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Energy Visualisation for Carbon Reduction in Buildings

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The Functionality, Interface and Uptake of an energy saving application for mobile devices

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Summary

Four focus groups involving 18 participants took part in a structured elicitation session in which they gave their views and opinions on the functionality and interface design of a possible energy saving application for mobile devices. A qualitative topical analysis of their discussions indicated a distinct expectation that the application would enable them to save money, and a preference for displaying information in a financial or cost-based format rather than in physical units. Summarising this by time period (especially day), rooms and even devices would be welcomed, as would relating consumption to a personally tailored target or baseline amount, and to normative comparisons (e.g., a typical person / household like you). Comparison of the tariffs of different energy suppliers would be a useful feature to promote initial acquisition of the app.

Data entry on first use followed by use of the camera to scan codes would be acceptable. While seen as useful when mentioned, integrating meter-reading functionality into the app was not seen as a key attraction. Provision of basic energy related information for the specific devices owned would be expected by users. Technology permitting, the ability to monitor each device's usage and to remotely control them would be welcomed – even the ability to turn on a device remotely would allow people to leave it off when away from the home. Alerts should be used with caution: where they are specifically informative and directly help the person reach goals that they recognise as beneficial, they will be acceptable, but they do run the real risk of annoying users. Games might play a useful function for users with children, who might prevent users from deleting the app if the game is attractive to them, but they seem unlikely to be a key attraction. Social networking was seen more as a way of virally spreading uptake of the app and maintaining its use within a community of users than as a way of motivating people to change behaviour. As with use of alerts, the ability to post to networking sites on behalf of users should be treated very cautiously, but allowing people to provide (or pass on) tips to each other might enhance the impact of advice suggested by the app.

Any graphical representations should be simple, with complexity presented on demand by the user ('drilling-down'). There was no consensus on bar or line charts, although dial and rainbow metaphors were well received: optionality would seem to be required here, with users able to select their preferred format. Any use of emoticons should be seen as additional to the main display of information, rather than as the central approach. Physical units such as kWh or joules should be avoided, and consumption expressed in financial terms wherever possible. There was clear awareness of the nature of thermographic images, which suggests that they could play a useful part in communicating consumption, even in simulations.

Short-term financial consequences dominated the discussion in all of the groups, but there was a realisation that for some the longer-term environmental benefits of behaviour change might be worth presenting. A jaded awareness of fear-appeal visualisations (e.g., polar bears on melting icebergs) suggests that such negative approaches to the consequences of energy use would have limited effect. Positive consequences were not mentioned often (e.g., ‘saved a child in Tibet’) and might thus have more impact, through being novel and unexpected.

Introduction

eViz is planning to construct an application that can be downloaded to mobile phones or other portable devices, with the goal of influencing energy saving behaviour by making energy use visible. As well as supporting behaviours that do directly reduce energy use, the hope is that the application can be a vehicle for information that will encourage the motivation to engage in energy saving behaviours, through use of techniques suggested by Elaborated Intrusion Theory (Kavanagh, Andrade & May, 2005).

EI Theory argues that motivation can be enhanced through two strategies: strengthening the association between cues in the world, mind and body and the target action, so that people are more likely to think about acting; and providing a repertoire of visual imagery representing the positive consequences of the act, so that once a thought has occurred people are likely to mentally elaborate the thought and desire the act.

The conventional behaviour change approach of ‘fear appeals’ involving shocking negative imagery is seen as counterproductive, because while such images might make people aware of the need for behaviour change, their negative affective content makes them aversive, and people are more likely to avoid thoughts of behaviour change than to elaborate them. Fear appeals may have an impact on intention, but will have little effect upon behaviour.

However technologically innovative and psychologically well-constructed an energy saving application might be, if people do not download and use it, it will have no effect upon behaviour. The primary aim of this component of eViz was to discover what people expected such an app to do, and what aspects of this functionality would encourage them to download it and continue to use it. We also sought to find out the groups’ preferences for different forms of graphical representation of energy saving information, to inform the interface design.

Methodology

We chose to run focus groups to obtain unbiased and unprompted ideas from participants. These ideas correspond to the initial expectations that someone might have on accessing the iTunes store or the Android Marketplace, and so if the eViz app did not meet these needs the browser might move on to another app and never download the eViz app.

We also wanted to assess the relevance and attractiveness of some of our own ideas about functionality, and of functions offered by existing energy saving applications. To do this, we needed to be able to prompt the focus groups with ideas that they had not spontaneously generated. Finally, we needed to ask our participants which of the ideas they had discussed would be key to them downloading and using the app, or whether they simply wouldn’t use such a product.

To meet these needs, we divided our focus group time into four parts, each roughly 15-20 minutes, in which we became increasingly directive, a technique based on an approach to knowledge elicitation called Structured Elicitation (SE; e.g., McBride et al, 2012). Conventionally, SE is used with domain experts to obtain a consensus about scenarios involving high degrees of uncertainty. Individuals are first asked to make their own suggestions about the scenario, and are then shown all other contributors opinions and asked to re-assess their first impressions. This proceeds until a consensus is reached. The process is thought to avoid common cognitive biases such as anchoring, confirmation and definitional ambiguity, although it is also prone to social biases such as risky shift and polarisation.

In our use of the technique we first asked our participants to brainstorm ideas about an application, in as undirected a manner as possible:

Exp: 'I've told you that we're about creating this mobile application that you can download onto a smart phone or tablet that will help you save energy in your home....Suppose you heard by somebody telling you, or it was on the news, that there was one of these applications available. What do you think it would do? Let's have some ideas, this is where we just talk.'

The Experimenter attempted to remain neutral in this part, bringing all of the participants into the discussion and clarifying points but not adding new ideas. In the second, prompted part, the Experimenter summarised the points that had been raised and introduced topics that had not been mentioned by the group themselves, trying to make sure that as much as possible of the ground had been covered. The third part worked through some visual images of existing smartphone apps taken from the iTunes store, to demonstrate the current state of the art to participants and to obtain their views on both the usefulness and usability of the apps (see Appendix A). Finally, participants were asked to highlight the issues discussed that would actually lead them to use the app:

Exp: O.K so those are just ideas of current things that are out there, I just wanted to get your response to them really. So now we've sort of gone around all sorts of potential ideas, I want to find out would you, and could you actually use one of these things if it was on your phone and maybe it did everything that we've talked about. Which bits would you actually look at? Because I'm sure we've all got things on our phones that we've downloaded or installed or something and we never use them. So what is it that would actually attract you to look at?

The four focus groups all took place between 11 and 12.30, in the Experimenter's office. The sessions started with an ethical briefing, in which the aims of the research were explained, was followed by the signing of consent forms.

Four to five participants took part in each group, seated next to each other facing a projection screen, and the sessions were video-recorded using an iPad positioned so that participants could see the recording on the screen. A clock was placed behind the participants, visible in the video, to aid transcription. A separate audio recording was also made, from the other side of the room to the iPad, to enhance audibility.

During the session, slides were projected onto the screen to remind participants of the purpose of the current stage of the session, and in the third stage, to display the prototypes. These slides are included in Appendix A, and referred to by number in the Results section and in the Transcription (Appendix B).

Participants

Eighteen participants (6 Male), aged between 18-64 (Median 20) took part in four focus groups (Table 1). The first group of participants were members of the public recruited from the School of Psychology Paid Participants pool, and each received £12 for taking part in the research. They responded to an online advertisement, and were asked to take part only if they paid utility bills. They were asked to bring copies of a recent bill to the group. After the first group, it was thought that this placed too much of an emphasis upon cost, and so the requirement was dropped for the remaining three groups, which were therefore able to recruit undergraduate psychology students as participants. Each received three points that they could later use to recruit participants in their own research.

Table 1: Focus group membership

	A	B	C	D	E
Group 1:	M (42)	F (64)	F (19)	F (39)	M (50)
Group 2:	M (22)	F (28)	F (18)	F (19)	
Group 3:	F (19)	F (19)	F (18)	F (19)	F (24)
Group 4:	M (20)	F (20)	M (20)	M (19)	

Letters are used to identify participants in Results and Transcript

Following the focus groups, the audio and video recordings were transcribed by the second author. The first author then conducted a form of thematic analysis (Howitt, 2012) to identify the

common aspects of functionality raised by participants. As we had prompted participants about topics that they had not themselves raised, this is not strictly a thematic analysis as normally used in qualitative research, and so we refer to it as a *topical analysis*.

The analysis was conducted by first reading through the transcript, making notes about topics that were being mentioned. The whole set was then read through two more times, with each row being assigned a topic, and with notes being added within each topic. Once this had been completed, the topics and notes were examined to remove redundancy and to condense the analysis into as few topics as possible. Finally, the annotated transcript was sorted by topic and stage to support the analysis given below. A few more reclassifications were made at this final point.

Results

Topical Analysis

Overall, twelve topics were identified from the transcript, clustered into three superordinate groups (Table 2).

Table 2: Topics identified in focus group transcripts

Superordinate	Topics
Functionality:	Setup; Consumption; Metering; Devices; Thermography; Alerts; Games and points; Social Networking
Interface:	Graphics; Emoticon; Units
Uptake:	Motivation

In the following sections, quotations from the transcripts are used to illustrate individual topics. Each quote is preceded by the identity of the speaker, in the form of a number indicating the group, and a different letter for each individual within the group (see Table 1). Following extracts, square brackets indicate the stage of the group that the example is taken from, and the row of the complete analysis file (Appendix B). Quotations involving more than one speakers are run together with the stage and location coding given at the end, and for brevity ellipses are used to indicate editing. For example, [1: 1162-5] indicates that the quotation is in rows 1162 to 1165 of the transcript and was given during the first, unprompted stage.

Setup

In the first phase, people thought that the app would require some data entry in order to give realistic targets or baselines:

1B: 'But you'd also have to enter a lot of details into it wouldn't you to get that sort of information back.' [1: 144]

Exp: 'Where would it get the information about you from?' 2B: 'Questionnaires and that, you'd have to select.' ...2A: 'Yeah.' 2C: 'That's a good idea. So at least it focuses on you and not just random.' 2B: 'You could say what kind of house you live in and if you often use computers and stuff like that. To help it specialise it for you.' 2D: 'Or if it was measuring energy for the house, it could say measure it for a month and use that as a baseline, and then work around that. Give advice around that. Would be an idea.' [1: 639-645]

3B: 'I think they'd need to be to just talk to everyone about how they can save energy but it could be that you put in some details about your lifestyle and then personalise it for you so you say oh I have eight cups of tea a day or I drive everywhere or I always have the heating on it could then adapt for you and it would feel more personal then. With energy saving stuff it could say here's where you can buy these things as well so it's not just like giving you advice it's saying this is the option you can take.' [1: 1138]

4A: 'You could set yourself a base rate on the app itself and then.' [1: 1619]

In the prompted phases, the need for the app to work for everyone was recognised:

2C: 'If I for example get the app and it tells me oh sorry you're a full time student and then there's nothing on there to help you it would be extremely frustrating.' [2: 792]

and that this involved a certain amount of data entry:

2D: 'I imagine it would be quite complicated to set up. Linking all those devices around your house to a phone.' [3: 841]

4C: 'Yeah like a questionnaire kind of thing when you set it up.' [2: 1774]

4C: 'Suppose if you have all your devices on the registration then they'd already know how much energy they've used. If you take a picture of a room and it will recognise the devices and then if a TV uses so much, a red amount of energy, then it will glow red.' [2: 1805]

It was noted that data entry was only likely to be done on first use, and that repeated demands would lead to deletion:

3B: 'I think when you first, like with most apps when you first download it you do everything the app tells you to do and then after a few weeks it's like oww it's asking me to do something now I'll just delete the app.' [2: 1208]

4C: 'I think when you set it up, input the data, rather than go round taking pictures but if it asked you how many things do you have plugged in currently in this room, and then you have to type it in and explain which ones they are but you do set it up, personally when I download an app I set it all up and then I forget about it. So if I then have to go set it up later I just delete it.' [2: 1765]

Setting up the data intelligently through the camera was approved of:

3A: 'They've got, I don't know what it's called, those little black and white images.' 3B: 'Yeah, where you scan them.' 3A: 'It can come up with loads of information can't it. You might have one on your gas and yeah.' [2: 1195-8]

3E: 'I think you'd be far more likely to pictures of everything and have it self-discovery, you know when you have to swap all your number over and it's like oh that's tedious, so if you had to enter barcodes or serial codes for everything it would get so boring I'd do the first two but taking a picture would be really easy I think.' [2: 1211]

4B: 'Taking a picture... It could have picture recognition or something. Don't know how it would work..... it could have one of those barcodes that you can scan, because you can do that with a picture.' [2: 1790-4]

None of these issues were raised in the final, uptake stage. Overall, participants would expect a limited amount of personal data entry on first downloading the app, provided this did lead to information tailored to their own circumstances. Overt requirements for further data entry at a later point would be risky, as it might lead to deletion, although facilitating information gathering through use of the camera for scanning barcodes would be accepted.

Consumption

In the unprompted phase, most ideas focussed around the app's functionality were about its ability to provide information about an individual's energy consumption.

1E: 'I would say the only thing it could do is tell you what you were using at that particular moment.' [1: 28]

4B: 'I suppose it would measure the amount of energy that you are using. Don't know whether water electricity and gas.' 4B: 'And cost. Energy and cost.' 4A: 'You could set yourself a base level of your weekly or monthly allocated usage. Then if you go over that it could tell you if you are over spending or under spending.' [1: 16117]

4A: 'Would it be possible to link the app with the electricity company or someone like that so they could tell you your expenditure?' [1: 1641]

Cost also featured in the idea of comparing energy companies tariffs to show you who would be cheapest for your situation:

3A: 'Something like company comparisons. So how cheap eon is compared to sweb or something like that.' [1: 1146]

As well as expenditure, one person thought about encouraging microgeneration:

3F: 'You might want to have some sort of widget to tell you how much renewable energy you're making to counter act what you're spending.' [1: 1188]

Indicating usage room by room was suggested:

4D: 'It could show you room by room, because the companies that have smart meters, they can log onto the internet and then they can see which business of theirs is using the most energy, so then they could change it from there.' [1: 1703]

and by device, with an overall daily summary:

2D: 'Could you also have like, it sounds silly but, you know how people keep track of what they eat throughout the day, could you have it like that but with, so say you use your coffee machine for 20 minutes or something, I don't know, could it tell you how much you use, you could have an overall.' [1: 676]

4A: 'Yeah I think it shouldn't be too much work you know, I think if it's going to be something like this it needs to be as easy for people as possible. So if you have a summary for the end of the day it could say lighting has been the most

usage and then just before you go to bed that's what you'd be thinking about. Then the next day, O.K fine I use most of my energy on lights so let's make a conscious effort to prevent that and each day you'd be getting better and better because of the summary. For me that would be the most effective way anyway of getting me to change my behaviour.' [3: 2331]

The app was also expected to provide suggestions or tips about reducing usage, perhaps linked to campaigns and personalised:

- 1D: 'They have campaigns don't they, if they had an initial app that told you as well that would be useful.' 1B: 'They could tell you whether you're applicable.' [1: 141-2]
- 2D: 'Maybe it would give you tips for saving more energy?' 2D: 'So just general advice about switching stuff off and how much energy it could save potentially. Or how much money you could save because people would think why would I not.' 2C: 'I was going to say exactly the same thing...I think they'd just inform you about the importance of conserving energy just in the background. Look at you as an individual if you aren't really doing it you should be doing it because, and just give you guidance after that.' [1: 627-36]
- 3C: 'Tell you what to do.' [1: 1118]

In the prompted phases, cost was again frequently mentioned:

- 1A: 'Looking at 10 years, that's a lot of money. It does make you think. What could I have done with that.' [3: 470]
- 2C: 'Say for example it's got a budget calculator on there and you put in there how much you currently spend on energy or ideally how much you'd like to spend on energy. Say for example you say £200 and then as you're approaching £200 you can actually check to see and think oh yeah I've gone through so much in such a short space of time.' [2: 729]
- 2D: 'So maybe it could calculate how much money as well? So take the number and work out how much it's roughly going to cost you.' [2: 764]
- 2B: '... really hammer home the money side of things so you'd have just the figure and this translates to your spending this each month or a week so they could work out how much, like if they're on rent, it could work out how much energy they're using....: 'I would say money is probably the big thing....you could have almost like a reward system where if you do this you

could save this much and you could have an image of a pot of money which could gradually say well over a few months you've reduced that and you've saved this much. And you could have an animation of coins going into a pot and it could say you've saved this much, what are you going to do with the money you've saved?' [2: 778-784]

As were tariffs:

2B: 'You could also have a deal or comparison so people would be very interested in getting the best deal. So this company is how much, this is the cheapest.' [2: 789]

Referencing usage to a baseline was favoured:

3F: 'Show you how many kilowatt hours you used last month so you could actually know roughly how much you used last time and you kind of want to beat it. So you'd be aiming to keep it below that number.' 3E: 'You could talk about the amount that someone actually needs. Not third world country people, the minimum, sort of the average person in England the minimum amount that they use and they can still function properly with cups of tea and stuff and you could give them like the lowest possible number and then when you get it through you could see what you could cut out a bit so I could get closer to the lowest usage I could be because then it could give you something to aim towards as well.' [2: 1242-4]

3F: 'You'd have to do it relative to how big your house is. I'm sure there's an equation that someone's made up for it.' [3: 1465]

Analysing usage by room was seen as useful:

1B: 'Well then you could look at the wastage. The waste of money you've been using by using devices you don't really need to. For example radiators in certain rooms and you think 'oh I'm not even using that room'.' [2: 193]

3E: '...a breakdown with all the bits where all your electricity was coming from where all the usage was, from the kitcheny area or the living area.' [2: 1204]

Again, overall daily summaries were considered:

- 1D: 'How often would you have it then? How often would you have the alert I wonder? At the end of the day. Would it have to be at the end of the day would it tell you what you were using?' [3: 520]
- 4A: 'When you've left something on. You could set to a set time so just before you go to bed you could have a daily summary of how you've done and what you could change!' [3: 2327]

In terms of giving advice, usage information that was targeted to the individual was mentioned:

- 2B: 'I think you mentioned before like with the loft insulation, having an area you can go for suggestions so you could say well loft insulation costs how much.'
- 2C: 'What I noticed, when you talk about the free loft insulation, that usually extends to boilers and central heating but it's usually applicable to people that are at pension age or people on certain benefits, but you get people like us, students...Or what about someone that works full time that's not on benefits what about them? They've got to pay from their own pockets.' [2: 786-90]
- 3F: 'You couldn't just give rough guidelines for saving energy, they'd have to be really specific so that would increase your market if you created an app that you just ticked what appliances you had and whether it was fan or gas oven, you know the sort of basic breakdowns of appliances and at the end it would give you a rough estimate of how much energy you could save or how much energy you're producing, you know obviously not 100% accurate. I think if you tried to claim it was 100% accurate you'd get a lot of people complaining that their energy bills were still too high and that might be for other things that they don't know about but obviously you'd take a lot of stick for that.' [2: 1213]

In the final stage, one key aspect for using the app was the availability of a daily summary of expenditure on energy, which would allow the user to remember which activities had caused increased usage:

- 1E: 'The only thing I liked was the figures per day of how much electricity it actually costs me. I could look at for the last week, £2 on Monday, £1.40 on Tuesday and see what I was actually using on that particular day....Nothing that you've showed me up there would actually make me use less electricity because I'm extremely, not picky erm, I just don't leave things on I'm almost

paranoid about it. So I don't use electricity that I don't need. But to actually see what I've actually used over the last week, day by day, I would like.' Exp: 'Would you be able to tie that in to the memory of what you've been doing?.' 1E: 'I think over the week, yeah.' [4: 580-84]

Others mentioned the ability to monitor costs and making energy saving salient to children:

1A: 'Talking about use of the functions, probably I would say most of them. It would make my job trying to reduce my electricity bill so much easier. Also as well, when you've got children, I think if I can show the things visually they'd tend to understand better so it would be very useful for me as a teaching tool for my teenage daughter.' [4: 533]

1B: 'Cost, anything that would tell me how much money I'm spending and where my money's going. The games for my son I think they'd be good. Train him into turning lights and stuff off. Yeah.' [4: 543]

3F: 'The monitoring of your own electricity...compared to your other weeks and whatever.... and the one where it sends you a message when your electricity is running low.' 3B: 'I also like the idea of setting your own budget, that sort of idea. Maybe for a week the app monitors your usage and then suggests this is what you should be spending each day.' ... You would be more into the app I think if you had to use it for a week.' [4: 1545-7]

It was clear that representing consumption in terms of cost was a primary focus for all four groups, and was not just an artefact of the recruitment process for the first group. Summarising this by time period (especially day), rooms and even devices would be welcomed, as would relating consumption to a personally tailored target or baseline amount, and to normative comparisons (e.g., a typical person / household like you).

Metering

No groups spontaneously mentioned the possibility that the app could include any functionality related to meter reading. When prompted, they could see advantages (accessibility of meters being an issue) and mentioned taking pictures or scanning the meter:

Exp: 'Suppose this device could help you read your meter, make it easier for you to read your meter, keep track of that.' 1D: 'So just sort of flash something, you know, take a photograph it or something is that... Rather than climbing on a ladder and looking at the little numbers....Well that would be useful.' 1B:

'Plus you get lazy don't you I just can't bothered to go out and lift the thing to read the meter, so I don't do it.' 1C: 'Ours is up really high so I can't see it,...

I'm too short.' 1A: 'Mines easy to read, it's under the stairs ...It's harder to get to because there's stuff in front of it but yeah it can be done.' [2: 233-53]

1B: 'Might just do it automatically and not even read it. Take a photo, send it.' 1C: 'I probably still wouldn't.' 1A: 'Probably would read it a little bit more often.' [3: 268-72]

2C: 'I quite like that it's just straight to the point and I don't have to read pages of garbage.' 2D: 'You've still got to get to your meter and take a picture!'...2B: 'I think that's more reliable than typing it in. But then there's always the possibility that it could misread....Or if there's a lot of glare and it can't read the numbers properly.' Exp: '...So how often do you think you would be prepared to take a picture of your meter?' 2C: 'Once a week.' 2D: 'Doesn't really solve the problem of checking your meter though. Still got to get to it.' 2B: 'Yeah.' ... 2D: 'Yeah. I think it makes it a bit more complicated.' [3: 818-829]

3A: 'It could have something like that on your electrical or your gas so you can scan it and then find out how much you've used each day, not that someone would be that sad to do it each day but you never know.' [2: 1203]

4A: 'The only thing I could think it would be useful for is taking a picture of your meter.'...4C: 'Could it explain the meter to you? I've not had to check a meter so I don't really know what it all means. It might be useful in explaining.' 4B: 'Is that the kind of thing we're trying to avoid though? It's more of an easy way of keeping an eye on energy they wouldn't really have to check your meter.' [2: 1756-1]

4B: 'It could be like, once a month it gives you a reminder, it takes a picture of it and then it will recognise the numbers and it can calculate how.' [3: 1915]

One person did mention this aspect in the final stage:

1D: 'I think the metering monitor would be very useful....Where you had an application that could read the meter.... Without having to fill in the little numbers on the card. I think that would be very good.' [4: 577]

While seen as useful when mentioned, integrating meter-reading functionality into the app was not seen as a key attraction.

Devices

Beyond the consumption of specific devices noted in the earlier topic, the ability to provide a 'factfile' of information about specific devices in the home was mentioned in the unprompted stage by all groups:

- 1D: 'Could it tell you the cost of things to alert you to the fact that some things are more expensive to run than others. Perhaps if an electric fire was very expensive to run in comparison to a convection kitchen.' [1: 30]
- 2B: 'Measure how much energy you use?'... 2A: 'Maybe individual objects in your household. Say this typical uses X amount of energy.' [1: 621-4]
- 2D: 'Would you be able to go round your house with your camera on just looking at objects? And then it tells you information about the energy.' ... 2D: 'It could have all the information about it.' [1: 672-4]
- 3A: 'It's obviously showing advice as well but showing products that use the most energy.' 3B: 'Show alternatives or something, low energy alternatives for stuff that you use every day. Or it could show how much you spend if you use this product. Or if you use a normal kettle.' 3A: 'Show comparisons and stuff.' 3B: 'Yeah. Or a light bulb or something, this is how much it costs. Whereas if you use the low energy one you'll save this amount or this amount of energy as well.' [1: 1123-6]
- 4C: 'Maybe you could measure what individual things!'... 4A: 'It would also be quite informative towards what uses the most in terms of the energy you use. Then you'd be more aware of what you actually need.' 4C: 'Kind of like a fact file.' 4A: 'Yeah normally house hold appliances that some people use more than others.' [1: 1627-37]

One person came up with the idea that the app could provide you with the ability to control devices remotely:

- 4D: 'Should be able to remotely control your lights and stuff like that... Say if you want out and you'd forgotten to turn a light on and it alerted you, you could just turn it on without having to go all the way back.' [1: 1627-29]
- 4D: 'It could know when you're outside the home, and it could know what you've left on, so.' [1: 1732]

When prompted, the remote control aspect was received enthusiastically:

1B: 'That would be good wouldn't it? Sometimes I lay in bed and all the lights are on because my son wants it left on. When he's asleep I have to physically get up to turn it off.' [3: 284]

2B: 'But if you've forgotten to turn something off and you've left the house?'...2C: 'Safety if you're coming back from a night out and you're worried about walking down a dark hall you could get out your phone and turn the light on.' [3: 848-850]

3E: 'If you like go out the house and you're like ah I left the hall light on then you could just turn it off.' [3: 1321]

4D: 'You could use it inside as well, you're on the sofa, just sat down.' 4C: 'Being lazy.' 4D: 'You can see the light on out in the hall.' 4C: 'That is annoying to be fair.' 4D: 'You're not getting up.' 4C: 'The worst is when you go to bed and then to sleep and you get all comfy, the hall lights on. Got to get up' [3: 1972-7]

4C: 'If you can see you've left your bedroom light on or something you can turn it off.' 4B: 'Just before you get home, turn the heating on.' 4C: 'Yeah that would be good.' [3: 1982-4]

One practical problem with remote control was also noted:

4D: 'I think it would be abused. If I knew people were sitting in the other room.'
4A: 'And the bathroom, off.' [3: 1937-8]

Also seen positively in the prompted stages, was the scope for a fact-file for domestic devices:

3E: 'You know main appliances that everybody has, because I don't suppose many boys have hair dryers and straighteners so they could like be any separate category, but everyone has a cooker, everyone has got radiators and everyone's got that sort of thing so it could focus on those bits specifically.' [2: 1206]

3A: 'I think you should anyway you should be intrigued, especially in my house I'm always like how has my electric gone that quick. I can understand when I've got my tumble dryer on, that uses a lot, other than making the odd cup of tea and watching the TV or whatever I'm not using excessive amounts of electric but it seems to just go so quickly. Then you don't know if boiling the kettle uses loads of energy because I've never googled it to check. So you'd be intrigued to find out.' [2: 1210]

4B: 'Is there a database of all the different types of devices and stuff and their energy efficiency.' [2: 1778]

4A: 'If it was readily available people would be more willing to find out if it's all there, you don't have to search it each time.' [2: 1783]

4D: 'I think if there was a leader board of appliances where it was top on energy saving and then you could just look at what appliance you needed, like to buy that week, like a microwave for example, then it would tell you what's the best energy saving one.' [3: 2272]

In the fourth stage, device control was raised by one group as a possible key factor in uptake, with a practical caveat:

3E: 'I also like the one where you can switch things off if you weren't there.' [4: 1553]

3F: 'As long as you don't let people turn on the hob or anything. You don't want fires popping up all over the place.' 3D: 'Yeah I think turning the lights off and stuff in your house I think that's quite useful and the cost and stuff if you can wire it up to measure how much you use and how much it costs.' [4: 1560-2]

It was clear that provision of basic energy related information for the specific devices owned would be expected by users. Technology permitting, the ability to monitor each device's usage and to remotely control them would be welcomed – even the ability to turn on a device remotely would allow people to leave it off when away from the home.

Thermography

Two groups spontaneously suggested that that phone could capture or display thermographic images, while realising that this was not yet technically possible:

1D: 'I've seen something that showed the heat loss going out of your house, sort of, the red bits of the house. Out of the roof or something' 1B: 'oh thermal imaging.' 1A: 'thermal, yeah.' 1D: 'So I suppose it could show that couldn't it. You know if you had, I don't know we had wool insulation years ago.' 1B: 'So how would they shine on the actual house to show.' 1A: 'Thermal camera.' 1B: 'Yeah.' 1D: 'Is it? Yes, so either around your window frames or your doors or your, umm.' 1A: 'That would could wouldn't it. With a thermal

camera, will that cost loads? What would the cost of that be? It's a good idea but.' [1: 119-26]

3A: 'Have a thermal thingy on it. Like a scanner kind of thing.' 3E: 'It'll probably be around in about ten years or something.' [1: 1151-2]

One other group were aware of thermographic images when prompted, but thought it might be seen as a gimmick:

Exp: 'Have you seen thermo graphic images? Have you seen what they are?' 4C: 'Oh yeah where it will be red if it's a lot of energy.' 4B: Are they going to be on those phones though?.... 4B: 'It would be most useful for windows and stuff like that.' 4C: 'Yeah.' 4B: 'If you've got drafts coming, energy leaking out of your house that would be good.' 4C: 'That's the sort of thing dads would do....my dad's always like oh look at this. Oh look at this clever technology!' [2: 1801-25]

No-one mentioned this possibility in the final uptake stage. There was clear awareness of the nature of thermographic images, which suggests that they could play a useful part in communicating consumption, even in simulations.

Alerts

In the unprompted Stage 1, alerts were mentioned several times, by three groups. Alerts should not be intrusive:

4D: 'I don't think it should be an intrusive app though. I think it should just be there in the background.' [1: 1739]

but could also be ignored:

1D: 'Oh indeed I think it would be much easier to ignore an app, you know, an alert wouldn't it? Than trying to engage politely with someone that you don't want to talk to.' [1: 146]

Alerts were seen as being useful to warn people that they were about to exceed some usage threshold:

4B: 'If it goes over you can have an alarm bell or something like that.' [1: 1620]

and could also be related to particular devices:

3E: 'Tell you to turn the lights off and that.' [1: 1119]

3E: 'Related to that you could have a beep almost like how you're alarm in the morning gets really really annoying because you hear it so much. You could have a beep that goes off once every five minutes or so to keep you realising that something's been left on or that you were using something too much and then once it goes down the beeping will stop. Then I suppose it will just become something like.' ... 3A: 'So it can sense when a load of energy is being used in the house? Like I've got a radio wave thought in my head. Say you've left your straighteners on and they're using loads of energy and then a picture of your straighteners starts flashing up.' [1: 1162-5]

The intrusiveness of an alert was seen as part of its functional strength:

3C: 'If you're really bad with energy it could be really horrible music and you'd be like oh my god turn it off to save energy.' [1: 1158]

and if it related to specific devices was seen as potentially informative:

4B: 'Ideally, it would suggest what you can turn down.' [1: 1625]

Depending upon the context, alerts could also offer energy saving suggestions:

4C: 'Yeah. Could it have suggestions? Obviously it will say oh you're leaving all these things on, you're using both your laptop and something else, could you not just use one?' ... 4A: 'It could also give you eco alternatives.' [1: 1705-9]

1E: 'It could simply tell you the time and remind you that electricity is cheaper after 8 o'clock or whatever it was.' [1: 46]

Similar topics were addressed in the subsequent stages, including the annoyance factor, and the possible adverse effects of shifting responsibility from the individual to a technological support:

1C: 'I'd ignore it.' [3: 454]

1B: 'See my kids would hate it, I'd be like turn your tellies off.' [3: 505]

3F: 'It would still annoy me. If I was really that motivated I would have sorted it out every time I left the house. I would rely on my own cognition to do that. By replacing it with technology you've made yourself lazier.' [2: 1220]

3C: 'If it was on the app when you go on it and go to a separate bit of it, but if it just popped up on my phone it would annoy me so much.' 3E: 'I play those

games where you play it and you have to build your own little world and then every now and then it comes up with oh this is ready for collection, it sounds really errr, but then I'll look at my phone and I've got ten notifications from this game and I really don't care.' 3A: 'Yeah you just x them.' 3E: 'Just ignore them.' [3: 1506-12]

4C: 'I'd find it annoying if it was going off all the time.' [3: 2320]

Although budgeting against a cost threshold was mentioned in two groups:

3F: '... so couldn't you incorporate something that gives you an alarm when you've reached £5 or you're down to your last £2 or something. So then you can be like oh I must have left something on at home then....Or something that shows it going down constantly.' ...3A: 'Mine does do that a little bit, if I have music on, television in one room nobody's even in there and then I'll see my meter go down to £1.12 and then I'll start turning everything off. ' [2: 1259-62]

4D: 'When you're spending loads of money?' 4C: 'Yeah when I'm doing well and when I'm doing badly.' [3: 2325-6]

another focussed upon a personal usage thresholds, which might change over time:

4B: '...with a baseline thing as soon as you go over the recommended amount it will alerts you and it will give you options, how to be turning things off or.'...
4D: 'It could just be based on an average, have just a normal usage and it could alert you when you go over that.' ...4C: 'If it gave you that alert and when you clicked on it automatically went to that app then you'd probably be more likely to have a look for it, if that makes sense. So if it was like you've gone over your thing and then it would check how you've gone over it, suggestions, stuff like that.' ...4A: 'Yeah and then it would change based on the recommended changes. You could set yourself new rates so you'd spend this much this month, let's try for a little bit less and the method by which you do that is by remembering to turn your lights off when you go out the house or shutting all the windows.' [2: 1854-61]

In another group the alerts were seen as a motive to continue using the app:

2C: 'Yeah I would check it. Or perhaps if there's a facility that sends alerts.' [2: 731]

especially if the alerts gave usage suggestions linked to personal context or devices:

4A: 'It could be based on, if the app were able to register what kind of house you live in as well, whether it's a town house or quite an old house it gives you, it could give you new ways to save energy like double glazing, more insulation in roofs or.' [2: 1826]

4C: 'Where it just sends environmental updates, there probably is one though, not environmental techniques but energy saving techniques. You subscribe to it and then when you're going through it just shows you these pictures or facts.' [2: 1852]

1B: 'Suppose it could make you more aware.' 1D: 'Mmm, and it's that awareness isn't it, that reminder.' Exp: 'Yeah 1A just said sometimes you can leave things on.' 1A: 'Goes on a lot in our house, oven rings are a classic.' 1B: 'Yeah you forget don't you when you're rushing around.' [3: 512-6]

or to occasional reminders or updates about usage or helpful time-relevant advice:

4B: 'If you could set it into an interval sort of thing. So if you want regular updates you get regular updates of how much you're using and how much you're spending. [2: 1854]

3A: 'Yeah, great. Then again I don't know because if it was cheap light bulb day I'm forever going through light bulbs so I'd be rushing straight to the shop to get them, so it depends what the notification was really.' [3: 1515]

4C: 'If it's synced to your calendar rather than giving you individual updates that would probably be more useful....So if I want to check the day and it says today is world environment day I'll say oh that's interesting and then you can click on it and it will. ...I'd think that's quirky but it doesn't particularly impact me. If it was a tip I'd want to know, I'd want an alert.' [3: 2250-64]

In the final 'would you use it' stage, alerts were seen positively:

1C: 'Errhm, probably like only having the alert thing. I'll try and budget myself this type of way. So if I'm going over then I could get that.' [4: 545]

3F: 'And the one where it sends you a message when your electricity is running low.' [4: 1549]

but also negatively:

2A: 'I suppose if it got a bit too confusing. If I didn't know what it was trying to tell me I probably just wouldn't bother with it again.' 2B: 'If I was bombarded with information it would.' [4: 1063-4]

Alerts should therefore be used with caution. Where they are specifically informative and directly help the person reach goals that they recognise as beneficial, they will be acceptable, but they do run the real risk of annoying users to the point that they are disabled or the app deleted.

Games and points

Two groups did spontaneously come up with the idea of a game, one as a reward (although not without some scepticism):

3C: 'I could let you play a game if you're doing well and if you're not saving energy it could be like you're not playing that game and then you'll be like oh my god I need to save energy to play a game.' 3A: 'it would have to be an awesome game.' [1: 1183-4]

and the other as a motivating aspect:

4C: 'An eco version of four pics one word.' [1: 1716]

The idea of a game was not prompted in the second phase, but in the third phase one person mentioned a game as a weak motivating factor, in response to slide 19 showing the 'leaderboard':

3B: 'Every now and again I get a message saying I've still got a game with this person, they're waiting for you....And then I'll go back on it and be like oh yeah I was playing that and then we'll start up again. Every now and again you have a spree of playing it for a week but then it goes back down again.' [3: 1472-4].3B: 'Every now and again I get a message saying I've still got a game with this person, they're waiting for you...And then I'll go back on it and be like oh yeah I was playing that and then we'll start up again. Every now and again you have a spree of playing it for a week but then it goes back down again.' [3: 1472-4]

When shown the games on slide 22, comments revolved around their attraction for children, as an educational tool, rather than for adults to change their behaviour:

1B: 'It would be good for the kids actually to get the kids to stop and think, yeah.'

[3: 487]

1D: 'I think it could, yeah. I think it could make them think. It's another way of assaulting their senses really isn't it rather than verbally demanding them to do things.' [3: 502]

3E: 'It would be better if you had kids to teach them from a young age but I think because we're already set in our ways like we know that we're supposed to do it but if you're playing a game and it's showing you the best thing to do and you think oh I know I should do that but then if you actually go to do in real life you won't do it. 3A: 'You might do it for like a week and then think oh I can't really be bothered.' [3: 1520-1]

Exp: 'Who might this be good for?' 4D: 'Kids.' 4C: 'Kids.' 4B: 'Kids.' [3: 2288-91]

Rather than a social or competitive function, coupling the points to a financial reward was suggested:

4C: '...With games generally you do just play it to beat yourself. It is kind of that idea, if you get the points you are just doing better yourself. I think if there was the idea of a reward it would probably work better. Say if it gave you 395 points and it just told you this equals £5 in energy saving or something. If it just said that it would be a bit more real world.' [3: 2167]

Games might play a useful function for users with children, who might prevent users from deleting the app if the game is attractive to them, but they seem unlikely to be a key attraction.

Social Networking

The only mention of social networking in the unprompted phase concerned one person's ideas about the use of celebrity endorsements as social role models, based on a quit smoking site:

2C: '...a lot of us got onto the internet started to see what celebrities were doing... they thought right if we're going to put a whole page of information whoevers reading it will think I don't have the time. Whereas with a few pictures like, there just like little words, you know captions, it's more interesting than because you can just flick through them and think oh Gary'

Lucy smoked once upon a time then you can take your time out and research into him further.' [1: 683]

2C: 'You could get an ambassador. You approach one of these celebrities, for example if someone approached David Beckham and said we're thinking of doing this would you care to trial some of the devices we have and that sort of thing and be the face or what we're doing. Then at least you can perhaps have a David Beckham page encouraging people and you know get them to be an ambassador.' [1: 702]

When prompted, several negative points were raised about boring people with inappropriate information:

1A: 'After a while it becomes quite annoying actually. More stuff you just don't want to know about.' [2: 171]

1E: 'If you can't think of anything better to say than 'oh I've saved some electricity this month' then you really need to broaden your horizons.' 1D: 'I think it would be something you might discuss with friends. But I would do it through verbal discussion rather than through networking.' [2: 158-161]

1E: 'If this wonderful thing actually did something like say saving a huge amount of electricity say 30 or 40%, say something significant, then yes, I would tell all my friends and everything about it, but if all you're taking about is saving 2 or 3% then it's no different than having a chat in a pub saying petrol down the road was a penny cheaper and that is just so dull it's not going to happen. It would be one of the most boring, pointless conversations. You would just get laughed at by your friends if you were talking about football and you suddenly just threw that in. But say if it was significant say 30 or 40% you wouldn't have a problem getting the message out there.' [2: 178]

3A: 'It's fine if you're sharing it with your friends on facebook and stuff but only so many people are going to be interested in switching lights off and stuff.' [3: 1475]

4C: 'It might work. It depends on the type of person though because in my family if they did that I'd probably get quite competitive and be like yeah I'm going to beat you all and my brother would be like yeah I really don't care.' [3: 2158]

Another person actually saw the public availability of their usage information as a spur to motivate change:

3B: 'I was just thinking, when people try to lose weight they often use apps that connect to facebook because they don't want their friends to know that they've gained weight so they go to the gym more, and that sort of thing. You don't want people to know you've wasted a load of energy.' [2: 1253]

Another in the same group saw the possibility of social influence:

3F: 'If it posted it to your wall about how much you've saved or whatever people might look at it and be like oh how have they done that then? Then they get all curious about it and that would lead to them downloading the app.' [3: 1476]

There was also seen to be scope for social networking to promote inclusion:

2C: '...get them involved don't make anyone that lives in halls feel excluded from it say fair enough whilst we appreciate if you live in halls, this is the case, we'd like your ideas get them to contribute to take part your opinions and suggestions will be welcome....' 2B: 'You could have a feedback way so you'd get suggestions on what you could do but I suppose you could also have a thing about if you've got any ideas yourself then it could have a feedback thing and you could just type your suggestion and it would go off to' 2D: 'Like a forum.' 2C: 'You want everyone that uses the app to be somehow part of it. You don't want them to look at it and think this is irrelevant to me and just toss it aside basically. You want them to go on there and before you leave, it would be nice to have people contributed, taking some information away regardless of who they are. So they can choose whatever they do with the information.' [2: 809-12]

3F: 'It's a win win for the eco people like yourself because they will do it on their own anyway and they'll see other people getting involved with that.' 3C: 'If all my friends are doing it I might just join in.' 3A: 'Probably the new craze.' [3: 1482-5]

The collaborative aspect of sharing information with friends was also seen positively:

3D: 'You could do it with friends.' 3F: 'You could have your score on your app, and you could compare it to other people in the same area using wifi or something.' 3B: 'It could be a social network thing on facebook or on twitter.' 3A: 'I think I'd end up doing something like that.' Exp: 'How long do you think that would last for?' 3B: 'As long as the app probably.' 3A: 'You could make it quite fun. If you were going to bring that into it.' [2: 1246-52]

Although the idea of competing for points was scorned:

Exp: 'Would this actually appeal to you three.' 1C: 'No.' 1B: 'No...Not sort of publicly displayed. To keep costs down yeah but not to be in competition with everybody. It seems like it's trying to get you hooked in to pay quite a bit to use the app.' [3: 403-7]

2D: 'Yeah I couldn't care less about how my friends are doing.' 2B: 'I just couldn't care less. So for me something like that just would not work.' 2D: 'It would have to link to something else I think for it to be completely effective.' [3: 968]

3B: 'I think it would be a novelty, that sort of app, instead of being a serious app. It would be for the first couple of weeks ha I'm beating you in energy, but it would wear off I think.' 3E: 'Like the ones where you draw something.' 3A: 'Someone would just get it to say nought and then what's the point.' [3: 1455-7]

3E: 'Then if you hadn't saved enough you'd be all embarrassed and everyone can see. Obviously you can choose not to share things if you're that embarrassed. Maybe the fact you have to click don't share will prompt you into doing something about it. You're so embarrassed you don't want your friends to see how much energy you've wasted'.... 3B: 'It's not that embarrassing but once you make people aware of it.' 3F: 'Everyone wants to be socially desirable. It kind of plays on that social desirability thing that everybody has. So if you played it to that. Everyone would want to make themselves, well, not better, as good as they could show themselves in a positive light.' [3: 1477-9]

The advantage of individuals sharing energy saving information via social networking was mentioned:

2B: 'I think if it gave a suggesting like they did it by doing this then that would be effective. But not be as effective if it just said they gained ten points, good for them.' [3: 972]

3B: 'Yeah, I quite like that idea. Sometimes a company would say if you change to this you could save X amount of energy but when you actually do it you don't physically see a difference for ages. But when someone says I use these light bulbs now, I use this kettle, over a month I saved this amount and people go yeah I did exactly the same from personal experience, it's a lot more real having someone say to you this is what happened.' [3: 1490]

The idea of personal recommendations, cued by the recommender site on slide 20, was not seen as very useful, unless the recommenders were personally known:

4C: '...you can't really say this is a lovely light bulb if you only like dim lights.... Yeah, I think if that was an add-on to the app it would be good but I don't think people would.' [3: 2244-6]

2B: 'If it linked to friends directly and if they've commented then that would carry a hell of a lot of weight, yeah.' [3: 996]

In general, linking to social networking sites was seen as useful:

2B: 'Yeah on the app you'd have to have all the social networking options so facebook, twitter, tumblr, myspace or whatever. If people had all options then people could do whatever way that they prefer to use.' [3: 1026]

Families could share information, perhaps through a game:

2D: 'Families could get involved if they were all quite linked in together. They could all get involved in some sort of game.' [3: 1038]2B: 'I've played them but not for the incentive of beating my friends.' [3: 965]

In the final stage, social networking was seen as useful for providing cost information from friends:

1C: 'How much things cost really, yeah cost.' [4: 549]

But the points were not seen as motivating:

2B: 'Again it would have to translate to something else. That never motivates me by itself.' [4: 1081]

and there was scope for annoyance:

1B: 'My son has blocked me on facebook. He's 15 so I don't want to embarrass him too much.' [4: 541]

Social networking was seen more as a way of virally spreading uptake of the app and maintaining its use within a community of users than as a way of motivating people to change behaviour. As with use of alerts, the ability to post to networking sites on behalf of users should be treated very cautiously, but allowing people to provide (or pass on) tips to each other might enhance the impact of advice suggested by the app.

Graphics

Graphical representation of usage data was praised in the first phase as being simpler than using a lot of text:

2C: 'The NHS no smoking have a fantastic app ... the way they've done it is there's not many words on it so you don't feel like you've got to read through streams and streams of information it's just, you know, pictures or symbols that people can understand. So that's what I like about it, it's simplicity.' [1: 679]

This person then led their group into a discussion of presenting simple information first with the option to delve deeper:

2C: 'But the one thing I've got to emphasise is that because of the different types of people that will access that app... you've got to make sure it is simply and clearly worded, ...you get some people that aren't as well educated that's not going to make any sense at all or it's just going to terrify that person so put it in plain English and make things as simple to understand.' 2B: 'You could have easy to read numbers. You wouldn't be bogged down. You could be given a main figure and say this translates to whatever.' 2A: 'But if someone is say, less educated, would they be concerned with energy? Because they haven't really been educated on the importance of consumption and saving so would they really know about.' 2B: 'You could have an option that says for

more a detailed analysis press this button and then it could go into the harder stuff!' [2: 771-6]

When graphs were presented in stage 3, difficulty of interpretation was mentioned by two groups:

2C: 'That's the first thing that hits you when you go onto the page. It's like driving four cars. So you'd be thinking what do I look at first?' [3: 924]

2D: '...With all the dials you have to look at them multiple times to figure out.' [3: 941]

3B: 'It's too much information on one graph.' [3: 1391]

and again the idea of delving deeper came up:

3E: 'You can do an overall on the bar and then if you want to break it down a bit you can break it down if you want.' [3: 1436]

4C: 'If it's tracking your energy anyway and then you just click on a graph or option then it will just give you a visual representation of the numbers that it would be giving you anyway so that might be useful.' [3: 2066]

One group initially claimed not to be able to understand a graph, but when pressed showed that they could:

Exp: 'You don't like graphs.' 2C: 'No I don't.' Exp: 'What does this graph tell you?' 2B: 'I have no idea.' 2C: 'I'd have to take some time out to work it out.' Exp: 'it's got units on.' 2D: 'Energy use over time.' Exp: 'It is energy use over time.' 2C: 'Is it throughout the day? Because you've got 0800 and going on to 2000. So I'd say during those periods of time energy is the highest. It starts out O.K and then it drops later on.' [3: 853- 861]

Regardless of actual ability to read a graph, if people feel negative towards them, they are unlikely to try. One group brought up the motivating aspect of being able to make comparisons over time:

4B: 'Yeah because if you're aiming to improve you can obviously see if you're making any kind of improvement.' 4C: 'Yeah like those weight loss apps, ... it tracks your progress so if it's going down you're like, if it's going up you're like ahh.' [3: 2045-6]

4A: 'I think graphs are really good for that actually because often when you're trying to maintain something like that you get quite engrossed in it, being able to step back and see your progress would be quite encouraging to see that you're making progress.' [3: 2053]

4B: 'I think if there was a comparison between devices like a pie chart that would be quite easy to recognise what's using more.' [3: 2071] 4B: 'Gives you a time scale doesn't it. You can see what you were doing at the point it was more energy consuming.' [3: 2116]

Making comparisons over time was also mentioned in another group:

2B: 'You'd have to have a second line in another colour saying you've used this much from last year so that you could do a direct comparison.' [3: 889]

By representing usage over time, the ability to identify usage by device or activity was mentioned by two other groups:

1B: 'You could probably work out what's using the energy by that though couldn't you.' [3: 345]

3A: 'You start thinking though if it was a week day and you couldn't really remember what you've done in that day you'd think oh what did I do there to make it go like that.' 3B: 'Them maybe you could input notes and stuff, I put the tumble dryer on at 1100 or whatever it was. You could put that into the app.' 3B: 'Yeah, because you can then look back and think oh yeah I did that or I was out the house then that makes sense. Put it into context.' 3E: 'You could only do it for like a week but the you'd know which one's.' 3B: 'Yeah maybe it's each week or month or something.' 3A: 'Yeah.' 3D: 'And then you'd get your head around what you do that makes it go all the way up and then you wouldn't have to keep thinking about it all the time.' [3: 1370-9]

In terms of preferences between line and bar charts, opinions were divided, with each group being unanimously in favour of whatever the first person supported:

Exp: 'What sort of graphs do you prefer? Lines or bars?' 1B: 'Bars.' 1D: 'I like bars.' 1A: 'I have a slight preference for bars.' 1E: 'I like all graphs. More the better.' [3: 408-412]

Exp: 'What sort of graphs do you prefer? Ones like that where you've got lines, one at the top, or this one to show the same information but as bars.' 2C: 'Definitely bars.' 2D: 'Bars.' [3: 906-8]

Exp: What sort of graphs do you prefer though? The top one here, line graph, bottom one, bar graphs. 3B: 'I prefer the line one.' 3A: 'Yeah.' 3C: 'Yeah.' 3E: 'Yeah.' Exp: 'Lines? You're all happy with lines?' 3F: 'Yeah I don't think I understand the bottom one necessarily.' 3E: 'Lines make more sense as well.' [3: 1381-7]

Exp: 'Yeah. What sort of graphs do you like best? Lines or bars?' 4B: 'Probably lines. It shows your progress.' 4A: 'Yeah.' 4C: 'Yeah. Normally I like bar charts but not for this sort of thing. If you're trying to show a reduction lines more of an improvement.' 4D: 'I don't really like graphs. I prefer tables.' [3: 2059-62]

Other forms of representing data were approved of. The 'rainbow' slider of slide 14 was liked by two groups for its simple and colourful approach:

1D: 'I think the colours good.' 1B: 'Easy to read isn't it.' [3: 418-9]
 3E: 'I like that a lot.' 3A: 'Yeah.' 3B: 'Yeah.' 3D: 'Yeah. I'd download that.' [3: 1394-8]

Other groups did like it felt it was a bit too simple and had drawbacks:

2B: 'I prefer that to a graph.' 2D: 'It's quite simple.' 2C: 'Yeah, definitely pretty straight forward.' Exp: 'So the advantages are its simplicity.' 2B: 'I think also a tab to change, to have options to not have just by hour so per day or per week so you could click on something and change that.' 2D: 'The rainbows a good visual, colour aid.' Exp: 'What are the disadvantages of that?' 2B: 'Possibly can't show you the averages of other households? So you can't compare. Six on that would seem really bad but if you could compare you might see if it's normal or.' 2C: 'Very basic.' 2D: 'Doesn't give you any sort of feedback or advice about how to change. So say you had a high kilowatt hour usage that doesn't look like it gives you any advice about learning.' [3: 910-9]

4C: 'If you're not particularly bothered by the numbers it gives you, oh I'm in red, oh no, that's bad.' 4B: 'I think the disadvantage of that is you obviously don't really know what specifically is taking up all the power.' [3: 2076-7]

4C: 'Yeah it's good to have it, definitely, but I just don't really see the point in having a rainbow representation. Unless you're a bit ditsy.' 4A: 'I think those are good actually because if someone says you're doing badly it doesn't mean much but if you have representation, red is a very effective colour for bad and green is universal for good.' 4C: 'I agree but I just don't think a chart like that where it just goes up and down, because you'll just be like oh I'm a bit in the red I wouldn't, I don't know, it's not visual enough for me. ... Well its fine it's just personally I'd want a more visual representation if you're going to do the colour thing. If it said the kilowatts in red rather than having the bar.' Exp: 'So if the numbers changed colour?' 4C: 'Yeah. That would be more visual for me.' 4A: 'The only problem with this is its too short term. As in it only shows you today and yesterday so if you had a bad day yesterday, a bad day today, you'll think O.K forget about it we'll have a new day tomorrow.' [3: 2086-93]

The 'speedometer' dial of slide 13 received mixed reactions:

Exp: 'How about dials? ' 1A: 'That's a good idea I like that.' 1E: 'I don't like the dials.' [3: 420-2]

3E: 'I think most adults can relate to that. Not even adults, when you're younger you could look at your parents, just everyone's used to a dial whether it's petrol or speed or something like that we're used to it, it's a familiar image.' [3: 1417]

4C: 'Yeah see personally I prefer that, but that's just a personal thing.' [3: 2098]

One group liked the dial, but again suggested ways of delving deeper:

Exp: 'Which do you prefer? That linear rainbow diagram or the dial? They're saying the same information.' 3A: 'The dial.' 3B: 'The dial.' 3E: 'The dial because instead of just being green to red you can see on the dial the amount that you're using, you can see what sort of end you're on or what degree you're on.' 3A: 'It's also giving you the actual appliance as well. Oh my god the light is using all of that.' 3E: 'Yeah.' 3F: 'I think you can incorporate both of them...Have the slider as the total for everything and then have this for individual ones!' [3: 1423-31]

Only one group mentioned graphical representations as being key to uptake:

3C: 'Yeah I like the simple one. The simple ones with a lot of detail.' [4: 1566]

3B: 'I like the one with the line graph where you can compare days and stuff.

Where it also had underneath where you could add notes to it so you knew

11:00 that's where you know what you did to make it go up or down.' [4: 1569]

3B: 'Yeah. I also liked the idea of having the meter that changes colour. I always thing that that sort of is your clue, it's quite quick, oh god it's in the red. I'll turn off the lights or something or I don't need the TV on now.' [4: 1573]

Any graphical representations should be simple, with complexity presented on demand by the user ('drilling-down'). There was no consensus on bar or line charts, although dial and rainbow metaphors were well received: optionality would seem to be required here, with users able to select their preferred format.

Emoticon

One group came up with the idea of representing energy saving performance using affect, through a game involving a pet animal:

3E: 'On my phone I've got a little app that shows me the battery on my phone and it's a little cat and you can play with it and feed it.' Exp: 'Like a tamagotchi?'

3E: 'Yeah. It's face gets really really grumpy if you're really low on battery and then you feed it and play with it a bit more, charge it and then it gets happy again. That's probably a bit more of a girly thing. I think that would be quite fun. Then the better you were doing the happier your animal is. If you're being really bad and not turning any lights off it gets all grumpy with you.' 3C: 'It could die.' [1: 1153-6]

When the emoticon on slide 17 was shown to participants, it was seen as a simple and direct way of communicating information, but perhaps as too condescending, suitable for children rather than adults::

1D: 'I think it would be quite depressing wouldn't it getting little frownies all the time. Nothing you can do about it.' 1E: 'I think maybe just show you the good news and not the bad news. So give you a nice smiley but nothing when it's bad news you are quite able to judge that yourself.' 1D: 'Yes try and aim towards having a smiley.' [3: 436-8]

2B: 'I quite like that system. It can be quite juvenile but I think it gets the point across.' [3: 945]

3A: 'It'd probably be more simple, for like you say, using it for you're trying to teach children and stuff as well, but rather than a bar graph and stuff as well, just the face and maybe the budget and stuff because the graph seems to be a little bit...' [3: 1442]

4C: 'Maybe it seems a bit simplistic as well, that's probably good for kids, you get something on your face if you do this today, but I'm not exactly going to be like oh yay I got a smiley face for my energy use.' [3: 2125]

One person felt that it might have an adverse effect:

4D: 'Thick people would see it as a game then. You start when you drive through villages and there's those flashing light happy faces and then you put your foot down it changes. So it will be 28 miles per hour and it will be smiling and then I'll put my foot down and it's 31 and then it will be unhappy.' [3: 2120]

and one group tried to ground the emoticon in terms of cost:

4B: 'The smiley face should be replaced with how much money you've saved.'

4C: 'Yeah.' 4B: 'If you're reminded of the extra money that you will have.'

4C: 'A dollar sign or something.' 4D: 'But it's nice to see a smiley face.' 4C: 'I think if you had, O.K this sounds really immature but if you had a little money with a smiley face, you know those paper clips on word?...But it's money instead, then if you didn't it would be like, I don't know. Sad face on money.' [3: 2126-35]

In the final stage, the appeal of the emoticon as a simple way of informing children was seen as a positive feature:

3A: '... I also like, I don't know the name, what you said about teaching younger ones it's good to get them at a young age. Like my son, I'll say look it's a smiley face or it's a sad face we better go switch some lights off.. ' [4: 1581]

Any use of emoticons should be seen as additional to the main display of information, rather than as the central approach.

Units

In the prompted stages, when discussing different ways of presenting energy consumption, there was a clear confusion about the meaning of units displayed on prototypes:

4B: 'It's kilojoules per hour isn't it? Or is it temperature?' [3: 1925]

Few people were really confident about what a kilowatt-hour meant:

Exp: 'Do you know what a kilowatt hour is?' 2C: 'No.' Exp: 'Do you know what a kilowatt is?' 2C: 'I do know what a kilowatt is.' ... 2B: 'Wouldn't it be easier to have it in watts? It would be more understandable.' [3: 866-877]

3A: 'I don't think I've seen something that says oh you're using so many kilowatts and I'd be like what is that.' 3B: 'Yeah how does that compare to what I should be using.' 3A: 'I wouldn't know whether 500 kilowatts is really really high or really really low.' Exp: 'Do you all know what a kilowatt is?' 3A: 'Not really.' 3F: 'I do.' 3A: 'I've heard about them.' 3B: 'I think they need to make it more sort of, because a kilowatt, you could just throw around a kilowatt, most people would say oh a kilowatt I don't really know what that is. So you could say this is the equivalent of using this, it could power this, the amount that you've used in a week of a month you could power X Y whatever it is.' [2: 1228-43]

3B: 'It's not just confusing it's a bit out of context. Great I know I've used .012 kilowatts, that's my peak. Great.... is that a lot because I wouldn't know that's not a lot. I wouldn't know that actually I've done quite well. So it needs to be put into context you need to say you've done well today you haven't used a lot of energy or you haven't used a lot of gas.' [3: 1354-6]

Exp: 'do you know what a kilowatt hour is?' 4A: 'Not really.' 4C: 'No.' 4B: 'Is it an amount of kilowatts?' ... 4C: 'I don't know what a good amount is though.' Exp: 'Yeah, how much do you think boiling a kettle uses?' 4A: 'I have no idea.' 4D: 'Three.'

People were much happier with the idea of presenting cost:

Exp: ' Do you prefer to have cost or kilowatt hours?' 1B: 'Cost.' 1D: 'Cost.' 1E: 'Cost you can relate to.' Exp: 'Basically it's all going to be the same. What do you prefer it to be labelled in?' 1D: 'Cost.' 1E: 'cost.' 1C: 'Cost' 1A: 'Cost' [3: 373-381]

1E: 'I like pence per hour.' [3: 416]

Exp: 'But you don't really have a feel for how much a kilowatt hour is.' 4D: 'If that was in money though. If it was like 20p.' 4C: 'Yeah. It would be more relatable.' [3: 2013-5]

4C: 'I think generally people would probably look at the money more.' 4D: 'yeah but then they've got the kilowatts per hour.' [3: 2085]

Physical units such as kWh or joules should be avoided, and consumption expressed in financial terms wherever possible.

Motivation

In the first stage, several reasons why people might want to use an energy saving app were suggested. Saving money was one:

1B: 'Hopefully it would save you money, if it would save you money I would use it.' [1: 34]

4D: 'You could reward them for energy saving....give them money off their bill.' [1: 1686-8]

Environmental awareness was also mentioned, linked to 'fear appeals' based on the negative consequences of not saving energy:

2C: '...we would talk about how the environment can influence us and if you have pictures on there with something that used to be gorgeous, lots of trees lots of plants and now just basically barren that would shock someone that's into nature. Oh gosh what I'm doing is this the end result. Or just general depressing pictures and get them going.' [1: 704]

3E: 'I'm quite the eco-warrior so I don't know if it would be more for me about saving money because, especially when you get all your bills covered for you because mine doesn't really count that much but you can see the impact that it could have later on. Because I'm a big fan I recycle and everything but I don't really think about electricity that much but if it showed you bad things that could happen I think that would be quite good. ... I suppose when you watch documentaries and all the polar bears are drowning because all the ice caps are melting and then you're like oh god I have to do something, I'd get more sort of, I don't want polar bears to die.' [1: 1127-31]

4C: 'For the environment. You should try and make it a bit graphic if you're trying to. Most people would just put it out of their mind, that it does affect the environment. They're like yeah I know if you leave the light on it's not good for the environment but you don't really know you directly it effects it.'

4B: 'if you just, I don't know how you would do it, but every time you use a certain amount of energy it shows exactly how much environmental damage it was causing.'4C: 'Maybe if you did it like, if you'd been really bad it will show you one of those really horrible adverts where there's polar bears falling from the sky and stuff. Have you not seen this advert? There's this advert, it's horrible, it's these polar bears dying by falling through the sky and then there's blood everywhere, oh god, it was pretty disturbing. ...' 4A: 'I think there is a point there because out of sight out of mind, if you're not thinking about the environmental effects you're not really worried about it, but if you're being constantly updates you're going to be more environmentally minded.' 4C: 'You don't want to bombard people with....'

4B: 'They should have a choice.' 4C: 'Yeah.' 4B: 'You could have it for money orientated or environmental orientated.' [1: 1664-79]

In the prompted phases, saving money was again mentioned:

2B: 'It would have to provide some sort of figure initially and then maybe it could relate back to your everyday life so per minute this is costing you so much and then maybe do comparisons that maybe say if you do this you can reduce it by this much.' 2C: 'I like that idea.' 2B: 'So yeah it would be a money incentive.' [2: 766-8]

2C: 'Also you could use simple, the ways to describe it, this is how much it costs per month in terms of a normal house hold in terms of energy and potentially that amount of money could buy you a holiday in the Caribbean, you know that sort of thing. Just simple ways, you think wow I'm possibly using that much in my house per month I could use that money to go on holiday.' 2B: 'Yeah it could translate into if you were to do this you'd save this. Using that money you could do whatever.' [2: 781-2]

2D: 'Nectar points you could use for a day out or something. But if the points are just there because you're getting points and you can't use them for. Students all love deals and stuff.' [3: 955]

4C: 'You know we said earlier with the suggestions, it will come up with suggestions about how you can save energy or money, if it did that then it could obviously ask questions when it suggests, so it could give a little bit of a reward by saying you might be able to save some money by answering the questions.' [2: 1776]

4D: 'Would a positive reward not be that you save money I'll stop annoying you.'
[2: 1867]

Other ideas again mentioned environmental impacts and fear appeals:

2B: 'Probably have to go down the route of well this is how it's going to affect the environment. So do sort of a classic polar ice kind of thing.' 2C: 'Ideally it would be great to have... something that would stop people from having that oh it's nothing to do with me I don't use energy to kind of get everybody on the same wave length and take the same amount of responsibility because that's a problem, everyone is divided, you get some that will assume they are saving energy and it doesn't apply to me.' [2: 779-804]

However, it was apparent that these would not work for everyone, and that perhaps customisation would be needed so people could choose, although there were disadvantages in terms of complexity:

3E: 'Then it's a bit like you wouldn't do it for you you'd do it for other people. You wouldn't get the good feeling that you get, I don't know you only get a good feeling when you do something good and you're like I've done this for myself, but if you're trying not to look like you're killing the planet, if you do it for that reason, that you don't want people to think that about you, you don't get the yay.' 3A: 'Its different reasons though isn't it. Like you say you're an eco-warrior, for me I would do something, but there's not enough people out there that would, my input is not going to make any difference so I'm all in it for saving money whereas you're probably in it for saving the environment and stuff, so it's going to be like different motivations.' [3: 1480-1]

4C: 'Well if you have the choice of being environmentally motivated or financially motivated and it reminded you on whichever one of those I think that would be good because where I come from is a bit hippy dippy, they're all kind of well off so they don't really worry about the money but they will

all where hemp clothes and stuff like that and worry about the environment.'

...I think having a choice is probably good because then it gives you different types of people.' 4D: 'I think giving people a choice would be too difficult for them. Imagine if you wanted to save money and be an eco-person. I think it should just tell you you've saved this much money and saved a child in Tibet.' [2: 1871-]

The points and badges of slides 18-19 were recognised as a way to engage people with the app:

1B: 'To keep them using the app isn't it....gives them an incentive to keep using it.' [3: 393-6]

One person struggled with the need to motivate people and turn a challenging activity into something easy and enjoyable:

4A: 'I think people would be more willing to do it if it was less of a chore because saving the world, it's not fun, it's not easy, something like this should be made into quite an active, something that you feel better for doing. Instead of just thinking oh god I forgot to turn the light off.' [2: 1863]

4A: 'I think that's important though that it's able to do everything itself, well not itself but you know, not have to rely on other apps to help it because with too much effort people just can't be bothered anymore.' [3: 1917]

4A: 'I think positive reinforcement is better than negative. I mean scare factor people do get defeatist. They're like oh there's nothing I can do. The world's in the darkness as well. Saying to someone you are making a difference is far more encouraging than saying you're messing this up for everyone else.' [3: 2132]

In the final stage, motivation focussed upon saving money rather than reducing energy use:

Exp: 'How would you know when it's helping?' 2B: 'If costs went down.' 2D: 'Yeah I'd want to see some sort of result if I've used it for a while.' Exp: 'Results in terms of it showed you your behaviour had changed, would that be a sufficient result?' 2D: 'The money obviously everyone's more focused on. So everyone will be looking at that.' 2C: 'if I'd achieved what I aimed to achieve I'd probably just forget about using it. Stop using it.' 2B: 'Yeah I

suppose something like that where you could have an option for a graph to say that your usage has gone down. You could have a section for results so you could say you've saved this much since using this app. With different ways to view it.' [4: 1068-75]

Exp: 'So money saving is the primary...' 4C: 'I think that's the primary motivator for most people.' 4A: 'Yeah.' 4C: 'Because it's a selfish views, everyone wants to help the environment, everyone knows if you save energy then you help the environment but unless you put it into context of you're also helping yourself then it's a little bit difficult to motivate it.' 4A: 'Yeah.' 4D: 'Yeah.' 4A: 'I think they come hand in hand as well you know because especially if you make it so that if by saving money you're saving the environment people will do it.' [4: 2340-6].

Short-term financial consequences dominated the discussion in all of the groups, but there was a realisation that for some the longer-term environmental benefits of behaviour change might be worth presenting. A jaded awareness of fear-appeal visualisations (e.g., polar bears on melting icebergs) suggests that such negative approaches to the consequences of energy use would have limited effect. Positive consequences were not mentioned often (e.g., 'saved a child in Tibet') and might thus have more impact, through being novel and unexpected.

Discussion

The qualitative topical analysis of the four focus groups' discussions indicates a distinct expectation that the application should save them money. Coupled with this is the view that it should display information in a financial or cost-based format rather than in physical units. This was apparent even when the idea of an emoticon was proposed, as it was turned into an idea of an animated coin. After the first group, we had worried that this focus on money was due to our emphasis in recruitment on paying utility bills, but it recurred in the other three groups, some of whom lived in halls of residence and did not have to pay bills. In any representations of the costs of energy use, and the benefits of energy saving, making the amount of money saved very concrete would be useful: it might be helpful to scale it up as costs or savings per year to increase the dramatic effect.

Summarising consumption by time period (especially day, which would help people to use retrospective recall to identify activities or device usage that had caused rises in consumption), by rooms, and even by devices would be welcomed, as would relating consumption to a personally tailored target or baseline amount, and to normative comparisons (e.g., a typical person / household

like you). These summaries would be more informative than simple amounts, which were seen as meaningless when out of context.

Data entry on first use was expected, and indeed seen as necessary to let the application deliver advice that was targeted to the individual's situation. It would prevent spurious or irrelevant suggestions being made, and would support the formation of initial consumption targets. After the initial setting-up period, data entry should be avoided, but some use of the camera to scan codes or to take pictures around the home or of devices would be acceptable: it might actually encourage use of the app and act as an environmental cue to engage in energy saving behaviour.

While seen as useful when mentioned, integrating meter-reading functionality into the app was not seen as a key attraction, although it would perhaps encourage people to pay more attention to their meters. Difficulty of accessing meters, and a lack of awareness of what they displayed, were barriers to people using them to monitor their consumption.

Provision of basic energy related information for the specific devices owned would be expected by users: a fact-file or comparison between potential purchases. Similarly, comparison of the tariffs of different energy suppliers was mentioned: while not actually an energy saving measure, and likely to be used only once or twice, choosing between tariffs would be a useful feature to promote initial acquisition of the app.

Technology permitting, the ability to monitor each device's usage and to remotely control them would be welcomed – even the ability to turn on a device remotely would allow people to leave it off when away from the home.

Alerts should be used with caution: where they are specifically informative and directly help the person reach goals that they recognise as beneficial, they will be acceptable, but they do run the real risk of annoying users.

Games might play a useful function for users with children, who might prevent users from deleting the app if the game is attractive to them, but they seem unlikely to be a key attraction, and the idea of motivating people through awarding points or badges for achieving energy saving targets was not well received. Again, discussion turned to giving monetary rewards.

Social networking was seen more as a way of virally spreading uptake of the app and maintaining its use within a community of users than as a way of motivating people to change behaviour. As with use of alerts, the ability to post to networking sites on behalf of users should be treated very cautiously, but allowing people to provide (or pass on) tips to each other might enhance the impact of advice suggested by the app.

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