Prototyping the Future: Engaging Users in Future Energy Scenarios

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ABSTRACT
In this position paper, we review some of our own work on HCI and energy use in the home with the endeavor to develop a methodology that we have called 'prototyping the future', the goal of which is to study use and gather user feedback on not-yet-existing energy use scenarios. This relies on a number of techniques also echoed in the wider literature, such as grounding in the present, relating to people's current lived realities, and forecasting future developments.

Author Keywords
Future energy systems; prototyping; smart grids.

INTRODUCTION
Sustainability and in particular energy use has become a widely funded and studied topic in the HCI community in the UK. Persuasive technologies that provide feedback on consumption to raise awareness and promote behaviour change have dominated this genre [3,7]. Our interest has been to move beyond feedback, focusing on emerging energy systems such as renewable energy and smart grids that aim to orchestrate user demand and variable supply; for this area of work Pierce and Paulos stated that HCI has an important role to play in 'prototyping future energy applications before the technical infrastructure, service and policy systems to support them are fully in place' [7: 672].

In particular, we have been interested in the role of autonomous agent-based technologies that have been proposed to support the consumer in monitoring and controlling their home energy consumption [8]. In this space, we have been intrigued by the tensions these technologies raise between the promise of making the grid 'smart' on one hand, and the potential to make complexity visible and require more interaction with users on the other [11]. Our research aims at understanding how users manage these trade-offs; more broadly, how users embed future 'smart' energy infrastructures within their everyday lives.

In this position paper, the challenge that we seek to address is how do you involve users in future-oriented energy research? We offer some considerations that emerge from four years of research, beginning to set out an approach that we have boldly termed 'prototyping the future' [2,11].

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PROTOTYPING THE FUTURE
In beginning to reflect on our past work, we may begin to pull out the considerations that appear important to what may be termed our approach. We develop these in the following sections in relation our own past work and that of colleagues.

What is it? Why do we do it?
Our approach relies on envisioning [10], and prototyping, and making these prototypes available to be commented on or experienced by people, which in the past has taken the shape of lab studies [5], focus groups [11], home visits [6], and deployments in the wild [2]. We do this in order to gather feedback on possible future energy scenarios and infrastructures that have not yet been realised, which convey for example socio-economic issues in energy systems [11] or the experience of living with real-time pricing and fluctuating supply [2].

Who do we engage?
We have not just recruited users for deployments of prototypes in their homes [5, 2], but we have also found it useful to recruit members of the public who frequently attend focus groups [11]. This has provided us with more frank and candid opinions than is perhaps possible for example in field trials, where quasi friendships can easily emerge between researchers and participants. We are also engaging with professional energy advisors working for a charity, including observations of their work in the field, participatory design of technologies to support their advice giving practices in home visits [6].

Prototypes
We understand prototypes broadly, not limited to high fidelity working systems, but including partially working, non-functional prototypes, and sketches. Sometimes, our goal is to create a 'boundary object', rather than a fully usable system. The prototypes that our considerations are based on mainly include:

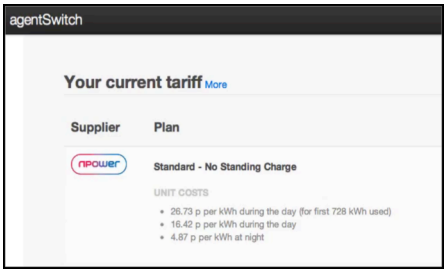


Figure 1. AgentSwitch showing personalized tariff cost estimates (left), and recommended actions (right).

Figure 2. Whiteboard animations illustrating energy infrastructure concepts.

- ***AgentSwitch***, a system that utilises electricity usage data collected from users' households over a period of time to realise a range of energy-related recommendations on energy tariffs, load detection and usage shifting (Figure 1) [5,9];
- ***Whiteboard animations*** that convey the nature of a future smart energy infrastructure including key technologies, the underlying concepts, key stakeholders and the nature of the end-to-end system (Figure 2) [11];
- ***AgentB***, an agent-based interactive system that enables users to effectively operate the washing machine in scenario that relies on a highly variable, real-time electricity prices (Figure 3) [2].

We refer back to these prototypes as we are developing our prototyping approach in the following. In designing the future prototypes, the following principles guided our work.

Appropriate Fidelity

Aspects of the system may only *appear* to work (Wizard-of-Oz), or they may heavily rely on a scenario, i.e., a narrative of a future reality. For example, key to the AgentB deployment was that it was conceptualised to users as a scenario that relies on highly variable, real-time electricity prices due to a grid that mainly relies on renewables [11]. Based on the users' bookings, the agent charges a virtual battery when the electricity price is low. The scenario is further made tangible to participants by providing them with a real budget that they have to use to pay for the bookings — the remainder of which they got to keep in real money as a reimbursement for taking part in the study.

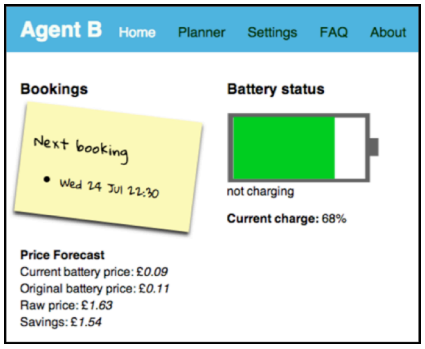
High fidelity is not always necessary. While the whiteboard animation infrastructure sketch was of course non-functional, it still had many advantages; it is perceived as more disposable, so participants are more openly critical; and it is minimalist and ambiguous, in that it focuses on essential features and allows people to fill the gaps from their own experience.

The local specificities of energy systems

The 'energy system' (generation, supply, and consumption) differs from country to country; we are not the first to say that it is also important to consider the wider societal, and economic context in which the energy system is embedded [4,12]. In our own work we have found it important to ground our approach in an understanding of the UK-specific energy system, that is unique for its wide choice in energy suppliers (24 in 2013 [5]), tariff structure (such as 'Economy 7', 'dual fuel'), and relatively regulated consumer freedom (e.g., as stipulated by Ofgem). AgentSwitch for example uses current UK tariff data to compute estimated cost based on consumption data from people's homes [5,9].

Grounding in the present

Anchoring the proposed vision in current technologies (and sometimes a demonstration of those) aim to establish



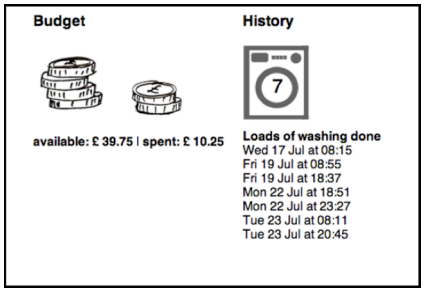


Figure 3. AgentB dashboard showing next booking, battery status (left), budget and washing history (right).

common ground for our audience when moving towards future technologies that borrow the concepts, or rely on similar infrastructure. For example, we have grounded our whiteboard animation in reference to the current meter-based charging model, off-the-shelf electricity monitoring devices, and the ability to store data in the cloud [11]. The dynamic pricing and variable supply scenario was grounded in explications of fluctuations in current renewables due to weather (e.g., sun and wind) [2].

Relating to the user's world

One key concept is to make the prototype relatable from the user's own experience. Giving everyday examples such as "putting the kettle on during half-time of an important football match" to illustrate concepts such as peak demand [11], and making the prototype relevant to everyday activities such as washing lets us explore how these integrate or rub up with against everyday practice [2]. Using data from people's own homes, for example to suggest fitting energy tariffs is perhaps the most obvious, yet not always the most effective way to engage people [5].

Forecasting future technologies

Another key element is to present forecasts of likely near-future technologies by drawing on public policy, technology trends and future-orientated technology research and product development, such as smart meters (which are already being installed), dynamic, or time-of-use pricing models, and large domestic batteries (which are now becoming commercially available) [2, 11], and automated tariff switching [1].

CONCLUSION

We are hopeful our considerations may be useful, prompt discussions in the workshop, and invite feedback that further improves our thoughts by drawing on the experience of colleagues doing research around sustainability and HCI in the UK.

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