Energy Advisors at Work: Charity Work Practices to Support People in Fuel Poverty

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ABSTRACT

We present an ethnographic study of energy advisors working for a charity that provides support, particularly to people in fuel poverty. Our fieldwork comprises detailed observations that reveal the collaborative, interactional work of energy advisors and clients during home visits, supplemented with interviews and a participatory design workshop with advisors. We identify opportunities for Ubicomp technologies that focus on supporting the work of the advisor, including complementing the collaborative advice giving in home visits, providing help remotely, and producing evidence in support of accounts of practices and building conditions useful for interactions with landlords, authorities and other third parties. We highlight six specific design challenges that relate the domestic fuel poverty setting to the wider Ubicomp literature. Our work echoes a shift in attention from energy use and the individual consumer, specifically to matters of advice work practices and the domestic fuel poverty setting, and to the discourse around inclusive Ubicomp technologies.

Author Keywords

Energy; fuel poverty; low income; advisors; charity; non-profit; ethnography; home visits.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Sustainable energy consumption has become a major area for ubiquitous computing. The ability to measure both energy use and human behaviour has resulted in a wide range of Ubicomp systems to better manage energy consumption by developing more effective control systems (e.g., [36]) or promoting awareness of use to encourage behaviour change [7,13,32]. Ubicomp and HCI's focus on energy has largely been on providing systems for consumers, often requiring access to a range of digital devices with a presumption that these will be generally available and affordable. We are concerned that Ubicomp might benefit only those most able to acquire and install novel digital consumer devices.

Although poverty is a major societal concern, the practices of how people manage and are supported, and the resulting implications for Ubicomp have received little attention in the literature, with some notable exceptions [5,9,10,14]. We are interested in how Ubicomp might aid the work of professional energy advisors who provide advice and support to clients in fuel (energy) poverty. Fuel poverty is a key societal concern. Millions of people in many countries struggle to pay bills in order to maintain adequate heating and are exposed to the associated financial, physical and emotional effects [27].

This paper studies the work of The Centre for Sustainable Energy (CSE), a UK national charity with over 30 years of experience in providing energy advice to people in fuel poverty. CSE employs energy advisors to provide advice on a case-by-case basis, often in home visits. For example, their work comprises diagnosing the causes of health risks (e.g., damp and mould) recommending both material and behavioural improvements, and liaising with third parties to make the case for adjustments on their client's behalf (e.g. landlords, councils, and energy suppliers). Advisors currently suffer from a paucity of information about energy use in households that limits their ability to tailor advice to clients and to provide evidence when acting on their behalf; our work explores whether and how Ubicomp may mitigate this paucity and support practices in the advice process.

We present an ethnographic study, drawing on observations of home visits to uncover the work practices of energy advisors who advise people in fuel poverty in their own homes. To involve the advisors in the beginnings of a participatory design process, we also conducted a workshop with advisors to gather comments on demonstrations of seed prototypes. We draw on our fieldwork to discuss opportunities for Ubicomp technologies to scaffold the advisor's work in the home visit, supporting sense-making of the client's energy-related practices, and accounting for and providing evidence of both practices and property conditions that may be useful to support the advisor's mediating role with landlords, authorities and other third parties to improve the living conditions of their clients.

Ubicomp '14, September 13 - 17 2014, Seattle, WA, USA
http://dx.doi.org/10.1145/2632048.2636081

BACKGROUND AND RELATED WORK

We introduce fuel poverty, and review the discourse within Ubicomp and HCI on inclusion and engaging marginalised populations, the non-profit charity workplace setting, and related work on energy and sustainability.

Tackling Fuel Poverty

The European Commission suggests that people live in poverty "if their income and resources are so inadequate as to preclude them from having a standard of living considered acceptable in the society in which they live" [17:10]. In the UK this is generally interpreted as earning less than 60% of the median income; this applies to around a fifth of the population [48]. Many are in fuel poverty, particularly in colder months where energy bills are higher. A household is said to be in fuel poverty when they spend 10% or more of their income to maintain adequate heating and electrification. Millions of households are affected in the US (15.9m households in 2006 [34]) and Europe (9.8% of all households [43]). In the UK alone, 4.5m people were affected by fuel poverty in 2011 [8]. Vulnerable households (those including children, elderly, sick or disabled) are especially at risk [23]; recent statistics estimate 78% of vulnerable households are affected by fuel poverty [8]. In cold and damp climates such as in the UK, being unable to affordably maintain adequate temperatures paired with poor insulation may cause dampness that may even result in mould and the growth of fungi [46]. The health effects of cold homes are manifold, including respiratory problems (particularly asthma in children) and cardiovascular diseases, often contributing to 'Excess Winter Deaths' [27].

In the UK, fuel poverty is primarily affected by rising energy cost, low income, and energy inefficient housing stock (e.g., lack of insulation). The challenge is how to help clients break free of fuel poverty by raising monetary savings and energy efficiency (lowering energy cost is a further option, however usually only available to suppliers and policy makers). Therefore, information on available discounts, benefits, grants for efficiency improvements, and using a limited budget wisely is a key enabler to reduce fuel poverty. In the UK, this sort of information is provided by a network of 52 Energy Efficiency Advice Centres, funded by a combination of public welfare (e.g. the Energy Saving Trust) and charitable donations [16].

Inclusion and Marginalised Users

Our work relates to a broader discourse on inclusion and how HCI engages (or should engage) with marginalised and disenfranchised members of societies abroad and at home [15,21,41]. In particular, a complex set of issues and cautions to be mindful of has been highlighted, such as to "apply care and concern for what, exactly, is going on around us" [41:693], to acknowledge and account for local specificities and to embrace partiality in design (rather than attempt to abstract away and neutralise) [15], and to be sensitive to how uneven power relationships may be enacted in design practice [21]. We seek to contribute to this discourse, specifically to the emerging work documenting the ways in which energy efficiency, use, and advice practices are bound up in complex relationships between individual and organisational stakeholders [11,22].

Non-profit Workplace Settings and Design

We study the work practices of energy advisors employed by a charity in the UK. Non-profit settings have attracted HCI and Ubicomp research for a number of years. Research topics span across a range of issues, including information management practices in non-profit organisations [28], participatory design with community groups [29], inter-organisational ICT use, coordination and awareness [6,38], and the role of informal interactions [39]. Much like our work, this work has a focus on *work practice*, and draws on ethnographic fieldwork and participatory methods with a view to inform design; an approach popularised in early workplace studies in CSCW [33]. Research has also focussed on technologies supporting specific activities of non-profit organisations, such as fundraising [19], volunteer coordination [44,45], and providing information services to clients when resources are scarce [5]. Follow up work reports on the ways in which a deployed information technology mediated existing relationships between non-profit workers and clients [4], which emphasises the need for ecological, socio-technical design perspectives such as *infrastructuring*, that considers the "social and political work that the infrastructure is doing" [37:242]. Our approach is aligned with the view that ethnographic study of work practices is a key feature in the design process to gain such crucial socio-technical understanding [ibid.].

Energy and Sustainability in Ubicomp

Related Ubicomp research in energy and sustainability includes advanced sensing techniques for monitoring domestic energy use [20] and the display of this information to promote understanding and awareness [2]. The use of air quality sensing [24,25], and occupancy sensing to control home heating [36,47] are also relevant. Our work is aimed at developing an understanding how these principles and techniques of Ubicomp research in sensing, visualisation and actuation might be applied in an inclusive manner to support the broader process of charitable advice giving to communities that are unlikely to have access to the latest digital devices.

Particularly to fuel poverty, a study of energy use in low-income communities showed that barriers to saving energy were bound up with issues of lack of control and property ownership [9], and follow up research highlights that energy-related technology design for rented properties must engage with potential conflicts between tenants and landlords [10]. Such relationships between stakeholders are a key concern in our work; we seek to understand the broader socio-economic ecology of energy advisors, their clients, and third parties (e.g., landlords and councils).

THE ENERGY CHARITY

The Centre for Sustainable Energy (CSE) is part of the network of Energy Efficiency Advice Centres in the UK.

CSE states their goal is to help "*meet the twin challenges of rising energy costs and climate change*" [42], by sharing knowledge and experience to help people change their thinking and actions on energy through giving advice, managing energy projects, training others to act, and researching policies. CSE provides advice through three key forms of engagement with members of the public. First, the advice line provides the most accessible and general form of advice via a telephone help line, and is often the first point of contact for clients who may be referred for home visits when fuel poverty is evident. Second, advice is provided face-to-face in drop-in 'surgeries'; these are open events held in community centres. Third, and the focus of our fieldwork, energy advice is provided through home visits to people affected by fuel poverty.

The client group of CSE often deals with compound issues around language, education, employment, personal finances, health and bodily ability. As a complicating factor, people in fuel poverty often live in rented housing in poor condition that they lack the funds to improve. To give an idea of the resources put into home visits, in 2013 CSE has conducted 238 home visits to households in their local area. Of these, 163 took place in the colder months of the year (Jan-March and Nov-Dec), due to the seasonal nature of problems related to fuel poverty.

Energy advisors come from a diverse set of backgrounds. Most of those we have spoken to have a University degree, and some have further specific qualifications in subjects related to the environment, sustainability, or energy. In addition, many have prior work experience in local authorities or other charities. All advisors undergo the City and Guilds Energy Awareness training, a short full time course generally lasting 3 days that includes a final exam, and further training on the job before leading home visits.

Being a non-commercial and non-profit organisation, CSE is essentially (and existentially) dependant on funding. It is mainly funded by public bodies, government grants and charitable donations. Consequently, CSE has to manage on a tight budget; funding is strictly allocated to specific project work. Therefore, energy advisor time for home visits and related casework needs to be tightly managed.

STUDYING ENERGY ADVISORS

We conducted an ethnographic study of energy advisors at work. Our particular interest is to study the work practices that advisors employ, and how these can be supported. We provide an ethnographic account of the sequential ordering of activities (cf. [3]) that comprise the work practices underlying the provision of energy advice (see figure 1).

The ethnographic record comprises field notes and audio recordings of participant observations of 10 one hour-long home visits to fuel poor households with three different advisors. A researcher accompanied an energy advisor to observe *just how* energy advisors work and *just what* they do to accomplish provision of advice during the visit. Interviews and conversations with advisors were conducted to elaborate (an overview of) the work setting, only as an addition to the field observations. Informed consent was gained at the beginning of each visit. We also conducted an initial participatory design workshop with advisors.

We provide *"quotes from advisors"* throughout the next sections to let the advisors speak in their own voice, and to provide a feeling for the *members' glosses* that they use when talking about their work. In addition, we provide observations and fragments of dialogues transcribed from audio recordings of the home visits that display the detailed work of providing energy advice in home visits.

THE WORK OF THE ENERGY ADVISOR

This section provides a detailed account of the work practices involved in providing energy advice. The structure of this section follows the sequential accomplishment of the activities that comprise the job of work of organising and delivering the home visit (see figure 1). Before we begin unpacking the activities that comprise 'giving energy advice' (in home visits), it is worth considering the on-going 'office work' of the advisor.

Keeping up-to-date and managing information

Knowledge of the ever-changing landscape of funding schemes to help those in fuel poverty, supplier regulations, and energy efficiency measures is part of the essential repertoire of the energy advisor. The day-to-day work in the office is one of constant training, learning, and reading. One of the advisors takes on the job of maintaining the Advice and Information Directory, a large document with detailed information on what is available in particular areas.

In addition, there is the central Household Energy Services database in which information on all of CSE's active projects and their clients are recorded. This database presents a significant resource both for *"tracking clients, a client's contact with us, their journey, if you like." [Sara],* as well as for accountability purposes to funders, to put together reports and evaluations of projects. Shared electronic folders contain further resources, such as advice leaflets ('fact sheets' often handed out during visits), and information on buildings and heating types and so on.

Moreover, routine and regular face-to-face meetings with co-workers present a significant method to keep up-to-date and exchange knowledge. The on-going 'knowledge work' of energy advisors includes communication and information practices essential for giving up-to-date energy advice.

Leading up to home visits

CSE recruits most of its clients through referral from other organisations that work with vulnerable people. These 'frontline workers' are employed by local authorities (e.g., city councils) housing associations, or other charities. CSE may collaborate directly with local authorities on a number of projects, so some referrals may be designated to specific funded projects. Also, some clients are self-referred; they

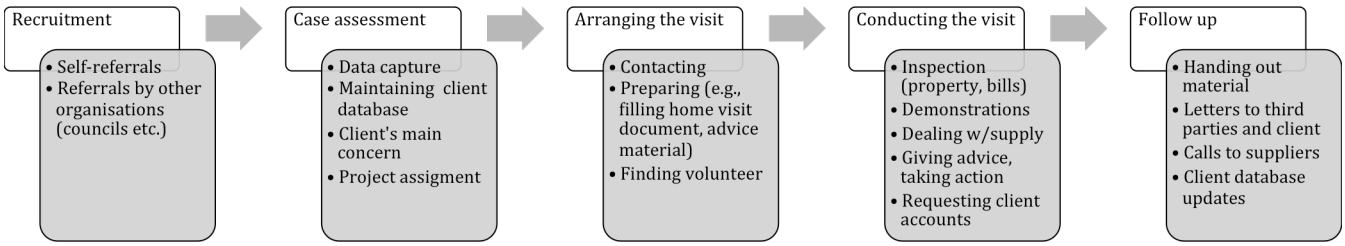

Fig. 1. Work practices of the energy advisor to accomplish giving advice in home visits.

may learn about CSE from leaflets and posters distributed to community centres, libraries and other public places.

Once a potential client has been referred, an advisor gets in contact with them (usually by phone), and records initial details in the Household Energy Services database. This process involves form filling to capture personal details as well as information about any social welfare benefits the client receives (e.g., tax credit and housing allowance), the kind of tenure, type and age of property, and details about their energy supplier and payment method, heating system and energy efficiency measures (e.g., insulation); and any case specific concerns. While the details vary considerably, concerns around fuel poverty tend to be around cold, damp and mould, and affordability of energy bills. Based on this initial information, the advisor confirms the project to assign the case to. All cases must be assigned to projects to match any required casework (such as home visits) to available funding. As a result of the assessment, the advisor decides whether to recommend a home visit.

Once it has been established that the client would benefit from a home visit, an advisor contacts (or is contacted by) the client to arrange a time and date for a home visit. The advisor then uses the client information already in the database to populate the Energy Advice Home Visit Survey document. Based on the information, particularly the kind of problem faced by the client, the advisor chooses additional printed advice material ('fact sheets')[1], and may consult the shared electronic document drive for additional resources on potentially relevant funding schemes, discounts etc. The advisor then needs to find a person to accompany them on the home visit to comply with personal safety policies. The advisor may contact volunteers registered with the charity, or they may take a junior advisor for training purposes.

Conducting the home visit

While the exact ordering of activities varies according to situational contingencies, the home visit comprises an identifiable ensemble of activities. The initiating activity is aimed at *establishing the main concern* of the client. The advisor would often draw on prior knowledge of the client's case to introduce the matter, often by referring to the (partially) pre-completed Energy Advice Home Visit Survey document. The advisor begins the work to reduce the uncertainty of what caused the main concern *"Quite often you spend an awful lot of time figuring out where the energy waste has come from or why the bills are high. It's a bit of detective work really." [Leila, in the workshop]* The advisor uses the survey form to confirm or complete the client's details. The document provides a sort of template structure for the visit and is used as a means of note taking by the advisor (it is often carried around the property on a clipboard). The form is completed either in an interview-like fashion or interspersed with the *property inspection.*

The inspection focuses on the *installed equipment* that forms part of the infrastructure of the home (e.g., heating system, extractor fans and insulation, rather than gadgets or appliances), and the *problems* (e.g., dampness) in the property. The inspection typically follows once the main concern is established, and involves looking at and/or talking about the heating system (radiators, thermostats, timer and boiler), the insulation (windows, loft, walls), and the gas/electricity meter. Symptoms of problems are inspected (if applicable), such as draught, damp and mould. The inspection typically also includes looking at one (or more) copies of a recent energy bill; although the bill inspection typically comes after the property inspection.

The observable and reportable *work of inspecting* actually goes beyond mere inspection of the equipment; what is inspected and called to account is the client's usage of the equipment, and their everyday practices surrounding its use.

Demonstration

A key feature of the inspection, then, is *demonstration*. Demonstration is conducted both by clients to support their *account of how they use* the equipment, and by the advisor to *demonstrate proper use* of equipment, for example a timer or night storage heaters. Advisors may also use demonstration to *explain* how equipment works (as displayed in fragment 1).

Fragment 1 (HV7). *Advisor (AD) and client (CL) standing next to storage heater. The client is a 73 year old man, who has not used the night storage heaters in his apartment since his wife died a few years ago. It is cold, we all wear winter jackets and hats inside. The advisor is in the process of demonstrating how to use the heater.*

CL: *Pointing at output dial.* So, if I... if I... which way do I put it? That way, to nought, to knock it off?

[1] A complete list of the fact sheets can be obtained from http://www.cse.org.uk/resources/energy-advice-leaflets

AD: Yes, if you twist it like, yes, like that. (*Turns dial to zero.)* So that's on nought now.
CL: And then I put it to...
AD: And that turns... (*Turns dial back to two).* Now it's on two, so that's open now. (*Points at heater vents.*) (…)
CL: Oh, right. And then I knock it off in the night, or do you leave that?
AD: If you... when you go to bed, turn it off.
CL: Right.
AD: So that, that is... can you see the thing in there? (*Points at flap underneath heater vents, inside the heater.*) (….) it's opening and closing. That flap keeps more heat inside there. So, if this is turned down, it's closed. If you turn it down, you can, actually, see it in there. See that thing moving around? (*Pointing again, with his finger touching the vents.)*
CL: Yes. I can see it now, yes.

The interaction in fragment 1 displays the work between advisor and client to ensure the client understands, not just how to operate the night storage heater, but also the way the heater works (i.e., what the 'output' dial does), as suggested by the final utterance (I can see it now, yes). Explanation and proper usage of the equipment is further embedded in the client's everyday routines (when you go to bed, turn it off).

The deictic character of the language and the use of pointing is a key feature of the situated nature of the interactional reasoning at play. The advisor explains the heater through *making visible* cause (turning the dial) and effect (flap opens), and repeating the action until the client confirms he has seen it.

In addition to this kind of physical demonstration, the advisor may also use an energy monitor to make visible just how much electricity that equipment and appliances use. The following fragment illustrates the use of a monitor in this way.

Fragment 2 (HV5). *The advisor (AD) has just inspected the meter and temporarily attached a CT-clamp. The client has only lived in the property for a few months, but was concerned by a relatively high electricity bill and struggled to reconcile this with her usage. Client and advisor have entered the bathroom.*

CL: Does the shower use much?
AD: Yes, it does. I mean, we could try that now to see; showers usually…(*Reading monitor.*) So it's on 0.09…
CL: So that's with the light on…
AD: … we'll see how… how much this changes it. (*Turns on electric 'power shower'.*) It does normally… can take… (*Looking at monitor*). Okay, so it uses 8 kilowatts an hour, or 8.3…
CL: Hmm-hmm.
AD: So if you were to use the shower for an hour…(…)
AD: … based on your tariff rates it would cost… probably about £1.20 an hour, so…
CL: Right, okay. What if I put this on? (*Turns on wall-mounted electric heater.)*
AD: Yes, if you put… Put that on. So that uses…(*reading monitor*) that's gone up to 9.7 now, so it uses about 1.2. So, yes, if you had that on for say an hour it would use about… it would be over 15 or 20p. The thing is as well, it doesn't sound much on its own…
CL: No [overtalking].
AD: … but if you think about it, every day…

They move on to the kitchen, where the oven and the electric hob are switched on and the advisor converts the power values into £.

Fragment 2 shows how the advisor makes use of the monitor during the inspection to make visible the electricity used by the electric shower in the bathroom, an activity the client co-engages with by switching on the heater. *Making visible* again is accomplished by demonstrating cause (switching on) and effect (power consumption going up). Moreover, the advisor quickly converts the power values into monetary terms based on knowledge of the client's actual rate, which the advisor has noted when inspecting the bill earlier. In the workshop we learned that advisors routinely convert units into monetary cost when speaking to clients. The episode ends with the advisor reminding the client that the values will add up over time.

Dealing with energy supply, bills and tariffs

The tariff and supplier landscape is notoriously complicated in the UK, which has recently prompted the energy regulator ofgem to oblige suppliers to offer simpler, clearer and fairer tariffs [31]. Switching providers, in particular, is difficult and can be associated with a penalty if a current contractual break clause is not met. The advisors were hesitant to recommend switching suppliers: "*I tend to not encourage it as much (...) I tend to be on the side of trying to get the best out of the supplier that you've already got." [Leila, in the workshop]*

Lily summed up the issues with energy suppliers during the workshop "*Tariffs are very confusing, switching companies is very difficult, and bills, basically very few people understand them.*" A key part of the home visit is to inspect a recent bill in order to understand the client's (alleged) consumption, tariff and costs.

"The other thing that I find really confusing is just how different the bills are from the different suppliers (...), even from the same supplier households have different bills depending what tariff they're on. And I've seen loads of bills in my time at CSE and I've seen one the other day and I just couldn't understand what has been paid for. (...) And you end up phoning them and - it's just a minefield really." [Leila, in the workshop]

Phoning the energy supplier may help the advisor to make sense of the bill, but primarily it is an immediate way for the advisor to take supportive action. In order to gain permission to act on behalf of the client a Client Authorization Form first needs to be signed, and permission that they are happy for someone to speak on their behalf needs to be granted again during the call to the supplier. The advisor sometimes has to make a considerable effort to mediate between energy agent and client, repeating and rephrasing to the client what was said.

The exact purpose of the call varies according to the client's concerns, however the main purposes are to ensure the client is on the most appropriate tariff and payment type, does not pay more than necessary, and receives all the potential discounts (e.g., the Warm Home Discount is available to people over 75 years of age and some vulnerable groups on a low income).

Bills in the UK are often based on *estimated* consumption, so in order to reconcile estimates with actual use the advisor submits actual meter readings to the supplier that they have noted down during the inspection. The meter inspection may also prompt the advisor to establish whether the client knows how to 'read the meter', and if not, demonstrate how to do so.

Fragment 3 (HV1). *The client is troubled by high electricity bills that are probably caused by a faulty night storage heater. The bill inspection showed the bill is based on estimated usage, so the advisor has noted down the actual consumption displayed by the Economy 7 meter (two rates, one for day and one for night time consumption).*

AD: […] shall I just show you with the meter - like how to - how to read it? ahm. Okay. So if we go back to the - (*gets up and moves back to meter*)
AD: Okay. So. So you've got the low - and then the normal.
CL: Uhu.
AD: So the low will be how much you've used between 12 and 7. You know on the cheaper tariff. So from 12 midnight until 7 it's a cheaper rate.
CL: Til 7 am.
AD: Am. Yea. So - 12 midnight unitl 7 am. Ahm. You have used - 01722
CL: So - which one is- which one?
AD: So that's the top one and it says low.
CL: top?
AD: Yeah. The top and it says low on it. That means the low rate.
CL: (*Leans in and points*) This one?
AD: Yah. And you read it from left to right- So 01722- Do you want to get in and I'll-
CL: What about the other?
CLD: (*Points at dial.*)
AD: No you don't- that's ahm- You don't need to worry about that- that's just the dial going round so when that gets up to- 9 -that will change to 3.
CL: Alright. (…)
AD: And then the normal is from 7am until 12 midnight.
CL: Uhu.
AD: Okay and- did you get the number?
CLD: 30635.
CL: So both of them are 5 figures.
AD: Yah. So both of them are 5 figures- yea (…). And just read them from left to right. But ah- I've got a fact sheet here so I can leave that with you so then you know how to read them in future.
CL: Okay.

The interaction between client and advisor displays the accomplishment of 'showing how to read the meter'. To 'read the meter', of course, is a *member's gloss* for a routine activity that involves identifying the displays on or near the meter, and associating labels ('low' and 'normal') with tariff structure (night time and day time usage), and drawing on experience that electricity-only properties with night storage heaters usually have Economy 7 meters (two rates) and so on. The client displays co-engagement in the activity through their requests for clarification and pointing actions (Which one?, This one?, and What about the other?), and crucially the client's present adult daughter (CLD) then correctly 'reads the meter', suggesting the demonstration has been a success. Finally, the advisor hands over a 'fact sheet' containing information how to 'read meters' (so you know how to read them in future). The fragment evidences that giving energy advice successfully is a *mutually accomplished collaboration* between advisor and client.

The highest discounts on tariffs in the UK are usually only available to customers who agree to pay by direct debit (standing order). However, many in the client group CSE is working with either don't have bank accounts, don't trust the supplier to take more than what is owed, or direct debit is simply not an option because of debt problems and low credit ratings. Moreover, many live in council properties fitted with prepayment key card meters (6 out of 10 clients visited). Advisors report that they do actually recommend prepayment for some in order to stay out of (further) debt; however trouble with these is, as Leila put it in the workshop, "[…] *you don't get any discounts, and you can cut yourself off, you can be without gas and electricity in the winter, and it's awful to think that that's the best option for some people because you're paying in advance."*

Giving advice and taking action

How then, in the face of diverse material, financial and social issues encountered by the advisors is advice provided? It should be clear from the observations of home visits provided thus far that there is no one-size-fits-all solution; however, it is probably safe to distinguish the following broad categories of advice (or action):

- ***Smaller material changes*** suggested as 'Do-it-yourself tips' to help clients manage better with what they have got, or with what can be obtained cheaply or made easily.
- ***Larger material changes***, such as energy efficiency improvements that often involve third parties (e.g., landlords and the council).
- ***Changes in practices*** ('behavioural change'), such as operating equipment, heating or ventilating.
- ***Financial benefits or discounts*** either directly arranged by the advisor (e.g., by phoning supplier), or in terms of suggested future actions for the client to look into.

Suggesting DIY remedies and behaviour change to address the problems may be the charities' main forte, given that expensive upgrades are often not an option for the client. This kind of advice would often be given orally to the client during the property inspection, and in many cases supporting material ('fact sheets') outlining the remedies would be handed out towards the end of the visit. Depending on the type of problem the client is facing, the advisor can draw on a repertoire of DIY remedies and behavioural suggestions, an essential resource to provide energy advice. For example, if the problems are around damp and condensation (mould is a symptom), the advice is to keep doors shut while cooking and bathing and ventilate afterwards using windows and extractor fans (if available), avoid drying clothes on radiators (ideally, clothes should be dried outside), and to heat rooms a little more if possible. If the problems are cold or draughty homes, DIY remedies include fitting thicker curtains, avoid blocking radiators and

fixing heat-reflective foil behind radiators, making draught excluders, and wearing more clothes.

To give an example of a DIY advice that seemed to be particularly effective, the advisor suggested the client should use a newer, more efficient oil-filled (mobile) electric heater that the client declared was "only for emergencies" instead of the older and less efficient wall-mounted electric heaters in the two bedrooms. Here, the advisor draws on their prior knowledge of the efficiency of different electric heaters to provide advice particularly relevant because it is focused on making better use of equipment the client already has at their disposal.

Requesting client accounts of practices

One of the most challenging aspects of the job of work of the advisor is to give behavioural advice, such as suggestions of changes in operating equipment. In order to do this, the advisor first needs to gauge the client's routine practices and ways in which they usually operate equipment, etc.

Fragment 4 (HV1). *Client and advisor are standing next to the (presumed faulty) storage heater, the advisor is just starting the inspection.*

AD: D'you know how the electric storage heaters work?
CL: Ya at night we just press this one (*points at ON switch*) one.
AD: Okay. Yah.
CL: And during the day we switch it off. Its (1.0) (Can you see it)?
AD: Yes ahm:: so you=
CL: =press this (*points at OFF switch*) one=
AD: =press that (*points at OFF switch*) one
CL: Yah.
AD: Ya. Okay.
CL: and then: I press this one:: And this (*points at DIRECT switch*) one is:: (1.0) direct electricity
AD: Ya.
CL: If you press this one the electricity comes direct.
AD: Ya.
CL: So: which is very expensive- we never used it this
AD: Okay so its just (1.0) it sounds like you're (2.0) it does sound like you're using them in the right way

The advisor opens their inspection with a question whether they *know how the heaters work* that prompts the client to start *demonstrating* how they *use* the heater, making sure the advisor is watching (can you see it?), demonstrating by pointing at buttons in the sequence in which she pushes them to operate the heater. The client in effects is making behaviour *accountable* that is not naturally observable at the time of the visit. This makes her actions observable and reportable to the advisor, who is in turn able to make an assessment of the way in which the heater is apparently operated ("it does sounds like you're using them in the right way").

The case of assessing the way the storage heater is operated is more straightforward than is often the case with more complex problems that affect the ambient living environment (e.g., cold, damp and condensation). Particularly with mould, it is often a combination of structural inefficiencies aggravated by excess moisture (produced by people), so advice is often a combination of suggesting installation of equipment to help (e.g., extractor fans) and making people account for the relevant actions they might take in response (e.g., whether they keep the doors shut when cooking, etc.)

Mediating between clients and third parties

The importance of the client's accounts of (relevant) routines and practices becomes particularly evident when considering the advisors' (and the charities') role as a *mediator* between tenants (clients) and landlords, and other third parties such as the city council (a significant proportion of people in fuel poverty live in public housing). Landlords and the city council may be contacted by the advisor with suggestions of larger material changes to the property, such as necessary repairs (e.g., leaks), improvements to help with damp and condensation (e.g., extraction fans), or energy efficiency upgrades to the property (e.g., insulation and draught proofing). However, the charity has to be diligent in their inspection of the property (including an assessment of the client's routines and practices) in order to be seen to ask for reasonable improvements and to have done a 'good job' of reminding tenants to do their bit, as it were. Presumably, the charity's reputation is key to be taken seriously, particularly when appealing to goodwill and putting under 'gentle pressure' is the primary remit when asking third parties to improve their tenant's living conditions. The purpose of holding clients to account for behaviours is then more than just to advise people what they can change themselves, it is part of the advisors own accountability to her employing charity, and, in turn, the charity's wider accountability to its funding bodies, and network of organisations it is part of.

Concluding the visit and follow up

At the end of the home visit, the advisor hands out any relevant material they have not yet provided (e.g., 'fact sheets' or a thermometer card), and summarises the follow up actions they promise to do. Aside from updating the client's record in the charity's database, the follow up actions usually entail paper work for the advisor once they are back at the office, typically including typing up a letter for the client and (if relevant) to suggest actions to third parties (e.g., landlord or council). Follow up work may also include phoning the energy supplier, speaking to someone at the council (e.g., at the private housing team), or compiling follow up information such as on funding schemes (e.g., on the 'Green Deal' for insulation or boiler upgrades) or community switching projects. In some cases, the advisor may refer the clients to a different organisation better equipped to deal with, for instance, social or financial problems.

Beyond producing a paper trail of advice material, a follow up visit to for example to evaluate whether the advice has been put into practice, or to provide more of a guiding process, is out of scope of the very limited resources and budget that the charity has to contend with. *"[…] at the moment the ways our projects are funded we do one home visit and that's it. And we do anything up to one day of*

casework afterwards and that's it. [Nina, in the workshop]" Some advisors in the workshop have expressed a desire to learn whether the advice actually helps; an evaluation would also be beneficial to the accountability purposes that the charity has towards her funding bodies.

Sometimes word does get back to the charity that their recommendations have led to improving the living conditions of their clients. For example, in the case of HV1, the faulty storage heater has been replaced with a new one as the result of the advisor's letter to the council.

WORKSHOP WITH ADVISORS

In order to discuss opportunities for Ubicomp technologies to support the work of the energy advisor, we have complemented our fieldwork with a workshop with advisors. We conducted the workshop to begin a participatory process. We first asked advisors to each share the challenges they face on a daily basis, as reported throughout the previous section. The reported concerns were around the complexities of energy supply and billing; insufficient resources of clients and charity; lacking housing stock and unwilling landlords; their client's (lack of) motivation to change; and conveying information and talking to people, *"getting past people's embarrassment of lack of money, so that they talk more honestly". [Jane]*

We then demonstrated three interactive seed prototypes in turn, interspersed with discussions.

- *FigureEnergy* offers the ability to annotate the consumption data in terms of 'activities' or 'events' and then visually compare their impact on the overall expenditure [2].
- *AgentSwitch* predicts the yearly consumption to recommend switching to an energy tariff that could yield financial savings [18].
- *MyJoulo* analyses logs from an in-home temperature logger to create a simple thermal model of the building used to show how much could be saved by turning the thermostat down [35].

The prototypes were developed in previous projects on energy, although not specifically related to fuel poverty. They were selected to expose advisors to a range of capabilities, in order to solicit comments given the advisors' unique perspective, not to evaluate the individual prototypes. The prototypes had all previously been published within either Ubicomp or HCI and we believe they are generally illustrative of current approaches to energy within Ubicomp. They all share a number of common characteristics in that they are web-based, and driven by data collected in homes (electricity or temperature). Their functionality goes beyond just visualising the data (e.g., historic and real-time consumption). FigureEnergy and AgentSwitch rely on household-level electricity data; the reported deployments have made use of off-the-shelf CT-clamp sensors. MyJoulo uses temperature data captured for a week on a USB data logger, manually uploaded to a website.

The advisors were less enthusiastic about the more advanced technologies that provided suggestions based on data analysis (e.g., how much could be saved by switching). For example, while it was appreciated that AgentSwitch provides *"an accurate record of how much you could pay"*, it glosses over the specifics that complicate each case, such as current contractual obligations to the provider, *"it's all the bit that comes after that actually confuses people" [Leila]*. Instead, comments suggest that advisors saw the most potential in the interactive visualisations.

"What I really like are those graphs (…) people can see that they have peaks, see their energy use. I see a lot of families they (…) absolutely do not understand why, when they've been told they should pay 60 pounds a month, (…) that it's actually tallied in with their usage. So actually show people, when it goes up like this you're gonna pay more (…) so just really basic stuff." [Leila]

Such orientation suggests that these graphs could be used to scaffold the interaction between advisor and client rather than simply as a facility for clients to access directly. The presumption was that advisors would provide explanation of the nature of these graphs and help clients read them. In particular, representations such as FigureEnergy's visual comparison of energy-related activities were seen as intuitively legible:

"*I really like the idea of showing the usage by physical shape, cuz you haven't got to have any mathematical understanding, people can see the bigger lump is more than the smaller one*" *[Lily]*.

Consequently, the idea of having access to client usage data *before* the visit to improve the advice based on the client's own behaviour was also received as having much potential.

"The idea that you have a technology there… that you can actually have a look that can back you up, if you want to give a bit more specific advice in the home. You can make it, your advice around the home visit much better, because you know things before you go there, or you can see things, the data, while you're there. That was really valuable, and I think could really help to improve the quality of the advice we give." [James]

However, comments in the workshop also confirmed that clients might not have access to digital technologies. *"A lot of our clients - they don't use computers at all,...[Nina] (…) and they don't have broadband. And they don't have tablets, and they don't have iPhones." [Lily]* This suggests that while clients should also be able to access and control their own data, tools to help advisors interpret and explain the data to the clients should be based on an independent infrastructure.

OPPORTUNITIES AND CHALLENGES FOR UBICOMP

Herein we synthesize key opportunities for Ubicomp to support energy advice work, for which we discuss implications and design challenges, drawing on both the observations from fieldwork and the comments advisors made in the workshop.

Design opportunities: supporting energy advice work

Demonstrations in home visits were a key resource to support mutual accountability of action. In particular *making visible* what cause and effect has recurred as a methodical way of engaging clients, whether it was through manual operation of a heater, or digitally aided by an energy monitor to make visible the consumption of appliances. This practice shows strong potential to be augmented with Ubicomp, such as through visualisations of sensor data collected in client homes. Our observations emphasise the need for Ubicomp energy systems to move beyond eco-feedback to motivate reductions, echoing the literature that stresses that energy consumption is enmeshed in the ordering of everyday practices [40].

Opportunity 1. Ubicomp to enhance advice in home visits

The face-to-face setting of the home visit enables *performing* energy advice as a collaborative, *interactional accomplishment* between advisor and client, tightly linked to situated reasoning and action. We propose to *enhance* rather than replace this collaborative process; for example, by enabling the advisor to engage the client with suitable data representations, such as visualisations. The potential for visualisations is further supported by the findings from the workshop: advisors most welcomed the idea of showing clients the impact of their own activities *during* the visit, and thereby supporting the advice they are giving. The possibilities for Ubicomp point to a potentially useful system consisting of a *sensor kit* installed in people's homes, and *digital representation* of the data. The sensor kit may for example consist of a set of locally networked wireless sensors (e.g., temperature, humidity, electricity) configurable by the advisor according to the specifics of the case; and a lightweight sensor gateway and computing platform for local storage, data processing, Internet transmission and/or remote access (e.g., RaZberry Pi).

Opportunity 2: Ubicomp to support remote advice work

Providing remote access to an existing period of the client's energy data prior to the visit in order to give better-targeted advice during the home visit emerged as a key opportunity from the workshop. Remote access may enable advisors to interrogate the data for changes in client behaviour, or to compare data from different households. Related work shows that in order to interpret comparisons in a useful way, it is essential to have access to the 'social context' (e.g., knowledge of a client's routines) [12]. This highlights the need to frame remote access technology as complementary to direct advisor-client interaction, and not as a replacement for face-to-face interaction.

Opportunity 3: Ubicomp to support upward accountability

Beyond supporting immediate and remote advice giving, representations may also be used to support upward accountability practices of both client and advisor. Our fieldwork showed that clients provide demonstrations and oral reports as *accounts* of action to legitimise their asking for help; and in turn, advisors display an orientation to these accounts that reveals their own accountability to their employer and its funders for the advice provided, and to other third parties for the improvements requested on behalf of the client. Records of energy data may legitimise the client's accounts for energy-related practices, and data has the potential to make the advisor better informed and more confident in assessing the contributions that client behaviour and housing structure have on the overall situation. With appropriate privacy protection (especially given that many clients are vulnerable), interpretations of the data may also be provided as supporting 'evidence', when suggesting larger improvements to landlords, when reporting to funding bodies, and when communicating with other third parties. This echoes related work that has described endemic 'scale crossing' in the public sector as inherently related to this kind of upward accountability [6].

Implications and challenges: the fuel poverty setting

The nature of the fuel poverty setting poses a number of challenges for designers that we need to consider when designing supportive technologies. Our findings point to a multitude of issues the advisor faces at work, including the client's financial situation (e.g., bad credit history), the complexity of energy supply and billing, and the challenges of communicating advice effectively. While we endeavour to address the challenges through a participatory and iterative design process with advisors and clients in future work, we anticipate at least the following design challenges.

Challenge 1: Designing for configurability by advisors

First, with regard to opportunity 1, design challenges include that the advisor has to be able to *configure* the sensor kit with limited technical ability, for example selecting the appropriate sensors for the case at hand and connecting them to the sensing platform. The advisor's encounter of the setting in situ is essential to targeting advice; therefore, their assessment of the needs of the particular case should guide the flexible configuration of the sensor kit; for example, to ensure that the elderly single man we have visited is now able to heat his home, in an affordable way (HV7). The challenge is to offer sensor kit customisability for *local specificities* (cf. [15]), including home infrastructure, environment and the client's needs, moving beyond simply deploying an off-the-shelf solution.

Challenge 2: Sensing the symptoms of fuel poverty

When designing the sensor kit, the case of the elderly single man (HV7) epitomises that the symptoms of fuel poverty cannot be sensed by measuring electricity consumption alone. While electricity monitors may be useful for problems related to for example high electricity bills, they are insufficient to capture the extent of the more frequent problems people in fuel poverty face. Gas use typically accounts for the larger proportion of a typical dual fuel home with central heating (about 60% [30]). Also, many cases we have seen may benefit more from ambient environmental data, such as temperature and humidity sensing (low temperatures and high levels of humidity may lead to mould growth and may affect health). Ubicomp is well placed to address challenges such as detecting damp or

creating an early warning system; prior work has demonstrated for example humidity [24] and indoor air quality sensing [25]; and small form factor computing platforms become increasingly viable for data capture and connectivity to servers and visualisation apps.

Challenge 3: Data representations for clients and advisors
Both the home visits and the workshops confirmed that people in fuel poverty may often have lower levels of numeracy and technology literacy (literacy and numeracy skills are below average among the low income population [1]). Therefore, in order to complement the on-going social interaction of situated and collaborative sense making and giving energy advice in the home visit, we must respond by designing representations that are not only useful for advisors, but that can easily be explained to and read by clients. When designing for this context, we need to assume that while advisors may be tech savvy, clients may have little or no prior experience with this kind of technology.

Challenge 4: Designing for lack of access and infrastructure
Advisor comments and our observations highlight the need to consider that access to digital devices and broadband are likely to be limited. Beyond our own observations, recent statistics also show that more than half of low income households in the UK lack Internet access at home [49]. In future deployments, then, connectivity independent of the home's infrastructure needs to be provided; a common approach in many Ubicomp projects. Moreover, future designs should not rely on the clients independently engaging with the technology, e.g. through mobile apps or websites; instead, engagement via these channels should be considered optional and provided on demand.

Challenge 5: Supporting trust through privacy and consent
The client's trust in the charity is essential in order to accept and act on advice. Technology needs to take care not to impede on this sensitive relationship. In particular with regard to providing remote access and using representations in interactions with third parties (opportunity 2 and 3), user consent and data privacy are sensitive matters, which need to be addressed in such potentially intrusive deployments to enable *informed* consent by design [26]. For example, an on-going mechanism of consent and withdrawal may be implemented by providing an 'on/off switch' with which clients can disable data capture. Such privacy 'features' may also serve to enhance the clients' trust in the charity.

Challenge 6: Deploying with limited resources
The charity's limited resources pose a challenge to how deployments might best be done in practice. CSE's current project budgeting only allows for one visit. This presents perhaps the biggest practical challenge to future deployments of Ubicomp in fuel poor homes. In future work with CSE we will trial ways to address this, including employing volunteers, making the kit easy to mail or cheaper to give away for free; and conducting community workshops in which we train members of the community to install the kit in their relatives' or neighbours' homes. Resourcefulness in the face of tight resources is a trait (and sometimes necessity) echoed in the literature on non-profit workplaces (e.g.,[44]).

CONCLUSIONS

Addressing fuel poverty requires a key shift in emphasis. Rather than energy reduction, the approach has to be centred on encouraging wise energy use while keeping people warm and healthy. Supporting fuel poor households has to address the challenge of providing advice on how to make the most of what is there and to do so with minimal additional costs, whilst considering multiple stakeholders and their place in the wider socio-economic ecology.

We have presented an ethnographic study of the work of energy advisors employed by the charity CSE, in particular focussing on how energy advice is given during home visits to support people in fuel poverty. Our fieldwork comprising participant observations of 10 home visits supplemented by interviews and a design workshop with advisors has revealed the sequential organisation and assemblage of activities that encompass the work practices of the advisor.

Technology support of energy advisors in the home setting has to complement the ways in which the collaborative energy advice work is tightly linked to situated reasoning, accounting and action, and gives rise to the kinds of advice given (e.g., DIY tips), the material handed out (e.g., fact sheets), and the follow up actions promised (e.g., writing letters to third parties). We presented opportunities and challenges for Ubicomp technologies focussed on supporting accountability practices through digital representations of environmental data related to fuel poverty (e.g., temperature, humidity and electricity), both to facilitate the advisor's advice giving, as well as to provide accounts of the client's behaviour to third parties and stakeholders. We highlight implications for the design of Ubicomp specifically based on the work practices of the advisor, the domestic fuel poverty setting, and the concerns of the people encountered in these settings.

Our orientation to the use of Ubicomp technologies extends the energy and sustainability agenda in two significant ways; towards inclusion of vulnerable, low income fuel poor households, and towards CSCW for workplaces that advise and support people with regards to energy and sustainability issues, such as charities, and their particular work practices and the ways Ubicomp might support activities such as giving energy advice in homes.

ACKNOWLEDGMENTS

Special thanks to the Centre for Sustainable Energy (CSE) for generously hosting the authors and granting access. We are grateful to the anonymous reviewers for their invaluable suggestions, and to Peter Tolmie and Stuart Reeves for their comments on an earlier draft of this paper. This work is supported by EPSRC grants EP/I011587/1 and EP/L02392X/1.

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