Beyond Energy Feedback

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Abstract

The aims of this commentary are to generate thought and discussion about the potential role and value of energy feedback in future energy transitions. There is now a global research and policy effort devoted to developing energy feedback (e.g. from improved bills, metering or displays) in order to change energy-use behaviour and reduce demand. Within this, calls to go beyond conventional energy feedback through the use of disaggregation are increasingly common. An alternative approach is presented for how to go beyond energy feedback. Instead of focussing solely on generating larger energy savings, it is argued that new approaches need to consider how conventional energy feedback frames energy problems and shapes the agency and engagement of different actors. Three potential routes are highlighted for going beyond conventional approaches to energy feedback through emerging work on practice feedback, policy feedback, and speculative design. Three core challenges for future work on energy feedback are: i) recognising the multiple forms of energy-related feedback that shape everyday life, ii) engaging with a much wider range of actors involved in shaping energy feedback loops, and iii) using new approaches to energy-related feedback to re-frame energy problems and establish new roles for actors engaged in energy transitions.

Keywords: energy feedback; feedback; policy feedback; feed forward; smart meters; social practices; speculative design; user engagement

Introduction

This Special Issue, and the wider Symposium which gave rise to it, are testament to the fact that there is now a vast amount of research effort and attention being devoted to energy feedback. The conventional approach to energy feedback, which is the focus of this paper, involves the provision of principally numeric information to consumers (through improved bills, metering or displays) about their levels of electricity and gas use in order to try to "equip them with the information they need to help reduce their overall energy consumption…shift it away from periods of peak demand, and/or respond flexibly to periods of 'over' supply" (Buchanan, Russo & Anderson, 2015, p89). This effort is global in its extent and reach (Lovell and Powells, 2016) with a wide range of experiments and trials of energy feedback being undertaken and evaluated (e.g. AECOM, 2011; Ehrhardt-Martinez, Donnelly and Laitner, 2010). Alongside this research effort, energy feedback has now become a key part of energy policies around the world as a means of engaging the public in managing their energy use to change patterns of energy demand (e.g. Department of Energy and Climate Change [DECC], 2015; US Department of Energy, 2014).

Most conventional energy feedback research has focussed on trying to improve its effectiveness in delivering higher levels of energy savings through behavioural change (e.g. Darby, 2006; Ehrhardt-Martinez et al., 2010). As part of this, it is becoming increasingly common to argue for a need to go beyond *energy* feedback, by disaggregating feedback to the level of either specific appliances (Weiss, Mattern, Grami, Staake and Fleisch, 2009) or to domestic activities (e.g. Stankovic, L., Stankovic, V., Liao and Wilson, 2016). This commentary agrees

firmly on the importance of going beyond conventional approaches to energy feedback. However, the core aim here is to provoke fresh debate about precisely what this could or should mean.

The paper is structured as follows. It begins with a critique of the conventional approach to energy feedback, and the principal focus of most energy feedback research (*i.e.,* the provision of numeric information on energy use to individual energy users as a means of encouraging them to change their behaviour and reduce or shift their energy consumption). It then considers three distinct and emerging approaches that, in different ways, extend the focus of energy feedback research. These approaches have the potential to generate new understandings of what going beyond energy feedback might mean. First, the many normal and unavoidable forms of energy-related feedback are highlighted that operate on everyday life and social practices (what might be called 'practice feedback') in ways that shape patterns of energy demand. In this way, it is argued there is a need to go beyond conventional forms of feedback on 'energy' to focus instead on what energy is for (Shove and Walker, 2014). Second, a UK-based case study is presented as a means of discussing the forms of 'policy feedback' and lock-in that shape and constrain policies about energy feedback and prevent alternative problem framings and potential solutions from emerging. This suggests a need to go beyond the dominant focus on energy users as the sole recipients of and respondents to energy feedback. Consideration must also be given to the forms of feedback shaping the behaviour and decisions of policy-makers and other system actors. Third, and finally, a range of new experimental and speculative approaches to energy feedback are identified. These are explicitly designed to create new ways of framing relationships between everyday life, policy decision-

making and energy demand. In doing so, it is evident there is a need to go beyond the retrospective focus of conventional energy feedback – as a means to raise awareness about past actions and courses of behaviour. This can help to generate more prospective and speculative approaches that seek to open up new questions about the desired trajectories of future energy transitions and the potential roles for different actors within them (cf. Whittle et al., 2015).

The purpose of introducing these three distinct approaches is to try to expand the debate about the potential role and value of energy feedback in future energy transitions and to begin an exploration of different ways of extending currently conventional approaches. These three approaches have thus been chosen because they each offer new perspectives on and possible ways of extending conventional approaches to energy feedback. To be clear, they are not presented as being related to or integrated with one another in any way. Nor is any suggestion being made that these are the only ways one might go beyond conventional approaches to energy feedback. Indeed, in the spirit of provoking new debate in this area, one aim of this paper is to invite others to introduce and develop still newer ways of extending and going beyond energy feedback that may have even more potential.

Existing approaches to energy feedback and their limitations

Over the last four to five decades, attempts to improve the effectiveness of energy feedback have transformed into a global enterprise (Buchanan et al., 2015; Lovell and Powells, 2016). As Darby (2006) observes, early feedback studies typically centred on providing energy users with notes telling them about their consumption. Subsequently, such approaches developed into the

provision of more informative bills (Wilhite and Ling, 1995), to todays' digitised in-home displays (IHDs) that offer real time feedback which may even be disaggregated to highlight particular appliances (Weiss et al., 2009) or activities (e.g. Stankovic et al., 2016). In short, over this period an enormous variety of types of feedback have been developed providing it in different units (e.g. Fischer, 2008; Harries, Rettie, Studley, Burchell and Chambers, 2013), through a wide range of different media (Weiss et al., 2009; Mankoff, Matthews, Fussell and Johnson, 2007; Wilson, Lilley and Bhamra, 2013) and across a range of different contexts encompassing homes, workplaces, community groups and even remotely (Wallenborn, Orsini and Vanhaverbeke, 2011; Burchell et al., 2016; Whittle et al 2015; Weiss et al., 2009).

Whilst there is enormous variety in the different forms of feedback that might be provided, across this diversity there is a strong, dominant set of assumptions about how and why conventional approaches to energy feedback should work. The information-deficit based approach assumes that the provision of more and better information to energy users about their energy use will raise their knowledge and awareness, encourage them to take decisions to change their energy-use behaviour, and thereby reduce their consumption (Wilhite and Ling, 1995). Even studies which provide energy feedback in social settings, such as to community groups (e.g. Burchell et al., 2016; Gupta et al., 2017) or which combine feedback with other forms of information, such as on social norms (e.g. Harries et al., 2013), still rest principally on the provision of new information as the driving force of changed behaviour. Perhaps the key outcome of such a framing is that the role for energy users in future energy transitions is narrowed

down to responding to the information they are given by undertaking a relatively short list of actions designed to reduce their energy use. Anderson and White (2009, p10), for example, summarise the list of potential changes into just five core types of action: turn it off, use it less, use it more carefully, improve its performance, and replace it/use an alternative (see Pierce, Schiano and Paulos, 2010 for a similar list). As Strengers (2013) observes these can all be seen as 'small changes' (p79) that, it is assumed, individuals can undertake relatively easily in the course of their normal lives, or what Marres (2011) refers to as a 'change of no change' (p523).

Early results from experimental studies and trials of different forms of energy feedback gave cause for optimism that energy feedback could have quite substantial effects in reducing energy consumption. Darby (2006) reported savings ranging between 5% and 15%. Despite reviews yielding suggestions for how to improve the design and delivery of feedback (e.g. Fischer, 2008; Ehrhardt-Martinez et al, 2010), more recent and larger scale trials have lowered expectations of how much demand reduction might be achieved in this way. The UK's Energy Demand Research Project, for example, found that, when coupled with smart meters, real time displays generated average savings of around 3% across 18,000 households (AECOM, 2011). The systematic review by Delmas, Fischlein and Asensio (2013) is particularly sobering; suggesting that the more optimistic findings reported in feedback trials tend to stem from less robust studies. Alongside these findings, a range of in-depth qualitative studies of how feedback is actually interpreted and used by householders have also been highly critical of conventional approaches to energy feedback for a wide range of

different reasons. These include a lack of interest from householders, feedback being confusing and hard to relate to, an over-emphasis on financial motivations for energy saving, and risks of 'fallback effects' where energy use returns to previous levels after a short time or rebound effects (see, Buchanan et al., 2015 for a comprehensive overview). Most of these critiques identify reasons why feedback fails to achieve hoped-for energy savings, and how this may be overcome through improved design or delivery. Three further critiques, however, deserve more attention as they highlight some of the unintended consequences of conventional approaches to energy feedback that suggest a need to think more broadly about its role and place in wider energy transitions.

First, Hargreaves, Nye and Burgess (2010, 2013) note that even when motivated to make changes in response to energy feedback, some energy users feel unable to realise significant savings as this would mean compromising levels of comfort or convenience. Strengers (2013) extends this point to argue that whilst conventional approaches to feedback often help householders identify wasteful, unnecessary, 'bad' energy use, in so doing they can also serve to legitimise the remaining bulk of energy demand as normal, necessary or even 'good'. In this way, whilst potentially generating small savings for individual households, feedback fails to challenge wider public and social trends towards ever more energy intensive lifestyles (Strengers, 2013).

Second, once individuals have made the range of 'small changes' they feel they can realise, Hargreaves (2014) observes that some then come to resist the way feedback individualises responsibility for energy problems. In short, they start

asking not what they can or should do to reduce their energy use, but rather what government, big business and other more powerful system actors are or should be doing (see also Whittle et al., 2015). In this way they come to question and challenge what Marres (2011) refers to as the 'distribution of the problem' created by conventional approaches to energy feedback which places the agency and responsibility for energy savings onto energy consumers whilst leaving other system actors out of the picture and unchallenged.

Third, and finally, Morozov (2013, p260-2) critiques energy feedback, and other forms of quantified feedback, for appealing to and thereby strengthening what he calls the 'numeric imagination'. The numeric imagination 'enables us to think in numbers – that is, to ponder how much we can consume and, in the best of all cases, what we can unplug – but it never challenges us to think of how a different set of numbers might be generated' (Morozov, 2013, p262). In so doing, Morozov argues, it unwittingly locks users in to their existing patterns and trajectories of energy consumption. Worse, by feeding the numeric imagination, conventional approaches to energy feedback also serve to downplay and marginalise forms of 'narrative imagination' which actively explore different problem framings and the alternative understandings and solutions that they may generate.

Despite initial optimism, therefore, conventional approaches to energy feedback have not been free of problems. Whilst much might still be done to improve its design and delivery in order to achieve larger energy savings, these more substantive critiques suggest that there is an urgent need for a much more fundamental re-thinking of the role that energy feedback can or should play in

trying to change everyday life and associated energy demand. In particular, several of these problems imply a need to go beyond thinking merely about energy and individual energy users, to expand analysis to the broader dynamics of everyday life and the sociotechnical and political systems which underpin it.

Beyond Energy Feedback

Three emerging areas of work are described briefly below. Each identifies ways to go beyond conventional approaches to energy feedback. Each attempts to broaden the focus of analysis beyond individuals and their energy use. The first – around forms of 'practice feedback' (Strengers, 2013) – seeks to situate energy feedback within the broader dynamics of everyday life and social practices. The second – 'policy feedback' (Pierson, 1993) – considers the roles and effects of energy feedback within broader settings of policy decision-making. The third – 'speculative design' (Wilkie, Michael and Plummer-Fernandez, 2015) – attempts to generate new questions and controversies about the directionality of future energy transitions and the potential roles of different actors within them.

Practice Feedback

Strengers (2013) argues that for feedback of any kind to have a significant impact on everyday practices it must 'be involved in changing what makes sense for people to do' (Strengers, 2013, p91). Yet, through her review and synthesis of international energy feedback studies, Strengers finds that 'feedback about energy is not currently integral to many practices of domestic living' (Strengers, 2013, p89). In short, Strengers' explains the limited success of conventional approaches to energy feedback as resulting from an individualist, rationalist and

energy-based focus which fails to connect with the multiple social and practice-based logics of everyday life.

In the course of performing normal social practices, such as cooking, doing the laundry, heating the home etc., Strengers argues that individuals encounter and are influenced by three forms of what might be called 'practice feedback'. In essence, practice feedback represents the range of evaluative judgements on how well (or badly) one is performing a particular practice that, in turn, shape how we perform that practice in future. For example, it is perhaps common sense to note that if a friend or family member compliments or criticises a meal we have cooked for them, this is likely to impact on how and what we choose to cook in future. Similarly, we may judge the success or failure of our performances of practices in a number of other ways, such as how we or others feel, how much things have cost, whether or not things went to plan etc. Unlike conventional forms of energy feedback, these forms of 'practice feedback' are not usually delivered to practitioners via an intervention by an outside agency with a specific intention (e.g. to reduce energy use). Instead, they are informal, routine and to some extent an unavoidable part of learning to become a competent practitioner. Thus, practice feedback has a role in how social practices evolve and change. Through receiving and responding to forms of practice feedback, practitioners' evaluate their past performances against a dynamic range of criteria and attempt to adjust their future performances accordingly.

Strengers (2013) identifies that the limited impacts of conventional energy feedback stem from its role as a form of 'social feedback' within at least some

practices. Particularly when it is first introduced to homes, energy feedback can help people make normative judgements about their performances of certain practices as either acceptable or wasteful in terms of the energy they demand. Through these evaluations, conventional energy feedback can indeed make some difference to how some people perform certain practices as they either attempt to be less wasteful future or, conversely, they receive reinforcement that their current performances are acceptable.

At the same time, however, a range of other forms of social feedback also operate on practices in ways that often serve to increase energy use. Here, comments or judgements from friends, family members, colleagues, advertisers, the media, and even from pets can all serve to shape patterns and levels of energy use in different ways. Berker (2013), for example, illustrates how, through the images and terms used to sell new bathrooms, interior design and lifestyle magazines cast a form of social feedback on bathing practices that encourage more energy intensive forms of bathing. In such magazines, bathrooms are invariably large spaces involving large volumes of heated water, and often with heated floor tiles and elaborate lighting. Through such imagery, such magazines cast a form of social feedback onto bathing practices, tacitly informing their readers that the successful performance of bathing practices rests upon using large amounts of energy. In a more mundane fashion, Wright (2016) demonstrates how even pets can provide social feedback on practices in ways that increase energy use. As one of her participants stated: 'I would know if it was cold in the house from Marley [the dog], if he were sitting on the warm patch of floor by the airing cupboard' (Wright, 2016, p28). In the course of learning to become competent performers

of different practices, people receive and respond to a huge range of social judgements that become embedded in the very definition of what it means to perform a practice successfully. At present, for the vast majority of practices and practitioners, conventional approaches to energy feedback do not play such an important role.

Strengers (2013) identifies two other forms of practice feedback: material feedback and embodied sensory feedback. Material feedback operates through the wider material environment serving to guide the performance and evolution of practices. For example, homes may be built in ways that require forms of mechanical rather than passive heating or cooling and thus demand that their inhabitants routinely use the heating or air conditioning (Shove, 2003). Similarly, televisions and other digital equipment are designed to remain on standby as a matter of course (Gram-Hanssen, 2010) thus sending a message to their users that this is normal and acceptable behaviour. Participants in Wright's (2016) study, for example, observed how, once purchased, new domestic appliances demand to be used rather than left redundant: 'Because we have spent money on the tumble dryer, the coffee machine, we might as well use them now' (Wright, 2016, p30). Whilst energy feedback may indeed become a part of the material environment that cautions against energy use, it seems unlikely, any time soon at least, that it will compete successfully against, or somehow begin to challenge or arrest, the long-running trend towards the adoption and use of ever more energy-using domestic appliances (Energy Saving Trust, 2006).

Finally, embodied sensory feedback operates in the ways that practitioners can feel or sense when they need to adjust their performance of practices. Royston (2014), for example, lists a range of ways that people sense that their homes are too cold, including: 'I could see my breath…the wind whistling through the catflap…I got out of the bath, touched the door handle with my wet hands and actually froze stuck to the handle' (2014, p148). In all of these ways, these practitioners sensed that they needed to take action to warm their homes and thus to consume more energy. Similar forms of embodied sensory feedback can be observed when people feel dirty or sweaty and decide to have a shower (Hand, Shove and Southerton, 2005). Or, when plagued by the 'senseless tyranny of spotless shirts and immaculate floors' (Schwartz-Cowan, 1983, p216), they choose to launder their clothes or vacuum their carpets.

As Schwartz-Cowan (1983) demonstrates, precisely what is defined as a successful or competent performance of a practice can change dramatically over time. As such, forms of practice feedback must be understood as dynamic. The crucial point, however, is that the range of forms of practice feedback identified by Strengers (2013) are currently far more significant in shaping how people perform energy-using practices than most conventional forms of energy feedback.

This section has argued that a first way to go beyond conventional approaches to energy feedback is to recognise it as only one form of feedback among many others that routinely shape people's everyday lives and associated energy demand. Further, it has suggested that when contextualised as a form of social

feedback on practices, conventional energy feedback appears to be relatively weak in the face of other forms of practice feedback that are an integral part of social practices. Strengers' (2013) analysis leaves open two potential routes for those interested in changing patterns of energy demand. They can either (a) try to make energy feedback a more important and integral part of social practices, such as efforts to disaggregate feedback to the level of appliances or activities attempt (e.g. Weiss et al, 2009; Stankovic et al., 2016), or (b) try to go beyond conventional *energy* feedback and explore whether and how the many other forms of practice feedback might be used to re-orient practices onto less energy intensive trajectories. Route (b) would demand a radical rethink of how to go about providing people with feedback on their practices that might change energy demand. For example, it could include re-designing infrastructures, architectures and products to provide forms of material feedback that generate lower levels of energy use (cf. Jelsma 2003), or efforts to change forms of embodied sensory feedback (and how people respond to it) such as Jack's (2013) experimental intervention into people's sense of cleanliness and how they wash their jeans, or to wider and more creative efforts on how to change the forms of social feedback people receive on their practices, such as by working through community groups or peer-networks rather than with individuals (e.g. Burchell, Rettie and Roberts, 2016; Peacock et al., 2017), or designing forms of feedback that encourage practitioners to reflect on wider social conventions, habits and routines rather than solely on their energy use (e.g. Buchanan et al., 2015). What is certain is that route (b) would involve engaging with a much wider range of actors and agents encompassing marketers, designers, builders, appliance manufacturers, town planners, schools and even potentially pet shops, and that,

in so doing, it would redistribute the problem of energy demand across whole social practices and the many actors that influence them, rather than keeping it on the shoulders of energy users.

Policy Feedback

A focus on practice feedback points toward important ways of expanding understandings of energy-relevant feedback as they operate on everyday life. Nonetheless, calls to recognise the diverse forms of feedback that have effects on patterns of energy demand will fall on deaf ears if the dominant ways in which energy feedback is thought about in policy and decision-making arenas are not also expanded and diversified. As such, a second, connected, way in which there is a need to go beyond conventional energy feedback is by exploring how evaluations of and learning about energy feedback interventions are themselves fed-back into policy and decision-making (Robison and Foulds, 2016). In short, this means developing a new, as yet under-developed focus on forms of policy feedback about energy feedback (Pierson, 1993).

Alongside the global expansion of different forms of energy feedback, there has also been a growth in policy evaluations of energy feedback (e.g. Darby 2010; US Department of Energy, 2014). Taking the UK as a specific case study, there has been a significant amount of effort and investment dedicated to learning about energy feedback and how it might best support the ongoing smart meter roll-out (e.g. Darby, 2006; DECC, 2015). The UK Department of Energy and Climate Change's (DECC) Smart Meter Implementation Programme, for example, undertook an 'Early Learning Project' (ELP) focussed on early installations of

smart meters, which included a range of small-scale behavioural trials[1] that sought 'to guide plans for consumer engagement' (DECC, 2015, p8). To be clear, the UK's smart meter roll-out is about far more than merely providing energy feedback to change consumer behaviour, nonetheless the manner in which energy feedback is thought about and evaluated as part of the smart meter roll-out is strongly indicative of approaches to energy feedback among the policy community. The range of reports, synthesis and policy conclusions drawn from this project thus provide a valuable case study to explore how policy makers – in the UK at least - frame questions about, define and develop evidence on, and make decisions about how to improve energy feedback.

Despite the wide range of trials that were conducted[1] - encompassing both quantitative and qualitative research, on a range of different types of smart meters, forms of feedback and other behavioural interventions – three core areas of focus stand out as significant in indicating how energy feedback is thought about in UK policy-making circles, and thus how policy feedback about energy feedback is shaped.

First, the core focus of all aspects of the ELP was on the purchase and use of energy. For example, DECC's 'Policy Conclusions' report begins by stating: 'Consumers have been placed at the heart of the [ELP], because of the transformational impacts which smart metering could have on how consumers buy and use energy' (DECC, 2015, p9). It is hardly surprising that energy should be a key focus of a policy evaluation of smart meters and energy feedback. What is notable in the outputs from the ELP, however, is a lack of any real discussion of

what energy is used for (Shove and Walker, 2014). As a result, energy appears to be conceived as something that users are expected to be aware of, have knowledge about and pay for through various means, but in ways that are curiously separate from their normal everyday lives.

The second core focus of the ELP is on the specific material devices offering forms of energy feedback to users – such as IHDs, prepayment meters or energy audits and advice leaflets. Reports conducted as part of the ELP (e.g. Darby, Liddell, Hills and Drabble, 2015; Griggs, 2015; Ipsos MORI, 2015) are variously concerned with how these material devices are used and engaged with, understood and acted upon by their recipients. It is firmly to be expected that policy evaluations of forms of energy feedback should focus on the specific material devices being used to provide that feedback. Yet, again, there are notable absences and exclusions. In particular, the focus on the use of specific material energy feedback devices is strangely disconnected from the wider social and material contexts in which these devices are used, made sense of and that they are in many ways competing against.

Third, and finally, despite the contributory research reports revealing a wide range of wider social and structural impacts on energy demand, DECC's (2015) analysis of the ELP is overwhelmingly framed around a focus on individual behavioural change. The very basis of the ELP, for example, derived from the starting assumption that 'an effective consumer engagement strategy requires an understanding of consumer attitudes and how different drivers of behaviour affect energy-consuming habits…' (DECC, 2012, p21). On the back of this framing,

a core focus of all ELP research was to explore six assumed 'drivers of energy behaviour', namely: energy literacy, knowledge of behaviours, self-efficacy, beliefs about outcomes, salience [and] social and household norms (DECC, 2012, p22). Despite the smart meter roll-out being recognised as 'the biggest national infrastructure project in our lifetimes' (Smart Energy GB, no date), beyond asking how forms of energy feedback may change individuals' decisions and behaviours about energy, the ELP makes little meaningful attempt to consider how wider infrastructures and institutions shape and constrain everyday life and energy demand. Indeed, several of the research reports commissioned as part of the ELP challenged the limits of a narrow focus on individual behaviour, yet this was substantially downplayed in the 'policy conclusions' DECC derived from the ELP (DECC, 2015) [2]. For example, Darby et al observe that: 'There is considerable research evidence that…energy use is a social rather than an individualised process…This stems from analysing the activities that lead to energy use, and how these are influenced by social norms and acquisition of know-how; also from social learning theory' (2015, p46). Yet, when translating these findings into 'policy conclusions', DECC chose to focus on consumer satisfaction with smart meters and IHDs, the need to provide tailored information at installation 'to overcome barriers to accessing the full range of smart meter benefits' and the challenges of 'enabling consumers to use smart metering data to change behaviour and reduce energy consumption' (DECC, 2015, p43), all of which serve to reinforce rather than challenge or expand the initial behavioural framing.

Taken together, this narrow problem framing around energy, material devices of energy feedback, and individual behaviour change generates a very particular

definition of valuable evidence in attempts to improve the effectiveness of energy feedback and thus to enhance the smart meter rollout. Specifically, valuable evidence is understood as that which relates to: i) how trialled feedback interventions impact on the six behavioural drivers outlined above, ii) the extent to which the interventions impact on consumer engagement with smart meters, and iii) the measured energy savings the interventions generate. The result of this narrow framing, as Shove puts it, is that: 'useful data are specified in ways that rule out historically grounded analyses of how relevant social practices, systems of practice, and related infrastructures and institutions evolve' (Shove, 2010, p1280).

Perhaps more worryingly still, by relying only on evidence that is divorced from its local and historical specificities, this narrow framing generates a research and policy agenda that is not connected to any particular context and, as a result, can circulate globally and be rolled out anywhere. Lovell and Powells (2016), for example, highlight the global policy mobility of energy feedback and how this is resulting in similar networks of governing institutions in many locations around the world. This represents a particular form of policy feedback that Beland (2010) describes as 'lock-in'. Through lock-in, 'policies…create incentives that encourage the emergence of elaborate social and economic networks, greatly increasing the cost of adopting once-possible alternatives and inhibiting exit from a current policy path' (Pierson, 1993, p608). In short, policy lock-in effects around ways of understanding and evaluating energy feedback generate forms of path-dependency that serve to shut out alternative problem framings and thus to close-off a range of potential futures.

This section has suggested that a second way to extend and go beyond conventional approaches to energy feedback is by challenging the assumption that energy users are or should be the sole targets of energy feedback. Instead, attempts should be made to expand energy feedback loops to recognise that other actors, such as policy makers, play a vital but often unrecognised role in these feedback relationships by limiting what the focus of energy feedback is, who it addresses and what acceptable responses to it might be. It is not a new point to note that policy evaluations often fail to challenge problem framings and, as such, it should be recognised that expanding conventional energy feedback loops to include other actors will be far from easy. Nonetheless there are at least two ways that efforts to go beyond energy feedback in this way might be pursued. First, there is a need for energy feedback researchers themselves to do more to shift the focus of energy feedback research and evaluation beyond energy users and to draw more explicit attention to the roles that policy makers and other system actors play in shaping and responding to energy feedback. This means engaging more, and more creatively, with policy makers to increase their reflexivity by challenging conventional framings of energy feedback and exposing them to alternative understandings of and approaches to feedback (such as the forms of practice feedback highlighted above). Second, more effort should be devoted to generating a new and alternative evidence base around energy feedback by conducting experiments, trials and evaluations of different approaches that seek to expand problem framings and actively explore different ways of conceiving and assembling relationships between energy demand,

everyday life and policy making. The next section identifies some emerging work that seeks to do just this.

Speculative Design

The third way of going beyond conventional approaches to energy feedback that I would like to highlight seeks to change the orientation of energy feedback approaches away from raising awareness about and reflecting on past courses of action and towards actively speculating about alternative future trajectories and arrangements. The emerging field of speculative design is increasingly experimenting with a range of energy feedback-like devices that encourage their users not only to reflect on their energy use, but also to generate new problem framings, subject positions and forms of narrative imagination around alternative energy futures. In this way, arguably, speculative design represents an effort to go beyond energy feed*back* by experimenting with forms of energy feed-*forward*.

One way in which this is attempted is through the creation of 'threshold devices' (Michael and Gaver, 2009). 'Threshold devices are designed playfully to open up social settings to the hitherto unapprehended complexity, heterogeneity, and ambiguity of their connections to the 'world beyond'' (Michael and Gaver, 2009, p369). Threshold devices seek actively to resist, obscure and complicate narrow and instrumental framings of social and technological problems, such as those around energy demand, in order to invite new kinds of understandings, roles and relationships. Two examples of energy-related threshold devices are briefly

mentioned below: the Energy Babble (Wilkie, Michael and Plummer-Fernandez, 2015) and the Natural Fuse (see Morozov, 2013).

'The Energy-Babble is a radio-like sound device that vocalizes and amplifies energy-related content drawn from the web (including Twitter and UK electricity grid updates) and combines this with voice and SMS messages inputted by… community members' (Wilkie et al., 2015, p84). Unlike conventional forms of energy feedback which seek to raise individuals' awareness of their own energy use, the Energy Babble tries instead to encourage its users to become more aware of and reflect on their place and role within a wide range of energy debates. It does this by periodically reading out energy-related content derived from a wide range of sources including the Twitter feeds of government departments, the National Grid, the media and other energy commentators and activists, but also from posts and text messages generated by members of the community energy projects in which it was being trialled. The result is a swirl of discourse about energy that sometimes makes little sense, but which nevertheless provokes reflections and reactions from its listeners. These reactions were sometimes positive and sometimes negative but, as Gaver et al., (2015) identify, often served to expand discussion beyond the device itself, and beyond energy, to 'encompass the broader and more particular issues, practices and controversies with which our volunteers were living' (p1122) and the 'entanglement of energy concerns with other issues' (p1123).

The Natural Fuse (Morozov, 2013, p330-333) is more openly normative in how it seeks to re-frame energy issues. Essentially, it acts like a miniature carbon sink

that takes the form of a household plant. Like a kind of smart plug, the plant sits between the electricity socket and the appliance to be plugged-in, and works such that the appliance will only function if it requires a carbon footprint smaller than the amount of CO_2 that the plant itself can sequester. As many domestic appliances would require more than one plant to sequester the CO_2 their use emits, this means users have to 'borrow' carbon sequestration from other plants that are part of a wider internet-connected network of Natural Fuses. If users use their appliances too much, their plant dies (a jar of vinegar is poured into its soil) and everyone in the network is emailed about the death. Users can select between 'Selfish' mode, meaning their appliance can be used as much as they wish but at the cost of killing their plant and those of others in the network , or 'Selfless' mode meaning they can use only as much energy as will avoid killing any plants in the network, but at the cost of only being able use their appliances for a short time. Whilst the Natural Fuse is clearly more targetted than the Energy Babble in its efforts to encourage users to reduce their energy demand, like the Energy Babble it encourages its users to make connections between their energy use, wider communities and broader sustainability concerns. Further, it forces them to seriously consider the importance of some everyday practices and associated energy use, over the life of their own houseplant as well as those of distant strangers in the network.

Neither the Energy Babble nor the Natural Fuse provide ready solutions to contemporary energy demand problems, nor do they seek to. Their potency and importance, however, is in the ways they actively unsettle conventional framings and distributions of energy problems. As well as encouraging their users to re-

consider their own relationships to and uses of energy in everyday life, they also generate broader questions about what role individuals should play in wider energy transitions as compared to other actors – such as local communities, energy system operators or policy makers – and about the possible relationships between energy use and wider aspects of everyday life and society (see also Whittle et al., 2015 for an analysis that raises similar questions in relation to more conventional approaches to energy feedback). In this way, they represent a third way of going beyond energy feedback because they attempt to develop space for alternative ways of thinking about energy futures that may involve diverse courses of action and agency on the part of multiple agents, rather than merely encouraging individuals to make small changes to their energy use.

Conclusions

The core aim of this paper is to stimulate further thought, debate and discussion about the potential role and value of energy feedback in future energy transitions. To achieve this, after critiquing currently conventional approaches to energy feedback, three potential ways were outlined for extending and going beyond them – practice feedback, policy feedback and speculative design. In different ways, these try to reframe energy problems, develop new roles for both energy users and other system actors, and seek to generate thought and discussion about ways of re-imagining energy problems. Thus, these approaches devise different kinds of solution.

The sole focus of conventional approaches to energy feedback has been to change individual behaviours through the provision of principally numeric information on energy use. There are many other ongoing efforts to engage and

challenge extant forms public engagement in energy transitions that thus fall beyond the scope of this analysis (e.g. Chilvers and Longhurst 2016). Similarly, no claims are made that the three approaches highlighted here are the only ways of going beyond current dominant approaches to energy feedback. Indeed, others are invited to introduce and develop still newer ways of doing so that have even more potential.

Three core challenges are presented below for future research, development and policy that the three ways of going beyond conventional energy feedback discussed here serve to generate.

First, broadening the focus of energy feedback to reflect on practice feedback highlights the multiple, diverse and interacting forms of energy-related feedback that act upon everyday life. In the face of this multiplicity, currently conventional approaches to energy feedback must thus be recognised as only one form of feedback and, indeed, one that is seemingly relatively weak with respect to shaping everyday life and practice. Going beyond such approaches does not necessarily mean that they should be abandoned altogether, as they clearly do hold some potential value for some actors in some situations and they may be used and interpreted in ways that either close down or open up problem framings (e.g. Whittle et al, 2015). The key point, however, and the first core challenge, is to move beyond understanding these conventional energy feedback interventions in isolation or as something that is likely to have universal, context-independent value. Instead there is a need to contextualise them within the multiplicity of energy-related forms of feedback on everyday life. This will

demand more holistic and comparative forms of analysis that helps to identify the specific situational strengths and weaknesses of conventional forms of energy feedback and to develop understandings of when, where and how they might be used in more interesting and challenging ways. In so doing, it has the potential to generate more diverse, creative and multi-pronged interventions that attempt to shape whole practices and not merely change individuals' energy-using behaviours.

Second, a focus on forms of policy feedback reveals that multiple actors are involved in shaping energy-related feedback loops even though the dominant focus of analysis is on end users and the material devices providing them with energy feedback. The second core challenge is thus to broaden energy feedback research and policy to incorporate a wider range of relevant actors and agents. This will certainly include end users and material feedback devices, but will also more explicitly recognise the roles that policy makers, energy companies, local communities, and even energy infrastructures and markets play in defining energy problems and shaping patterns and distributions of agency in attempts to solve them.

Finally, approaches based around speculative design suggest that a third core challenge for future work on energy feedback is to identify ways of using forms of energy feedback not merely to modify existing patterns of behaviour, but to develop new questions, re-frame energy problems and carve out new roles and subject positions for the many different actors involved in energy transitions. Whittle et al., argue that energy feedback interventions have the potential to

provide “window[s] of opportunity…[f]or these are the moments when things *can* be otherwise” (2015, p248). Seizing this opportunity will demand going beyond conventional forms of energy feedback to generate new, more creative and experimental approaches that seek diverse forms of engagement from many different actors and which attempt to keep open and expand rather than close down and fix the potential range of energy and ultimately societal futures.

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Endnotes

[1] See: https://www.gov.uk/government/publications/smart-metering-early-learning-project-and-small-scale-behaviour-trials [last accessed 20.06.17] for links to reports.

[2] The author thanks an anonymous reviewer for this observation.