energy costs and climate change. There's going to become a point where, like our lifestyles will change so much that some of the things, some of our arguments won't be that good, but right now, they are, you know what I mean, it's a big change for us, so right now, it's like, no, can't do that.

We noted above that not all participants started from the same position relative to the two personas. Highly notable was the different levels of engagement with energy between groups who had direct experience of community or personal energy systems and those who did not. Those with direct experience had a heightened awareness of energy's roles within their practices. This appeared to foster a greater openness to the smart grid schemes discussed in the focus groups. They were quick not only to engage as energy citizens on a theoretical level, but also at a practical level of lived experiences.

Practice theory suggests that a change in one element of a practice—for example an unresponsive device, or new knowledge gleaned from a friend—can lead to a reconfiguration of the entire assemblage [21]. Pierce and Paulos' [40] phenomenological account of human-electricity relations provides further insight into this process. Drawing on Ihde's [41] schematic of human-technology relations, Pierce and Paulos describe rare occurrences of "alterity relations *to* electricity" (p. 2407), when energy becomes presenced as an object in its own right. This is markedly different from the "background relation" energy commons occupies, in which it structures experience (e.g. by lighting a room) without being consciously noted. An example of alterity is the running flat of a battery, at which point energy becomes realised in its absence. Our research showed that community energy schemes have a similar effect through making energy salient; in particular microgeneration technologies draw attention through the *creation* of electricity.

For those producing energy through microgeneration, as well as consuming it, the effect of this surfacing is a reorientation towards energy as an active component in their practices, rather than something taken-for-granted. In contrast to the negative surfacing invoked by paying energy bills this is in a positive frame, which focuses on the gains to the individual (see [42]). This engagement potentially eases transitions to lower carbon lifestyles, as suggested by the following excerpt.

> L: we have a four kilowatt [PV] system and what I find very interesting is it's not what it generates, it is how it changes our behaviour because we've suddenly become much, much more aware of what we're doing and what we're spending, there's the meter that they gave us which shows how much we've been generating but there's another meter which shows how much we're using. My eye is now on the meter of which we're using and that's really changed my behaviour.

It is important to emphasise that this shift to an alterity relation to energy goes beyond mere visibility, as the surfacing metaphor might suggest. The surfacing offered by displays acting in isolation can be characterised as hermeneutic [40, p. 2407], that is *reading* energy *through* the device. The device is a mediator: the user primarily experiencing *it* rather than the energy being *represented*. By contrast, the alterity surfacing offered by microgeneration is marked out by the greater "ratio of objectness" [41, p. 108] accorded to energy. It does this by involving the user in its creation as well as consumption. This creates potentials for more intuitive engagements:

> C [PV owner]: I think it would be interesting to use the smart meter thing, but I suspect it would just be interesting, whether we change the way we operate as a result of the information, I'm not sure. We've kind of come to the conclusion that now you use all your big machines when the sun's shining.

Here devices are recognised as dependant on the energy flowing from the sun and captured by the PV panels. It was clear from participants' accounts that microgeneration technology was triggering different meanings relating to energy, most notably personal ownership, a close correlate of citizenship. In turn, this was prompting the development of new knowledge and skills (e.g. checking the weather forecast and setting the washing machine to run when the sun was out).

This linking of energy and specific practices is a more powerful catalyst of change than one which conceives of users as individual economic actors and accordingly targets them with information such as price signals [16, p. 7320]. We highlight the importance of recognising the interpersonal and embedded nature of energy practices. The ownership of production gives energy an overt role in users' formulations of their practices, with implications for how they both use and think about it. The following quote hints at the potentially complex ways in which behaviour and values are co-constructive [43]. For this participant, the presenced role of microgenerated energy in behaviour influenced energy-related values, in turn feeding back into behaviour:

> L: I think both on the supply side and the turbine and the PVs and the demand side, conscious that you're using [. . .] I don't think it's constantly looking at some sort of gizmo reminding you of what to do, rather than having a general subconscious notion, perhaps I've used too much hot water. It's sort of lifestyle things really, changing them slowly.

In this manner, microgeneration is a catalyst for reformulating practices—concerning consumption as well as production.

3.7. Ownership and trust

Ownership is as a central feature of citizenship and plays an important role in responses to smart grid technologies. In marked contrast to energy technologies like nuclear power, the materiality of such technologies were treated by participants as being largely benign. The issue lay in their institutional framework. There was a perception that, through CDSM, ownership of energy could translate to ownership of the home. Discussions of energy use being monitored; cheaper tariffs requiring time shifting; or the purchase of specific remote-operated 'smart' appliances,[4] prompted fears of

[4] 'Smart' appliances here refers to networked devices which in this case would allow them to be started and stopped remotely by, for example, grid operators.

a loss of autonomy over the ordering of domestic life. These concerns were typically realised in references such as 'Big Brother' and 'Orwellian'.

This discourse was closely associated with distrust of industry—and, to a much lesser degree, government—motives. Interestingly, whilst the notion of being monitored by energy companies provoked highly negative responses, Strengers' research with Australian participants in a 2008 dynamic pricing trial found that notions of being monitored by the energy company were positive—participants reported themselves encouraged to adapt. This discrepancy highlights the importance of local context to how such technologies are received. International work does suggest that the high levels of distrust in energy companies in the UK [44] [39] are becoming increasingly common elsewhere [45].

For the focus groups this distrust undermined the case for CDSM, not only in terms of home autonomy, but also throwing doubt on claims for environmental and financial benefits of such schemes. For example, whilst accepting of the logic that a more efficient use of energy sources would result in lower carbon emissions, participants noted that efficiencies also meant lower costs for the energy industry, which it was assumed would not be passed on.

> W: we have taken things on board over the years like recycling which we have actually been told to do and we now do [. . .] but I think it's who tells us, I think it's the companies that we don't trust. So it's actually who gives out that information I think is really important and whether people trust it, is it for their own good rather than the company's good? We recycle because we believe that it's good for the planet but we feel they're not, they are doing it just to increase their share then it's different.

The mediating influence of ownership was demonstrated by the different responses given by focus groups in communities with and without locally-owned power schemes. In communities with DisGenMiGrid-like ownership of local energy schemes, negative discourses around profit-based industry motivations contrasted with positive discourses around the community reaping rewards.

> W: It is to do with trust and the trust [in energy suppliers] is gone. But that's why one of the things that's going on at the moment in Weston is the [community power] thing because there is the trust so people are willing to go along with it, because the money is going back in to Weston. When it's disappearing into the ether, into directors' pockets. . .

Furthermore the shared ownership of community schemes introduced additional practices supportive of energy citizenship. Participants in the Lowell community turbine scheme were in the process of deciding how to spend a community fund generated by the profits from the scheme at the time of our focus groups. Another practice emerging from the scheme involved a group of members who had set up a monthly exchange of energy use data through which they could compare savings and learn from one another. In these examples we see the strongest expression of energy citizenship, not only adopting a role as custodian of energy, but also integrating energy into the social structures they inhabit. In this way, these new forms of practice resemble the 'co-management of practice' that Strengers calls for [10], though it is notable that it is the 'co-management of resources' which appears to provide the impetus to this development.

4. Discussion

In this research we identified two forms of engagement with energy, forms that we characterised as personas. Participants often switched between them depending on the context—few stuck solely to one throughout. Despite this plasticity, it was clear some participants found one easier to adopt than the other. The *energy consumer* was often the initial perspective and gave little thought to energy, and despite concerns that they weren't using it as efficiently as they could—whether in environmental or financial terms—they were not seeking a greater level of engagement. The popularity of IHDs that provided information in intuitive forms (e.g. colour coding) was understandable in this framework, proving a means of doing *something*—namely demonstrating concern about energy use—whilst not *requiring* anything. Such forms of participation Marres labels the 'change of no change' [46, p. 517].

The poverty of options available within an energy consumer frame were captured by the following perspective:

> C: I might charge my phone at work instead of home, but you can't totally change your lifestyle because you've hit your limit on your energy use.

The current energy system in its dominant form, of multinational energy generation companies on the one hand, and individual household users on the other, is markedly skewed towards the creation of energy consumers. Given this context, it is to be expected that focus group participants were quick to adopt the persona of energy consumer. However, they were just as quick to undermine it through discussions that revealed how such a framing was incomplete in capturing their motivations. In this complex setting modest financial inducements are likely to struggle for traction. The alternative option open to the energy consumer frame is to limit CDSM to schemes which do not threaten existing convenience.

Within this frame there is a tendency to treat consumers' 'choices' as sacrosanct, which has the danger of unnecessarily ossifying high-energy practices [16]. Furthermore, in approaching the smart grid user as a consumer, CDSM risks becoming simply another means of targeting the sale of electronic devices to the home, with the effect of increasing consumption rather than reducing it [47]. Darby points out that some DSM—such as automation of fridge-freezers—requires little or no input from the user [6], and so it would not be correct to suggest that all smart grid technologies require conscious end-user engagement. Even within an energy consumer frame, such technology could be adopted. However, these passive options offer only a fraction of the efficiency possibilities the smart grid offers, and given the scale of carbon reduction targets such limited ambition could be disastrous.

For many focus group participants, the energy consumer persona itself was unsustainable. Instead as discussions continued, they often adopted the more reflexive, engaged persona of energy citizen. From a practice theory perspective, the energy citizen can be said to emerge from participants' knowledge, meanings, skills, and access to technology. Taking knowledge firstly: awareness of the contradictions of government and industry tasking consumers with consuming less, prompted distrust of the dominant consumer frame. Regarding meanings, discussion from wider perspectives prompted accounts in which energy's role was more than simply an unacknowledged resource. These perspectives could be spatial, such as in contrasts between wasteful Western lifestyles and those less wealthy elsewhere, or temporal, as in nostalgic reflections of how participants' communities had united in response to disruptions such as black outs (see also [48]). Energy was placed in a wider social context in which responsibilities were considered alongside rights. Perhaps most notably for smart grids, where supported by DisGenMiGrid systems, the citizen could demonstrate the skills to enact their own self-guided supply-responsiveness, e.g., running appliances when the home's solar panels were generating electricity.

For those with experience of community and/or personal energy schemes there was a greater salience of energy. Far from rejecting the idea of reconfiguring practices to conserve energy, they already had experience of such changes. What microgeneration achieves with energy we have labelled 'alterity surfacing', for the manner in which it renders energy a functional element of household planning. More than simple increased visibility, individual and community power generation shifts the public from a position of outsider upon which the system imposes change. It was from this position one participant responded "*Why should I change my routine? Because Big Brother wants me to? Go and take a flying leap*" [B]. Instead the public becomes a stakeholder: "*When I see I've got surplus, [. . .] when I know I'm using 300 watts and I generated 4 kilowatts, I think 'what can I do with that?*"'[L]. Strenger's [10] argument to look beyond co-managing resources to co-managing practices is a compelling one, and provides a fully realised vision of what energy citizenship might extend to. We note though that in our sample the closest this came being realised was within community energy schemes, and these may be thought of as first steps in this regard.

For the smart grid to achieve its full potential, it is clear that the model of energy citizen holds out greater promise for change than does that of the energy consumer. The question becomes how such a frame can be pursued. Such a question is too great to do justice to here, but some points stand out immediately. Smart metres have a clear utility for energy suppliers, and in a supportive socio-technical environment (e.g. combined with community- or micro-generation), the display of this information by IHDs could encourage user engagement. However, deployed in isolation, in the expectation of increasing engagement, the rollout of smart metres and IHDs is likely to be a missed opportunity.

Our data has indicated the wealth of change brought about by community energy schemes and by microgeneration technologies in particular. Here, the utility of such schemes should not merely be calculated in terms of energy produced, but also energy citizens produced. Indeed, the popularity of community energy schemes contrasted starkly with the pervasive distrust of the major UK energy suppliers. Community level solutions are not immune to conflict and distrust [49], and to succeed must be tailored to local circumstances [2, p. 831]. It is promising then that the UK government is now making greater efforts to support such schemes through its *Community Energy Strategy* [50], though in taking no steps to challenge the current energy consumer frame, and the dominance of the big generators, it appears there is still some way to go before a local-scale implementation of DisGenMiGrids is realised on any significant scale.

5. Conclusion

The challenge of realising the smart grid is at least as much institutional as technical. At the core of this lie two conflicting visions of the 'demand side' [5]. In one a largely passive consumer hands limited control of some devices to the grid, with an IHD providing consumption and pricing feedback that is likely to go largely unnoticed by the householder. Consumers here are a '*managed*' demand side and the agent of change is limited to the technological realm, supported by some form of financial inducement to encourage adoption. The user of this smart grid remains essentially dumb. This vision limits DSM opportunities to weak interventions requiring little user engagement and subsequently fewer efficiencies.

The contrasting vision is of an active citizen who becomes a '*manager*' in the process of consumption as well as, potentially, generation. Such a perspective avoids reifying current practices as sovereign consumer choices, and frames—and so co-constructs—users who are involved in both problem and solution. Whilst tensions exist between the two visions, they are clearly not mutually exclusive, and in practice they are likely to co-exist. We note that the energy citizen is not a panacea for the challenge of de-carbonising energy supplies, after all the active stance of a citizen cannot simply be assumed to correspond with the goals of other stakeholders, whether they be distant communities, government or industry. It appears a necessary step for ensuring user engagement however and a broad uptake of smart grid technologies. Ultimately, the most effective smart grid will be one in which intelligence is sourced from users as well as devices.

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Appendix A. Focus group demographics

Location	Modal household income	Gender	Ethnicity	Age
City	£25,000–50,000	Female – 10 Male – 8	White–British – 11 White–Other – 2 Black and Ethnic Minority (BEM) – 5	18–30 – 4 30–45 – 8 45–60 – 3 >60 – 3
Bickerton	<£25,000	Female – 11 Male – 7	White–British – 15 White–Other – 1 BEM – 2	18–30 – 1 30–45 – 4 45–60 – 8 >60 – 5
Weston	<£25,000	Female – 13 Male – 5	White–British – 13 White–Other – 2 BEM – 3	18–30 – 0 30–45 – 5 45–60 – 5 >60 – 8
Lowell	>£75,000	Female – 8 Male – 10	White–British – 16 White–Other – 0 BEM–2	18–30 – 1 30–45 – 7 45–60 – 7 >60 – 3
Totals		Female – 42 Male – 30	White–British – 55 White–Other – 5 BEM – 12	18–30 – 6 30–45 – 24 45–60 – 23 >60 – 19

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