Are 'home' and 'smart' contradictory concepts or fluid positions that will converge?

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Abstract

Given the extensive research literature on energy in buildings, especially housing, it is striking how little there is on the home. Although recent socio-technical energy studies have begun to include ideas of what the home means to people, 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. Yet within the energy literature there is a growing focus on how 'smart homes' in smart grids could be part of a sustainable future. In this paper we bring together these two discussions on homes and on smart homes, raising the question of whether aspects of smart home visions can be compatible with more traditional understandings of being 'at home'. Or are the two fundamentally at odds with each other?

The first part of the paper examines the concept of home. We distinguish four different approaches to the concept of home including Home as security and control; Home as a place for activity; Home as permanence, continuity and social relations and finally Home as social status and identity. Discussing these concepts against different types of studies on Smart Home reveals that especially the technological approach to smart homes has a strong link to aspects of security and control in the home, whereas it is rare for any type of smart home study to focus on aspects of the home related to social relations and identity although these may well relate to how energy management might influence energy consuming habits. Strikingly little research involves evaluations of the smart home technologies in practice and we suggest more research on this, including questions on how smart home technologies might take part in transforming ideas of what the concept of home means.

Introduction: the concepts of home 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 do start to include notions of what the home means to people (Aune, 2007; Ellsworth-Krebs, Reid & Hunter, 2015) there is still room for expanding this area. From sociology (Mallett, 2004), geography (Blunt & Dowling, 2006), anthropology (Sjørslev, 2008) and architecture (Després, 1991), there is a longer tradition for working on ideas, concepts and practices of home. Here we learn that a house and a home are two fundamentally different things and there are discussions on how people appropriate houses and

thus turn them into homes and discussions on whether home should be seen as a place, a feeling or a practice?

On the other hand, we also have within the energy related literature a growing focus on whether, and if so how, 'smart homes in smart grids' might be part of a more sustainable future (Balta-Ozkan, Davidson, Bicket, & Whitmarsh, 2013; Hargreaves, Hauxwell-Baldwin, & Wilson, 2015; Hargreaves & Wilson, 2013). 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 (our primary interest in this paper); greater security against break-ins; health monitoring and independent living arrangements.

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 for the occupants and for system efficiency. Implicit in all these questions is a further question about boundaries: for example, is a smart home an 'inclusive, two-way communication system between the house and its occupants' (Saul-Rinaldi et al., 2014, p5) or a system that also brings the home into the ambit of others – utility, government – traditionally kept on the doorstep, while taking control away from occupants?

Bringing discussions on what a home is into the field of residential energy consumption, and especially the emerging focus on smart homes as a low-carbon and grid-management 'solution', thus seems highly relevant. In this paper we bring these two discussions together. This raises the question of whether aspects of smart home visions can be compatible with more traditional understandings of being 'at home'. Or are the two fundamentally at odds with each other?

The concept of home

The home is a concept with many different connotations. An often cited review study of all the different meanings of the concept of home list a pluralities of these meanings (Després, 1991). Here we will divide them into four broader categories summarizing the different aspects of home as reviewed by Després. These categories are in no way excluding each other, rather they should be seen as complementary and intertwined. 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 the city 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. The importance of home as control and safety are maybe best understood when studying those who have to life in places which do not accommodate this notion of the home, as e.g. marginalised people living in rooming houses (Mifflin & Wilton, 2005).

Second is *the home as related to the performance of practices* either in the form of all the many different practices as cooking, cleaning, eating and sleeping which constitute the 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 accommodate our activities and ideas. Within practice theoretical studies and energy consumption there have been quite some focus both on these everyday practices (se e.g. Gram-Hanssen, 2008, 2011; Hand & Shove, 2007; Røpke, Christensen, & Jensen, 2010; Shove, Watson, Hand, & Ingram, 2007) and at the practices of transforming the home (Bartiaux, Gram-Hanssen, Fonseca, Ozoliņa, & Christensen, 2014; Hand, Shove, & Southerton, 2007; Horne, Maller, & Dalton, 2014; Maller, Horne, & Dalton, 2012). Though these

study have not specifically related to the question of the concept of home. The anthropologist Gullestad has called the home the centre of the everyday life, as it is from here we depart and to here we return, as well as here where we perform the most of our everyday practices (Gullestad, 1984).

Third *the home is about permanence and continuity and relations to family and friends*. Permanence and continuity relates to the question of family in the way houses have been handed over from one generation to another, and also the way we call certain fine families with the name of the house in which they reside (Sjørslev, 2008), like the House of Windsor. Today in the global north middleclass families do not inherit the house from their parents, though ideas of home and what we do with our houses are still closely related to our ideas of family. When asking people questions about when they bought their house or why they build new extensions or did other things to it, the questions most often related to what happen in their family life, like have a newborn or kids moving from home (Gram-Hanssen & Bech-Danielsen, 2004). Also a study of what happens to the feelings of the home when partners are separated illustrate this strong connection between family life and ideas of home (Gram-Hanssen & Bech-Danielsen, 2008). Questions of permanence, continuity and family relations and their connection to ideas of home sounds very traditional, and thus also calls for investigating what happens to the idea of the home in our postmodern globalised world, where the home through all modern communication media are connected directly to the rest of the world. It has been argued that in the globalised world the home is, as everything else, an object for negotiation, disruption, construction and reconstruction (Mechlenborg, 2007).

The fourth and final category of ideas of the home deals with how the home is *a reflection of one's own ideas and values and an indicator of social status* including being a property to own. This can be understood in the language of Bourdieu and how we through our possessions reflect and show our lifestyle to other, unconsciously guided by our habitus (Bourdieu, 1986). Higher social classes distinguish themselves from lower through their cultural and economic capital and new ideas of highbrow consumption continuously develops also within questions of what a good home should look like. The decoration of our homes not only signal to others who we are, but also works as a reflection of and dialog with our self of what is important and right to us. What people do to their homes, in the form of retrofitting, decorating and furnishing them thus might reflect many different understandings of consumer cultures (Gram-Hanssen & Bech-Danielsen, 2004).

The review from Després (Després, 1991) is more descriptive than analytical, and what might miss from this approach is an understanding of how different social groups relates differently to meanings of home, and how this also relate to e.g. societal power relations. From a sociological perspective (Mallett, 2004) it can be raised that home is not a secure place for abused women and children, and that e.g. many teenagers might not feel that home is where they are in control of their own life. Thus it is important to state that these different ideas of the home are in no way a checklist which applies in all cases. Though, as a guideline for what aspects to discuss in relation to questions of smart home they might be useful.

Discussing the smart home

This section discusses some aspects of 'smart homes' in relation to the ideas of home as presented above. As noted above, a smart home is one in which at least some electrical devices are connected and can be controlled remotely by the householder or some outside agent. From an energy management perspective it can be seen as a way of attempting to get efficiency (especially system efficiency) into the home, This is shown in a report on 'Making sense of the smart home' (Saul-

Rinaldi et al., 2014) where the authors reflect on the home performance/ efficiency industry and the smart home industry as being in separate silos when they would, ideally, work together in the interests of customer and system.

This idea that the home is in some way an extension of the grid and ripe for the application of particular understandings of efficiency is a widespread one. For example, a recent systematic review of papers dealing with smart homes, users and technology found that, of 150 articles selected for analysis, three-fifths came from engineering and technical sciences, with one-fifth written from either a health or social science perspective. The authors note a lack of user-centric perspectives and the tendency to treat householders as essentially passive: people are to adopt the automated solutions provided and use them as intended by the designers (Wilson et al., 2015).

Clearly there are many ways of making sense of smart homes, depending on who is doing the sense-making, their theoretical standpoints and aims. In the table below, based on our general reading (not on any systematic analysis), we categorise smart home studies under four broad headings.

Types of smart home study and what they can tell us

Study type, with examples	What they tell us	Comments
Conceptual (Green and Marvin 1994; Wilson et al., 2015)	Meanings ascribed to smartness; situating technologies in relation to time, space, activities, agendas and actors.	Reflecting on the ideas and potentials for different smart configurations, these should be read in conjunction with the other types of study.
Technical (Wu, Liao and Fu, 2007; Rashidi and Cook, 2009)	How system elements can communicate with each other; what a system looks like; algorithms to optimize system efficiency.	The largest single category, dealing with aspects of design, interoperability, system security etc. Generally optimistic in tone.
Prospective (Balta-Ozkan et al., 2013; Skølsvold and Ryghaug, 2015)	How smart homes might fit within smart systems; what types of smart systems are possible and how they might be configured and operated.	While technical issues are often foremost, these studies set out or imply scenarios that include some 'home' issues: for example, user priorities, willingness to cede control.
Evaluative (Christiansen and Andersen, 2013; Woodruff et al., 2007; Nyborg and Røpke, 2013)	How smart homes work in practice (routines, meanings, tech and knowledge), including relational aspects and functionality.	Few in number, but important in order to assess how smart technology might work in particular contexts.

These types of study do not map directly on to the four concepts of home that we set out above, but there are some interesting correspondences. As the figure below indicates, only conceptual and (qualitative) evaluative studies typically address all four sets of Home meanings. Technical and prospective studies both tend to emphasise control, with prospective analysis taking relationships between actors into account to some extent. The figure indicates how some aspects of Home may be side-lined in smart home discourses, especially the more technical accounts. Below, we take a

look at each aspect in turn and comment on its relationship with the developing concepts of the smart home.
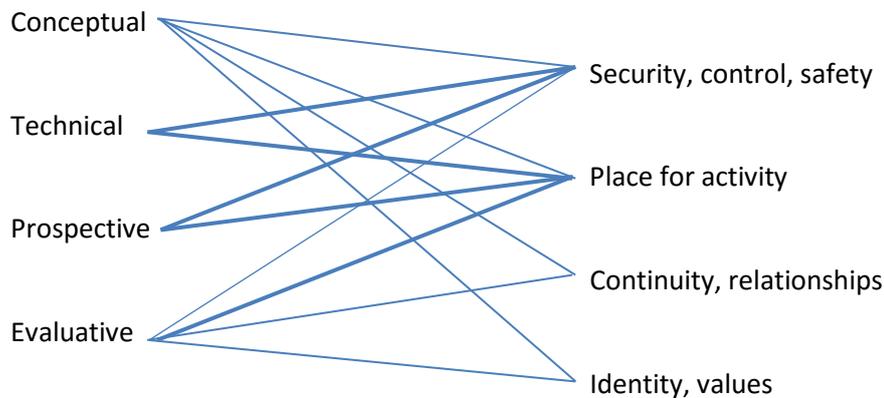
Different types of smart home study and the elements of home life that they tend to prioritise

Smart homes and security, control and safety

The concept of security plays a prominent role in the development and marketing of smart home technology, and some companies have moved into smart homes in order to develop their businesses on the basis of expertise in security systems and a reputation for reliability. There are also interests in developing in-home health monitoring and technology for assisted-living. But to adopt smart technology is to open up both 'horizontal' and 'vertical' data flows to and from the home, and privacy concerns have been a factor limiting enthusiasm for smart home technology (Naus et al., 2014). The extent to which householders trust their technology and energy providers, along with the extent and nature of their social networks, are likely to influence where they wish to draw the boundaries of 'home' as a secure place. There may be tensions between social and personal safety and security. For example, while load-shifting may help to keep a neighbourhood electricity network stable, yet there are safety concerns about operating technology while the owner is absent (e.g. Darby and Pisica, 2013).

While homes have throughout history been places for argument and conflict as well as harmony and caring, the smart home is somehow presented as conflict-free. Yet new technology can redistribute control within households, towards the person who best understands new controls or who most wants to operate household equipment (Wilson et al., 2015). This redistribution may be in addition to shifts in control between the occupant(s) and 'outside' agents such as the network operator. If direct (industry) control of certain electrical loads is involved, there is an understandable wish to know that control is being delegated to a trustworthy agent, even if it is automated (Fell et al., 2015). Essentially, smart connections redraw home boundaries and control arrangements, rather as joining an international alliance may alter the nature of sovereignty in a country. Whether the occupants feel more or less secure as a consequence will have a lot to do with their disposition towards the people they share information with, and their perceptions of what constitutes a threat to security.

Smart homes as places for activity

Homes have always been sites for activities and digital interconnections can add a dimension to such activity. They can also substitute for traditional activities, for example temperature regulation,

keeping an eye on family members, and some of the routine checking and tweaking of household equipment.

As noted above, smart technology developers often seem to assume conflict-free home life and the possibility of automated systems 'learning' our routines and adapting to them. This possibility will depend on how fixed the routines are. For example, Woodruff et al. (2007) offer a fascinating account of how home automation was brought into play to support strict Sabbath observance by Orthodox Jewish families, showing how the automation came to alter some household practices slightly. In homes with less predictable patterns of activity, the potential for machine learning and coordination is likely to be far less; troubles with the 'learning' NEST thermostat indicate the type of problems that can arise when trying to coordinate information from both human and machine activity. [1]

Smart homes and permanence, continuity and places for relationships?

ICT affects our ability to sense, communicate and control. A home can now exist in history, geography *and* cyberspace and it is commonplace for ICT to be involved in building and maintain relationships, buying and selling items for home-making, and passing on knowledge and skills for running a home. While these developments can extend the 'reach' of the home, they can also erode some of its 'refuge' characteristics, allowing people and agencies on the 'outside' to know and to influence what is going on inside.

This is not all new, of course: the lack of privacy and sharing of resources in traditional societies is well-recorded. But ICT does have the power to alter the sense of permanence and continuity that we often associate with Home, in either direction. For example, someone who frequently moves between tenancies may find that smart technology offers some stability and continuity, allowing them to maintain contact with their family, friends and colleagues and to negotiate the challenges of finding and keeping employment. On the other hand, long-term owners of a home may use ICT as a way of introducing new practices, artefacts and personal relationships, allowing them to keep their home alive as a project. A real smart home may be a home which offers flexibility as well as reliability to new residents: one where they are not 'locked in' to practices that they dislike or do not understand.

Smart homes and reflection of identity and social status

A home may be seen as temporary or permanent, complex or simple. In any case, it reflects the life of the person or people living there, from a migrant worker's shared room or a nomad's shelter to a luxury city apartment or a manor house that has belonged to a family for centuries. From a sociological consumption perspective the house reflects identity and show status of its residents and thus a smart home might also be considered according to what it signals to the residents and their peers. With all new technologies which are brought into the everyday life there are first mowers who are interested in the newness and the social status that can be part of having this new technologies and this may be seen as a general driver of still more consumption (Røpke, 1999, 2001). Though in the longer run often follows a normalisation, when it becomes widespread to use these new technologies and they lose their distinctive power (Gram-Hanssen, 2008; Røpke, 2001). Studies on who are first movers within smart home technologies, and what the driving forces are behind this might be an interesting contribution to studies on smart homes.

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[1] http://fortune.com/2016/01/21/nest-issues/

Provisional summary and conclusions

We have examined some of the ways in which the concepts of 'home' and 'smart' have been addressed by researchers. First we can notice that it is interesting that the term 'home' only arrives fully in energy discourses at a time when the place where we live becomes a site for technology that changes its nature, possibly making it less homelike. Conversely, the word 'home', with its strong emotional weight, can domesticate the term 'smart'. In the idea of the 'smart home', there seems to be an attempt to make the terms flow together in order to produce some sort of functional, satisfying hybrid. Is this attempt viable or fundamentally unworkable? Our provisional answer has more to do with interpretations of the older concept – Home – than with the newer and still-shaky concept of smartness.

We selected four expressions of what home can mean (a place of security, activity, continuity and identity) – and four modes of analysing the nature and performance of smart homes (conceptual, technical, prospective, evaluative). Looking at the research literature on smart homes, we find most of it is made up of technical and prospective studies that focus on security and control, with a secondary emphasis on activity. This emphasis draws attention to the perceived *boundaries* of home and how they may shift when a home becomes connected through digital technology to new physical, commercial and social networks, occupying a place in cyberspace as well as in three-dimensional space and time. We have to turn towards more conceptual and evaluative studies in order to find an analysis of continuity and identity in the home.

The body of research literature on smart homes throws up a paradox: in spite of attempts to increase the certainty of outcomes through digital technologies, we can expect some highly variable outcomes (in terms of energy demand, activities and relationships) in smart homes just as we have found them in traditional, pre-digital homes. As we might expect, from a socio-technical standpoint, the attribute of smartness is an emergent product of technology, knowledge, know-how, meanings and activities. Like the concept of Home, it is fluid.

This does not mean, though, that the two concepts are always fluid enough to converge. This analysis suggests that, while 'smartness' is not always opposed to traditional aspects of home life, it may be hard to reconcile with others, particularly where the boundaries of the home and locus of control are concerned. Maintaining a home has always been a social enterprise (even a hermit may need assistance with roofing or plumbing), but the advent of 'smart' adds an urgency to this sociality: activity has to be coordinated with others in real time for the sake of maintaining system stability and efficiency. It is hard to see how this can happen without changing some of the identity, continuity and affective dimensions of home life, or the balance of agency and power within and beyond the home.

As yet, we have few evaluative studies from which to judge how far smart homes live up to the claims and estimates made for them in technical and prospective studies. In future evaluative studies of smart homes, we will suggest to include questions of how meanings of the home might change along with the new technologies, following the ideas presented in this paper.

Acknowledgment

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