



Research paper

“Home is where the smart is”? Evaluating smart home research and approaches against the concept of home

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ABSTRACT

This article develops concepts of what the home is and reflects on smart home technology and the research literature on smart homes in relation to these concepts. The focus is on the aspects of smart home technologies related to energy management within the home (end-uses) and at network or grid level (system). Four aspects of a home are distinguished: a place for *security and control*, for *activity*, for *relationships and continuity*, and for *identity and values*. These aspects of home are used to discuss approaches to, and ideas of, the smart home, as reflected in the research literature. It is shown that technical and ‘prospective’ research literature focuses on aspects of security and control in the home as well as on activities, whereas research papers that are more conceptual and evaluative are more likely to include questions of relations, values and identities. The paper concludes that a broader understanding of the home in all aspects is needed when conducting research into smart homes. This can be valuable when evaluating how smart home technologies work in real homes, as well as in the more technical and prospective approaches to developing new socio-technical configurations.

1. Introduction: energy consumption, homes and smart homes

Given the extensive research literature on energy in housing, it is striking how little there is on the home. Even though recent socio-technical studies within energy start to include notions of what the home means to people [1,2] there is still room for expanding this area. The concept of home is largely absent from the thousands of papers in which building functions are analysed and modelled and the ‘behaviours’ of occupants are dissected and discussed. However, in sociology [3], geography [4], anthropology [5,6] and architecture [7], there is a longer tradition for working on ideas, concepts and practices of home. Here we learn that a house (that is, a building) and a home are two fundamentally different things; and that there are discussions on how people appropriate houses and thus turn them into homes, and discussions on whether home should be thought of as a place, a feeling or a practice.

On the other hand, we also have within the energy related literature a growing interest in whether, and if so how, ‘smart homes in smart grids’ might be part of a more sustainable future [8–10,73]. There is no fixed definition of a smart home, but an understanding that smart homes incorporate digital sensing and communication devices. Crucially, these devices *communicate with each other seamlessly* in the smart

home ideal, in order to provide one or more of the following services: more sophisticated control of energy (the primary interest in this paper); greater security against break-ins; innovations in home entertainment and ambience; health monitoring and independent/assisted living arrangements.

There are many great expectations to how these networked technologies will transform our homes and everyday life but they often seem far from reality [11,12]. As The Economist magazine commented “*The fanfare has gone on for years (...) But so far consumers have been largely resistant to making their homes ‘smart’* [13]. The Economist used the example of Google buying Nest (makers of ‘learning thermostats’) to show how companies have shown huge interest in developing smart home technology and also as an example of disappointing sales figures for smart home products. Market analytics have established that only a few percent of US households have smart (networked) appliances and the vast majority of UK households have no plans to buy any [13]. Explanations for the reluctant homeowners are diverse but include questions of reliability, cost, control, privacy and security [8,14].

Not only private companies but also public authorities have shown huge interest in smart home technologies, especially relating to health care and to energy consumption and management. The latter is for instance seen in the European Union H2020 funding schemes, including

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the SET (Strategic Energy Technology) plan and its integrated roadmap.¹ This sets out the goal of secure, affordable and sustainable energy and states that this goal can only be reached through the use of new smart energy technologies. The active participation of citizens is considered crucial to this strategy and it is made clear that citizen participation and engagement form part of smart solutions in the home, although the documents tend to be vague about the form that this engagement should take. As Skjølvold and Lindkvist illustrate, user engagement can be woefully tokenistic, even when there is an aspiration to include users in the design stage of a smart energy technology project [15].

Some of the main questions raised in the smart homes literature are data security, locus of control in the household, and the extent to which smart homes offer greater understanding and ability to manage energy to occupants on the one hand and greater system efficiency on the other. Implicit in all these is a further question about boundaries: for example, is it sufficient to describe a smart home as an ‘inclusive, two-way communication system between the house and its occupants’ ([16], p. 5) when that system may bring a home into the ambit of others traditionally kept on the doorstep – utilities, government – by setting up new data-sharing and control mechanisms?

Bringing discussions on *what a home is* into the field of residential energy consumption, with its growing interest in smart homes as a low-carbon and grid-management ‘solution’, thus seems highly relevant. In this paper we bring together discussions on the nature of the home with some research approaches to smart homes, and use this exercise to identify possible absences in the smart home literature and policy approaches.

2. The concept of home

The home is a concept with many different connotations. An oft-cited review of the concept of home lists ten of these meanings [7]. To make a more workable categorization we will combine these ten concepts into four broader categories, based on different aspects of home as reviewed by Després and others [7,3,17]. These categories in no way exclude each other: rather they should be seen as complementary and intertwined, as also established by several authors [7,3,17]. Also the orders in which we present them are arbitrary, as their importance may depend highly on the context and vary with different groups.

First is *home as security and control*. In opposition to workplace, institutions and cities or wild nature, home is the place where you are in control and can feel safe, even though, or maybe precisely because, the home might be surrounded by a hostile society. The home in this understanding is thus also associated with a safe haven and a refuge from the surroundings. Després talks about security and control as one aspect of home and a refuge from the outside world as another aspect, whereas in our terminology we combine them into one as we see them as two sides of the same experience. From a sociological perspective [3] it can, however, be objected that home is not always a secure place, for instance for abused women and children, and that, for example, many teenagers might not feel that home is where they are in control of their own lives. The importance of home as control and safety can maybe best be understood, paradoxically, when studying those who have to live in places which do not accommodate this notion of the home, such as marginalised people living in rooming houses [18].

Second is *the home as a site of activity*, either in the form of the many different activities of cooking, cleaning, eating and sleeping which constitute everyday life, or in the form of actually working on and with the home, physically transforming the home to make it the place that best accommodates our activities and ideas. In the categories from Després [7], she mentions three different meanings of the home including the home as something to act upon and modify, the home as a

centre of activity and the home as a material physical structure, whereas we in our approach combine these three into one aspect of the home as a physical place for activities. Within practice-theoretical studies there has been considerable focus both on the everyday practices (see e.g. [19–23]) and on the practices of transforming the home [24–27]. Although none of these studies has specifically addressed the question of the concept of home, it is reasonable to infer from them that the idea of a home as a site for activity is well-established. Not only practice-theoretically-oriented researchers have however worked with this aspect of the home as a site of activities. The anthropologist Gullestad has called the home the centre of everyday life, as it is from this we depart and to this we return, as well as where we perform most of our everyday activities [28].

Third, *the home is a place for relationships and continuity*. One of Després’ ten meanings of the home is about continuity and permanence, indicating that home is a temporal process, changing over time but also relating back to what was before. Permanence and continuity relate to the question of family in the way houses have been handed from one generation to another [6], but also to our childhood memories of our birth home and generally to a sense of belonging and having roots [7]. Another meaning of home according to Després refers to relationship with families and friends, with a strong connotation of home as a place to strengthen relationships with people one cares for. This was also found in a Danish study, where qualitative interviews were exploring meanings of the home and found that whenever asked about the home, residents answered with tales of the family and their relations [29].

The fourth and final category of ideas of the home deals with *the home as identity and values*. It combines three meanings from Després [7], including home as a reflection of one’s ideas and values, home as an indicator of social status, and home being a property to own. The status and identity can be understood in the language of Bourdieu, expressing how we reflect our lifestyle to ourselves and show it to others through our possessions, unconsciously guided by our habitus [30]. Higher social classes distinguish themselves from lower through their cultural and economic capital and new ideas of highbrow consumption continuously engender new questions of what an ‘ideal home’ should look like. The decoration of our homes not only signals to others who we are but also works as a reflection of and dialogue with ourselves of what is important and right to us. What people do to their homes, in the form of retrofitting, decorating and furnishing them, might thus reflect different understandings of consumer cultures [29]. Housing researchers argue that the home is increasingly becoming an expression of the residents and their values and lifestyles [31] and that the house with its interior decorations and other equipment can be seen as a microcosm reflecting the residents’ social values and identities [28].

In the above we have identified four different concepts that cover important aspects of what a home is. The review from Després [7] which inspired this list is however more descriptive than analytical, and what might be missing from this approach is an understanding of how different social groups relate differently to meanings of home, and how these different meanings of home relate to socio-economic differences and societal power relations. Furthermore, it is important to state that these different ideas of the home are in no way a checklist which applies in all cases. However, as a guide to aspects to discuss in relation to questions raised by smart homes, they might be useful.

The four concepts described above build on a strong relationship between home and dwelling, where ‘home’ related to the meanings that the residents ascribe to the physical building which they inhabit. It can be argued that historically and cross-culturally there is not always this strong relation between the concept of home and the physical building, and that this mode of thinking is rooted in the Enlightenment of the seventeenth century [3]. Home can, however, also be understood in terms of concentric circles radiating out from the dwelling into the neighbourhood, region or nation. Although homes in the western world today are often spoken of in terms of the dwelling itself, empirical

¹ <https://setis.ec.europa.eu/archive/technology-roadmaps>.

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