The electric commons: a qualitative study of community accountability

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Abstract

This study explores how energy might be conceptualised as a commons, a resource owned and managed by a community with a system of rules for production and consumption. It tests one aspect of Elinor Ostrom's design principles for successful management of common pool resources: community accountability for consumption behaviour. This is explored through interviews with participants in a community demand response (DR) trial in an urban neighbourhood in the UK. Domestic DR can make a contribution to balancing electricity supply and demand. This relies on smart meters, which raise vertical (individual to large organisation) privacy concerns. Community and local approaches could motivate greater levels of DR than price signals alone. We found that acting as part of a community is motivating, a conclusion which supports local and community based roll out of smart meters. Mutually supportive, voluntary, and anonymous sharing of information was welcomed. However, mutual monitoring was seen as an invasion of horizontal (peer to peer) privacy. We conclude that the research agenda, which asks whether local commons-based governance of electricity systems could provide social and environmental benefits, is worth pursuing further. This needs a shift in regulatory barriers and 'governance-system neutral' innovation funding.

Keywords:

Community infrastructure

Demand Response

Energy commons

Privacy

Smart meters

Surveillance

1 Introduction

[1]

This paper explores the use of commons frameworks for urban energy management, in the context of a community-based trial of electricity demand response (DR) in a UK city. Despite substantial literature on smart grids, including discussion of their system value, DR, privacy concerns and community approaches (Beckel et al., 2014; Kloza et al., 2013), there remains a gap in scholarship bringing commons theory to this context.

The introduction provides background on the role of DR in a smart energy system, in particular in relation to community based motivation and privacy concerns, and outlines the potential contribution of commons approaches to these challenges, focussing on the mechanisms of community accountability. The second section describes the case study and methodology, and the third discusses the findings of the interviews and focus group in relation to attitudes to privacy and mutual monitoring for urban electricity DR. The conclusion highlights the policy implications of applying commons approaches to local energy systems.

1.1 Smart meters, feedback and demand response in a smart energy system

A 'smart' energy system, or smart grid, is defined by the UK government and energy market regulator as "one which uses information technology to intelligently integrate the actions of users

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[1] Abbreviations
CSE – Centre for Sustainable Energy
DNO – Distribution Network Operator
DR – Demand Response
IHD – In Home Display
LiM – Less is More
WPD- Western Power Distribution

connected to it, in order to efficiently deliver secure, sustainable and economic electricity supplies" (BEIS and Ofgem, 2016, p. 7). The need to decarbonise our energy system is leading to a shift towards decentralised and intermittent electricity generation, and potentially electrification of heat and transport (Quiggin and Wakefield, 2015). This creates a need for greater spatial and temporal flexibility in the electricity system. At the same time, innovation in information technology creates an opportunity to use 'smart' technologies to achieve greater distributed flexibility, including active management of the timing of electricity demand to support whole system balancing. Regulatory approaches for achieving this are being consulted on by the UK government (BEIS and Ofgem, 2016).

One mechanism for achieving flexibility is demand response (DR) – the decrease or increase of electricity demand in response to moments of scarcity or abundance. In a domestic setting, this can be achieved by shifting the time at which cooking, laundry, dishwashing, heating, and other activities take place (Bulkeley et al., 2014; Frontier Economics and Sustainability First, 2012; Strengers, 2013). The UK government aims to achieve domestic DR through a combination of direct feedback using in home displays (IHDs), which show real-time electricity consumption; indirect feedback through informative bills; advice and guidance; and motivational campaigns (DECC, 2015). Smart meters, which record real-time electricity consumption, are a key enabling technology for this, and are due to be rolled out to all households by 2020, as part of an EU directive implemented in UK policy (DECC and Ofgem, 2011; Official Journal of the European Union, 2012).

1.2 Motivating demand response

Smart meters by themselves will not motivate changes in energy consumption behaviour or social practices[2]. As Strengers (2013) highlights, energy is consumed through everyday practices, which are

[2] There has been extensive academic debate about the relative value of behaviour change and social practice approaches to understanding and changing energy consumption patterns. This study follows Wilson and Chatterton (2011) in seeing both approaches as valuable and compatible.

responsive to many other forms of feedback, in addition to feedback on energy consumption. The time at which people do laundry is influenced by factors such as the weather, clothing needs, work, school and social schedules, and social expectations of cleanliness. Factors such as housing costs, unemployment and changes in household composition also affect the energy consumption patterns in households (Bulkeley et al., 2014). Influencing changes in behaviour through policy interventions is complex. Several experts advocate the use of multiple approaches to inform the development of behaviour change policy (Chatterton, 2011; Darnton, 2008a; Gardner and Stern, 2002; Jackson, 2005), and emphasise the importance of testing these in practice (Darnton, 2008a). Forms of motivation that have been well-researched include price signals such as time of use tariffs and real-time pricing, and educational feedback through IHDs, detailed billing and emails. However, price-based incentives risk impacting those in fuel poverty and exacerbating social inequalities (Thumim, 2014).

The focus of this study is on community-based interventions. The concept of community is itself ambiguous. Burchell et al. (2014) identify six meanings of 'community' in the literature on community energy: "a place-based or local activity, an interest-based activity, a community-led and collaborative process with benefits distributed fairly and locally, a mid-scale activity, an actor with agency, and an experimental niche". They also note the issues of "power, division, exclusion, conflict and oppression" which can be part of community.

Community-based activities can be supported by social mechanisms for behaviour change. Previous studies have made use of several social mechanisms for motivating shifts in energy behaviour, including social norms feedback (Burchell et al., 2016; Harries et al., 2013), peer learning (Catney et al., 2013), and civic concerns (Ehrhardt-Martinez et al., 2010). The Smart Communities project (Burchell et al., 2016) trialled the use of IHDs and regular feedback emails in a community in the UK. They highlight factors making their feedback successful: a focus on the local; supportive, regular emails; and a framing that emphasised the community working together which increased participants' sense of self-efficacy. This was successful in achieving lasting, high levels of engagement with IHDs. These factors have a strong fit with the concept of 'community' and therefore support further research into community-based approaches.

A community-based programme may be a good way to achieve high quality feedback to households cost-effectively at a large scale, by enlisting the voluntary co-production of feedback by residents. The importance of high quality feedback in motivating energy behaviour change was identified by the VaasaETT (2011) study of 100 worldwide smart meter pilot studies. They found that the most important success factor was tailoring the programme to consumer needs, and that smaller scale trials of less than 100 participants achieved higher levels of energy conservation, perhaps due the quality of feedback provided to smaller populations.

1.3 Smart meters, privacy and community DR

Whilst smart meters can support the use of renewable energy by enabling balancing through DR, their use also raises concerns about privacy and data (Beckel et al., 2014; Döbelt et al., 2015). DR and smart meter data relates to activities as intimate as taking a shower, doing laundry, or watching TV, and as distant and shared as our national electricity infrastructure. It is thus both private and of public concern. Real-time electricity consumption data can reveal occupancy, a potential security concern if burglars can identify when a house is empty. Highly granular data (measured every second or minute) can reveal the 'load signature' of different appliances being used, indicating the "composition and behavior of individual households" (Horne et al., 2015). This can be used for targeted marketing by corporations, and is useful to researchers.

Privacy concerns about smart meters have the potential to impact their public acceptability. Evidence on this, however, is inconclusive. Horne et al. (2015) conclude that privacy concerns may lead to public rejection of smart meters. However, this may depend on context, and the acceptability of smart meters could be greater if the wider societal benefit of the smart grid is clearly communicated, and if individuals feel that they have control over the technology installed in their home (Buchanan et al., 2016).

Privacy concerns about smart meters extend beyond public acceptability. Key vertical privacy concerns in a smart energy system include the risk to political rights and freedoms from state surveillance; unequal power relations involved in big data; and potential for corporate profit from using personal data for targeted marketing. Naus et al. (2015) identify two dimensions of privacy: the 'vertical' privacy of individuals relative to large organisations such as energy companies, data companies and the state, and the 'horizontal' privacy of individuals relative to their peers. Solove (2002) describes two additional aspects of privacy: not being seen, and not being interfered with. Solove (2001) discusses the need for privacy theory in the age of 'big data' to consider the unequal power relations of individuals to large corporations and government, who can derive useful knowledge from large quantities of data.

Some computer sciences studies on smart grids seek to preserve privacy through the design of the information processing architecture of the smart grid. Souri et al (2014) classify privacy preserving techniques in two categories. Those with aggregation have a local gateway which processes individual smart meter data, and sends only an aggregate to utilities or other parties, whereas those without aggregation carry out privacy-preserving operations within the smart meter itself, or by reliance on a trusted third party. In the UK, the trusted third party approach has been chosen, with the Data Communications Company set up for this purpose (Smart Energy Code Company, 2013).

Trusted third party approaches to data protection have ongoing vertical privacy risks, whereas aggregation approaches and in-meter data processing reduce this risk. The use of a trusted third party relies on that institution being trustworthy, and limits the user's control over where their data goes. Privacy-preserving operations carried out within the smart meter increase the computational requirements of the smart meter itself (Souri et al., 2014), with some also affecting system management functionality derived from the smart meter. Aggregation-based systems avoid the need to trust a centralised holder of data, and reduce smart meter computational requirements, but carry a risk in the case of the failure of the gateway (Souri et al., 2014). This study considers a governance based approach: trading off vertical privacy risk with a reduction in horizontal privacy, through community based aggregation.

1.4 A commons framing

This paper adds to the existing literature by bringing a commons framing to the development of the smart grid. A commons is defined here as a resource owned and managed by a community, with a system of rules for production and consumption of the resource. For Bollier (2014), a commons is "a resource + a community + a set of social protocols".

A commons is characterised by situations where there is a social dilemma, or a need for collective action – which Darnton describes as a " 'tyranny of small decisions' whereby the outcome of millions of individual decisions is at odds with what people collectively want" (Darnton, 2008b, p. 6). Scholars including Künneke and Finger (2009), Frischmann (2012) and Rose (1986) argue that infrastructure should be considered a commons, due to the positive social and economic externalities of universal access to energy, negative climate externalities of associated greenhouse gas emissions, and the natural monopoly tendencies of energy infrastructure.

A commons is also characterised by consumption and production activities being carried out by the same groups of individuals. This was the case in historic agricultural and peasant communities, and is now being rediscovered in a modern context with the concept of a 'prosumer' (Ritzer, 2010). This term is widely used in the context of smart grids, both with reference to individuals (Mitchell, 2014; Skjølsvold et al., 2015) practicing 'self-consumption', and with reference to community production and consumption (Hertig and Teufel, 2016; Karnouskos, 2011; Moreno-Munoz et al., 2016). At the same time, the growth of the community energy sector in the UK and in other countries (Bauwens et al., 2016; Blanchet, 2015; DECC, 2014; Seyfang et al., 2013), and the movement for energy democracy (Angel, 2016; Platform London, 2014; Sweeney, 2012), shows an appetite for collective, local participation in the development of the future energy system and greater participation in energy system governance.

A community of prosumers needs new approaches for successful governance, and could learn from management of traditional commons. Elinor Ostrom (1990) developed a set of eight design principles for successful management of common pool resources, through a meta-analysis of traditional rural commons such as fisheries, forests, pasture land and irrigation systems worldwide. These are effective in the context of small-scale commons, with stable communities, not subject to strong external disruption (Araral, 2013; Cox et al., 2010). The design principles originally published by Ostrom in 1990 were updated by Cox et al (2010), following reviews of their robustness by many researchers in the intervening years. Wilson et al. (2012) generalise the use of Ostrom's design principles to other contexts. Roelich and Knoeri (n.d.) use the design principles to analyse the UK community energy sector. Melville and Cooke (2013) use Ostrom's design principles as a framework for imagining a commons based arrangement for a UK energy system, with a focus on community DR.

A successful community management institution is characterised by the presence of all eight design principles, listed in full in the appendix. However, this study focuses on one aspect, community accountability, which is addressed by design principles 4, 5 and 6[3]:

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[3] The term 'appropriator' refers to consumer, and the 'users' are individuals who both consume and produce or manage the resource. The phrase 'assessed graduated sanctions' means that a smaller

4A Monitoring users: Monitors who are accountable to the users monitor the appropriation and provision levels of the users.

5 Graduated sanctions: Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and the context of the offense) by other appropriators, by officials accountable to the appropriators, or by both.

6 Conflict-resolution mechanisms: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.

This level of community accountability goes beyond the social norms feedback of studies such as Smart Communities (Burchell et al., 2016) or Customer-Led Network Revolution (Bulkeley et al., 2014), with mutual monitoring impacting on horizontal privacy, and community conflict-resolution and sanctioning giving some coercive power to the community, rather than relying on internalised norms or external parties to adjudicate.

Whilst there are some examples of small-scale commons-like community management of electricity systems, these tend to be in remote locations such as islands. For example, the community energy system operating on the Scottish island of Eigg has a wind, solar and hydro power based energy system, with batteries and backup diesel generators. Islanders are allowed to consume up to a maximum of 5kW of power at any given time (10kW for businesses). If a household goes above the 5kW limit, they are automatically cut off, and the Eigg energy maintenance team must be called to reconnect them (Community Power Scotland and Friends of the Earth Scotland, 2016). When power

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sanction is demanded of an individual who breaks a rule for the first time, or in time of need, whereas a repeat or casual offender will be more severely sanctioned.

availability is low, islanders are alerted through a traffic light system with green/amber/red lights, and encouraged to voluntarily reduce their consumption (Yadoo et al., 2011). This means that household energy consumption below 5kW is a private matter, and any consumption above 5kW becomes a public matter, depending on how talkative the members of the maintenance team are.[4]

1.5 This study

Energy commons have been less explored in an urban context, where much of the domestic electricity consumption of industrialised countries takes place. This study was motivated by an interest in the potential for neighbourhood-scale commons governance approaches to motivate more sustainable energy consumption practices, whilst providing social benefits of a greater sense of belonging, agency and social connection, in the context of urban residential neighbourhoods. However, researching this directly encounters regulatory barriers, a challenging funding environment, and a steep learning curve for research participants. This context is currently a competitive market rather than a commons, where people are used to individually buying energy from large companies.

Exploring commons in an urban context requires imagination, an important step for social research that serves the development of a better future (Levitas, 2013). One scenario could be a spatially nested system, shown in figure 1 (adapted from Melville et al., 2016), following the principle that large systems should be organised as 'multiple layers of nested enterprise' (Ostrom, 1990), with boundaries of governance congruent with infrastructure boundaries (Cox, 2012). This complements research on interconnected, islandable microgrids (Stadler et al., 2016).

[4] In practice, people on Eigg rarely go above the 5kW limit. However, the maintenance team are aware of which households are using more energy overall, as they buy prepaid energy tickets, and this is common knowledge in the island community (Leaver, 2016).

The spatially-nested system could reduce vertical privacy risk. With appropriate computer programming, the problem of vertical privacy and power relations could become a challenge of horizontal privacy and power dynamics within the community, a shift which may or may not feel desirable for different individuals. Data from individual meters could be aggregated at the boundary of the community, and the energy supplier provided with real-time, temporally granular data for the area as a whole rather than individual households. The community would then be billed collectively for the value of their electricity consumption, taking into account the time of use, and costs passed on to individuals by the community. This is comparable to the virtual metering arrangement used by the innovative EnergyLocal project (2015).

Domestic DR could make an important contribution to a smart, flexible energy system, enabled by smart meters. However, as past research has shown, smart meters in themselves are insufficient to motivate DR, and could exacerbate fuel poverty. Community action shows promise as an alternative or supplementary motivation to price signals. Smart metering also raises concerns about data privacy and surveillance, conceptualised in terms of vertical privacy risk. A commons approach could protect vertical privacy by keeping detailed data within the community, traded-off against reduced horizontal privacy. New energy commons could learn from the experience of traditional commons, including the use of community accountability mechanisms.

To establish the concept of commons-based neighbourhood energy management, this study chose a case study where participants had a partial experience of an energy commons, in the form of a community-level incentive for electricity DR. It focused on one element of an electricity commons, community accountability for consumption behaviour in a smart energy system; and its impact on privacy. This approach allowed exploration of people's initial responses to this idea, through interviews and focus groups.

2 Methods

In order to explore energy commons framing in an urban context, interviews and focus groups were conducted with participants involved the Less is More project (LiM), which was testing the use of a community incentive for electricity demand management (Centre for Sustainable Energy, 2015). The following section begins by describing the LiM project and characteristics which make it suitable for this study, before describing the interview and focus group methodology.

2.1 The Less is More project

The LiM project trialled the use of a community incentive for electricity demand management at ten substations in the Western Power Distribution (WPD) area, where the community around each substation in the trial was offered a financial incentive of up to £5000 over the project period, earned by achieving target reductions in peak and overall demand. The community suggested how to spend the money earned. Minutely electricity demand data was recorded at the substation level by WPD, but no household level data was recorded, due to privacy and data protection considerations[5]. The collective incentive created a commons situation, but there was no direct community accountability of individuals. Progress towards fundraising was shown on the graph on the LiM website which also showed the target consumption line (see figure 2).

Community interventions were coordinated by the Centre for Sustainable Energy (CSE), and engagement activities and events were carried out by local charity and community partners. At the substation chosen for the interviews, the project also trialled a specifically designed energy monitor,

[5] This was because the LiM project design involved monitoring the substation for several months before the participants were aware that the study was happening, in order to measure a baseline. It was judged to be acceptable to monitor the aggregate at the substation level without informed consent, but not acceptable to do this at the individual household level.

the Greenbank Energy Monitor (GEM), which enabled some awareness of the level of collective action taking place in the community, a step towards the mutual monitoring described by Ostrom's design principle 4A, without infringing on individuals' privacy.

The GEM was designed to alert householders connected to the substation of the times when the substation was under pressure (i.e. times of peak demand). This prompted them to look for opportunities to turn off or delay using electricity consuming devices in the home for a period of time, called a 'challenge', which occurred once a day, at some point during the evening, for 30-45 minutes. The GEM units displayed one of two screens. Most of the time, the display showing was the 'default mode' shown in figure 3. Once a challenge period started, the display changed to the challenge screen, shown in figure 4.

The LiM project was designed with the intention that the GEM would be in place for several months. However, due to delays in the production and development of the GEM, it was in place for a shorter duration than was originally planned[6], which may have affected participants' perceptions of the GEM and reduced the extent to which they discussed it with their neighbours. Full details of the LiM project, and the methodology used, are available in the final project report produced by CSE (Centre for Sustainable Energy, 2015).

2.2 Interviews and focus group methodology

The present study focused on the response of LiM participants in the Greenbank substation area, where the GEM was used. All residents of the substation area were invited to be interviewed, with a flyer posted through their door. CSE workers also promoted the research as part of their project

[6] GEMs were installed in participants houses in a staggered way, over a period of two weeks. This resulted in some participants having GEMs in place for 4 weeks, and others for only 10 days. If they had been in place for longer, this may have resulted in reduction of interest as the novelty wore off, but it may also have provided greater opportunity to discuss with neighbours.

engagement activities. There were twelve respondents overall, who received a payment of £15 for each session in which they took part, funded by CSE. Interviews took place in the respondent's home, and the focus group was held in a local community centre.

Respondents had a basic understanding of and engagement with DR due to their participation in LiM, where this was framed as a community activity. They also had an experience of observing the participation of others in their neighbourhood through their use of the GEM, which provided a limited level of mutual monitoring. The sample had no particular prior interest in energy conservation. However, self-selection bias is possible as the more community-minded or energy-conscious individuals may have responded to the interviews.

Only one of the research participants was male. All of those who completed a demographic survey identified as white-British and were aged between 25 and 55, with a mixture of house tenure types. At this exploratory stage, with a small sample, the study was not intended to be representative. Horne et al. (2015) report that privacy concerns in their study were not related to demographic characteristics. However, approaches to commons management may be related to demographic characteristics. Further research might usefully explore this with different demographics.

The study consisted of three steps: a first interview prior to the installation of the GEM, with a total of twelve respondents; a second interview at the end of the GEM implementation period, with seven of the original twelve respondents; a final focus group attended by five of these seven respondents.

The first interview aimed to understand how respondents' sense of community and level of social trust affected their concern about free-riding behaviour and desire to monitor others' participation, and their energy consumption patterns and perceptions of time of use flexibility. The second interview began with questions about the respondent's experience of the GEM, including how easily they understood its functioning, their perception of their neighbours' participation in 'challenge periods', and their attitudes to the gadget and to having information about others' participation. It then raised questions about local infrastructure, including hypothetical community responses to a risk of local blackouts, and who should be responsible for investment in electricity system reliability.

The focus group session started with a discussion of the GEMs, two examples of which were in the room. In the first stage, there was minimal prompting from the facilitator. In the second stage, an imaginary future scenario was introduced. This described a situation where a neighbourhood had taken responsibility for keeping demand below a certain peak, to manage stress on the local substation, and had to deal with a blackout. After some clarifying discussion, participants were asked how they would manage the grid in such a scenario, with questions about the difference between different people's needs, privacy, allocation of responsibility, and decision-making processes.

Qualitative analysis of the data employed a combination of inductive and deductive approaches (Hyde, 2000; Morse and Mitcham, 2002). The central theoretical construct explored in the research was community accountability for energy consuming behaviour. Themes were introduced explicitly through the framing of the questions, but analysis was carried out with attention to emergent as well as a priori themes. All interviews and the focus group session were audio-recorded and transcribed. They were coded in Nvivo with some codes arising out of an a priori theoretical interest, and others emerging from the data. For example, an a priori code of 'community as motivation' had a priori sub-codes of 'fun' 'fairness' and 'normal', as well as sub-codes arising from the data such as 'part of a joint effort', 'demonstration of possible', 'share ideas and learning'. These were developed in part through the use of sensitizing concepts, (Bowen, 2006) such as 'reasons why respondents might find community activity motivating'. Names of all respondents were changed to pseudonyms to preserve anonymity.

3 Results and analysis

The following section presents a qualitative analysis of the interview and focus group data focusing on participants' views regarding privacy and attitudes to neighbourhood accountability.

3.1 Exposure and retribution

Most respondents had mixed feelings about the idea of mutual monitoring, expressing concerns about embarrassment and fear of retribution, and hope for mutual support and sharing of knowledge. The current status quo is one where individual household data is not created at a highly granular time step, and the business as usual deployment of smart meters would lead to reduction in vertical privacy, but not of horizontal privacy.

The idea of community monitoring of each other's energy consumption behaviour was framed through questions about whether people would want to see when their neighbours were consuming electricity, and whether they would want to know the names of who was and wasn't participating. Respondents' views on sharing individual energy consumption data with their neighbours were mostly negative (with some ambivalent or neutral), particularly if this was for the purposes of holding each other accountable. In particular there were negative feelings about identification of individual names. Participants used vivid and violent metaphors such as 'lynched', 'Hitler Youth', 'big brother' and 'witch-hunt' to express why they would not want individual energy users to be identified in the community:

> Interviewer: *If there was a blackout, would you want to know who did it?*
>
> Clara: *No, because if it had been us then I would be terrified of being* ***lynched****.* (referring to knowing who had been responsible for causing a blackout from overloading the substation, in a hypothetical scenario)

Interviewer: *And if it tells you the names of people?*

Anna: *I think that'd be horrible. I'd hate that I wouldn't want to participate if that was how it was going on, it would be a bit like* ***Hitler Youth*** *or something wouldn't it.*

Interviewer: *And if [a blackout] were to happen because a few people were just using huge amounts of power would you want to know who it was?*

Frances: *Well, now that's kind of more like one* ***big brother*** *watching and it's also kind of scary like picking on one people, I mean … I don't know, I think that could go terribly wrong.*

Interviewer**:** *And if [a blackout] did happen, because a few people were really maximising their power consumption, would you want to know who it was?*

Louise: *Oh no, that's a local* ***witch-hunt****! We're far too nice round here!*

These metaphors evoke violent, unpredictable, unaccountable, arbitrary and irrational punishment for transgression, without any transparent process, with a threat of death. Violent punishment is pictured by respondents, although the question only referred to information about who has transgressed, with no mention of sanctioning. In contrast to the violent images evoked by respondents, Ostrom's fifth and sixth design principles refer to graduated sanctions and accessible conflict-resolution mechanisms. These are accountable, transparent and proportionate systems designed to maintain community trust rather than instil fear. However, Clara, Anna, Frances and Louise clearly did not perceive community accountability as calm, fair and rational.

A community DR approach is conceived by the authors as a way of trading off some horizontal privacy for the sake of protecting vertical privacy. In this context, it is interesting that metaphors used by Frances, Louise and Anna (big brother, witch hunt, Hitler Youth) originate in historic or literary situations where an oppressive force of the state, political party or church recruited local people or technology to spy on each other – a situation involving infringement of both vertical and horizontal privacy for the purposes of the control by totalitarian regimes. The unequal power relations of the individual to the large organisation is central here. However, these metaphors are being used by interview respondents in the context of horizontal privacy, rather than vertical privacy.

Whereas the terms such as 'big brother' discussed above related primarily to the aspect of privacy that is about freedom from coercion, respondents also had concerns about being seen, embarrassment, or their reputation, using words such as 'voyeuristic', 'too much information', 'singles people out' , or simply expressing a general discomfort 'don't think I would want my name there', as shown in the following excerpts from three interviews.

> Interviewer: *And if you could identify who the people were that were logging on, would you have felt more or less inclined to do it yourself?*
>
> Clara: *I think I preferred the anonymity of it. I think if people were identified by house number it would be a bit, not **voyeuristic** but a bit **too much information** almost.*
>
> Interviewer: *And what kind of information would you like to see if you wanted to know how many others were participating in the project?*
>
> Frances: *I wouldn't want to know what houses were, because I feel like that **singles people out** and that's not the goal of it*
>
> Interviewer: *And what if the website told you the names of people?*
>
> Josie: *Don't think that's particularly a good, no I wouldn't really be bothered about that and **I don't think I would want my name there either**.*

The following excerpt, from the first interview with Clara, is more ambivalent. She thinks that having more information about neighbours' energy consumption would be 'interesting' and create a sense of 'something going on', and she also feels that energy saving is 'really, really important' and that she would 'take it seriously'. However, naming individuals could lead to 'embarrassment' and 'shame':

Interviewer: *What if it gave you the names of the people who were joining in?*

Clara: *I think I'd be quite **embarrassed** [laughter], I think it's quite, you wouldn't want it to be like a **name shame** thing but you'd have the house numbers but then again how personal does it get. Obviously it's all for awareness and not to **name and shame** but it's like I think it'd be quite **interesting**. If you do it by street that would be quite anonymous or at least let you **feel that there's something going on**, yeah.*

Interviewer: *And is there anything about the idea that other people that are participating about it being more fair that others are joining in and doing your bit...?*

Clara: *Okay so you mean say if my next door neighbours decided not to do it and I feel a bit aggrieved by it?*

Interviewer: *Yeah.*

Clara: *I don't think, I don't know if the word 'fair' would be more, you want to be quite **cohesive** don't you as a neighbour you want to **feel that you're working together** so if this kind of thing takes off and so it would be, yeah I don't think, and **obviously I'd take it seriously** but I wouldn't but not to the point that it clearly disrupting my **relationships** with my neighbours. I don't think it's not the first thing I would launch into talking to them about because it might seem a bit **mean** although **I do feel it's really, really important** and would be really good if whoever moves in on either side got involved. I'd be really happy to chat to them about it but it would be yeah I don't know if it would feel it's unfair, I'd just feel a bit like, "Oh that's a shame."*

Although Clara's understanding of the question about fairness is clear, her response is uncertain. This reflects an ambivalence of considering energy efficiency to be important, and wanting neighbours to participate, but feeling that relationships with neighbours are more important.

3.2 Perception of impact, social connection and peer learning

On the other hand, several participants, including some of those who had concerns about privacy discussed above, identified a number of positive aspects of sharing information about energy consumption within the community. These included making individual actions feel more worthwhile, social motivations of meeting others, and the potential for support through sharing tips and information.

Respondents expressed a sense of feeling more effective when acting with other people than individually, in the context of neighbourhood or community energy demand reduction or peak shifting projects, e.g.

> Clara: *sometimes it feels a bit futile if you don't think anyone else is doing it. So I think if you know that other people are doing it, it makes you feel you're having a bigger impact.* (with similar comments made by Gloria, Kelly and Josie).

This finding is supported by Burchell et al (2016, p. 182), who report a respondent feeling that acting as part of the local area can make more of a difference than acting as an individual. Josie, Kelly, Beth, Gloria, Anna and Louise also mentioned being motivated by meeting people or doing things together, social cohesion and community involvement, or community activities.

LiM respondents were generally interested in having access to detailed information about their own electricity consumption, in order to learn how to adjust their behaviour: "being able to see your own usage and when your own peak times are and make adjustments" (Emma, with similar comments made by Kelly, Anna and Clara).

The idea of knowing how their energy consumption compared with others, particularly others who were similar to them, in terms of number/age of children, type of heating system, house occupancy patterns etc. was discussed enthusiastically in the focus group. This is supported by VaasaETT (2011,

p. 46): "If comparisons are to be made then it must be to households of a like description". Some level of sharing of information between participants would also be welcome for the purposes of enabling mutually supportive shared learning, sharing ideas and hints and tips. Several respondents expressed a desire for sharing learning (Frances, Louise, Kelly, Imogen), or observed that knowing what neighbours had done would be an inspiring demonstration of what is possible (Gloria, Anna). This idea of a learning community supports the development of 'energy know-how' discussed by Burchell et al (2013), and the findings of Catney et al. (2013), on the value of "Community Knowledge Networks", which provide opportunities for peer learning about energy through discussion and sharing of tacit knowledge in a face to face interaction, 'making energy discussable' in an atmosphere of conviviality (RECCKN, 2013).

3.3 Fairness, accountability and recognition of diverse needs and capabilities

Respondents' concerns about horizontal privacy point to a fear that community based enforcement of acceptable energy use behaviour may be unpleasant, and less desirable than the bureaucratic, centrally administrated system of billing and metering currently in place. On the other hand, bureaucratic decision making processes can block creative and human responses to individual needs (Solove, 1999). This raises questions of fairness, judgment, and bias. Would devolution of enforcement of fair energy consumption behaviour to a local community result in more or less fair, compassionate and desirable outcomes?

Respondents were accepting of the diverse needs and capabilities of individuals in their community, in relation to the flexibility of their energy consumption:

> Imogen: *I think if* ***someone can only do a tiny bit*** *but they've actually done that tiny bit, it's all part of the bigger picture isn't it*

Frances: *It's also really hard because **you don't know the situation** of the people in the house. Like you don't know **ability** wise, you don't know anything about these people. So just to switch off, pick and choose to switch off someone's electricity it's like yeah … I know that we could make do and we'd be fine. We might be a bit cranky but we'll be fine. But there are **other houses maybe they couldn't** or maybe there's **something about them that we don't know on multiple levels**.*

This acceptance of the diversity of the population supports the idea that community groups could develop their own sense of fairness and be compassionately responsive to individual needs. The comments express a compassion that contradicts the fear of mob violence expressed in the 'big brother' discourse.

Frances also pragmatically recognises that "there's always going to be people that don't participate", a finding supported by Burchell et al. (2016), who note a 'pyramid of participation', in their project. This acceptance of free-riding, and potentially willingness to compensate for those who do not contribute, might be different in a context where the community provided the only mechanism of accountability, rather than an additional layer alongside the contractual relationship of buying energy. Although 'witch hunt' and 'lynched' seem to be dramatic exaggerations, vigilante justice systems do develop in human societies (Weisburd, 1988). The outcomes of a community based justice system may not necessarily be desirable.

The question of diverse needs also relates to horizontal privacy – judging whether individuals should be entitled to favourable energy access would involve access to detailed information about personal matters. The comment by Frances above implies an awareness of the privacy associated with different people's needs "you don't know the situation" "something about them that we don't know on multiple levels".

It is also possible that respondents' attitudes to different people's needs may be gendered, or subject to self-selection bias, with more socially minded people choosing to respond to research interviews. Levels of social trust of respondents were moderate to high, with the greatest social trust for colleagues, people working in local food shops, and people in the neighbourhood, and the lowest for the local councillor and local council. There was a stronger association between trust in people in the neighbourhood and motivation to save energy if others were doing so than between general social trust and community motivation. This high level of social trust may be related to respondents' accepting attitudes to the diverse energy needs within the neighbourhood. Attitudes may be different in another neighbourhood or with different demographics.

3.4 Community accountability and responsibility for infrastructure

Attitudes to mutual monitoring may be affected by the experience of responsibility for infrastructure. The discussion above shows that respondents saw mutual monitoring positively as an optional way of mutually supporting each other to choose ethical energy consumption behaviours. However, it was seen negatively in the context of enforced neighbourhood accountability. This ambivalent response challenges the applicability of community accountability in this neighbourhood electricity context. However, attitudes to community accountability may be different in a neighbourhood electricity commons where neighbourhoods had full responsibility for their infrastructure. This was explored through discussion of a scenario in focus groups.

In the LiM interviews, responsibility for infrastructure was a novel concept for most participants, introduced during the second interview and the focus group. Some respondents felt that the project had increased their personal sense of responsibility for local electricity infrastructure, talking about being more mindful and aware of their own impact. Others felt that it had not changed.

Imogen developed ideas of how a community based balancing system could be operated, in a way that would preserve privacy.

Interviewer: *Yeah, and if it did kind of trip and cause a black-out because of a few households really putting everything on, would you want to know who it was?*

Imogen: *Erm, not as such as in starting to get accusatory but I'd want to know that something was being done about it. So there wouldn't be my part to it, you know, you'd hope that there would be enough support and education going out. Then actually if that's doing that from one or two households, surely there should be some controls where you can stop it happening, so that household's limited.* ***So that basically there's some trip switch on that house so it doesn't affect everyone else****. So it could be actually that you do have flashing lights that say you're getting close to your consumption max and switch off, switch on,* ***warning lights****. Then if you don't do that your supply is shut off.*

The system she describes, with a physical limit on the power that can be used by each house, and warning lights to let people know when the limit is being reached, has much in common with the community energy system on the isle of Eigg described in the introduction.

When prompted to think about the potential for community decision making about local energy management, there was a mixed response, with some scepticism about whether people would have the time to participate locally, and an awareness that it may be difficult to get a sufficient percentage of the population interested. Two respondents referred to a local self-build community where they thought it could be easier to manage an energy commons.

Kelly saw the time needed to manage a community energy system as requiring a paid position:

Kelly: *Well it gives you more control but, again, you'd need people to do that and they'd cost. I don't think people have got enough voluntary time to do it, it would have to be paid, proper salaried posts to do all that*

Others commented that the decision making itself would take time, with some feeling positive about meeting together, and others considering that it would be difficult to find the time to meet. Clara observes that energy companies provide value by making these kinds of decisions:

> Clara *If it's a decision making process people might find that quite frustrating. So, for example, if we had to vote for particular items or aspects of the system then that might be quite problematic*
>
> Interviewer *And why do you say the decision making process would be frustrating and problematic?*
>
> Clara *Maybe it's time consuming for people and slows the processes down. And I suppose when you … **I don't know if we partly pay certain companies like energy companies for making decisions that we don't have to think about.** And that's what people, that's maybe part of the premium.*
>
> Interviewer *Yeah. You think that's a good thing?*
>
> Clara *I think it makes our lives easier, I wouldn't say it was necessarily a good thing. If you look at, obviously, energy prices but there's lots of different variables within that I'm aware. I don't know if that's … I don't know about the transparency of the system and where the money goes, so …*

In practice, the day to day decisions involved may not be too onerous. For example, on Eigg, a maintenance team accountable to the residents takes most of the decisions (Leaver, 2016).

4 Conclusions and policy implications

4.1 Overall conclusions and further research

This study is part of a research agenda which asks whether local commons-based governance of electricity systems could provide social and environmental benefits. Regarding the applicability and usefulness of a commons approach to electricity in urban settings, this study is inconclusive. We believe that this wider research agenda is worth further investigation. Pursing this research agenda directly is limited by: regulatory barriers to innovation in an energy system where reliability is a priority (Lockwood et al., 2015); a policy framing that prioritises competitive market solutions and cost reflexivity (BEIS and Ofgem, 2016) and an objective of narrow economic efficiency; and innovation funding which is framed in a similarly narrow way.

This study has provided insights that refine the wider research agenda, in particular people's initial responses to the community accountability element of a commons approach, and to taking responsibility for energy infrastructure at the local level. These ideas partially resonated with respondents, and appealed to their sense of community, desire to connect with others, compassion and recognition of different people's needs and circumstances, and the desire to work together with others in mutually supportive relationships. Participants engaged in lively discussion of the scenarios for community-based management. They were motivated by the idea that they were not acting alone, but as part of a collective effort and welcoming of comparison with neighbours for the purposes of sharing knowledge and supporting each other. This implies that the ideas are worth pursuing.

At the same time, the idea of community accountability was alien and frightening to respondents, who described concerns about protecting horizontal privacy and disproportionate community retribution using emotive metaphors. They were concerned about the time that would be needed to participate in community decisions about energy, given busy work and family lives. These are all issues of relationships, supporting the growing literature on the importance of relationships in energy demand and energy efficiency (Burningham and Venn, 2016; Butler et al., 2016; Jamieson, 2016). Developing a commons energy system would also involve a steep learning curve for participants, and have wider social implications.

This raises a number of questions for further research, which would best by explored in an commons electricity institution trial, with an action research approach supporting active engagement, ownership and institutional innovation by the research participants. Would people be interested in participating in a trial of community accountability and shared electricity use? How would a lived reality of commons governance affect self-reported attitudes towards community accountability? Would a commons situation lead to an increase in bad conflict in a community? Could participants learn healthy strategies for addressing conflict that strengthen communities? How could such a system work in a context of 9-5 work and nuclear families? Could it catalyse changes in these patterns? It would also be interesting to better understand people's perceptions of horizontal and vertical privacy in the context of energy, and whether computer science could ensure community based aggregation addresses the residual vertical privacy risks of currently proposed privacy preservation techniques, as a trade off against the reduction in horizontal privacy.

4.2 Implications for future UK energy systems

Policy and regulation is already moving towards enabling innovation, with the regulator consulting on Non-Traditional Business Models (Ofgem, 2015), launching a centre for innovation, and considering the development of a 'regulatory sandbox' (Ofgem, 2016). This would be a welcome space to trial a commons-based local electricity institution, and test the value this could offer to the local community and to the wider system.

Energy systems are changing radically. The old model of centralised provision of services to a passive, dependent consumer is being challenged by prosumers carrying out provision and production activities, and the narrow focus on competition and cost reflexivity (Ofgem, 2016) may lead to missed opportunities. The example of the isle of Eigg shows that communities can successfully manage electricity systems, and live well within consumption limits, something which could be useful for achieving demand reduction. However, existing government approaches to domestic DR are highly individualised, and innovation funding focuses on technology, business models and commercial arrangements. Innovation funding should aim to be ‘governance system neutral’ as well as ‘technology neutral’. Projects whose value may be non-monetary and based on peer sharing need to be supported, and the positive social and environmental externalities valued in energy policy.

4.3 Implications for the current roll out of smart meters

There are also more immediate policy implications. Smart meters are currently being rolled out in the EU and other countries (Official Journal of the European Union, 2012). The results of this study showed that community and commons approaches could be a powerful tool for capturing the full value of the smart meter roll out, as part of a smart grid. It is therefore important that technology and institutional lock-in should not prevent the development of innovative grassroots initiative. This could be supported by ensuring that locally accountable third parties are able to access smart meter data without excessively onerous regulatory barriers, whilst protecting individual freedom and privacy; by supporting locally-based roll out of smart meters, as proposed by the Bristol Smart Energy City Collaboration (CSE, 2015); and by providing innovation funding for the development of local community energy institutions which would support peer learning and effective use of smart grid technology for local benefit. The motivating aspect of acting collectively could be supported by making visible the collective impact of actions.

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Appendix: full list of Ostrom's design principles

Design Principles for successful groups as updated by Cox et al, (2010), developed from those originally published in (Ostrom, 1990)

1A Clearly defined user boundaries: Individuals or households who have rights to withdraw resource units from the common-pool resource (CPR) must be clearly defined.

1B Clear boundaries of resource system: The boundaries of the CPR must be well defined.

2A Congruence with local conditions: Appropriation and provision rules are congruent with local social and environmental conditions.

2B Benefits of appropriation and provision inputs are proportionate

3 Collective-choice arrangements: Most individuals affected by the operational rules can participate in modifying the operational rules.

4A Monitoring users: Monitors who are accountable to the users monitor the appropriation and provision levels of the users.

4B Monitoring the resource: Monitors who are accountable to the users monitor the condition of the resource.

5 Graduated sanctions: Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and the context of the offense) by other appropriators, by officials accountable to the appropriators, or by both.

6 Conflict-resolution mechanisms: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.

7 Minimal recognition of rights to organize: The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

8 Nested enterprises: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.