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When social practices meet smart grids: Flexibility, grid management, and domestic consumption in The Netherlands

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ABSTRACT

This article seeks to analyse recent shifts in goals concerning domestic energy uses. Drawing on two Dutch smart grid projects, we observe that in the smart grid transition the balancing of (renewable) supply and demand in energy grids becomes the key priority of grid managers. This shift becomes translated at the household level through so called 'teleoaffective structures' of energy practices which motivate and direct the behaviour of householders towards flexible timing-of-demand. New grid objectives are codified in the rules of social practice concerning the use of flexibility instruments (notably time-of-day pricing) and are materialized in monitoring devices, smart appliances, and energy storage. We investigated which domestic practices are most open for flexible timing-of-use. Cleaning practices were found to be most suitable for demand-side response, whereas practices implied in ambiance regulation, leisure, cooking and eating, align only with some flexibility instruments. Next, an analytical focus on linkages between social practices was used to specify opportunities and barriers to sustainable domestic energy consumption. In the concluding section, we argue that householder engagement with sustainability goals should be safeguarded from the flexibility instruments, goals and strategies that seem to turn this engagement into grid management performed for financial benefits only.

1. Introduction

In recent years, the smart grid has been embraced by grid managers, energy policy-makers, and energy market actors as a promising pathway for dealing with new grid challenges brought about by the introduction of renewable energy. Solar and wind power, both intermittent sources of energy, has to be integrated into existing, aging grid infrastructures [1]. This creates a need for real-time monitoring and management of energy flows, enabled by 'smart' energy technologies and techniques, at both the grid and household level. A smart grid can be defined as "a socio-technical network characterised by the active management of both information and energy flows, in order to control practices of distributed generation, storage, consumption and flexible demand" ([2], p. 824).

Yet within most OECD countries, under the present conditions 'energy' does not play a central role in running most households (with the notable exception of householders in fuel poverty). Interactions and engagements with energy in the domestic sphere are limited to choosing an energy contract, paying the energy bill, being mindful of wasting energy, and at times making some energy efficiency improvements in and around the home. Energy consumption in particular has become a taken-for-granted and inconspicuous aspect of everyday life [3]. Consequently, householders are not (yet) the imagined energy 'co-managers', who engage with the technologies and behaviours that are relevant to the objectives of smart grids, like extensive energy monitoring, energy storage within or around the home, timing of demand, and the co-production of renewable energy. If these smart grid aspects are to be integrated into the household, this implies major changes in domestic everyday life.

To analyse changes that smart grids bring along for households, we use the theory of social practices as developed within the sociology of consumption over the last decades [4–6] (Spaargaren et al. [46]). Practice theory is employed to analyse *energy practices* as the shared, routinized types of behaviours which involve "the production, distribution, storage, monitoring and use of domestic electricity in a domestic or decentralised setting" [7]. From a social practice perspective, the home is understood as a set of interdependent practices – for example, doing the laundry, showering, cooking, or watching TV – that fulfil specific domestic tasks [5,8]. To that effect, households can be understood as "hybrids of objects and people, which are implied in the (routine) performance of a series of interconnected practices reproduced in the domestic arena with the help of energy as a key resource" [9]. Last but not least, scholars have shown the importance of considering the normative and emotional significance of the home

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when studying the impact of new energy policies and technologies. Aune [10] illustrated how different ways in which householders relate to their homes – the home as *haven*, the home as *project*, and the home as *arena for activity* – reveal specific opportunities and obstacles for reducing energy demand. May [11] argues that what happens in and around the home goes along with "a sense of personal control which contrasts with the more abstract ways in which individuals are controlled by the market and the state in modern societies" ([11], pp. 13).

New energy practices which 'emerge' in smart grid contexts have been described by several scholars [12,9,13]. Emergence refers to both the birth of new practices (i.e. the monitoring of domestic energy flows, the utilization of new smart meters and smart appliances) and adaptations of existing practices (i.e. adapting the timing of laundry practices to moments of abundant solar energy supply) [7]. Strengers [14] raises concerns associated with these practices and what they represent: an inadequate depiction of householders as resource optimizers, rooted in misunderstandings of householder agency; and a Foucauldian imposition of a 'smart management' discourse which does not reflect the diversity of competing visions of sustainable domestic energy. In a similar critical vein, Bulkeley et al. [13] and Hargreaves [15] make use of the concept of 'governmentality' to expose the ways in which smart energy technologies attempt to steer domestic practices. Smart grid imaginaries are mainly technological and economical in nature, argues [16], which obstructs public debate and ultimately may undermine the legitimacy of a smart grid transition. Lastly, we take note of Throndsen's [17] warning against the uncritical 'end-user engagement' paradigm, which ignores strategies for *non-participation* of end users in the smart grid, which he argues are both relevant and necessary; other avenues for household engagement in smart grids, for example in the design of algorithms, may in theory be more genuinely empowering and ultimately more sustainable than an active demand-response regime.

Sensitive to the concerns addressed by these authors, we hypothesize that the need for (localized) balancing of supply and demand in energy grids crucially shapes the character of emerging energy practices. Our objective in this paper is to arrive at a better understanding of the specific ways in which smart grids may contribute to or detract from environmentally sustainable and low-carbon energy consumption practices at the household level. Moreover, we assume that domestic energy consumption is not the result of rational, information- and cost-driven considerations made by householders, but results from a complex interplay between structure and agency. We hypothesize that householders co-construct and then draw upon a normative and intuitive frame of reference for the performance of energy consumption practices, one which we argue undergoes major changes in smart grid trials. Despite an expanding body of social scientific literature on smart grids, the normative implications of smart energy systems in relation to domestic life have not been explored systematically or in an integrated manner, theoretically nor empirically. So, our central research objective can be formulated as follows: What shifts in objectives of energy management are implied by smart grid development, and how does such a shift influence the existing constellation of domestic energy consumption practices?

The paper is built up as follows. Section two outlines a conceptual framework for the study of household energy consumption in a changing context. After introducing methods in section three, we apply this approach to two Dutch smart grid pilot projects in section four: Samen Slim met Energie (Together Smart with Energy, SsmE) and Jouw Energie Moment (Your Energy Moment, JEM). Section five relates the case study findings to literature and asks critical questions regarding sustainability.

2. Analysing domestic consumption with theories of social practices

In this section, we explore and operationalize the theoretical notion that domestic energy practices co-evolve with energy systems. In doing so, we assign a key role to normative and motivational structures, building on Schatzki's [18] seminal work. The theoretical discussion starts an elaboration of what is meant by 'energy system', followed by an assessment of emerging objectives in the Dutch energy system. Then we discuss energy consumption and their social practice elements (Section 2.2). In Section 2.3 the concepts are applied to disentangle domestic practices, working with the hypothesis that smart grid objectives interact differently with various clusters of domestic practices. An analytical framework is presented visually at the end of Section 2.4.

2.1. New objectives in the Dutch energy system

In this paper, *energy system* refers broadly to the centralized and decentralized electricity provision infrastructures as well as the institutions, actors and markets directly engaged in the generation, provision and management of electricity flows. Any strict demarcation of 'an energy system' is problematic, because the boundary between energy provision and consumption has blurred, and actors are redefining their roles and responsibilities. A wide variety of professionals and end-users alike are engaged every day in the re-production of the energy system. However, by defining an energy system in contrast to the household, we emphasize the very different set of rationalities and normativities involved in energy consumption practices by householders versus the practices within the wider energy system. How and why new policy goals and objectives emerge in an energy system can be studied from a variety of perspectives. Ballo's [16] concept of the 'techno-epistemic network' is particularly useful: "the members of a techno-epistemic network share a dedication and commitment for realizing a technoscientific innovation, related to a specific societal challenge" ([16], p. 10). The changing practices of these actors in response to new grid challenges, while not the topic of this paper, are central to the construction of new imaginaries and objectives of future energy systems. Technology development and design processes are as much a situated practices as electricity use [19].

The actors engaged in smart grid development in the Netherlands arguably constitute a techno-epistemic network. This network can be characterized as led by distribution system operators (DSOs), in collaboration with both new and established smart energy technology and software companies. Dutch system operators state the following reasons for their support of and central role in the development of smart grids:

> *"They contribute to the integration of electricity production in all kinds of places in the grid. In principle, the directing and coordinating options make it possible to optimise energy use throughout the entire energy supply chain. Smart grids also make the energy user 'intelligent', because financial savings can be realised by flattening peaks in the power demand or at peak moments. Furthermore, they offer opportunities for new, energy-related services. And finally, the application of smart grids makes the energy system more 'dynamic' and they help to improve security of supply."* [20]

Solar and wind are intermittent and inflexible power sources, whereas domestic electricity demand is highly synchronized around the work-day, work-week, and the seasons. While the Dutch electricity grid is reliable and stable, the proliferation of centralized and especially decentralized renewable energy generation will this balancing act ever more difficult. Decentralized renewable energy and synchronized demand put pressure on local and central grids, which, in combination with the gradual phasing out of feed-in tariffs and the development of smart energy innovations, give rise to the new central objective of low-voltage grid management: matching renewable energy supply to domestic energy demand, locally if possible. This coincides with the interest of the Netherlands' many renewable energy cooperatives [21], as well as PV-owning households, in optimising self-consumption to attain ever increasing levels of energy autonomy. The flexible matching of demand to supply, performed actively by the 'intelligent' energy users mentioned above, or automated, is typically referred to in short as