

# THE DOMESTICATION AND USE OF LOW AND ZERO CARBON TECHNOLOGIES IN NEW HOMES

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Changes in the Building Regulations are demanding higher levels of environmental performance in the products of house builders in the United Kingdom. New approaches are being deployed, including incorporating low and zero carbon (LZC) technologies, in order to meet this challenge. It is recognised that the use phase of buildings is responsible for a significant majority of the energy consumption and therefore carbon emissions. A corpus of literature exists focusing on the technical potential of individual technologies but there is a relative dearth addressing the role that the end users (or occupants) play in the use of these technologies in the domestic setting of the home. If the overall objective of lowering carbon emissions is to be realised it is therefore critical that a more in-depth and nuanced understanding of the interaction between homes equipped with new LZC technologies and users is developed. Case study data from two households in a new development using solar thermal technology is analysed from a domestication theory perspective. The results show that the households had little knowledge of, or interest in, the technology prior to moving into the houses. The 'market pull' of consumer design or imagination for the solar thermal technology was absent - they were passive consumers. However, once in the houses, the meaning ascribed to the technology and the household practices emerging from user-technology interaction were significantly different in each of the two households. The findings contest the prevailing technical rationality notion that LZC technologies are uniformly absorbed and used by a homogeneous set of households.

Keywords: domestication, housebuilding, low and zero carbon technologies, socio-technical.

## INTRODUCTION

Recent and planned changes in Part L of the Building Regulations, driven by the broader UK Government zero carbon homes agenda, is challenging housebuilders to comply with ever increasingly high levels of performance in terms of carbon

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emissions. In response, some housebuilders are selecting and incorporating low and zero carbon (LZC) technologies into their products. The term LZC technology is used as to include any technology, additional to the fabric of the building envelope, which recovers or generates energy. Establishing the technical potential of individual technologies has spawned a still growing body of research (see for example Entchev *et al.* 2004; Mithraratne 2009; Bashaj and James 2007 and Hinnells 2008) and work has begun to address which LZC technologies housebuilders have selected and the rationale for their selection (Sexton and Lees 2012). To date, most effort has been expended on the production side: understanding, from a technical perspective, the business model and design and build challenges of low carbon homes.

In contrast, little research has been conducted on the consumption side: what happens to these LZC technologies once handover to the home occupiers has occurred? The cultural and media studies literatures have asserted that technologies must be culturally appropriated through consumption to become fully operational (for example, see Oudshoorn and Pinch 2005). From this lens, the physical technological assemblage of the home (with its LZC technical components) must move into the consumptive domestic realm and that this translation process may (or may not) result in 'successful' operational outcomes. In effect, the physical home becomes a socio-technical system, within which the occupiers domesticate the LZC technologies with meaning and practice which may be far removed from the designers abstracted view of users' interpretations and uses of those technologies. A better understanding of these domestication processes and outcomes, which are idiosyncratic to individual householders, is an important prerequisite to increasing the appetite for and appropriate use of these technologies.

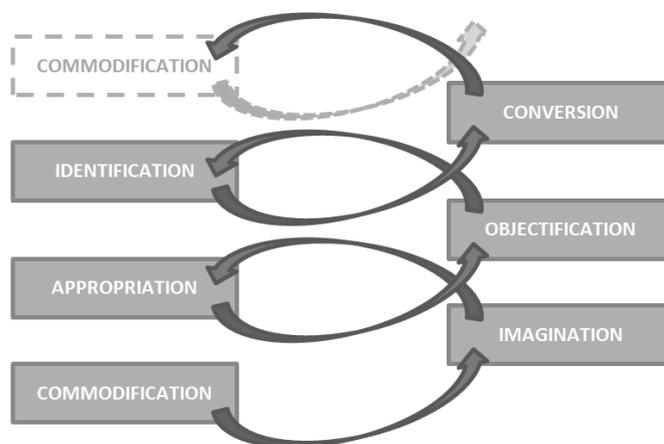
This paper seeks to achieve two tasks. First, broaden the prevailing literature on LZC technologies in new housing by drawing on the domestication literature (Silverstone 1994) to consider user - technology interaction and emergent meanings and practices. Case study data from two households in a new development using solar thermal technology is analysed. The results show that the households had little knowledge of or interest in the technology prior to moving into the houses. The 'market pull' of consumer desire or imagination for the solar thermal technology was absent - they were passive consumers. However, once in the houses, the meaning ascribed to the technology and the household practices emerging from user-technology interaction were significantly different in each of the two households. The principal moderating influence was the different working patterns of the households. The constraining effect materially affected the efficient use of the solar technology. The findings contest the prevailing technical rationality notion that LZC technologies are uniformly absorbed and used by a homogeneous set of households. Second, as a result of applying domestication theory to LZC technologies with new homes, we comment on potentially fruitful avenues to extend the theory from its original focus on discrete technologies towards an accommodation of integrated technological assemblages.

## **BACKGROUND AND THEORETICAL FOUNDATIONS**

The cultural and media studies approaches to user-technology relations are interested in the way technology and its appropriation is defined and moderated by consumption (Bourdieu, 1984). An important contribution to this agenda is the concept of domestication which seeks to explain and understand the adoption of the technology from a perspective that embraces the technology within the context of the household. The domestication discourse has its origins in the household integration of media

technologies such as television, radio and the internet (see for example Silverstone and Haddon 1996; Livingstone 1992 and Haddon 2006). In this perspective the household is seen as a dynamic, transactional system with its own 'moral economy' (Silverstone 1994: 122). The moral economy of the household is capable of actively engaging with the products of the wider formal economy both culturally and economically. Domestication considers how the products of the formal economy come to the attention of household, move into the household, are ascribed meaning and value and become part of the cultural context of the household both in terms of meaning and routines and practices. The process of consuming a technology is taken to be non-linear, rather it is a cyclical and dialectical 'cycle' of consumption.

Silverstone (1994) identifies six phases to the consumption of technology. These six phases are commodification, imagination, appropriation, objectification, incorporation and conversion. One possible configuration of the stages of consumption is shown in Figure 1.



*Figure 1: The six phases of the cycle of consumption.*

Commodification is the process by which material and symbolic artefacts are created, opened to the influence of the consumer and brought to sale in the formal market economy. The process of commodification permeates the consumption cycle, artefacts (symbolic and material) move between commodification and non-commodification as they develop different material and symbolic forms. The movement between commodification and non-commodification can also constitute part of the interaction between the moral economy of the household and the wider formal economy beyond.

The imagination phase is where goods are desired and coveted. Advertising creates social meaning for a technology with the aim of instilling consumer desire for the object. Consumers can actively engage in this construction of social meaning through the process of imagination. Goods can begin to influence the moral economy of a household well before they enter materially as individuals engage with the social meaning being constructed in the wider economy. Imagination allows symbolic meaning to develop before ownership is established.

Appropriate is the point at which a product is bought by the consumer. Appropriation is easily imagined when considering material objects but is as relevant to messages. Through appropriation a product can leave the formal economy and become possessed and therefore owned by an individual or household. Whilst appropriation embodies ownership and acquisition, objectification is physical usage. Households can seek to express their identities through the physical arrangement, and environment in which

this occurs, of the object. Technologies can be functional but not always in the way that designers intended them to be. This is the process of identification. Identification is the functional use of a technology, rather than its physical placement through objectification. Objectification is the physical acceptance of the technology into the household's moral economy whereas identification is its integration into the routines of everyday life. Objectification and identification are not always unproblematic. Struggles can emerge around the physical location of an object or its incorporation into daily routines. These struggles can be between individuals within the household or between the household and the object. Through negotiation these struggles can be alleviated and stabilised.

If an object enters the household through the process of appropriation, and the household makes sense of it internally through objectification and identification, then conversion is the reaching out of the household back across the internal-external boundary. Conversion is the process of taking the meanings ascribed to the object and communicating them back to the wider society. It is at this point that we come full circle and the process of commodification can pick up the signals of conversion to inform and influence future development.

This cycle does not happen once or in a linear fashion. The process of consumption is not quantum or isolated but dynamic in the sense that the technology, and the meanings ascribed to it, pass backwards and forwards between the internal moral economy of the household and the wider society and formal economy. Each influencing the other and both informing the uptake of a technology and influencing if it is successful or not.

## **METHODS**

The data used in this paper is from one housing development case study in an ongoing larger multi-case project. The goal of the larger project is to establish the day-to-day lived-in experiences of occupants relating to the low and zero carbon technologies. The project employs a number of approaches, including this domestication study, in order to establish the occupants' understanding and use (or non-use) of the technologies contained within their homes.

The interviewees participated through self-selection. A letter from the research team was sent to all the tenants of the housing development, through the housing association, inviting them to participate in the study. The letter outlined the purpose of the research and invited them to contact the research team by phone, e-mail or letter if they were interested in participating. Two out of the three homes on the development volunteered to take part in the study.

For each household two interviews of sixty minutes in length were conducted. The interviews were conducted in the participants' homes and were open in structure allowing the participants to direct the conversation towards aspects of their new homes and new technologies that they felt important. The conversation was guided by the interviewers by asking the participants to talk through their purchase of the property, a 'day in the life' of the household and seasonal differences.

The interviews were supplemented with photographs and notes taken on 'walk arounds' the house. During the walk arounds the participants were asked to demonstrate how they interacted with the technology and to elaborate on points made earlier on during the interview.

Recordings were made of the four interviews which were then transcribed, anonymised and thematically coded using NVivo 9 software (<http://www.qsrinternational.com/>). The coding of the transcripts allowed themes to emerge from the data which were coded as nodes in the data. Nodes were grouped and split in an iterative process until the researchers were confident in the themes that had emerged.

## **RESULTS**

The findings of the research are presented in this section. A brief description of the case study development and case study households is given. This is followed by quotes from the interviews structured around the phases of the cycle of consumption.

### **The development**

The two case study households live on a development of three terraced houses on a brownfield site. The houses were developed for a housing association as part of a larger local portfolio they manage in a village situated eight miles outside of a small city in the South East of England. The development was located between existing housing and access to the site was restricted by the width of the road running between two buildings. The access restrictions encouraged the housebuilders to use a traditional approach to construction as delivering frames onto site would not have been feasible. To alleviate the potential concerns of the local residents a significant local engagement campaign was run by the housing association and housebuilder. This was targeted more at providing information about the build to the current neighbouring residents rather than sales information to prospective tenants.

One of the requirements of the housing association was that the homes achieved Code for Sustainable Homes level 3. As part of the solution to this each house contains a solar thermal system which supplements a gas central heating system and an electric immersion heater. Solar thermal systems use solar collector panels to absorb solar radiation. This energy is used to heat water which is circulated through the hot water cylinder to pre-heat the water in the cylinder. The pre-heating of the water in the cylinder means that less energy is required to bring that water up to a usable temperature which displaces energy generated from non-renewable sources and lowers energy bills. As the radiation from the sun is subject to daily and seasonal variation so is the output of the solar thermal system. The system is most effective if the greatest amount of hot water is drawn off before midday when the solar radiation is at its greatest.

### **Household A**

Household A is a single parent family with one young child of nursery age. The family has strong ties to the local area. They have lived in the property for ten months. The young child attends a nursery each work day morning. The occupiers rent the house from the housing association. Four generations of the family live within walking distance of the development in properties managed by the same housing association. The housing association has begun a programme of retrofitting the same solar thermal technology throughout its existing local stock.

### **Household B**

Household B comprises two adults and two young teenagers who are social tenants in a three bedroom end-terrace property which is owned and managed by a housing association. The family has lived in the property for ten months. Both adults work,

one full-time and the other part-time. Household B does have loose family ties to the local area but not as many as Household A. Household B has moved back to the area after a period of first living abroad and then some distance away on the South coast.

### **Consumption of the solar thermal technology**

The cycle of consumption is used below to structure and analyse the data. Each section has a short narrative describing the phase and a series of indicative quotes from are given to illustrate the issues raised. In some cases these quotes are in conflict with each other demonstrating the diverse, often opposing, views of occupants to the same LZC technology on the same development.

### **Commodification**

Commodification is taken to be the process by which the low and zero carbon technology came to be incorporated into the homes and was made available to the tenants through the housing association. There is no evidence that either household influenced the design or production of the homes, including the selection of the solar thermal system. The commodification phase was dominated by two sets of interests: the housing association's interest to rationalise their local housing asset portfolio and achieve Code for Sustainable Homes level 3; and, the housebuilder's interest to meet the client brief in a commercially viable fashion.

### **Imagination**

Household A, through their local family ties, was very involved in the local regeneration-orientated consultation process surrounding the development. Household B was disconnected from this process. Both households did not incorporate the solar thermal technology (and its potential benefits) into their imagination to a significant extent before moving into the property. Imagination was constructed through post-appropriation processes. Household A, when talking about their understanding and imagination of the solar thermal technology noted that:

"I just assumed – I mean, it was – I think I just assumed it was just for your water. I didn't realise I was going to reap benefits from my heat, you know, from my heating bills, not at all, because I was absolutely gobsmacked when I received that cheque back into the bank. It was, like, whoa, Jesus Christ." (Household A)

Household B were unable to articulate any expectation or understanding of the solar thermal system originating from before appropriation.

### **Appropriation**

Appropriation of the solar thermal technology was not a separate, discrete episode divorced from the house. The technology was structurally integrated into the house and, therefore, the technological assemblage of the house as a whole (including the solar thermal system) was appropriated.

For both households the appropriation was driven by the location of the development. The solar thermal technology played no part in the decision to acquire the property (and therefore the technology). Household B was not even aware that solar thermal technology was installed in the property until they moved in:

"... it was only on the day that we got the house, really. We didn't know anything about it up 'til then." (Household B)

### **Objectification**

Objectification is physical placement and use of the solar technology system within the home. The household had no input into the physical location of the technology in the house. The solar thermal system was already located within the house when they moved in. The system for all intents and purposes is immovable. The solar thermal technology was integrated within the constraints of the standard design of the housebuilder. There was a loss of amenity as a consequence in both houses, as the cylinder was placed where normally the airing cupboard would be.

### **Identification**

The solar thermal technology was ascribed different meanings and affected the routines and practices of the two household in different ways. Both Household A and B were told by the housing association during the handover to try and use most of their hot water during the mornings to maximise energy efficiency and save money.

Although both households received similar instructions the different routines of the households constrained or enabled their capability to respond to this direction. Household A, not restricted by work patterns, have far greater opportunity to alter their daily routines around the requirements of the technology than the working couple making up Household B. Household A has shifted as much of their hot water consumption to before midday in an effort to maximise return from the technology.

“...I’m finding I’m trying to do everything in the morning, sort of, especially with little ’un, like her bath and that ‘cause nothing worse in the evening when it’s cold you have a, sort of, lukewarm bath.” (Household A)

In contrast, the working patterns of Household B constrains its discretionary capacity to align behaviours to the solar thermal technology: “[we] can’t ...because we’re at work, aren’t we?” (Household B).

The difference in opportunity for the two households to accommodate the solar thermal technology into their daily routines is manifest in their level of awareness of the financial returns of the technology. Household A was much more enthusiastic and aware of the benefits of the technology than Household B: “...my gas and electricity bills compared to where I’ve lived in the past have been absolutely fantastic here.” (Household A)

In both householders unfamiliarity with the operation of the solar thermal technology and the inaccessibility of the user manuals led to minimal use of the control settings, restricting the configurability of the technology to each household:

“Idiot proof information would be grand [laughs]. I like things very simplified. I don’t like – you know, I’ve learnt from my dad telling me off enough times that I don’t touch something that I don’t know what I’m doing.” (Household A)

### **Conversion**

Both households are supportive of the solar thermal technology, but appear to not have channels to feedback to the formal economy. The housing association and housebuilder have not sought feedback on the technology. Both appear to have become keen advocates of the solar thermal system and both would and have recommended them to friends and family.

[about solar thermal] “I tell them if they can afford to do it go ahead and do it most definitely, most definitely.” (Household A)

[about solar thermal] “Yes, I would recommend it and if people could get it installed then, yeah, great.” (Household B)

## **DISCUSSION**

The analysis of the interview data using a domestication lens has begun to reveal some interesting insights into how low and zero carbon technologies are consumed. Like Silverstone (1994), it is not intended to suggest that the phases are discrete well defined periods that progress in a linear fashion, far from it as these are 'fuzzy' processes which are cyclical in nature.

Domestication theory has allowed us to consider the adoption of LZC technologies in the social context of the households in which they are being used. It enables us to engage with the different social routines of a household and how this affects the physical (objectification) and temporal (identification) acceptance and use of the new technology. Perhaps the most obvious example of this is that Household B's routines are dominated by coming and going to work whereas Household A's is not. This allows a greater freedom to Household A in identification with the technology. Household A has flexed their usual routines to consume most hot water in the morning, following guidance from their housing officer and maximising their benefit from the technology. Household B does not have the same level of flexibility and this advice has been rejected.

The application of the cycle of consumption to LZC technologies in new homes has begun to hint at some interesting differences to its original use. When considering consumer electronic goods, such as televisions, in a material sense it is relatively easy to comprehend the processes of commodification, imagination and appropriation. This becomes more complex in the case of low and zero carbon technologies in a new home. Firstly, in Silverstone's (1994) discussion of consumption it appears as if the household, although dynamic, is well formed and in a stable but changing configuration. The new technology is adding to the formed moral economy of the household. For LZC technologies, in this case solar thermal, in new homes the routines and practices of the household have already been significantly disrupted through the change of home. The new technology is entering at a time when many things are changing simultaneously.

It is also clear from the interviews conducted so far that none of the households were significantly influenced in their decision of which home to chose by the technology it contained. The location of the home (to work or family) seemed significantly more important. In the two households studied here, the cycle (or spiral) of consumption of LZC technologies began with the commodification and imagination processes playing out on the technological assemblage that contains the technology (the house) rather than the technology itself. Once some time has been spent in the new homes the solar thermal system was ascribed more of a meaning in itself, either through changes in performance (with solar thermal typically seasonal), cost savings or problems.

This way of conceptualised how technologies are consumed has potentially interesting consequences for the way that homes perform once lived in. The effort expended by the housebuilders in marketing and selling their products begins the journey of the households in creating a meaning for the LZC technologies and incorporating them within the moral economy of the household (both materially and temporally). It is possible that a lack of focus on the technology in sales and marketing creates a void in meaning for the technology in which the occupant is left to negotiate the tensions unguided. This will require further investigation as the work develops but is of

potential significance to the way housebuilders market, sell and handover their products to their customers.

## **CONCLUSION**

The central problematic of this paper was to start a response to the dearth of research into the consumption of LZC technologies in new homes and, in so doing, contribute to an urgently needed rebalancing of the agenda to consider and integrate production and consumption. The paper has contributed in two important respects. First, case study data from two households in a new development using solar thermal technology was analysed through a domestication theoretical lens. The key findings demonstrated the broad utility of the cyclical and dialectical 'cycle' of consumption. It was found that the households had little knowledge of or interest in the technology prior to moving into the houses (the imagination consumption phase). The 'market pull' of consumer design or imagination for the solar thermal technology was absent - they were passive consumers. However, once in occupation in the identification consumption phase the meaning ascribed to the solar thermal technology and the household practices emerging from user-technology interaction were significantly different in each of the two households. The principal moderating influence was the different working patterns of the households. The constraining effect materially shaped the routines enabling efficient use of the solar technology. The findings contest the prevailing technical rationality notion that LZC technologies are uniformly absorbed and used by a homogeneous set of households.

Second, the empirical setting of the technological assemblage of a house in which LZC technologies are integrated systems is not accommodated by domestication theory which considers discrete technologies (such as televisions) which consumers have the discretion to purchase or not purchase. The majority of new homes in the UK are produced by volume builders and, for a variety of regulatory, planning and commercial reasons, consumers are not given the choice of LZC technology system at the time of purchase. The development of domestication theory for integrated technological assemblages would be a useful endeavour, particularly in the appropriation and objectification phases. On a broader level, the need for research to not treat LZC technologies as discrete entities, but as an integral part of the socio-technical system of the home, is reaffirmed.

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