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Domestication, acceptance and zero emission ambitions: Insights from a mixed method, experimental research design in a Norwegian Living Lab

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ABSTRACT

The Trondheim Living Lab is a detached single-family zero emission building (ZEB) that is planned to reach a zero-emission balance over the course of its estimated 60-year lifetime. This is achieved by a broad variety of technical strategies such as passive and active energy design and efficient installations, as well as calculations of embodied emissions. In qualitative experiments conducted between September 2015 and April 2016 six different groups lived in the house for 25 days each. Based on direct observation (mainly through sensors registering temperature, humidity, CO_2 levels and energy use), participant observation and interviews before, during and after the stay, the paper analyses the unfolding domestication of the building along three dimensions; practical, symbolic and cognitive. The paper provides an account of which expected or unexpected occupant actions matter in which way for the zero emission ambitions of the building. Moreover, by studying the way in which the six groups within the three different categories student, family and elderly experienced living in this demonstration building this paper contributes a more detailed understanding of the overall acceptance of a ZEB in Norway.

1. Introduction

The built environment is commonly described as a sector with a large, cost-efficient potential of greenhouse gas (GHG) emission reduction [1,2]. According to the 2010 *Energy Performance* of *Buildings Directive*, member states of the European Union are expected to implement building regulations that require all new buildings to be 'nearly zero energy' by 2020. The Norwegian government has followed suit, and aims to improve building regulations to nearly zero energy by 2020 [3]. Following a short but ambitious series of policy measures that produced a large number of passive houses, since 2017 new energy rules in the building code prescribe energy demands that reach 'passive house level' for all new buildings in Norway. The next step, pioneered by the largest construction-related research milieus in Norway, is buildings that not only reach a zero *energy* balance but also include *GHG emissions* into the life-cycle analyses.

In Norway, the Research Centre on Zero Emission Buildings (ZEB) has laid the groundwork to specify and define 'nearly zero energy' as 'zero emission', i.e. that GHG emissions related to construction, material, operation and demolition of the building are offset by renewable energy production on-site during the course of its life-time [4]. The Trondheim Living Lab is one of these projects combining demonstration with research on the viability of the concepts and technologies developed in the ZEB centre. To date, some research has been done on the role of engineers and craftspeople in making ZEBs (e.g. [5,6]), on the role of standards and building codes for ZEBs (e.g. [7]), or on expert and policy maker perspectives, and zero carbon governance (e.g. [8,20]). Moreover, although some research has studied inhabitants in high-performance or smart technology homes (e.g. [9,10]), not much research has been done with actual inhabitants of zero emission buildings.

This paper provides results from qualitative experiments conducted to examine the way in which people arrange their lives in the ZEB Living Lab in Trondheim. This study compares six different user groups where two groups are similar: two student groups, two family groups and two elderly groups. Each group stayed in the house for 25 days. Rather than assuming that one can study a new, stable, 'zero-emission' lifestyle, this paper identifies the impact the ZEB and its inhabitants had on each other during the 25-day period. This is useful in assessing the way and extent to which high technological, zero-emission buildings can be implemented and used in the future. In order to assess this, we study the interrelated process of negotiation and adaptation—what we call domestication or the process of normalisation—happening between the occupants and the zero-emission building. Hence, this paper deals

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with the negotiation between the social and the material observed when people with established everyday habits and routines inhabit a 'zero-emission' space. We therefore ask: to what extent do existing habits of the six groups concur with expectations about the 'zero emission' home-situation, and how do these existing home living habits affect the zero-emission ambitions of a house?

The paper is structured as follows. The next section discusses domestication theory and how it relates to the study of everyday life, energy use at home and ZEBs. Section 3 outlines the methodology and data used in this paper, Section 4 describes some selected scripts of the building before Section 5 goes through some of the aspects of living in the laboratory interpreted through the lens of domestication theory. Section 6 concludes the paper.

2. Domestication and low carbon building occupancy

–What does it mean to 'domesticate'?

–It is something that is too often forgotten, said the fox. It means 'to create bonds'

Saint-Exupéry ([11], p. 71), author's translation from French

Saint-Exupery's [11] definition of domestication 'to create bonds' is neat and simple, but it does not provide a way of analysis nor does it say much about how bonds are created. Domestication theory as applied here provides a useful way of understanding and analysing the interdependent relationships—the bonds—between humans and technology. Domestication theory emerged in the late 1980s and early 90s when it focussed mainly on how media technologies were taken into use and 'domesticated' into everyday life [12,13]. The perspective has later been applied to a broader set of technologies that were found to be relevant in wider contexts than of the socialisation of the technology itself. Influenced by actor-network theory and a semiotic understanding of science and technology, it was proposed to understand domestication as a co-production of the social and the technical [14]. From its beginnings, the basic tenet of domestication theory as applied here was that there is no such thing as an 'introduction' of an isolated technological artefact into a technology-free social sphere. Instead, an evolving process goes on between people and technologies that shape cognitive, practical and symbolic meanings connected with people's everyday life [14,15]. There is, in other words, a mutual adaptation between technologies and people's everyday practices.

The semiotic version of domestication theory [14] connects the mutual adaptation between technologies and people to the scripts that designers inscribe [16], and the anti-programmes that users conceive of [17]. The scripts are taken to be the representation of designers' (in our case: architects' and engineers') explicit or implicit worldviews within the artefact itself. Anti-programmes rooted in users' everyday lives can mean more or less heavy adjustments of the script that in some cases even can result in a complete boycott of the technology. Thus, technologies can be said to be 'moral enterprises' in that they include a prefigured understanding of how they should be used ([14], p. 56). For instance, the script of a paper cup could be 'throw me away after use', whilst the anti-programme is 'I will use this cup multiple times'. The anti-programme thus represents a kind of 'mis'behaviour on the part of the user. Acknowledging this idea means that multiple scripts are in play that are continuously negotiated in terms of anti-programmes. A house therefore can be said to contain a 'minefield' of scripts, and the domestication processes of these technologies is defined by the negotiation process between people and technologies within the house including potential anti-programmes [15].

Beyond the recognition of scripts, Sørensen ([14], p. 47) points out that domestication theory invites a focus on three main features: 1) the practices that are constructed around the use of an artefact, 2) the symbolic construction of meanings in connection to the artefact, and 3) the cognitive processes connected with learning a practice. Since the term 'practice' is widely used, we here take it to mean the routines and habits that are formed in connection with technologies. In this understanding, domestication theory centres on a new material artefact, such as the mobile phone or a car, in its users' everyday life and explores the mutual adaptation between the artefact, routines and habits, meanings and cognitive learning processes. This then enables a focus on the broader implications of technologies on the way the everyday is lived. For instance, one could study a technology; say the freezer, and how it has become domesticated through a process of adaptation applying to a wider range of routines and habits, meanings, and learning processes, e.g. connected to food preservation, cooking or eating. The introduction of the freezer (and the whole freezer chain, see Finstad [18]) introduced a change in Norwegian cooking and food storing practices. This change can also be told as a story of 'normalisation' in which the novelty becomes gradually embedded into the fabric of everyday life [19]. To summarise, domestication involves a period of tension between a new technology and established habits and routines, meanings, and knowledge. During the course of domestication this tension is reduced through a process involving different strategies: the technology could be experienced as familiar part of one's self, it could be rejected entirely, or it could tactically be relegated to the periphery of one's everyday life. In this sense, domestication is a heuristic that facilitates the study of technological change in a way that avoids technology determinist pitfalls that see technology as acting 'on its own' separate from humans.

This article builds on and develops the emerging field of user-centred socio-technical studies of low carbon buildings (e.g. [20]). Acknowledging that users have an important impact on the performance of low carbon buildings (e.g. [21–23]) we understand the interaction between low carbon buildings and occupants as an 'interactive adaptation', in order to ensure that complex zero-emission systems and users are well adapted [24,25]. Studies on energy efficient buildings show that technological arrangements connected to thermal comfort and ventilation are particularly relevant for the energy end-use of buildings, and this may be connected to a rebound effect as caused by increased levels of comfort [26–30]. Some studies have also explicitly used the domestication framework to show that energy use at home is intimately bound with a complex network of doings that must be understood in order to be able to effectively ensure reduction, and that energy efficiency measures work [31,32]. One recent study using domestication theory finds that living in smart and energy efficient homes can be both time-consuming and demanding, and instead of energy saving may end up generating energy intensification though new forms of energy demand [33]. However, since the zero emission building (ZEB) is a relatively new concept, not much research has been done to show how people actually live in them. This study therefore breaks new ground by analysing experienced comfort levels of occupants connected to the different 'zero emission' scripts in the Living Lab.

Turning to our qualitative experiment, all the six participant groups in this project went from one material setting, their initial home, to a new material setting, their 'new home' in Living Lab, and then back to their original home. As they moved from one place to the next, we can say that a new process of domestication or normalisation started, see Fig. 1. To be sure, given the brevity of the stay one cannot say that the domestication process is 'complete' after 25 days. Nevertheless, we believe that the stay makes an impact that is interesting in itself, and the domestication perspective can be expected to shed light on the process of 'normalisation' of the strange, high-technological building. How—if at all—were technologies embedded into the fabric of the occupants' everyday life? How did the occupants negotiate the various zero-emission scripts during the 25-day period? What types of adjustments were made from the perspectives of both the building and the occupants, and how did adjustments impact the zero emission ambitions of the building?