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Users, design and the role of feedback technologies in the Norwegian energy transition: An empirical study and some radical challenges

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ABSTRACT

In this paper we explore the interaction between new "smart" energy feedback technologies and households. Based on in-depth qualitative video interviews with participants in two smart grid demonstration projects, the paper analyses how smart technology become integrated in the day-to-day activities of these households – how they interpreted and understood the technology, and how the technology became interwoven in processes of social learning. We have identified four kinds of relational re-arrangements that the feedback caters for: knowledge re-arrangements, material re-arrangements, social re-arrangements and routine re-arrangements. The re-arrangements illustrate how the technologies' affordances open up for certain kinds transformative action, while sealing off options for others. The exercise points to some radical design challenges, and we suggest seeing both technology design and electricity use as situated practice in need of infrastructural support.

1. Introduction

Electricity consumption is tightly linked to grand concerns like environmental challenges and security of energy supply. Therefore, the consumption of electricity has been subject to moral scrutiny at least since the energy crisis of the 1970s [1]. From a grid perspective, energy consumption is too high, and too concentrated around particular times of the day, week, and year. The current study is situated in Norway, where pressure on the grid and demand for flexibility is expected to increase. In part this relates to the rapidly growing Norwegian market for electric vehicles [2]. Prospects of integrating Norway's hydropower balance more tightly in the European power system through new transmission cables to Germany, might similarly increase the need for more flexible and active electricity management in Norway [3], in part because the demand for new renewable energy production is expected to increase.

For many social scientists the character of energy consumption has become an important field of study: what is it, and why is it so difficult to change? (e.g. [4,5]). A fruitful idea has come from scholars who consider energy consumption to differ from many other kinds of consumption, in the sense that energy demand is a by-product of other, often mundane practices such as doing laundry, cooking and cleaning (e.g. [6]). As Gordon Walker has noted, "*energy demand* [. . .] *is intimately embedded in much of what happens from hour to hour, day to day, season to season and year to year in society*" [7]. Thus, aggregated electricity consumption amounts to what some authors call "social load", namely the causal connection between social factors and aggregated peak and base load patterns in electricity consumption [8].

Over the last years, the *smart grid* has emerged both as a potential technical solution to many of the issues described above, and as a new context for social scientists to study electricity consumption [9]. Generally, the smart grid can be characterized by "*an increased integration of new ICTs in the energy system* [. . .], *that enables new ways of communicating between different actors*", as well as "*the integration of new actors in the electricity system* [. . .] *and the assignment of new roles to existing actors*" [10]. Since the smart grid is an emergent development, involving a range of actor groups, it is subject to significant interpretative flexibility [11,12], meaning that different actors have different understandings of what the system is, what it could be and what it should be [11,13,14].

In this paper we focus on the role of ordinary households in this system, and argue that there is a need for radically new thinking concerning how to design smart energy technologies for households. The logic behind much of the smart energy roll-out activity still rests on the assumption that "*personalised, fact-based information enhances energy awareness and allows consumers to modify their behavior*" ([15], 1), a notion that has now been critiqued by social scientists for close to a decade (e.g. [16–20]).

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The dominant understanding of the role of feedback technologies in the smart energy transition comes out of a long tradition of system designers using feedback to consumers as a tool to try to reduce overall electricity consumption levels (e.g. [21,22]). As an example, since the 1970s Norwegian policy makers have approached the public through measures under the banner of "energy economization", where the goal has been to push consumers to make economically rational energy decisions based on better, quantified information about electricity use and its costs [23,24]. Some have proposed that such policies could prevail because of the very strong standing of social-economics as a discipline in Norwegian society, the result being a framing of energy use primarily as an economically motivated activity [25]. A similarly strong faith in one particular kind of economic rationality has become vital in the mainstream smart grid discourse, dominated by economics and engineering [19,26].

This stands in stark contrast to the social and collective character of electricity consumption highlighted above. In this paper, we explore empirically what happened in a set of nine Norwegian households when smart electricity meters and feedback technology were introduced. We use insights from this exercise and previous literature on similar interventions to discuss some major challenges that face developers in the smart energy field.

The remainder of this paper will be structured as follows: We begin with a brief remark on domestication before we move on to discuss and position our work in relation to relevant literature. We then discuss our methods, before turning to our empirical results. Finally, we conclude and suggests some implications of our work for the field of practitioners.

2. Domestication – learning to live with new technologies

Our empirical exploration deals with how householders make sense of, and begin to live with new feedback technologies in an experimental demonstration setting. Theoretically, we are inspired by insights from Science and Technology studies (STS) (e.g. [27,28]), and particularly the strands of STS that are concerned with technology users, and their many roles (e.g. [29–31]). On a generic level, such studies point out that technology users are more than passive receivers of "ready-made" technologies, but that they actively participate in shaping the roles technologies take on. The roles of technologies are not internally provided by technologies, but are produced through the heterogeneous relations they are parts of, where both humans and non-humans have agency [28].

More specifically, we mobilize the notion of *domestication* (e.g. [32–34]) to understand the process of learning to live with new feedback technologies. Domestication refers to the "taming" of new technologies, and illustrates the process of change that occurs in human-technology interaction. Typically, domestication studies in STS focus on three distinct features: A) The construction of a set of practices related to artifacts; B) The construction of meaning of artifacts, C) The cognitive processes related to learning of practice and meaning.

With this as a backdrop it becomes less interesting to talk about "the diffusion of" feedback technologies, and more relevant to explore how feedback technologies are made sense of, how they become interwoven with existing and new practices in everyday life.

2.1. Feedback technologies, everyday life and design challenges

Some years ago, the smart energy discourse was distinctly technology determinist [12], with digital technologies framed by many experts as a solution to most problems facing contemporary energy systems [35,36]. Feedback technologies, or some sort of energy monitoring has played a significant role in this discourse, particularly in narratives highlighting the economic rationality of electricity consumers [14]. Such narratives have highlighted that the invisibility (e.g. [37,38]) and intangibility of electricity to consumers combined with a lack of exposure to real-time prices, has been a major market deficiency, a barrier to proper economization and optimal performance of liberalized electricity markets [39].

Such debates, including discussions about the potential role of feedback do of course predate discussions about the smart grid, for instance through studies of how to improve information on traditional electricity bills [21]. During the 1990s and early 2000s there was a range of quantitatively oriented experiments conducted around the world, where the effectiveness of various types of feedback for energy reduction was explored. Systematic reviews of this kind of work, indicate a potential for initial energy savings in the range of 5–15%, with a somewhat declining trend after a period of time [40–42].

Arguably, the initial hype around the potential of feedback was underpinned by an understanding of human agency primarily as economically rational [43]. Over the last years we have seen a wave of research pouring cold water into the veins of those who thought energy monitors and other smart gadgets would be catch-all silver bullets. Through in-depth qualitative research such studies have arrived at critical and nuanced understandings of the roles that such technologies take on in households, and in turn they have ended up questioning whether the kinds of feedback technologies that dominate today will prove fruitful in the long run.

At a basic level, such studies have highlighted what should be a relatively trivial point, namely that the act of consuming electricity is seldom an individual choice, but rather a collective endeavor which involves anyone living in a given household, and the many practices these householders engage in (e.g. [17,18,44]). This means that energy monitors not only become technical helpers in acts of "good" electricity consumption, they can become sites where the legitimacy of different logics in a home are weighed against each other. This might lend itself to conflicts, for instance over the worth of creating a cozy home versus the worth of managing resources in an effective way [17]. Such conflicts might have highly gendered characteristics, as they relate to typically gendered patterns of work distribution in the home [35], and to gendered understandings of what constitutes the qualities of good life [45]. As Wilson et al. have noted: "*Homes must be understood as shared and contested places in which different household members may have different understandings, preferences, rights, responsibilities and emotional associations*" [46,469].

The character of the dynamics that unfold around such feedback monitors depends on the contexts and relations in which the feedback systems becomes part. Thus, such monitors have not surprisingly taken on quite different roles amongst different types of householders. A study amongst older users in Scotland have indicated that this group has little or no interest in smart energy solutions, and that they lack the capabilities to use currently provided feedback systems in the way that system designers want them to [47]. This image is not clear-cut, however. Others have found that the retired might be more prone to provide flexibility by mobilizing feedback, since they often do not have daily care of children or significant others [45].

This indicates that for families with children the story might be different. Nicholls and Strengers [20] explore the potential for such families to provide flexibility by time-shifting energy consumption from peak hours, a process that could be aided by in-home displays. However, the authors illustrate how family electricity peaks in the evenings and mornings are tightly linked to patterns and rhythms of practice that takes place outside peak periods, and that they constitute relatively solid chunks of "normality" which is deemed difficult to change (see also [45,48,49]). Thus, electricity consump-