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The Visible Energy Trial: Insights from Qualitative Interviews

Tom Hargreaves

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1. Introduction: Background to the Project

In December 2009, the UK Department for Energy and Climate Change (DECC) announced its intention to roll-out 'smart meters', accompanied by free standing real-time displays, to all UK householders by 2020. As well as paving the way to a 'smarter' grid able to handle large amounts of micro-generation and improved demand management, this decision is justified by the assertion that: "These meters will provide consumers with real time information on their electricity use to help them control consumption, save money and reduce emissions" (DECC, 2009, 7[1]). Previous studies on the provision of feedback to energy consumers support this assertion, suggesting it can help to realise savings of between 5 and 15% annually, depending on the quality and type of feedback provided (Burgess and Nye, 2008[2]). Several large scale trials into the effectiveness of various interventions into domestic energy use are ongoing, such as the Energy Demand Research Project in the UK (see OFGEM 2009[3]) however, as yet very little is known about the processes through which these kinds of savings are achieved. Katzev and Johnson's (1987) observation that "our understanding of *how* feedback does or does not work remains unexplored or untested" (in Darby, 2006, 7, emphasis in original[4]) still largely applies.

Burgess and Nye (2008) describe domestic energy use as 'doubly-invisible'. It is invisible first, because people are unaware of how much energy they use overall (e.g. it is obscured by billing and payment systems) and second, because they do not know how the energy they use connects with different aspects of their lifestyle (e.g. it is an inconspicuous form of consumption). Enabling individuals to see and understand their energy use patterns is therefore seen as critical in efforts to reduce energy consumption overall – whether motivated by financial or environmental reasons. Real time displays, or smart energy monitors, attempt to serve precisely this function – to provide immediate feedback and information on their energy use in order to help them reduce it. Understanding how people actually use these devices and the feedback they provide, how they relate this to their everyday lives and practices, and how (or if) this leads to changes in energy consumption patterns represent the core concerns of this paper.

Throughout 2008-2009, Carbon Connections in partnership with Green Energy Options (GEO), Sys Consulting Ltd, and the School of Environmental Sciences at the University of East Anglia ran a trial of a range of smart energy monitoring devices in 275 households in the East of England. As part of this 'Visible Energy

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[1] DECC. 2009. Smarter Grids: The Opportunity. London, Department of Energy and Climate Change.

[2] Burgess, J., & Nye, M. 2008. 'Re-materialising energy use through transparent monitoring systems.' Energy Policy, 36, pp4454-4459

[3] OFGEM 2009. Energy Demand Research Project: Review of progress for period September 2008 - March 2009 (Ref: 115/09). London, OFGEM.

[4] Darby, S. 2006. The Effectiveness of Feedback on Energy Consumption: A Review for DEFRA of the Literature on Metering, Billing and Direct Displays. Environmental Change Institute, University of Oxford.

Trial' (VET), and in addition to social surveys at strategic points throughout the trial's duration, 15 semi-structured interviews were conducted with trial participants in an attempt to address these concerns. This report focuses solely on explicating the findings of these interviews.

1.1 Methodology and Participants

Overall, the VET involved 275 households divided into four distinct experimental groups. Three of these groups (the solo, the duet and the trio) have a working, interactive display in their household. The fourth group has an advanced monitoring system installed but no interactive display. This group represents the experimental control group. Details of the devices being used in the trial are as follows:

The Solo (n=75): The Solo device (see figure 1) is designed around a car dashboard and offers a monochromatic display providing a 'speedometer' with information on current levels of electricity usage, daily usage up to the present moment (expressed in kWh, carbon dioxide emissions and sterling), and a 'fuel tank' which enables householders to set a daily budget and which indicates whether this is being met or exceeded by displaying a tick or a cross symbol. The Solo also comes with an SD card enabling users to upload their data to GEO's 'MyEnergy' website which provides more detailed graphical information. In the trial, the Solo has been administered to elderly and low-income households.

Figure 1: The Solo

The Duet (n=75): The Duet device (see figure 2) is more advanced than the Solo. The left-hand screen has the same functionality as the Solo. It thus displays a 'speedometer' of current and daily usage, and a 'fuel tank'. In addition, on the right hand screen, the Duet monitors boiler usage and up to 6 different appliances (appliances are monitored separately using 'Plugbugs' which transmit levels of consumption to the Duet unit, and of which 3 are delivered with the device). An SD card is also provided with the device for use on the MyEnergy website.

Figure 2: The Duet

The Trio (n=76): The Trio (see figure 3) has a full colour display with a very wide range of monitoring options. It monitors heating, hot water usage, all electrical circuits in the home, and up to 100 appliances (using Plugbugs – of which 6 are delivered with the device). Information can then be displayed graphically to investigate energy consumption patterns in more detail. For example displaying appliance usage over 24 hour or monthly periods and in kWh, CO2 and Sterling units. It should be noted, however, that during the trial itself participants were provided with a small PC laptop and not the device displayed in Figure 3.

Figure 3: The Trio

The Control (n=49): The experimental control group have had the Trio device installed in their home, which monitors their heating, hot water and all appliances, however they have not received the display unit. At the end of the trial they have been offered a report into their energy use patterns.

For the qualitative interviews, a random sample, stratified according to the device being used, was conducted to select four interviewees from each of the solo, duet and trio groups, and three interviewees from the control group. Summary details of all interviewees are provided in table 1.

The interviews themselves lasted for between 30 and 60 minutes. Six were conducted face-to-face with the interviewer visiting the participant's home or workplace, and nine were conducted over the phone. During the interviews, participants were asked to comment on the following themes:

- How they had got involved in the trial and their motivations for doing so.
- How they had used and interacted with the device.
- If the device had affected their energy awareness or behaviour, and in what ways.
- Any recommendations to help improve the device.

The interviews were then transcribed verbatim, and analysed using a grounded theory approach (Charmaz 2006[5]) to identify the dominant themes in each of these categories. Throughout this report, quotations are used widely to illustrate particular points. The individual quotations chosen are, in every case, representative of the wider theme under discussion. The intention behind using lots of quotations is also to convey a strong sense of how these devices are used in real life domestic settings. Crucially, throughout this report, conclusions are based solely on the interviewees selected from each group and as such should

[5] Charmaz, K. 2006. *Constructing Grounded Theory: A practical guide through qualitative analysis,* London, SAGE Publications.

ID[a]	Group	Gender	No. of household occupants	Ages of permanent occupants	Household income (thousands £)	Household type	Ownership	Year house built	Months using the monitor
S1	Solo	M	2	61, 57	20-30	Bungalow	Housing association	Pre-1964	3
S2	Solo	F	2-4	60, 59	0-10	Semi-detached	Housing association	Pre-1964	1
S3	Solo	M	2	73, 71	20-30	Detached	Owner	Pre-1964	2
S4	Solo	M	2	61	10-20	Bungalow	Housing association	1965-2001	3
D1	Duet	M	4	37, 35, 8, 5	50+	Semi-detached	Owner	Pre-1964	6
D2	Duet	M	5	49, 48, 21, 19, 16	50+	Detached	Owner	1965-2001	4
D3	Duet	M	2	60, 46	30-50	Detached	Owner	1998	7
D4	Duet	M	4	41, 39, 6, 3	50+	Terraced	Owner	1890	7
T1	Trio	F	2	57, 44	50+	Detached	Owner	1965-2001	4
T2	Trio	M	4	36, 36, 6, 2	50+	Semi-detached	Owner	1965-2001	12
T3	Trio	M	1	29	30-50	Terraced	Owner	Pre-1964	9
T4	Trio	M	1-4	37	0-10	Terraced	Rental	2007	7
C1	Control	M	2	45, 44	30-50	Detached	Owner	1965-2001	12
C2	Control	F	2	62, 61	20-30	Detached	Owner	1965-2001	5
C3	Control	M	2-8	54, 40	50+	Detached	Owner	Pre-1964	6

Table 1: Summary of Interviewees

[a] Throughout this paper, this unique identifier will be used to label quotations drawn from the interviews

not be the subject of extensive generalisations. Within this report, reference to 'all' or to 'most' users of a particular device therefore refers only to those interviewed, and not to other triallists who were not interviewed or to other users of the devices who are not participating in the trial.

Based on this analysis, this report is structured around the major parts of the interview. It is designed so that each section can be read and understood independently of all others. Next, section 2 will focus on participants' motivations for getting involved in the trial. Section 3 will detail how they have interacted with the device, including details on the installation and set-up process. Section 4 will focus on the effects of the devices: first, in section 4.1, on how the devices have influenced levels of energy awareness; and second, in section 4.2, on how the devices have changed patterns of energy use and behaviour. Section 5 then details the limitations participants had experienced to using the devices even further. In these sections, where relevant, clear distinctions are drawn between each of the Solo, Duet and Trio devices. If no such distinction is made, this is because there was significant commonality across participants and all devices. Finally, section 6 briefly concludes the report by highlighting some potential implications for the wider use of such devices.

2. Motivations for Participating in the Trial

Participants had heard about the VET through a variety of sources, including seeing adverts in local newspapers, attending local energy fairs, through their housing authority representative (particularly for Solo users) and through word of mouth. When asked to reflect on their motives for participating in the trial four distinct categories of motive were described: cutting cost, cutting emissions, gaining information, and interest in the technology. In most cases, more than one motive was offered, for example many interviewees argued that whilst cutting costs was their primary motivation, if they could cut their emissions in the process they were happy to do so. Although this sample is too small to make generalisations from, it did appear as if Solo users were more interested in cutting costs, Duet users in cutting emissions, and Trio users in gaining information or learning about the technology itself. Further research is required to confirm these observations, but such research would appear to be important because, crucially, each of the different motives appears to affect how the devices are used and what changes they bring about in different ways, as this section will outline.

Perhaps the most commonly offered reason for participating in the trial was to save money by reducing electricity bills:

> "I have to be perfectly honest yeah, the cost of it, and if we can lower those costs and in turn by lowering our costs we are saving energy." (D4, p3)

> "I have to say my primary motivation was financial, I was trying to reduce my costs." (T1, p1)

This motive was especially apparent among Solo users who, when recruited via their housing authority, were often explicitly told that participation in the trial would help them cut their bills. This motive appeared to affect participants by encouraging them to seek bigger changes, and therefore bigger savings, rather than smaller ones:

> "once we'd done that, got rid of the freezer and all the other easy things, there were actually limits to what we could do with our behaviour, because these things were all saving pennies really and I wanted to save pounds or even tens of pounds really." (T1, p2)

As this quotation illustrates, in some cases a cost motivation appeared to militate against small behavioural changes like turning lights off, and instead favoured either the disposal of old inefficient, or the purchase of new, more efficient appliances. This runs counter to much thinking and policy on behaviour change, which suggests that smaller changes, or 'low hanging fruit', should be targeted first. Further, those who expressed this motivation also revealed higher levels of frustration as prices rose, and as they struggled to save further.

The second dominant motive was environmental, with participants wishing to cut their carbon emissions:

> "at the end of the day I think it is environmental. You see the cost isn't too much of a problem 'cause we just pay it and that's what it is, but the environmental aspect of it I think yeah, it is definitely one of the major considerations." (T2, p1)

Whilst the actions taken by this group of participants in the home differed little from those who expressed other motivations, crucially this was one of the only groups of participants for whom energy saving behaviour appeared to 'spillover' beyond the domestic setting. For example, many of those who expressed an environmental motivation suggested they also tried to drive or fly less, had bought smaller cars, or had attempted to encourage their friends, family or colleagues to cut emissions themselves (see section 4.2.6).

The third and fourth motivations were less common, and expressed predominantly by the Trio users interviewed. Here, the interest appeared to be in gaining information on patterns of energy use, or on trying out the technology itself. In one case, for example, the participant was trialling the device to help inform various technological projects he was involved in at work.

> "To be honest I was just interested to see how the thing works. It was curiosity as much as anything else to get involved but it is interesting literally just to…the silly things, you know, you stand there with it and turn the kitchen lights on and off and just see how it changes. I could play for hours." (D3, p2)

> "It was primarily technical understanding over cost. It was to give me the experience in it, to aid my job role, for me was the primary interest" (T3, p5)

For those who expressed interest in gaining information, installing one of these devices was often an upgrade on a previous device. Similarly, several of those who expressed this motive regularly took meter readings, which were often already plotted and analysed in spreadsheets in order to track their usage and identify potential savings. For this group, therefore, the devices were often critiqued for the level of detailed information they provided and their accuracy. Alternatively, for those who were interested in the technology itself, the devices, particularly the Trio, were often criticised for their aesthetic appearance and for the design and layout of their displays. Several within this group called for the devices to be more customisable enabling the individual to tailor it to their home and usage patterns. Further, this group often expressed a desire for the devices to be developed so as to support further home automation, for example by using the device as a central control hub that can automatically switch appliances on and off according to preset schedules.

As mentioned above, most participants expressed several overlapping motivations for participating in the trial. As such, there is no clear-cut divide between the motivations outlined. What this section suggests, however, is that the manner in which the devices are marketed and sold – as cost cutters, as emissions savers, or as new gadgets – may have significant implications for how they are used, what effects they have, and how they should be developed in future.

3. Interactions with the Devices

3.1 Installation and Set Up

The Solo and Duet devices are designed to be self-installed, however, in the VET, as the Solo was often administered through housing associations or local authorities, Solo users were often given guidance and assistance in its installation. The Trio demands professional installation by both an electrician and an IT specialist. Whilst the installation and set-up of the devices might be seen as a relatively insignificant process, across all of the devices, interviewees regularly commented on how the installation and set-up process had shaped their perceptions of, and interaction with the devices. This first contact with the devices thus appears to be critical for the effects they are likely to have.

When the installation process was done well, participants felt they understood how the device worked, what it could provide information on and what it should be used for. Among those who considered themselves technically competent, many had been involved in the installation process, talking to the installers and even, in some instances, asking for more advanced and personalised set-ups – for example, two of the Trio users interviewed had set up the device so they could access their information remotely via their own personal computers. When the installation process was done badly, however, participants felt frustrated with the device, isolated from its workings and out of control of it. Some even suggested they almost gave up on it.

This process did appear to differ slightly across the different devices. For those Solo users who had received assistance with installation, this was often a negative experience:

> "some grumpy old installer who mutters, you know, a couple of startling bits of nuclear science to you. You know, that plugs in there, that's for that, here's the display, your card and here's your card reader, bye-bye, I'm going now, I've got to do another ten more before I finish at five." (S1, p28)

This participant went on to explain that he felt 'on his own' with the device, not knowing what to expect from it or how to get the best out of it. He commented that without his own level of computer literacy the device may well have been left unused. Whilst GEO were not responsible for the installation of the Solo devices, this does suggest that installers themselves should ideally be engaged and enthused by the devices in order to pass this on to their users. Another Solo user also felt that more assistance would be required in the installation process for elderly users at whom the device was targeted in the trial. To improve the process, as well as receiving more cheerful and forthcoming assistance, one participant suggested the need for a one-page 'idiots guide' in addition to the detailed instruction leaflet:

> "the handbook's quite good but again it wants like a separate laminated card perhaps. With an idiots guide of what you need to do to get results." (S1, p7)

Such a guide, he went on, would include details on how to set up the device, where to situate it, and also some hints and tips on how to reduce energy usage.

For Duet users, the installation process was unanimously described as difficult and complex. In particular all Duet users interviewed had experienced some problems with pairing the plugbugs with the device itself:

> "I think it's a good job that I'm reasonably technically competent because if I'm actually honest with you, Tom my concern would be that somebody who isn't wouldn't set it up properly 'cause when we first connected it for some reason the unit had all sorts of trouble finding its other units." (D2, p4)

Another, who had the same problem, found ultimately that the plugbugs had a relatively small range and therefore he was restricted as to where he could situate the device in his home. As will be highlighted later, this is a potentially vital shortcoming (see section 3.2.2). Here, the Duet users interviewed suggested the device needed a built-in feedback system, such as a click or a light coming on, to indicate when the plugbugs had successfully paired.

Some Duet users also commented that they had experienced considerable difficulty in installing the heating monitor:

> "I was tearing my hair out by the end. I'm normally pretty good at these things. Well the first difficulty was getting the boiler centre hooked up to the boiler because my boiler pipes aren't exposed….I had to drill holes in

> the side of the boiler to get the wires through and I had to take out a kitchen cupboard…I was determined to get it to work, but I was on the borderline of just saying let's forget this thing, I can't be bothered, and then the pairing process between the bugs and the thing was just awful. " (D1, p8-9)

To improve this process, one Duet user suggested having an installation guide that included real-life pictures of what the system looks like when set up correctly. In general, however, it was felt that a certain level of technical sophistication and competence was required to install the Duet device and that those who did not possess this may well have given up before they started. Whilst these problems were not the result of technical faults as all devices were eventually successfully installed, it does suggest a need to consider the clarity and level of detail of the installation instructions, and a need for further support if necessary.

For the Trio users interviewed, in contrast, the installation process was generally very positive. As noted above, several Trio interviewees had quite high levels of technical expertise and, in these cases, they often became involved in the installation process asking questions about how the device works and how they could get the best out of it:

> "I'm a nosy, inquisitive, talkative character, you know? If someone comes into my house to do work I want to know what they're doing, why they're doing it, how it's going to work? If someone wants to talk to my computer, now then! I need a lot of information. My computer is my life! So I was having very good conversations. Again understanding the computer background allowed me to converse quite happily to the IT person. Having a little bit of understanding about electrics I was able to talk to the electrical person and understanding what was going on. So I was lucky that I was able to engage in the process." (T4, p6)

As mentioned, in two cases, Trio users had personalised the system so they could access their information remotely, they both commented that this had been a very positive aspect of the trial and central to how they had used the devices.

As this section has hopefully shown, the installation and set up procedure, whilst seemingly insignificant in comparison to how the device is later used, is in fact a critical moment. It is at this point of first contact that a relationship is established between the user and the device that is likely to shape their perceptions of it, and influence how they act on the information it provides them.

3.2 What features of the devices have participants used?

3.2.1 Solo Usage

The Solo users interviewed spoke of using the device in two major ways. The first, and most common, was to use the device to reflect immediately on current levels of energy consumption and to take action on it quickly. Here, however, the Solo users interviewed did not appear to use the 'speedometer' section of the

device, which indicates current consumption, but instead preferred to make their decisions based on the 'fuel tank' display and whether or not the 'tick' or 'cross' symbol were being shown:

> "Well when we're cooking or leaving things on and you can actually push a button to show the usage and that actually show a tick on the unit that if you're in credit on the day. So we're looking at that you know, at least every day or several times a day. If you get a cross that means you've, you've used your credit up. I mean I think we're down to I think 10, I think 10 or 12 kilowatts a day." (S4, p9-10)

In this respect, the Solo interviewees did not appear too interested in the absolute amounts of electricity they were using, but in whether or not they were 'in credit' according to the budget they had initially set themselves. Several of the Solo users interviewed used financial metaphors to describe this process, such as being 'in the red or the black'. As mentioned, many of this group of participants were on low incomes, therefore such financial calculations are potentially very common. Whilst this would appear to illustrate that the devices are being effectively used, the potential stress and strain this places on low-income users as they can literally watch their money being spent, should not be underestimated (see section 5.1).

The second major way in which Solo interviewees talked of using the device was less immediate and more conscious and considered. Here, they discussed 'prioritizing', 'forward planning' and 'reviewing' their electricity usage either on a daily or weekly basis:

> "it makes me think back during the day as to what we've probably used it for, and for instance one of the things I have noticed is the tumble drier, which we have used on or two or wet days to dry quite a lot of washing and pushed it up quite a lot. I think we are becoming more aware of where the energy is being used." (S3, p6)

> "[My partner] does a check weekly to see like I said if, you know, if we've used more this week than we did the previous week or whatever or if a certain day. Then he will actually sort of say, 'well why did we use more today?', and then we'll, you know, then he'll say, 'well I know why because were out for half the day', you know, and things like that. "(S4, p8)

This form of usage involves more conscious and rational discussions about energy use patterns and how they might be changed in future, in contrast to the previous more immediate and reactive form.

What was notable across both of these forms of use, however, was that no interviewees appeared to be concerned by the current usage figures displayed on the 'speedometer' part of the Solo device. Where this was used, it was in order to understand not their absolute levels of electricity consumption, but how 'greedy' particular domestic appliances were. Here, several commented on the sudden realisation that the kettle, the tumble dryer, or an old fridge-freezer used significant amounts of energy. Many Solo users said they wished they could get

more information on specific appliances with one specifically calling for a Duet-type system.

With regards to the overall frequency of use, all of the Solo users mentioned that they had use the device more when they first got it, but crucially they all also emphasised that they continued to use it regularly:

> "I wouldn't say it hasn't been a novelty, you know, when it was first installed we used it more frequently than we do at the moment, but daily now we do actually use the device." (S1, p10)

Two reasons appear to have been central to this continued usage of the device. First, Solo interviewees praised the aesthetics of the device. In particular they mentioned that the colour display was eye-catching and encouraged immediate action:

> "This one is actually backlit with colours. So it's more striking and you feel like you got to do something about the problem that is presented for you." (S1, p11)

In addition, these aesthetics encouraged the Solo users interviewed to situate the devices in prominent locations – normally in the kitchen where many appliances are used, but occasionally in hallways or lounges, depending on where people spent most time or passed through frequently. All Solo interviewees emphasised the vital importance of situating the device appropriately so it was 'in your face':

> "rather than out of sight out of mind, it needs to be in a position where you can't miss it." (S1, p24)

> "The guy who come round, who fitted it for us, asked where we wanted it and we definitely said the kitchen, and not because there was a plug there, but simply because we use more power in the kitchen than anywhere else. So we decided that, you know, when the fridge came on you can look and see how far it would go up and then when you put the dryer on and things like that. Now it definitely needs to be near the appliances that you use the most." (S4, p26)

This was a common theme throughout all of the interviews for all devices. In order for them to be effective, they have to be used, and in order for them to be used they have to be aesthetically suitable to be situated wherever the user thinks they are most appropriate and can have the biggest impact:

> "It's a good thing to have as long as it's used. If it isn't used I mean you might as well just plug a piece of cardboard in and stand it there, cause that would do the same job really." (S4, p19)

Interestingly, given the level at which participants were able to discuss how they'd used the devices and how they should be used, when first asked most Solo interviewees commented that they hadn't used the device much at all. The following quotations are typical:

> "Interviewer (I): If you could explain how you've used the device since you got it, you know?
> Respondent (R): In a word we haven't. The only use we've made of it, as I say, is seeing the cross. Switching more lights off or more appliances off. If we see the level indicator saying thumbs up, we're doing all right. And if we get the tick well, we're doing famously well, you know, we'll give ourselves a pat on the back." (S1, p8)

> "Well we haven't really thought about it really, you know, it's no different from when we didn't have it, you know." (S2, p6)

When pushed to think more carefully about how the device was used, however, the reasons outlined above were explained. What this implies, is that usage of the devices had become almost sub-conscious and habitual. Several Duet interviewees suggested that the device worked in the 'corner of your eye' rather than taking ones full attention, and several Solo interviewees commented on developing new routines for switching lights and appliances off based on their interactions with the device. This, potentially, indicates that the devices may lead to long-term and lasting changes in behaviour. Confirming this suggestion would require further longitudinal research however.

3.2.2 Duet Usage

As mentioned above, the left-hand screen of the Duet device is exactly the same as the Solo device. As might have been expected, therefore, usage of the left-hand screen was the same as was found with the Solo device. Again, the Duet users interviewed had focused on the 'fuel tank' and tick and cross symbols in preference to the 'speedometer' showing current and daily usage. Indeed, some Duet interviewees went further to argue that the speedometer dial, indicating current and daily usage, was not particularly helpful:

> "I guess that's 21p so far today, but that number really isn't big enough. I think it needs to be a bigger number to actually, you know, worry people into…'cause you see that and it says 3p and you're like okay, that's 3p. 2p an hour, that's alright,…the monthly and the annual numbers are good for giving people a shock." (D1, p22)

The current usage figures were therefore criticised as being too low to encourage any action. At the same time, this same interviewee also commented that the monthly or annual usage forecasts, which become enormous when the kettle or tumble drier is being used, are unrealistic and therefore unhelpful. Again, as with the Solo users, what Duet interviewees appeared to find most interesting about the device was what it told them about specific appliances (see below).

Some of the Duet users interviewees had become involved in the trial for predominantly environmental reasons. As such, they were more able to comment on the effectiveness of the CO2 figures in encouraging action. Across the board, however, the CO2 figures were seen as meaningless and difficult to relate to everyday practices:

> "I guess that's kilograms of carbon but I can't relate to that. I don't know what that means. You know I could, well I do know what it means but, you know, it just looks like a number to me." (D1, p22)

At the same time, one Duet user criticised the kilowatt-hour readings as being too abstract. Here it was suggested that cost was the best and easiest to understand measure of consumption:

> "A kilowatt hour to most people is an abstract figure, isn't it, whereas pounds and pence, you know what you're spending." (D3, p5)

Even cost, however, was not without its problems as several interviewees, across all devices, commented that they had struggled to program the device to give an accurate estimate of their bill, either because their tariff involved more than one charging rate which they did not know how to program into the device, because they were unaware of what they were being charged, or because the prices change too rapidly. Several suggested that the device should have the major tariffs from the major electricity suppliers pre-programmed into it and updated remotely as a means of improving the accuracy of the readings.

The right-hand screen of the Duet gives further insights as to how users interact with the devices. Universally, the heating monitor was seen as confusing. Whilst all interviewees praised the device's attempt to offer some indication of heating, they all felt that the manner in which this was displayed (as a percentage of the amount of time the boiler had been in operation over the last quarter hour) was irrelevant:

> "The other side of it to be honest has been a bit of a waste of time because knowing the percentage time that a boiler is running doesn't, yeah, it doesn't turn into the real world again unfortunately." (D2, p6-7)

> "the heating side of it is a little bit odd and I try to wrap my head around. It's the idea of how much the heating's been on in the last, it does it every quarter of an hour or something, I can't remember, which is a bit odd. I would have thought they do it over the 24-hour period, stuff like how much your heating has been as a percentage of the day. So I find that one a bit odd to sort of, okay, what does that tell me?" (D4, p14)

To improve this part of the device, one participant suggested displaying a graph to compare indoor temperatures with cost:

> "I'd love to have an outside temperature compared to, or even an inside temperature compared with the cost. I think if there was an inside temperature to a cost graph, people might dawn on them that if they dropped the temperature one degree and saved that much, they might end up saving. Just a thought." (D2, p11)

The important aspect of such a suggestion, and this was true across all participants for all measurements (whether cost, CO2 or kWh) on all devices, was to relate the measurements to 'real life'.

In contrast to the heating indicator, the appliance bars on the right-hand screen of the Duet were generally felt to be very clear and successful and were widely used. As with the Solo device, interviewees appeared to be more interested in what the device could tell them about particular appliances than overall or absolute levels of electricity being used.

> "[My family] have a much greater understanding of appliances energy consumption now, and that's modified… that has modified their behaviour, there's no two ways about it. … I mean my son now has finally caught on why microwaves are actually quite a good idea just in terms of the speed of cooking, lower amount in terms of energy saving, they don't always produce great food but actually in terms of energy saving they're a real boon and things like that." (D2, p14-15)

> "I wanted to see what effect [my computing equipment] had on sort of overall usage and stuff like that and to pick them out as individual segments of our electricity use was quite good" (D4, p12)

The plugbugs were thus widely praised as one of the best features of the Duet device and indeed there was a demand for more plugbugs from both Duet and Trio interviewees. Participants had used a range of different strategies for situating their plugbugs. Some had put them on devices which they felt that had some discretion over and could therefore reduce their usage. For example, putting a plugbug on the kettle allowed a user to identify what difference was made by only boiling as much water as was needed. Others had used the plugbugs to monitor the appliances they felt would have the biggest load, and still others had used them on devices over which they felt they had no control such as the fridge or freezer. Here, the logic was that by using a plugbug on these devices, their usage could be subtracted from the overall usage displayed on the left-hand screen of the Duet. In general, once this logic had been arrived at, interviewees had not changed the location of the plugbugs during the trial.

The plugbugs did draw several critical comments, however. One participant noted that they were too large and therefore could not be neatly placed behind large appliances like fridges or washing machines. Another was frustrated that the plugbugs did not appear to work effectively or for a long time when using rechargeable batteries. The use of alkali batteries in these devices was then seen to partly offset the environmental gain deriving from using the device. There is, however, some apparent confusion here as to how the plugbugs operate as they are in fact mains powered. This confusion could perhaps be avoided through more engaging and inclusive installation procedures and instructions. Further still, one user called for the range of the plugbugs to be improved. Here, he had been forced to situate his device out of the way in order for it to function which, he felt, had impaired its effectiveness. Finally, one participant argued that the Duet was internally inconsistent – that the usage of the devices monitored by plugbugs did not always correspond to the overall usage levels displayed on the left-hand screen:

> "I've noticed also that the reading that it gives you kind of here doesn't always add up to the readings you get from the plugbugs. Sometimes the plugbugs say you're using 200 watts and the reading here says you're

> using 180 watts in total over the whole house so you know that must be wrong." (D1, p13-14)

Such small inaccuracies had led interviewees across all devices to lose faith and therefore potentially harm the device's overall effectiveness.

Another feature of the Duet and the plugbugs is to enable users to switch appliances off remotely. This feature, however, had been little used by those interviewed. Two mentioned that they had used it at first, but that it had then caused confusion among other household members about how to turn appliances on again:

> "Before we got the kill plugs I used it at night to turn off everything in the living room but the family couldn't work out how to turn it back on again in the morning." (D2, p12)

> "the ability to do the switching off with the plugs was quite handy, but then I found out that my daughter can't really understand that I've got to switch it on there, I've got to press that for three seconds. So it's negated, all sort of strange things" (D4, p2)

Accordingly, in both cases usage of this feature had ceased.

With regards to overall frequency of usage, the Duet performed in the same way as the Solo. All interviewees commented that they'd looked at it more when it had first arrived, but that this had now settled down into regular and repeated patterns:

> "I probably used it more when we first got it and tried to… because at the time when you first get these things you're trying to understand what differences you can make and what changes you can make and you think 'well if I switch this off does that make a difference', but then you kind of get into, you develop your habits around that. You develop habits to switch things off and keep the lights off and then you don't need to look at it so much." (D1, p13)

> "I still sort of check it and fiddle with it and see, you know, what difference things make. I mean obviously there's only a certain amount of lights and things you can turn off, aren't there, but yeah, I don't know whether it's because I've got into the habit of doing it after learning it to start with or if because seeing the thing there still keeps reminding me but yeah, I do still do it." (D3, p7)

Again, Duet interviewees suggested that the aesthetics of the device were important to its continued usage, and again they emphasised the importance of situating it appropriately in order that it is regularly seen and used:

> "We stuck it in the hall. I think the biggest mistake you could probably make is stick it somewhere where it wouldn't get seen or somewhere it is only seen by two or three members of the family. We deliberately put it in the hall and pointed it at the front door so anyone coming in immediately

says ‘what’s that?’ Everybody does and you say it’s the energy meter and then that starts a conversation, it keeps it front of the mind.” (D2, p10)

This participant went on to describe this as ‘the nag factor’. He saw it as absolutely central to the device’s effectiveness that it was well situated such that it could be regularly interacted with. As the two previous quotations suggested, by interacting with the device regularly, users had developed new habits and routines and this suggests that the devices may have lasting effects.

Whilst these aspects of the Duet were praised, some interviewees did suggest it could be further improved. The stand on which it sits was criticised as extremely basic and something that regularly falls apart when the device is moved. Given the importance placed on the aesthetics of the device this could potentially prove to be a critical weakness. Participants also emphasised that they wished the device was more portable stressing, for example, that the limited range of the plugbugs (beyond which they could no longer transmit information to the Duet unit) was seen as a limiting factor to further usage:

> “you do have to look over here purposefully to look at it, you don’t just catch it out of the corner of your eye. It would be nicer to have it somewhere more prominent in the kitchen, either by the front door or on one of the walls or something….I wish it had a longer range so that it would work anywhere in the house. I wish I could unplug it and take it around with me, ‘cause then I could take it up to bed and we could switch off all the lights and we could actually check, you know, are we okay or not? My old one was battery powered and I could carry that around and that was much more useful.” (D1, p13-14)

In summary, the Duet device was widely praised and was perhaps the most successful of all devices used in the trial. As this section has shown, however, there remain several ways in which it could be improved to encourage wider use.

3.2.3 MyEnergy Website Usage

As mentioned above, the Solo and Duet devices come equipped with an SD card that stores the users data so that it may be uploaded to the MyEnergy website. Once uploaded, the data can then be displayed graphically in a range of forms enabling the user to see, for instance, the monthly usage patterns of different appliances. The MyEnergy website unfortunately only became available for use when the interviews for this report were being conducted and, as such, it had not been used by most Solo and Duet users interviewed. Among the few who had used it, however, it provoked quite different opinions.

First and foremost, among those who had used it, it was felt that uploading ones data was a relatively easy and pain-free process as long as the user possessed a basic level of computer literacy:

> “if you can work a computer there's no problem [re: uploading data from the SD card]. There are people who have got computers, just the simplest of things, they’d have to think about it because you’ve got to download a

> programme, you know, a loader but once that's done I mean just pop your card in the card reader, which is supplied, and pop it in and download it and that's done." (S4, p15-16)

Here, some interviewees had mentioned that the website had asked them for a username, password or serial number which in many cases they did not possess. To reiterate a point made earlier, these moments of first contact between users and the devices (and their associated websites) are potentially critical if such features are to be widely used.

Once data had been uploaded however, interviewees differed in what they thought the website offered them. One mentioned that his whole family had had an 'analysis talk' based around the graphs the website offered:

> "We've been able to look at it, and now of course you look at it and you go 'guys, look at this, just have a look at this a second because that's week 1, that's week 2 and that's week 3, look at that there someone's left the oven on and we can drill into that day and I could tell you that somebody's turned the oven on to cook something and then gone off and played Football Manager for two hours. So we've been two burning 2.2 kilowatts for two hours there'." (D2, p9)

As is indicated by this quotation, this process had helped the whole family to review their electricity usage over a particular time period and to identify areas where electricity was being wasted and could potentially be saved. By contrast, other users felt that the website offered little that they did not already know:

> "I had a brief look at the graphs that it produced and I wasn't particularly impressed at the amount of information there. I didn't find out anything new for example by looking at the graphs and I would have liked to have found out something…for example it could have told me on average how many kilowatts does my freezer use everyday? How many has it used so far in the year? And I didn't find that kind of information. All I found was a graph with, you know, up and down, kind of as it cycles, you know. I looked at the hourly graph and it was just like a saw tooth and I thought 'well yeah, the fridge switches on and off. Big deal. I already knew that'." (D1, p14-15)

Several interviewees expressed a similar view here, as did Trio interviewees (see section 3.2.4). What they called for in addition to what the website already offered, was improved annotation of the graphs so it was very clear what was being displayed, the ability to drill down into each of the graphs in order investigate particular appliances over particular time periods, and most crucially, several called for the ability to export their data into Excel or other spreadsheet formats in order that they could manipulate and analyse it themselves. This final suggestion was particularly voiced by those who had been motivated to participate in the trial out of a desire to get more information. Many already kept spreadsheets containing a log of their meter readings and as such the website would have to be quite advanced to have significant added value.

The information available through the website thus divided opinion. Where all website users were agreed, however, was that the design and layout of the website in general should be improved:

> "It's [the website] just like somebody has had a spare five minutes in their break and they've knocked this thing together called a dashboard." (S1, p31)

3.2.4 Trio Usage

The Trio, at least in its trial form as a small PC computer rather than the device displayed in Figure 3, is a very different device from the Solo and the Duet and, as such, displayed some different patterns of use. Notably, one interviewee suggested that the level of detailed information offered by the Trio demanded some 'down time' in order to be fully comprehended. This suggests that, unlike the Solo and Duet, the Trio demands more active and conscious involvement and in its current form is perhaps not so effective for 'corner of the eye', unconscious engagement.

As with the Solo and Duet, all Trio users interviewed commented that they had used the device a lot at first. This despite the fact that several had been explicitly told by the installer to leave the device for a week or two to allow it to build up some data and start displaying information. Again, like the Solo and Duet, Trio interviewees were most interested in what the device told them about specific appliances rather than the information it offered on overall levels of use:

> "I've been interested in how it monitors the appliances, that's what I've found most interesting and in fact one thing I would say is that you need more plugbugs with it. It comes with six but really I think it should be 10 or even more, you should be able to monitor everything all the time." (T1, p2)

Here, again, the information on CO2 emissions was dismissed as meaningless:

> "I: Is the CO2 something you've used or not really?
> R: Absolutely meaningless to me. What am I meant to do with that information?... If someone turned around and said, you know, ten units of CO2 means you've got to plant a tree, great, tell me that and I can do something about it, but what does this mean?... You just need to be able to have a relationship as to what everything actually means. If you can convert what CO2 actually means to somebody…if there's a link to say, you know, this is for somebody who is very environmentally friendly, you know, 'you have used X amount of CO2, would you like to pay so much to offset your CO2 usage', then that might well help … some people may feel good about that sort of thing." (T4, p11)

Instead, users preferred to use cost estimates even though, again, they recognised that the cost figures were not entirely accurate because they had either not entered their tariff, or because they tariff had two rates and were unaware of how to program this into the device.

With regards to how the Trio was used, again there were two basic types of use: i) an immediate reaction to the data being displayed, or ii) more considered 'review' and 'planning' process based on the information provided. In both cases though, the Trio fared less well than either the Solo or the Duet among this group of interviewees. With regards to immediate usage, one user termed this 'using it hot', which referred to seeing how much electricity was being used at that moment in time and then immediately going round to turn off lights and appliances in order to reduce consumption levels. Another user, however, argued that the 'real time' feedback of the Trio device was too slow, and thus failed to provide the immediate prompt to take action:

> "if it's the actual real time consumption, as and then, then you would expect it to do that and that's the fun thing because if you go into the front room we've got 200, 400-watt lamps on the ceiling, ceiling lamps, so as soon as you turn them on you'd expect it to really ramp up, but you don't see any of that." (T2, p6)

In this respect, as well as in some others (see below), the Trio was seen to lack the 'nag factor'.

The second major way in which the Trio was used by interviewees, was to support or 'justify' particular decisions, for example, to replace old appliances. Here, however, the Trio fared less well than the Solo or Duet on two grounds. First, those who were motivated to take part in the trial and had signed up for the Trio because they wished for more information on their usage, found that they still had insufficient information on particular appliances. In particular, they expressed frustration that information on the absolute levels of consumption of new appliances was not easily available, that information on the embedded carbon in new appliances was not available, or that they were still unable to compare their own consumption with other households in their area and thus did not know if they were performing well or badly. Whilst these issues are not necessarily shortcomings of the Trio device, they were expectations of the Trio users which the device did not apparently fulfil. The second way in which the Trio fared less well was because its levels of usage dropped off significantly over time. Several reasons were offered for this and these will be outlined in the following paragraphs.

Where the Solo and Duet devices had been used heavily at first but this had later fallen to less frequent, but still regular usage, for all Trio users interviewed, usage had been heavy at first but had then significantly tailed off and had not been sustained at a regular level. The primary reason for this appeared to be aesthetic. As mentioned, rather than the touch-screen 'digital picture frame' type display shown in figure 3, Trio triallists were given a small netbook PC computer. All interviewees commented that they were dissatisfied with its appearance:

> "the very fact that it's the PC and not the [originally advertised device] makes a big difference in my opinion in terms of the usage because that gets stuck on a shelf and it's not as usable whereas if it was pinned to the wall in my kitchen or somewhere it's more visible." (T3, p7)

> "I was pretty, you know, unimpressed because it's PC-based, but, you know, I kind of expected it to some degree, you know, maybe 10% expected it, 90% I was hoping it was going to be the full system." (T2, p5)

Several interviewees described the PC display as ugly and, as the following quotation indicates, over time this led to the device being hidden away and going unused:

> "It was on top of the TV for the first two to three months I guess, maybe a little bit longer, then [my wife] decided we'd have a reorganise so then it gets put down onto a lower shelf at the front, then it's opened up and then she's slowly…closed the lid, she does that a couple of times. Then she puts it at the back and you don't see anything and all of a sudden it's out of the way. But if it was a standalone device which you could quite easily put on top of the TV or even onto the wall, then that would make things a lot better." (T2, p6)

Two Trio interviewees did mention that they had continued to use the device regularly, but in both of these cases a high level of technical competence had allowed them to configure the device so that they could access their information on their own computers either at work or at home. In these cases, the aesthetics of the netbook PC became irrelevant. To improve on this situation, several Trio interviewees suggested making information more easily available on home computers or on internet enabled televisions. Another suggested having a series of 'slave' devices, much like the Solo or Duet, which could be situated around the home so as to increase the 'nag factor'.

The second reason that the Trio device did not maintain levels of use was down to its reliability. Two Trio interviewees commented that when they had changed their home broadband set up, the Trio device had stopped recording data for a period. In one case, in order to start the device again it had had to be removed from the kitchen and placed in an upstairs study in order that it could be closer to the broadband router. These glitches had led to a loss of interest in the device, a loss of faith in its reliability, and ultimately to a reduction in its use:

> "The unreliability has made me lose interest in it somewhat, you know, if it's not working you just don't look at it as much, so you lose interest. I do think, if I had one piece of advice on these things, is that it really needs to be accessible. I mean my house has funny wiring and my router is upstairs so I now have to have the device upstairs, but it does mean I don't use it as often. I mean the little notebook is really interesting and quite easy to use, but it's a shame it's now somewhere where I don't see it all the time." (T1, p1-2)

To improve this situation several Trio interviewees called for occasional email reminders telling them to check on the device. One suggested these would be very helpful if they were able to detect when usage had significant and unusually risen as they would help in identifying waste more quickly. Another user called for the devices to be made more interactive:

> "It could be more interactive. One thing, which would be nice, is if the system had a motion eye, a motion detector, okay. It's just a simple thing. Basically if you walk into your room, or you walk into a room, it will give you the update for the day." (T2, p8)

Such suggestions would not be universally well received, but might improve the nag factor of the Trio device for some.

When asked which graphs and information they had found most interesting and useful, all Trio interviewees described the graphical displays as confusing. The following quotation details a user trying to explain the data the Trio offers and was typical of the Trio interviewees experiences:

> "Okay. So what we have appliances, we have the second page here as well, so you have two pages basically…which is items for kettle one, kitchen TV, toaster, etcetera. You can see here it's 0.11. That is, see that doesn't make much sense. It might be... yes. It might actually be. It must be, yes 0.03, 0.011, that must be 0.011 kilowatts per hour per day. That's today and if I went back yesterday…let's just say this week, that would be better. Here we go. Now that's given me 0.02 kilowatt per hour, but that's red for some reason when it's actually virtually zero anyway so as you can see…that basically just gets you, makes you more disinterested quite quickly." (T2, p12)

All Trio interviewees described the graphs as confusing, suggesting they were poorly annotated meaning it was hard to understand exactly what they were showing. Further, several argued that the information the graphs provided was irrelevant or unimportant:

> "It provides me my weekly information but there's a limit as to how much you can get from a graph on a screen and the biggest problem that I have with that, and compared to what I do, you know how I said I record my meter readings every single week? Well I've got that into a graph on Excel so when I look at my electricity usage for October this year I can compare to last year. I can't do that on the Trio. It's all very well being able to…you can look at last month but you can't compare this month to last month so easily and last month I may not want to compare to because if you start looking, trying to compare the summer months to the autumn months they're just meaningless. … So while I can get some information now, if you asked me how many times I've boiled the kettle today I can tell you. Is it better than yesterday? I can tell you. But how does that compare to last month, you know, it's a lot harder to get that information out." (T4, p7-8)

Trio interviewees regularly commented that they wanted to be able to 'drill down' into the graphs to get more and more detailed information on specific appliances. Here, the ability to manipulate the data oneself was also seen as important as, again, a triallist called for the data to be exportable in Excel or other spreadsheet formats.

In addition, whilst complaining that the information offered was insufficiently detailed, several interviewees also argued that the page design was cluttered and confusing:

> "there's too many tabs, too much information" (T4, p12)

Here, there was a desire to be able to customise the pages on the Trio so that they can display the information you want quickly and easily. For one Trio user, for example this meant displaying all of her appliances on the same page, rather than spread over two or three pages. In general, and as with the MyEnergy website, Trio interviewees felt that page design needed improving:

> "I think the graphics could do with being, I don't know, a bit more, not necessarily descriptive. The bit that, let's just say they're very standard graphics." (T2, p7)

3.2.5 Who uses the devices?

The previous sub-sections have focused on which features of the devices were used and how. In this sub-section, the attention will turn to who uses the devices within the participating households.

Although it did vary throughout the interviews, it became rapidly clear that all of the devices were heavily gendered in favour of men:

> "R: I must admit it's mainly blokes [who've shown an interest in it].
> I: Why do you think that is?
> R: Oh, we just like flashing lights and fiddling with knobs and things, don't we?" (D3, p5)

As mentioned earlier, the devices were designed around a car dashboard, which suggests their gendered nature may be partly intentional. What was emphasised regularly and across all devices, however, was the perception that the devices were neither liked nor understood by participants' wives:

> "My wife doesn't like it as much as just the old thing, which had a single big number on it, because there are too many things on here for her to look at. She doesn't understand it really. She understands a tick and a cross so that's okay" (D1, p12)

> "What we did is we got the Duet, we booked on the trial, we didn't go for the all the singing and dancing one 'cause I thought it'd terrify my wife." (D2, p3)

> "My wife's not particularly interested in it." (D4, p9)

Indeed, several participants went on to emphasise that this had led to some arguments:

> "R: It's hard with this family because the wife is just not interested at all. Her reasons for this is 'just another gadget'. That's what she sees it as and

> also for me to check what she's doing with the kettle because literally the first week I was just switching the kettle off on the computer, you know.
> I: So you can switch things off?
> R: You can remotely switch off and I had a lot of fun to start off with. It almost caused her to move out but, you know. She threatened me…some nasty language basically [LAUGHTER]." (T2, p11)

Another participant suggested it would be a very bad idea for his Father to get hold of a Trio device:

> "I've shown it to my dad who would like it, who would be monitoring it 24/7, which is why my mum doesn't like it…. if he had that information my mum wouldn't, she wouldn't dare put the television on and watch it, you know, 'it costs 2p to watch that TV programme'." (T4, p11-12)

Whilst only half serious, both of these quotations illustrate that the devices enter into already complex sets of domestic interactions, negotiations and practices and that they may not necessarily be welcomed by all household members.

In general across the interviews, one household member had been in charge of the device and shown the main interest in it. Several did mention, however, that different household members were interested in the devices for quite different reasons. For example:

> "I: Who has used it? It sounds actually like everyone has used the device?
> R: Everyone but my eldest son who really couldn't care but he's a guitarist. I mean he really is, and he's a 21 year old. To be fair my wife and daughter are the most conscientious. My daughter for the school reasons, that she's still at secondary school and she is the most environmental. My wife for cost reasons, me for both, and my two sons, who are 19 and 21, I think it just nags them to turn the lights out. Particularly my older, to be fair to my eldest son he does keep saying, 'who keeps leaving the light on?' That's a big thing with him. So it's just pester factor of those." (D2, p8-9)

Several interviewees mentioned that the device was good for young children as the colours and the dials, and particularly the tick and the cross symbols were easy to understand as opposed to numbers. For school children, 2 interviewees mentioned that the devices had been valuable for school projects, and argued that they had used 'pester power' to encourage the whole household to save energy. As the quotation above illustrates, older children were generally seen as harder to engage, although in this instance the cost of energy, and any energy savings realised, were being factored into the older children's housekeeping payments and this, it appeared, had been critical to getting them involved with the device.

Whilst such family involvement did occur and some families held regular and cooperative discussions about how best to save electricity, more often the devices were used by a single household member and had led to complex negotiations or even arguments. As will be shown in section 5.3 (below), given the strength of resistance and arguments against such devices, having only one

household member championing their cause may, in some cases, be insufficient to bring about significant and lasting changes.

4. What effects have the devices had?

4.1 On awareness?

GEO's tagline is 'making energy visible'. As has been shown in the preceding sections all three of the devices succeeded in doing this among interviewees to differing degrees.

Several interviewees emphasised their relative lack of awareness of their energy usage prior to participating in the trial. Here, electricity bills were described as incomprehensible and obscuring the actual amounts of electricity used. At the same time, direct debit payments were highlighted as further pushing energy usage 'out of sight and out of mind', or 'to the back of the drawer'. Further still, several participants simply argued that they'd never previously thought to question their energy usage, as it was something that they needed and thus they simply used and paid whatever they needed or wanted:

> "we don't avoid it, but we don't try and work it out, because it's also the most complicated bill in the entire world. It's obviously designed to be incomprehensible to a mortal man." (C1, p17)

> "we've never sort of queried our electricity bill or nothing because we always thought, you know, 'okay'." (S2, p7)

Across the board, therefore, interviewees praised the devices as vital in helping to make electricity use more tangible and more real. Here, across all devices, interviewees described this process as one of 'focusing the mind' or of making energy 'uppermost in your mind'. Interviewees regularly asserted that they were already aware of energy use, but that the device had somehow made this more important.

> "I suppose the device hasn't changed our awareness in that respect because we've always been aware of it; it just…it's a visual clue that if you haven't done something…it's just focusing I think, focusing the mind and showing it in a…in something that you can instantly see the benefit of doing." (D4, p22)

What appeared to be occurring, therefore, was not the brand new development of awareness of energy, but rather a focusing of existing attention on how energy is implicated in normally inconspicuous lifestyle practices. One participant described the devices as 'a good learner' for they had helped him to identify which practices and which appliances were energy intensive and therefore enabled him to plan around this. Arguably this is not so much a matter of 'making energy visible' as of 'making energy relevant to everyday lifestyles'.

Following this line of argument, it is easy to understand why interviewees described the CO2 or kWh measurements as meaningless, abstract and irrelevant, because they were unable to connect them to other aspects of their lifestyles. Further still, several interviewees called for still more information to help them contextualise particular activities and practices. Most commonly, participants called for more information on the consumption levels and patterns of other similar households in their area or region. Here, whilst they felt they had developed an adequate understanding of their own consumption, they had no means by which to evaluate or to judge such absolute figures. Others called for more information to help compare the energy consumption and emissions of their domestic electricity usage with other aspects of their lifestyle, such as using cars or planes.

These observations provide some insight into how the information the devices provide is helping to increase participant's awareness of their electricity use. Beyond this individual 'focusing of the mind', however, several interviewees mentioned that they had spoken about the device with friends, family members or colleagues. In this respect, the devices would appear to make energy visible and conscious beyond the individual user or household. At the same time, however, the reactions of such acquaintances are revealing.

Relatively few interviewees suggested that telling people about the device had led to significant interest. One Duet user mentioned that he had encouraged a friend to get a similar device, and a Solo user recounted a friend showing significant interest in the device but without getting one themselves. More commonly, interviewees suggested that their acquaintances were not particularly interested. A Trio user, for example, explained how when she first got the device she told everyone she knew about it:

> "When I first got it I was a bit obsessed with it, it was a new gadget and I'd constantly be telling people about it and every visitor to the house, friends and family and I'd be telling them all the things it could do and then there eyes would glaze over, so I was probably a bit of a bore." (T1, p2)

Others told similar stories although many emphasised that they were careful not to 'preach' to others about the virtues of saving either money or energy.

A second common reaction of acquaintances was to argue that possessing such a device was 'typical' of the user:

> "[My friends] response was 'that's typical of you, you have to monitor and look at everything' because, you know, I'm an analyst, that is me." (T4, p12)

In this particular quotation it was 'typical' of the user to want to monitor and gather information. In another instance it was 'typical' of the user to want a new gadget. In these instances, however, acquaintances appeared to be dismissing the device as something only 'early adopters' would enjoy, and therefore something that would not necessarily work for everyone.

The result of such reactions, for at least some of the users themselves, appeared to be a sense of resignation. Here, several emphasised the pointlessness of trying to engage others in saving money or energy, often suggesting this was a generational issue and that little could be done to reduce the energy intensity of 'modern ways of life'.

This sub-section has focused on how the devices have impacted upon the interviewees' awareness of electricity. It has indicated that the devices have a significant effect in making energy visible and relevant in the context of specific lifestyle practices. Further, it has shown that the devices can make energy a talking point beyond individual users and households. Here, however, reactions to the devices would appear to indicate that such devices might not work for everyone. As will be illustrated in section 5 (below), given the limitations and frustrations that even these 'early adopters' experienced, this observation might be very significant for the wider roll out and effectiveness of such devices.

4.2 On levels of consumption?

Despite the different usage patterns of the devices, as outlined in section 3 above, across all devices the manner in which the devices influenced interviewees' levels of electricity consumption appeared to have been similar. Here, if anything, the Trio performed worst simply because it was used least. Rather than distinguishing between the different devices, this section will therefore focus on the six different kinds of behavioural change that the devices appeared to inspire. These will be addressed in turn, and are as follows: i) using it hot, ii) identifying waste, iii) improving efficiency, iv) developing new lifestyle patterns, v) making future plans, and vi) spillover.

4.2.1 Using it hot: Immediate action to reduce consumption

One of the most common means by which the devices had effects on behaviour was described by one participant as 'using it hot'. This refers to taking immediate action to reduce current levels of consumption after having noticed excessive usage levels on the display:

> "It's in clear display just under eye level. So when it's illuminated during the day and, you know, the evening, we can see straight away what we're doing, you know, if we're doing something right. If we're not we'll do something about it straight away, we'll knock a few lights off or say switch the electric fire off because we got one of these flicker effect things so we'll switch that off." (S1, p9)

> "I think because you can actually physically see turning the light on or turning the light off or turning the socket on actually makes a difference to your consumption. If you turn it on you can see the dial go up so you actually see that you're using something and it makes you more aware. I mean I do go around turning lights off and things like that now whereas I didn't before and I think it is the difference between you actually seeing

> something and not seeing something, if that makes sense? Once you actually realise there's a direct relationship between turning that light on and off and that dial on the machine going round and when you sort of do the joining up yeah." (D3, p6)

This form of use tended to generate relatively small behavioural changes such as turning lights off or turning devices off standby. What was critical to such behavioural effects however was the 'nag factor' of the device, or its success in pushing information onto the user. For such changes to occur, participants suggested that the device had to be well sited and readily visible, usually just at or below the eye-line, in order that it could be almost sub-consciously noticed in the 'corner of the eye' and thus provoke immediate action. In this respect, among those interviewed, the Solo and Duet devices performed well, whereas the Trio device either because it was not prominently situated, or because it was not sufficiently 'real time', performed less well.

4.2.2 Identifying waste

A second, again very common, way in which the devices had been used was to identify areas in which electricity was being wasted and thus could be reduced. Here, as the following quotation shows, interviewees had used the devices to help them identify what their baseline energy use was. Once they'd done this they then attempted to reduce it by cutting out unnecessary consumption:

> "It is a bit of an eye opener just to see what, you know, the electricity that you use when you're doing nothing if you know what I mean?" (D3, p2)

Several approaches were used to reduce such unnecessary consumption. Perhaps the most common was to recognise that certain appliances were old and/or inefficient. This was particularly the case with fridges and freezers kept in outhouses, with incandescent light bulbs, with kettles or with electric heaters. For example:

> "We've done away with the £40 all singing and dancing kettle and it's been replaced with a two kilowatts instead of a three kilowatt one because as we're boiling less water is boils it just as quick. I'd say it's quite funny. We really have modified our behaviour in funny strange ways." (D2, p7)

Another common means by which the devices encouraged reductions in wasteful consumption was by encouraging participants to cut out standby usage. Here, several interviewees had purchased 'kill plugs' to make it easier for them to switch devices off at the plugpoint.

A third way that wasteful consumption was reduced was through behavioural measures such as only filling kettles with the necessary amount of water, or by only washing full loads.

Finally, the fourth way in which the devices helped to reduce wasteful consumption was by enabling the user to identify 'unnatural' levels of use and to 'investigate' how it might be reduced:

> "Sometimes you see things that are unnatural, that was different to yesterday, so I'll go round and investigate and stuff like that." (D4, p18)

This suggests, and several interviewees appeared to agree, that the devices help their users become familiar with the normal and hence 'natural' patterns of consumption in their household.

4.2.3 Improving efficiency

The third, and related, means by which the devices affected consumption levels was by encouraging users to invest in new, more efficient technologies. Several interviewees commented that the devices had made them realise what current appliances used and had therefore helped them to think through and rationally to justify their replacement with new, more efficient appliances. This was especially common with regard to replacing light bulbs, but several interviewees had replaced larger appliances such as fridges, freezers, kettles and TVs. For example:

> "I know that my fridge freezer is a reasonably efficient one, it's an A-rated one and it's quite new so that's fine, but I have used it to look at the sort of, work out in my head what the typical daily consumption is and how much it's costing me and it's not a million miles away from saying, 'well, actually that's costing me £100 more a year in energy than it should do. So it would pay for itself to buy a new one within two years'. That's more the economist in me, but working out the payback I thought great. It's quite easy to justify buying new appliances when you've got a 20 year old fridge." (T3, p10)

> "I can't see that I've changed my general behaviour but I can find examples of where this has helped me make a decision." (T4, p18)

This kind of conscious and rational decision-making did appear to be especially prevalent among Trio users, and particularly those who were motivated to take part in the trial because they wanted more information on their consumption patterns.

At the same time as this led to increased efficiency in energy consumption, for several interviewees it also appeared to lead to some considerable frustration that more information on the energy consumption of new appliances was not readily available. This is discussed in more detail in section 5.4.

4.2.4 Developing new lifestyle patterns

The fourth and probably least common means by which the devices changed consumption patterns among the interviewees, was by encouraging them to

develop new routines or lifestyle patterns. In most cases, and as will be discussed further in section 5.2 below, interviewees explicitly stated that they did not wish to compromise their lifestyle and that doing so would be using the device excessively. Some users, however, had been prompted by the devices to modify their lifestyles slightly in order to reduce their domestic electricity usage.

In one such instance, a Solo user explained how the device had changed his household's kitchen routine, explaining how his household worked together to avoid exceeding their self-selected daily budget by postponing some energy consuming activities (e.g. cooking) in favour of those which use less energy, such as making sandwiches:

> "I'll tell you what [uses wife's name] we'll do the washing tomorrow, you know, we'll just have sandwiches tomorrow. So in that respect we're thinking ahead if you like" (S1, p20)

He later described this as doing more 'forward planning'. By revealing the energy intensity of various household practices, in this instance the device appeared to enable individuals to plan their routines more carefully to reduce energy consumption. The same interviewee went on to suggest this made him feel more 'in control' of his electricity consumption.

In another instance, a Trio user argued that the device had cut his domestic electricity consumption by encouraging him to refrain from certain practices:

> "I am so aware of how much I'm using that I think to myself well do I need to? Do I need to put my light on right now? Can I still sit here in the dark and work by candlelight? Do I need to watch *Eastenders* tonight, you know? Sometimes it gives me the motivation to get on with other things as opposed to just sit down and maybe relax. I've spent more time working or studying than what I would have done purely because I think sod it, I can't be bothered to put the TV on, it's going to cost me a few quid so why bother?" (T4, p20)

This user went on, however, to argue that whilst his domestic consumption may have fallen, this may not have led to energy or financial savings overall as these were now simply being performed elsewhere, for example in the local pub or at friends houses. As mentioned, however, this kind of behavioural change was rare and would have been dismissed as excessive by most users interviewed.

4.2.5 Making Future Plans

Although not technically altering current patterns of electricity consumption, one of the most common means by which the devices had affected their users was in encouraging them to make future plans to cut either their energy consumption or their carbon emissions by investing in new and more efficient technology.

Almost all users interviewed commented that the device had encouraged them to seek only the very highest energy efficiency rated appliances when their existing appliances failed:

> "We never buy anything now unless that's rated as high as it can possibly be. I mean you can't, I don't think you can get an A rated dryer but you can get a B one, you know, well the previous one we had was C. So we wouldn't go and buy another C one, we'd always… and like the fridge freezer we had was quite low but the new one I got, the fridge is A rated. So yes we are, we are, having that meter has made us to do that." (S4, p25)

For most interviewees the devices had brought about the realisation that at least some existing appliances were inefficient and therefore should be replaced. In some cases, as mentioned above, appliances had been explicitly disposed of or replaced, in these cases however, users had simply resolved to improve their efficiency in future.

Another very common example of how the devices had encouraged users to make future plans to change their domestic energy consumption was by encouraging them to look into various forms of microgeneration technology, and particularly solar thermal or solar PV. Several interviewees mentioned that they would like to install such technologies or even that they had looked into it quite seriously. In all of these cases, though, interviewees went on to argue either that such technologies were prohibitively expensive or that there was insufficient support available. As will be discussed further in the section 5.5, this feeling of a lack of support from the surrounding socio-political context was a critical limitation to the effectiveness of the devices.

4.2.6 Spillover

The last way in which the devices effected changes to the interviewees' energy consumption patterns was through 'spillover' to other lifestyle areas. This was relatively uncommon and appeared to occur with only two distinct groups of interviewees. First, among those with a strong environmental motivation for participating in the trial, and second, among those who felt their close friends and family might also be able to save money by reducing their electricity use.

For the first of these groups, cutting their domestic electricity consumption was actually considered to be a fairly minor activity in the context of the many other actions they were taking to reduce their personal carbon emissions:

> "I'm convinced that, you know, CO2 is a problem and so I have believed that for the last 4 or 5 years I suppose. We do…I mean we've got two cars but they're both small ones and we use the park and ride and the bus pass so as we don't use our cars all the time. We do try and save energy. I mean when you look at it actually objectively it's probably fairly minimal. What we really should be doing is never using our cars at all…. We are also quite good on waste recycling and compost heaps and grow our own vegetables, we do that kind of thing." (S3, p3)

In these cases interviewees called for the devices to give a better indication of how cutting their electricity consumption compared to the actions they were taking to reduce their emissions in other lifestyle areas:

> "One thing these devices haven't told us is how to put our energy usage in the context of other things that we do like driving, flying, using water, using gas." (D1, p17)

Here, several interviewees discussed online carbon footprint tools and carbon offsetting features wondering if these might be built into the devices or to the website. Another suggested that the website might also provide comparisons of different electricity tariffs, including green tariffs.

The second group amongst whom spillover appeared to be occurring, was those for whom saving money was the primary motivation and who thought that close friends or family might also benefit from cutting their consumption. In these cases the interviewees had explicitly told their close friends and family about the device and encouraged them to cut out wasteful consumption. It was emphasised here that such activities occurred only with family members and close friends. Although some had discussed the devices with colleagues, none mentioned that they'd tried to convince colleagues to change their behaviour. Here, even among close friends and family, there was a feeling that such appeals fell on deaf ears:

> "I would say to him about, you know, 'you don't need them lights on, you gotta pay a bill, blah, blah, blah'. But I think that's quite difficult to tell other people what to do." (S4, p26)

It was also regularly mentioned that such appeals, although attempted, were ineffective with 'the younger generation':

> "I don't want to sound rude about it, but younger generation isn't it… they want everything and they want everything now sort of thing. Perhaps when they get a bit older they'll start thinking about well saving for a rainy day sort of thing. Does that sound like I'm a bit of dinosaur or something?" (S1, p26)

Here, several older interviewees suggested that whilst they found the devices useful, they were potentially more important for more profligate energy users, particularly the young and the well off. Although it was not the case amongst this small sample, there is a potential danger here that some device users, particularly low income or elderly users, will become frustrated at attempting to 'do their bit' whilst more wasteful others are not being targeted in the same way.

4.2.7 Summary

Where section 2 focused on which features of the devices had been used and how, this section has focused on how the devices have had effects on their users awareness and on their energy consumption. Very few interviewees were able to state exactly how much electricity they had saved or whether or not their bills had fallen, but most felt that the devices had helped them to save. Further, and as this section has shown, several of the behavioural effects that the devices had, in particular helping to develop new habits and routines, reducing waste and buying new more efficiency appliances, suggest that the devices will have quite

significant and lasting effects. Further research is required both to judge the size of the changes being made and to confirm whether or not they are durable.

5. Limitations

Whilst the last two section have focused on how the devices have been used and what effects they have apparently had on interviewees awareness and consumption patterns, this section focuses on a theme that was given equal weight by most interviewees: the limitations they experienced which prevented them from using the devices still further. Limitations were experienced by all interviewees and were common regardless of the device being used. Specifically, this section will highlight five distinct kinds of limitation: i) certain appliances are necessities; ii) lifestyles should not be compromised; iii) family negotiations; iv) lack of further information; and v) unsupportive policy context. These will be addressed in turn.

5.1 Certain appliances are necessities

One of the most common limitations to further action that interviewees mentioned was, quite simply, that they could not do without using certain appliances or electricity to a certain level:

> "Well I suppose really we could cut down quite a bit, you know, cut down the computers. That's the main thing when you have the computer on, and the kettle and that on, but then you gotta have a kettle to make a cup of tea." (S2, p7)

> "I've got no choice there, I can't…I can't sit in front of a piece of paper and write something. I've got to use the computer day-in and day-out." (D4, p4)

> "I am struggling with thinking what could we actually do to improve things because of the big power consumption things that we need to use. It's almost, it's difficult, I got to a point where I don't know what more I can do. I got this lovely toy that shows me how good or bad my day is, but actually getting that down to changing it has now become a sort of what can I do?" (D4, p16)

In three cases, participants also mentioned that household members experienced medical conditions, which meant they had to use particular appliances or heat the home to certain levels.

In these instances, participants had used the device to identify their baseline energy usage, had then attempted to reduce this through behavioural or technological measures, but had then reached a point after which they felt they could do no more. It was at this point also, that the devices often began to cause their users some frustration or worry that they couldn't go further. One participant from the control group, for example, explained how his wife, despite hating the cold, began to feel guilty for using energy:

> "She could literally kind of feel the money seeping out every time she had the boiler on and to be honest beating herself up over, you know, 'I can't have it on because I'm wasting money but I'm cold' and so…that's why we did positive things about double glazing." (C3, p4)

Although there was no visible display indicating how much energy was being used by the boiler in this case, it does provide a clear example of how such devices may create stress in certain situations. To 'literally…feel the money seeping out' may lead to positive changes in some cases, but in others, particularly among low-income groups for example, it may have significant negative effects.

5.2 Lifestyles should not be compromised

The second major limitation interviewees mentioned is related to the first but here, instead of feeling certain appliances or activities to be a necessity, they are perceived to be desirable and reasonable expectations. Several interviewees mentioned that whilst they had used the devices to help them make certain behavioural changes or to buy new technologies there was only so much they felt they should be expected to do, after which point it would be excessive:

> "I used to like using the bread maker, I used to love to making bread, but when you work it out it's quite costly. You know, I haven't actually used it since we had the meter but I'm sure that it actually costs you a lot more money than buying a loaf of bread. But if you look that way on everything I mean you wouldn't do anything. So, you know, you've gotta give and take on certain things I think." (S4, p9)

A similar sentiment was expressed by several interviewees and was encapsulated in the phrase 'life is for living':

> "As much as we'd like to save the planet, actually I wanna be a bit comfortable as well." (D4, p22)

> "there are some things you just can't change. So, as I say, I have my fish tank and the fish need a pump, and I cook so I can't really change that. I mean I think that life is for living and I don't want to become obsessive about it or like Scrooge or anything, I want to enjoy living and working in my house." (T1, p3)

Here, users particularly emphasised the importance of a comfortable, warm and well-lit home as the main thing they refused to compromise on. Exactly what such a home comprised differed significantly between participants. Various different appliances were seen as non-negotiable including computers, televisions, fish tanks and, in one case, a set of Venetian lamps.

The other way in which users felt they could not compromise on certain aspects of their lifestyle was with respect to the particular temporal rhythms of the household. Here, interviewees mentioned that their energy use was based on the times they left for work, or their children went to school and felt that there was

nothing they could do, and that it was unreasonable to expect them, to change these 'natural' cycles.

> "Yeah I mean you see the peaks and troughs but it's difficult. The house is busier in the morning. Invariably if it's a school day, work day. I'm here during the day and it's just, yeah plateaus out because there is nothing odd coming on and off. But then again straight away the house is full in the evening we are up again. Natural cycle - I don't see how we could flatten it out enough to…yeah, it's a difficult one." (D4, p17)

> "For me, I go home and I've got a few things like cooking that I need to do, like watching the football and I'm gonna do that regardless." (T3, p15)

Such observations certainly challenge some hopes that smarter meters may encourage load shifting, or the use of energy at different times of day or night in order to flatten out peaks in demand. At the same time, however, some interviewees did suggest that if incentives were on offer, such as time-specific tariffs, devices like those used in this trial may well encourage more 'rational' patterns of consumption.

In both of these cases – refusing to compromise on certain appliances or feeling limited by 'natural' household patterns – interviewees began to express some frustration towards the devices themselves. Here, the devices began to make them feel guilty or disappointed that whilst they were trying to save electricity or emissions they could not go further.

> "I think it's really important to get the balance right between the sort of big brother and monitoring things and also just allowing people to enjoy their lives and their homes… you see all this stuff in the media that makes you feel guilty about things, but I think life is for living." (T1, p4)

As this interviewee observes, it is important that a balance is struck with these devices to ensure that they encourage energy saving but do not cause negative psychological effects by giving people a constant, nagging and visible reminder either that money is being spent or emissions produced.

5.3 Family Negotiations

As mentioned in section 3.2.5, in general among the interviewees the devices were used mainly by a single household member, although there were some cases in which whole households had been engaged. Whilst this is perhaps unsurprising, it had become a limitation to further action for some interviewees. It was regularly emphasised that whilst the individual who used the device might want to take particular actions, their partners or children prevented them from doing so:

> "Well we have told them, you know, that that [using the computer] puts the electric up but what can you tell a 24 year old?" (S2, p5)

> "We have a family difference, my wife leaves them [lights] on and I switch them off." (S3, p2)

> "If I'm here we tend to stay on top [of our energy use], but if I'm away it kind of like distracts. My wife kind of distracts from the goal. That's the problem." (T2, p15)

This is a significant limitation for many and reveals clearly that although the devices may be desired, purchased and used predominantly by individuals, they are then operated within pre-existing and very complex sets of social relationships, which are not necessarily always supportive. In this respect, it appears that the devices should aim to engage whole households rather than single users. In those cases where this had happened, interviewees spoke of cooperative endeavours to reduce energy usage. In other cases though, the device had led to arguments and conflict about what was appropriate action in response to the information the devices provide. Importantly, and as has been highlighted throughout, these conflicts were often gendered or generational. Men typically complained that women did not understand the devices and did not wish to save energy, and older users complained that the younger generation was too wasteful.

Whilst they may appear trivial in some cases, these issues clearly indicate that the devices are limited by the complex social contexts in which they are used, and they must be sensitive to this. It is not exaggerating too far to suggest that whilst these devices may help to reduce electricity consumption, they may also increase the divorce rate.

5.4 Lack of further information

Several interviewees suggested that they might have taken further action to reduce their electricity consumption had more information been available. In particular, it was mentioned that whilst the devices had helped their users to understand what their current appliances were using, it was then very difficult to find information on the absolute amounts of energy new appliances consumed:

> "Government policies get things totally wrong. They like to tell you how things are energy efficient. They've got this wonderful A–G scale, everything has got an energy marker. It doesn't mean a squid to me. I bought a television. I want to know, okay it says energy efficient A, what does that actually mean in financial terms? How much electricity is that television using? Why doesn't it tell you? Okay, it may be using less than [my] television but again if I don't know how much it's using I can't work out how much it's going cost me to run." (T4, p4)

Several other kinds of information were requested by interviewees including the embedded carbon in new appliances, how their own electricity consumption compared with similar households in their area, and how their domestic electricity consumption compared to other lifestyle activities like driving or flying in terms of carbon emissions. For several interviewees, the lack of such information had led to the development of some complex conundrums about what was the best action to take to reduce their consumption. For example:

> "This is a point of interest….to keep a kettle, which is a fast boiling one or to get one which is less wattage but slower boiling, which one would cost the most? So things like that, you know, I mean that… I suppose that's if you did everything like that you could cut your bills down. But I really do think you can only do so much." (S4, p6)

> "Sometimes I'll sit upstairs and watch TV in bed and I think it must be cheaper to watch TV on a 15 inch screen than it is on a 30 inch screen. You would assume that, but I don't know that because there is nowhere to actually tell me what it's using. So if I know what I'm using, know what I'm monitoring, I can make decisions upon it, but nowhere can I find that information out." (T4, p5)

The lack of this kind of detailed information, for several interviewees, generated a sense of frustration that whilst they were trying to take action they were being poorly supported by government and industry. As the next sub-section shows, for some this was beginning to generate a sense of fatalism.

5.5 Unsupportive policy context

Several interviewees commented that they felt they had done as much as they can to reduce their electricity usage and that there was nothing more they could do. Here, they observed that they had already installed thick wall and roof insulation, had double-glazing, had bought A-rated appliances and had modified their behaviour in several ways so as to further reduce their consumption. At this point, they felt they could do no more:

> "I think we've probably gone just about as far as we can go on the electricity." (D1, p18)

> "I'm looking to buy a new house now as it is, so having the experience of this trial, I'll definitely be installing a new combi boiler because I know what the efficiency setting is and it will pay for itself within 5 years. I will be re-insulating the roof. I will be looking at getting the cavity walls insulated and the like. I think I've probably done everything that I needed to do that was reasonably achievable in the house that I'm currently in." (T3, p16)

> "We've got, you know, all our cavity walls done and loft insulation and doors are insulated and double glazing and all the rest of it. So there's not actually very much more we can do that would cut down our carbon footprint, really." (C1, p17)

Beyond this point, there seemed to emerge a strong sense of frustration that the current industrial and policy context was not supporting further action. Here, interviewees criticised appliance manufacturers for making devices that were difficult to switch off completely, they criticised housing associations and local authorities for planning policies which made it very difficult to install solar panels, heat pumps or small wind turbines, they criticised housing developers for not automatically installing efficiency and generation measures on new

homes, and they criticised the government and politicians for failing to match their rhetoric with action. As a result of such a significant lack of support from so many important institutions, many interviewees reported feeling as if they were on their own in attempting to save energy and reduce emissions. Such a perception led to a sense of despondence and even fatalism:

> "I must admit that I'm afraid I think I'm probably much like everybody else thinking that, you know, it's one house and if we do change something it won't make a vast amount of difference so we don't bother." (D3, p2)

> "When you think of what we're doing, we're only tinkering at the edges really." (S3, p12)

It should be remembered that theses interviewees, and the participants in the VET more generally should, in the large part, be characterised as early adopters. If such feelings are beginning to be exhibited by this group, it suggests there may be significant, even insurmountable barriers to encouraging others to use such devices as a means of reducing their electricity use or saving emissions.

6. Conclusions and Recommendations

This report has offered considerable detail on participant's motivations for taking part in the VET, how they have used the Solo, Duet and Trio devices, how the devices have changed their awareness and usage of electricity, and what limitations they perceive as preventing them from taking further action to reduce their consumption.

Although the sample size used in this study is small and, therefore, extensive generalisations should not be drawn, several practical recommendations for how to improve such devices can be made, all of which deserve further investigation. First, the process of installation has been shown to represent an important moment of first contact between the devices and their users. Whilst in some cases self-installation proceeded without problem, in others more support appeared to be needed, either in the form of clearer instructions or on-hand assistance, to ensure users were not left feeling 'on their own' with the devices. Second, a key challenge to users experienced when using the devices was making the feedback they provided 'relate' to everyday household practices. Here, absolute measures of consumption expressed in CO_2 emissions or kilowatt hours appeared to be 'meaningless' to most interviewees, whereas pounds and pence seemed more relevant. If such devices are to realise substantial savings, it would appear that more consideration should be paid to how the abstract numbers they generate are translated into practical, grounded actions. Accompanying the devices with detailed and tailored advice on how to realise energy savings is perhaps one way in which this issue might be improved upon. Third, throughout this report one issue that appeared central to the devices usage and success was how well they were built into what one interviewee described as 'the fabric of the home' (T1, p3). This comment referred not only to the devices being prominently situated within the household, but also to their design and

aesthetics, and how well these fitted-in with the wider household. It is clear from this issue that ensuring such devices are sufficiently portable that they may be situated anywhere in the household is vital, but further, this suggests that more attention be paid to their form as well as to their function. Fourth, and finally, several interviewees expressed a desire for the feedback that the devices provided to be customisable to each specific household situation in order that the user can quickly extract the feedback they find most relevant and meaningful. This and other user-centred developments in design should be taken seriously as the devices undergo continued development.

In general, despite these recommendations for improvement, interviewees were extremely positive about the devices themselves and about how they had helped to reduce their energy consumption. Reflecting on the kinds of changes the devices have brought about suggests that these positive effects will be durable, although further research is required to confirm this. A key theme throughout the interviews and which deserves considerable further research attention, however, was the complexity of the household situations into which these devices enter. Throughout, although the devices were predominantly used by a single household member, the ways in which that householder could bring about energy savings depended fundamentally on wider household dynamics and interactions. For example, a delicate balance appeared to be required between the devices effectiveness in nagging householders to reduce consumption, and the frustrations, stress, limitations and at times resistance these users felt towards doing so. A key observation here is that the devices should not be addressed to individuals, but seen as operating within pre-existing household dynamics. The household, rather than the individual, thus becomes the user of such devices. Exploring how the devices fit into different kinds of household dynamics demands extensive further research to examine the social changes the devices engender, and the ways in which these lead to savings (or fail to do so). More practically, the suggestion here is that engaging a single householder may be insufficient to bring about changes to wider household practices and levels of energy consumption. Instead, attention should be paid to how such devices might engage whole households to help generate cooperative and energy saving household dynamics.

Finally, interviewees regularly referred to a perceived lack of information and support available in the broader social and political context. Whilst the early adopter households in our sample considered they had 'done their bit', they felt let down by government and industrial organisations who continually failed to do theirs. Vitally, this observation makes it clear that devices such as those used in the VET trial do not operate in isolation. In this respect, a key conclusion that should be drawn from this report is that the devices are only as good as the broader household, social and political contexts in which they are used. There is, however, a strong suggestion in the interviews that the devices themselves are able to alter this context or at least perceptions of it. Crucially, this can occur in both positive and negative ways. When negative, the devices can make environmental and financial challenges seem larger and even more insurmountable. In these (relatively few) cases, the additional information the devices offered appeared to create a sense of fatalism or despondency among interviewees that 'doing their bit' was only 'tinkering at the edges' of much

broader social and political problems. In this respect, the devices can make the surrounding context appear even more unsupportive. In contrast, and as was true in a larger number of cases, the devices encouraged some interviewees to take stronger action to reduce their own energy consumption, to discuss such matters with their family and friends, and to seek further information, advice and assistance from housing associations, appliance retailers and local authorities. In these cases, the devices would appear to have had a positive effect on the surrounding context, making energy saving (and its financial and environmental benefits) appear to be easier to achieve, more desirable and, crucially, a normal aspect of using energy in everyday life. Ensuring that the devices engender the second of these effects on their surrounding contexts will be absolutely vital for organisations like GEO, and in the roll out of smart energy monitors more broadly, to ensure that they realise their evident and exciting potential.

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