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# Technology Probes: Experiences with Home Energy Feedback

**Jacky Bourgeois**

The Open University  
Walton Hall  
Milton Keynes, UK MK7 6AA  
jacky.bourgeois@open.ac.uk

**Janet van der Linden**

The Open University  
Walton Hall  
Milton Keynes, UK MK7 6AA  
j.vanderlinden@open.ac.uk

**Blaine A. Price**

The Open University  
Walton Hall  
Milton Keynes, UK MK7 6AA  
b.a.price@open.ac.uk

**Gerd Kortuem**

The Open University  
Walton Hall  
Milton Keynes, UK MK7 6AA  
g.kortuem@open.ac.uk

**Abstract**

We discuss our experience in applying a Technology Probe approach to the study of new concepts and technologies at home. We discuss benefits and challenges of using this methodology based on an experiment which aimed to bring solar panel energy feedback into everyday life.

**Author Keywords**

Technology Probe; Energy Feedback; Home Study

**ACM Classification Keywords**

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces

**Introduction**

The home is a highly contextual environment steered by everyday life, habits and implicit rules [1]. To understand how people accept new concepts and technologies in their domestic life, we need to get people thinking and talking about it. However, it is difficult to observe a user's behaviour change in a real context.

A number of studies have shown that displaying energy consumption feedback at home leads to more sustainable behaviours where people subtly adapt their behaviour [2]. In contrast, we explored the potential of displaying the amount of energy that is *generated* by a

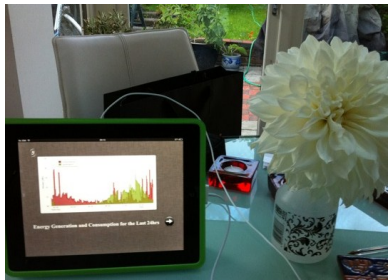
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building, through solar panels mounted on the roofs of participants' houses. This type of information is not normally available to people and when it is available it is usually in a very abstract form. It is difficult to answer questions like "will the solar panels power the washing machine on their own?" or "how long will this 'free' electricity last?" If this data was available, how would it affect people's domestic routines? In our study, we investigated this through a Technology Probe approach [5] using semi-functioning displays as part of a kit that people could experiment with at home.



**Figure 1:** Probe in the kitchen

### **Methodology**

The central idea of the design probe approach is to introduce a concept in a specific context, in our case the house. This concept has to be different enough from everyday life at home to attract and put questions to householders; but not so different from their routines that it disturbs them.

The residential context cannot be simulated in a laboratory and therefore field studies are necessary to understand people's attitudes to generating energy at home. These field studies have to blend as much as possible in the scenery to be visible without transforming the actual situation.

As Hutchinson explains, a probe is an instrument that is deployed to find out about the unknown [5]. Through this method, we can address such questions as: What are the needs and desires of users in a real-world setting? What are the effects and the effectiveness of a technology in a new environment? How can they drive users and researchers to think about new technologies and initiate new concepts and ideas?

### **Related Work**

Gaver introduced the concept of '*Cultural Probes*' as a user-centric approach to open discussion between the designer and the users, where a probe is designed to elicit user reactions and inspirations. An example is the *Dream Recorder* [4] which participants used at home, and upon awakening they were invited to talk about their vivid dreams. These probes required many interactions (take picture, talk about a dream). In contrast, our study focused on the user feedback while observing energy display features.

Hutchinson et al. studied communication patterns in the family through a Technology Probe approach [5]. They implemented a fully functional standalone 'Message Probe'. They see technical testing as part of the approach and mention minor technical issues during the experiment without impacting on the results. Our study was on a technological aspect as well, but required more observation than action. While a cultural probe acts as a behaviour sensor, a technology probe measures potential device integration.

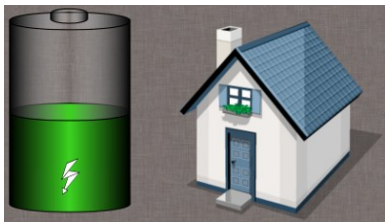
Although design failures like engagement have been discussed [3], no one has highlighted the different challenges directly linked to this method.

### **Study**

Our study took place in the context of a larger project aimed at understanding energy use at home and finding ways to reduce energy consumption. This project involved 75 households around Milton Keynes (UK) and included focus group and discussions [6]. We used outcomes of these discussions to inform the design of our probes which focused on *production*



**Figure 2:** Wash Load Availability



**Figure 3:** Renewable Energy Availability



**Figure 4:** Renewable Energy Forecast

rather than *consumption* of energy, by reflecting the feelings and the language of the participants.

We implemented seven display features in two groups – global home feedback and per appliance feedback. These features explored real-time, historic and predictive aspects through familiar metaphors like a fuel meter, a battery or a weather forecast (Figures 2, 3 and 4).

We wanted the participants to be presented with a realistic view of the energy produced by their own house. However, wiring our displays to the actual energy generation of the participants' houses is a major engineering challenge. Hence we simulated the generated energy from an external house in the same city and we based energy forecast on the weather forecast. We also generated virtual consumption data based on one-week real data to display historic and real-time consumption, avoiding the need to implement energy metering. Finally, we introduced the concept of renewable energy availability by representing a battery. Without a physical battery, we simulated the battery level with a model that could be updated remotely.

We displayed features on tablets in six households (19 participants in total) for one week to give participants time to explore and to discuss the designs among themselves. These probes were placed on high-traffic areas of the families' homes, in their kitchen or living room. Four of six households had solar panels on the roof. All the households were middle to upper-middle income households with different family structures: without children, some with teenage children or children who had left home.

Participants were informed that probes were not final products. In addition to tablets, our probes kit included a note pad and a video camera and participants were

invited to make notes about ideas and to capture discussions about the probes in their family setting.

During our experiment process, we faced two main challenges: How to collect the user feedback of real usage of the technology without influencing the user and how to immerse the participants helping them to relate consumption and generation data without bridling their creativity.

## Lessons Learned

### Feedback Collection

To limit the 'study' effect, we collected user feedback through one interview, conducted at the end of the experiment period. In contrast with other studies we did not provide a list of tasks to do, cards with questions to answer or other ways requiring participants to undertake any extra effort. This is because we wanted to bring the researchers' presence and visibility to a minimum. Unfortunately, none of the participants had felt comfortable enough to video themselves. However some participants took rich and precise notes about what they observed, understood and things they had done. They were also able to describe their daily routines about appliance uses and energy habits. This points out that probes were blended in the background but visible

### Technical Challenges and User immersion

Every home is different and highly customizable. In this way, probes have to be adaptable. In many studies like domestic energy or air quality, data are often difficult to access because of infrastructure (metering, sensing, control and so on). In our study, some participants had difficulties imagining 'energy availability' – represented by a battery level like laptop or smartphone – without a physical battery in their garage. This point underlines



**Figure 5:** Probe in the living-room



**Figure 6:** Probe near the washing machine

the gap between our study and Hutchinson et al. [5]. The communication probes they introduced were stand-alone products, which could be placed in the house and would work – while our energy probes, to be fully functioning, would need to be part of the fabric of the house, which is a big outstanding engineering problem. Furthermore, whilst Hutchinson’s probe provided interactivity, we wanted to observe how our probes were able to blend into the domestic environment.

Participants needed to imagine the probe being integrated in their everyday life. During our study we chose tablets to deploy our energy prototype features easily (Figures 1, 5 and 6). In an actual implementation, these energy features would be displayed directly on appliances (i.e. washing machine LCD) or integrated on an existing screen in the home. One issue participants reported was that they worried the display itself was too bright at night or used too much energy as it was on all the time. This worry seemed to distract them from being able to imagine such features as part of future product design.

#### *User focus*

As mentioned above, the design probes approach allows collection of user responses about a new concept or product. This user feedback can be easily affected by technical issues or aesthetics which draw the user’s attention on them and reduce the emergence of creativity and ideas. Nonetheless, several participants came up with creative ideas about the location of the probe and the use of this new ‘energy information’. For example, a participant suggested placing our probe in the corridor above the laundry basket rather than near the washing machine, far away in the garage.

## **Conclusion**

To conclude, the design probe approach is an effective way to understand needs and desires in a real world setting and to test the effectiveness of technology and initiate new concepts and ideas. In spite of some difficulties of immersing the users and capturing their attention, we did observe creativity and innovative behaviour around *generated* energy. However, it is important to find the right balance between blending into the background and making the probe visible. This applies not only to the probe itself, but also to the manner in which we engage the participants in an interactive or observational activity.

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