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RESEARCH PAPER

Residential heat comfort practices: understanding users

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The user-centred approach to heat consumption in housing is a highly relevant, but often neglected, aspect of residential energy consumption. The practice–theory approach is presented as a development within the socio-technical approach. A detailed analysis of empirical evidence from different households living in similar buildings in a suburb of Copenhagen, Denmark, shows significant variation in energy consumption due to different usage patterns of both the house and its heating system. An analysis using practice–theory finds that technologies, embodied habits, knowledge, and meanings are the main components in the understanding of both what holds this practice together as a collectively shared practice and the different socio-material configurations of each of the individual households.

Keywords: control systems, domestic heating, energy demand, habits, indoor environment, inhabitant behaviour, social convention, thermal comfort

Un aspect hautement pertinent, mais souvent négligé, de la consommation énergétique résidentielle consiste en une approche de la consommation de chauffage dans les logements axée sur l'utilisateur. L'approche, basée sur la théorie de la pratique, est présentée comme un développement intervenant dans le cadre de l'approche socio-technique. Une analyse détaillée des données empiriques probantes provenant de différents ménages vivant dans des bâtiments similaires d'une banlieue de Copenhague, au Danemark, montre l'existence de variations importantes de la consommation énergétique en raison de modes d'utilisation différents, qu'il s'agisse de la maison ou du système de chauffage. Une analyse faisant appel à la théorie de la pratique permet de constater que les technologies, les habitudes ancrées, les connaissances et les significations sont les principaux éléments qui donnent à comprendre à la fois ce qui permet à cette pratique de se maintenir en tant que pratique collectivement partagée et les différentes configurations socio-matérielles de chacun des ménages concernés.

Mots clés: systèmes de contrôle, chauffage domestique, demande énergétique, habitudes, environnement intérieur, comportement des habitants, convention sociale, confort thermique

Introduction

In Denmark, as in many other Western countries, one-third of all energy is consumed directly in households, and the main part of this relates to maintaining a comfortable indoor climate (Danish Energy Authority, 2003). Research and policy efforts over the last 30 years have mainly focused on more energy-efficient buildings and technologies. However, the actual energy consumption for space heating is determined not only by the efficiency of the equipment, but also by inhabitants' use. This paper focuses on how users regulate their indoor climate and it proposes a framework for understanding why they act as they do. It

also shows how use strongly influences actual energy consumption.

The questions of residential thermal comfort have been addressed in several studies. A special issue of *Energy and Buildings* examined the social and cultural aspects of cooling, and it described and analysed how culture and technology influence what temperatures are considered as comfortable at different times and places (Kempton and Lutzenhiser, 1992). These studies provided details on how people regulate and use their air-conditioning system. Most users switch off the units manually rather than set the thermostat

to control cooling and, contrary to what would be expected from a technical approach, these families were found to consume less energy than those using the thermostat (Lutzenhiser, 1992; Kempton *et al.*, 1992). These studies included analysis of how cultural myths (or 'folk theories') on air-conditioning functions influence user patterns. A similar approach was used by Kempton (1986) in a study on residents' use of heating systems. Two different prevalent cultural myths on the function of thermostats are described together with how these theories actually guide peoples' daily habits of heat comfort and thus their level of energy consumption.

A more recent special issue of *Building Research & Information* is also devoted to the subject of social and cultural aspects of comfort. The focus is on how today's expectations of indoor thermal climate are historically and socially specific and thus also likely to change, preferably in a more sustainable direction (Shove *et al.*, 2008). A diversity of questions are addressed: how thermal comfort standards shape both the built environment and lifestyles (Healy, 2008); the malleability of social norms and consumers' expectations of comfort tempered by the relation between production and consumption (Parkhurst and Parnaby, 2008); and how routines and everyday life practices are implicated in constructing a need for cooling exemplified by a study of residential homes for the elderly (Brown and Walker, 2008).

Much research on comfort and energy consumption with a user perspective has been within a socio-technical approach (e.g. Healy, 2008; Parkhurst and Parnaby, 2008). An influential example of the socio-technical approach within comfort studies is the work of Elizabeth Shove, who has shown how preferences and practices of indoor climate have changed historically in response to the scientific and technological development of indoor-climate technologies (Shove, 2003). Wilhite *et al.* (1996) compared practices in Japan and Norway to show how cultural differences coexist with technological differences and strongly influence both practices and preferences for space heating.

All these studies provide examples of how user practices related to comfort must include an understanding of different social, cultural and material structures. Recent research in consumer studies and in the socio-technical approach have introduced practice theory to understand how routinized everyday activities are socially structured (Warde, 2005; Shove and Pantzar, 2005). Practice theory could also be a relevant approach for the study of heating practices.

The next section provides an introduction to practice theory and its relation to socio-technical studies. This is followed by a description of the empirical material

in which that the study is based and empirical analyses with a detailed focus on the everyday practices of regulating domestic heat and ventilation. A theoretical discussion considers how practice theory can be developed for use in this kind of empirical analysis. Finally, based on the findings, different types of heat-comfort practices are interpreted and the potential benefits from the use of practice theory considered.

Practice theory in an empirical context

Practice theory is a fragmented body of theories that embraces questions about what role things and technologies should have in the understanding of practices. To understand what is common in practice theory, one can talk about 'the practice turn' of social sciences corresponding to what has previously been known as 'the cultural turn' of social sciences (Schatzki *et al.*, 2001). Rather than focusing on signs and symbols as the ground for understanding social relations, practice theorists argue that the actual practices, the actions and expressions, should be at the centre of analysing the social (Schatzki *et al.*, 2001). This shift of focus aligns practice theory with socio-technical approaches to consumer studies. A shift has occurred from spectacular and conspicuous consumption toward the more mundane and routine consumption (Gronow and Warde, 2001).

The practice theory approach can be traced to the early work of Giddens (1984), Bourdieu (1976) and others' efforts to overcome the structure-actor dualism. Regardless of some significant differences between these two theorists, it may be argued that their understanding of practices and routines do resemble each other (Warde, 2005; Reckwitz, 2002a). In Giddens's view, based on a practical consciousness, individuals continually perform daily tasks and at the same time reproduce the social structures of society. With Bourdieu's notion of habitus, social and cultural structures are unconsciously embedded in bodily actions from early childhood and thus contribute to the reproduction of routines and practices.

In Schatzki's (1996, p. 89) more philosophical approach, social practices are coordinated entities that are temporally unfolded and spatially dispersed nexus of doings and sayings. As one example of what social practices can be, Schatzki mentions cooking. Different actions and expressions (cleaning vegetables, discussing recipes, cooking rice, etc.) performed by different actors constitute the social practice of cooking. Individual actors taking part in the social practice of cooking do not necessarily know each other; however, they participate in the same social practice when performing the actions and expressions. The actors are carriers of the social practices and by that they also maintain them (Reckwitz, 2002a).

Saying that a practice forms a nexus also means that there are certain elements holding the practice together and Schatzki (1996) identifies and describes three elements holding practices together: practical understandings, rules, and teleoaffective structures. However, several authors using Schatzki's work include either more or less elements or name the elements in different ways (*e.g.* Warde, 2005; Shove and Pantzar, 2005; Reckwitz, 2002a, 2002b). An important discussion is the question of how technologies, things or products are incorporated into practice theory (Reckwitz, 2002b; Schatzki *et al.*, 2001). Moreover, it has been argued that the way Schatzki and Reckwitz elaborate practice theory means it is not ready for empirical analysis (Warde, 2005).

The current paper's contribution to the development of practice theory will assist by focusing on practices that are strongly shaped by technology use. The three elements in Schatzki's description are discussed below, and a fourth element is added, inspired by the work of other authors (Reckwitz, 2002b; Shove and Pantzar, 2005): technologies or product.

Practical understanding, embodied habits, know-how

This is about knowing what to do, and knowing how to identify and react to something. It is about routinized bodily and mental activities, carried out by (or in Reckwitz's term, 'carried by') practitioners who at the same time respond to the patterns that constitute this practice and contribute to sustaining and developing the practice. This is also what relates to Bourdieu's 'habitus'.

Rules, knowledge, language

Different authors offer different ideas on this concept. Schatzki states that this only includes explicit rules of how to do things, what is allowed and what is not, but tacit knowledge or implicit rules are excluded. This creates a problem of assigning other types of knowledge (*e.g.* tacit knowledge or cultural myths) to other elements. Warde (2005) translates Schatzki's term 'Rules' into 'Procedures'; however, this may make it difficult to separate it from practical understandings. Shove and Pantzar (2005) write about competences and do not differentiate between tacit and verbal/theoretical knowledge, which is unsatisfactory when dealing with energy consumption and comfort where both theories and embodied habits are relevant. Reckwitz (2002a) includes knowledge and language/discourse, but he emphasizes that language/discourse loses its omnipotence as compared with its status in much cultural theory. For the purpose of the present paper, it seems relevant to include technical knowledge and cultural myths of heating systems and energy consumption as well as rules of how to regulate the system.

Engagements, meanings

Schatzki uses the label 'teleoaffective structures', a compound term made up of teleological and affective, meaning being goal oriented, where the goal is directed by normative views or moods. This is complicated compared with engagements or meanings used by Warde (2005) and Shove and Pantzar (2005), respectively. Practitioners are engaged and meaning accumulates through their actions. This must be an important element of holding a practice together.

Products, 'things', technologies

Schatzki explicitly does not consider the material structure, 'things' or technologies as important in holding practices together; rather, he considers them a result of social practices. As argued elsewhere (Gram-Hanssen, 2007), this can be problematic. Several socio-technical studies have shown how technology takes part in structuring practices. Warde focuses on 'things' (*e.g.* items of consumption during participation in practices). Reckwitz and Shove and Pantzar use the concept of 'things' and technologies as much more important elements for holding practices together.

Methods

The presented empirical material is an in-depth analysis of the qualitative interviews that were part of a study conducted in 2000 and previously reported (Gram-Hanssen, 2002, 2003, 2004). The study focused on electricity, water and heat consumption in 1000 households in a planned development of terraced houses built in the 1960s–70s in Albertslund, a suburb of Copenhagen, Denmark. Albertslund is internationally known for its environmental policy and efforts. One initiative has been to publish an eco-account every year. Among many other things, this eco-account shows the average energy and water consumption in all neighbourhoods and a folder is also published for each neighbourhood showing the (anonymized) internal distribution of energy and water consumption of the households. As many of the neighbourhoods consist of a large number of identical houses, this allows the individual household to compare its own consumption with that of other families living in similar houses. These eco-accounts raise further research questions and provide opportunities for studying why one family uses three times as much energy as another living in an identical house.

The study comprised a questionnaire survey among 1000 households concerning their socio-economic status and possessions, behaviours, as well as attitudes to energy consumption. The survey had a response rate of approximately 50%, thus resulting in 500 respondents. The questionnaire results were combined with energy and water consumption data as supplied by

utilities. Based on these analyses, 30 households were selected for detailed measurements of indoor temperature, humidity and air exchange during two weeks in the heating season. The selection criteria for the 30 households were variation in energy consumption (including the highest, lowest and middle range of heat consumption), as well as including both owner-occupied and rented social housing. Among these 30 households, ten were selected for qualitative interviews. The ten families were interviewed with an open question guide on their everyday practices in the house related to water, electricity and heat consumption. The interviews were performed at the same time or few weeks after the measurements. Each interview lasted about two hours; they were recorded and later transcribed. These ten households were selected to represent as wide a variation as possible with regard to energy consumption, attitudes and socio-demographic description, while keeping in mind that more or less all people living in these terraced houses are middle or lower middle class and all have quite low levels of energy consumption compared with wealthy neighbourhoods with big villas. Only five of the ten interviews were chosen for presentation in this paper, thus allowing a more detailed description of their individual practices. The five families were chosen so that the most information-rich interviews (with regard to indoor climate) were included and because they lived in identical houses, thus making the comparison between them easier. However, all ten interviews have been analysed. The five families presented here can be regarded as ideal types of the broader material and the analysis and the results thus reflect all ten interviews. 'Ideal types' means that these five families display a range of different ways of relating to heat consumption, and the five other interviewed families can thus be characterized as belonging to the same types or possible combinations of these types. The types have not been tested against the quantitative material as the types are found during the analysis of the interviews.

The five households all live in owner-occupied two-storey terraced houses with a full basement. The floor area of each storey is 55 m². The kitchen and living room are situated on the ground floor; on the first

floor are three bedrooms and a bathroom; the basement has a big room for varying activities, a second bath, a sauna and a utility room (Figure 1). The houses are built in concrete with double-glazing (as was normal in Denmark in the 1970s) and are quite airtight. Furthermore, they all have central heating supplied by a district heating plant, as well as a big water tank in their basement that supplies hot water, also heated by district heating. The recorded energy consumption thus includes both space heating and hot water.

The names and other details of the occupants presented herein have been changed in order to anonymize the interviewees.

Different practices for regulating the indoor climate

The five different families' approaches are described in detail: use of their home, regulation of heat and ventilation, as well as their knowledge of and interest in their heat consumption. Table 1 can be consulted when reading the five stories to compare what the interviewees say about their temperature and what they have actually consumed.

Family 1: Hot, cosy and easy

Per and Anja are in their late 40s; he works as a non-skilled worker on night shift and she is a home help; they have two daughters in their early 20s still living at home. They communicated that they like to stay at home and put an effort into creating a nice and welcoming home for their children and their friends. 'It is important to feel good and be happy', Per said. They bought the house when they were expecting their second daughter and chose it because it contained abundant space for low cost – perceived as good value. Per enjoys doing do-it-yourself (DIY) and has improved both kitchen and bathroom. They like their house and especially the distribution of rooms on the three floors: They are often in the basement where they do different hobby activities, and it is nice to have this room where they do not have to tidy up all

Table 1 Heat consumption (measured yearly) and room temperatures (measured during 2 weeks of wintertime) in the interviewed families

Family	Heat consumption, measured (kWh/year)	Ground floor, average, measured (°C)	Ground floor, maximum, measured (°C)	Temperature variation, measured ^a	Basement, average, measured (°C)	First floor, average, measured (°C)
1	14 600	20.5	22.1	Steady	20.8	18.9
2	14 000	20.3	21.4	Steady	20.4	18.1
3	10 300	18.5	20.2	Vary	18.4	18.1
4	4900	22.0	24.7	Vary	20.9	16.9
5	4000	19.0	22.7	Vary	17.5	16.0

Note: ^aA 'steady' temperature variation means the temperature is normally at the same level, whereas 'vary' means there is a more or less systematic variation in temperature, e.g. where they lower the temperature at night.

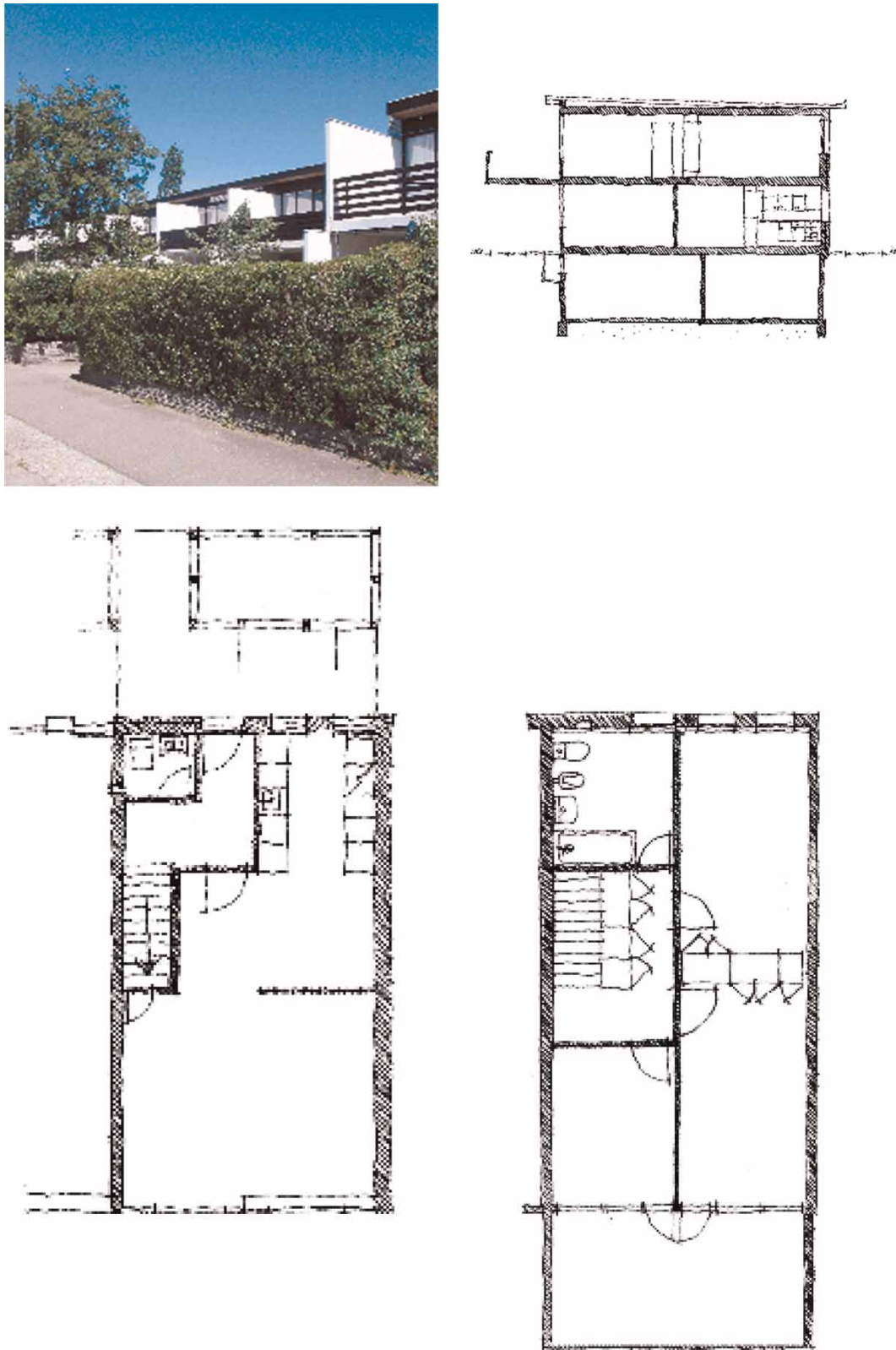


Figure 1 Photograph, plans (ground floor and first floor) and section of the terraced houses that is the home of the five interviewed families. Courtesy: Albertslund municipality

the time. The living room on the ground floor is tidier and is primarily used for dinner and for reading or watching television, whereas the first floor is rarely used for anything but sleeping.

‘Heat is something we use, not something we think about’, Per said. However, when interviewed they seemed quite conscious of what they do and why. They think they have 21–22°C in the living room and only little less in the basement ‘because when you are active you do not need as much heat’. They prefer the bedroom to be cold, 10–15°C, they said. The heat is never turned on in the bedroom and the trickle vent (a part of the window that can be opened with a sliding valve) is always open. On the other hand, they like the bathroom to be warm. Per explained how they regulate the heat and it is obvious that he is the one in charge of this. It is probably related to the fact that he previously worked in a company dealing with residential heating systems. Per explained that the thermostatic valves on each radiator are always at the same setting as they never touch them. In summertime when they do not need any heating, he has made a switch system to decouple all radiators simultaneously and only has heating for domestic hot water. When the heating season starts, he switches all radiators back on again without touching the individual thermostats. As a reason for why he acts like this, he said, ‘otherwise, if you turn the radiators up and down all the time, you cannot control anything’.

For ventilation, they explained that they normally open the terrace door and a window for a few minutes to let in some fresh air. They do this a couple of times a day, at least when Anja comes home from work; after cooking dinner and before going to bed. They explained they need a lot of fresh air because they smoke and Per also said, ‘to keep a good heating you need fresh air, fresh air is easier to heat than thick air’. He further explained that they do not turn off the radiators when they air: ‘you do not save anything by turning off radiators when airing, because when you turn on the radiators again after airing five or ten minutes, they are still warm, so what have you saved nothing’. When asked where their habit of ventilation came from, they explained they had probably heard on television or read in the newspaper that it is important to have fresh air, or maybe they learned it at home as children, and furthermore they think they should teach their children that airing is important.

Per follows their heat consumption and writes down every month how much they use. It is a routine and interest he acquired in his previous work in a company dealing with heat systems. However, they do not really think about their level of consumption. He knows the eco-account from the municipality and sometimes consults it, so he is aware they use more than the average household in their neighbourhood. As he remembers it, they use 10–12 MWh/year. To the

question of whether the knowledge that they use more than others encourages them to save, he answered:

we like the way we live, and then some heat is needed. I do not want to economize on it, because what we can save in money is not very much [...], of course we do not use just for using, but we use what we think is needed to feel nice and comfortable [...] there is always cost involved in living, so we just pay the cost.

Family 2: Fresh air and enjoy life

Susanne and Frank are both office workers in their late 40s. They have two children and the youngest daughter of 18 still lives at home. They have moved several times and previously owned a big, older detached house, on which they spent a lot of money and time to renovate and live in. When they decided to buy their present house, they prioritized a cheaper and easier-to-maintain house that allowed them to focus more on their enthusiasm for sailing. They spent ‘all their money’ on a big sail boat and have since then spent most of their summers on the boat; they explained that after a summer it is difficult to get used to being indoors again – they really enjoy outdoor life. They are pleased with their house, even though they sometimes find the living room a bit too small. Their daughter lives in the basement and they spend most of the time on the ground floor including the terrace, when the weather allows, whereas the first floor is used only for sleeping.

They do not like to have too much heat and many of their friends often complain that they feel cold, and they were therefore surprised when I told them that their heat consumption is among the highest in the neighbourhood. They said, however, that they find it difficult to regulate the heat. They like it really cold where they sleep, whereas they like it warmer in their living room. However, Susanne does not like ‘closed doors and small rooms’, maybe because she remembers how her parents focused much on closed doors in order to save energy and shouted at those who forgot to close them. Therefore, the door between the staircase and the living room is always open. They think this probably means that the heat from the living room rises to the first floor making it warmer there than they like:

It is stupid to heat the first floor. It is probably because we do it wrong. It is cold there, but there is also steam on the windows.

Susanne explained about airing:

Well I just closed the window when you arrived – it had been open for two hours – it probably means that the radiators are turned on. I do not know if I should turn them off.¹

When asked why she opened the window for two hours, she answered:

Because I like to get fresh air – we live in concrete and the smell of cooking – it just needs airing.

She also told how the trickle vent in the bedroom is always open. If it is really cold outside, she sometimes closes it, but then they have steam all over the windows in the morning. She said:

And that's wrong, then we have to turn on the heat and open the windows, but that seems wrong too.

Susanne and Frank do not care about the size of their heating bill. No matter what, the bill is very small compared with what they used to pay in their previous house. Actually, they thought that their consumption was small compared with that of their neighbours, because they compare it with their previous consumption and that of their friends, who live in a bigger detached house. They said they know the eco-accounts from the municipality and think that it is a good idea, but obviously they have never studied them in detail, as they think their own consumption is at the lower end, whereas it is at the absolute high end. Furthermore, they do not really care about the money they could save. Out of environmental considerations they think they ought to do something, but obviously this is not really affecting their everyday habits for regulating the indoor climate.

Family 3: Concerned but it is not that easy

Gitte and Hans are in their 40s; she is a textile artist and he teaches history at the university. They bought their house when they expected their son nine years ago, and the main reason was the combination of a low price and a large basement, where she can work with her textiles. They are pleased with their house in the sense that it suits their needs well, but Gitte is not very pleased with the style and materials of the house and the type of neighbourhood. She would have preferred an old brick house and a more socially integrated neighbourhood. They are often at home and appreciate a functional home that suits their different activities, and they are not very concerned about interior decoration and DIY. The basement and the ground floor are the most used parts of the house; the first floor is only used for sleeping and sometimes if their son has friends visiting.

Concerning heating, Gitte was very focused at the time of the interview on a penalty tax they had just received from the heating company because they were not cooling the district heating water enough.² Both Gitte and Hans are obviously confused about what they are doing wrong and think it is difficult to understand.

Hans thinks it has something to do with the fact that they do not use all their radiators; one in the entrance and another in the kitchen are never turned on, and only when it is very cold do they turn on the heating upstairs. They think they should use more radiators, but they also find it contradictory that it should be better to turn on more radiators. Furthermore, Gitte said that she often regulates the heat several times a day in both the living room and the basement. In the daytime when she works, for example, she does not need so much heat as in the evenings, though in the evening she also likes to sit under a blanket. It is also related to what mood she is in, but generally she prefers more heat than her son and husband do, she explained. The first years they lived in the house they focused more on saving energy for heating due to a lack of money; now that they can afford more heat and as the house is actually cheap to heat, they do not think so much about saving.

There is not really any method in how Gitte and Hans ventilate their house. As an example, Gitte explained that often at the start of the heating season they wait to turn on the heating in the basement until it is almost too cold and then it gets rather damp down there. To deal with this, Gitte then turns on the heat and also airs a lot. Otherwise, she would normally turn down the heat when she airs, but she does not always remember.

Gitte is especially interested in and concerned about environmental problems, and in many ways she thinks about how to save and not pollute the environment. Her concern is basically a political conviction, and maybe it is also based on a reaction against her mother, who in Gitte's view is much too focused on buying new things. Gitte explained that she can feel physically ill if she is shopping and thus she prefers to buy second-hand. She knows about the eco-account from the municipality and appreciates that they are active in environmental politics. She also knows that their own level of heat consumption is at the medium level compared with that of the neighbourhood and that it has been going up in the last couple of years, but this does not really seem to worry her. However, she feels that they need more information on how to heat their house and points to a collective solution:

If this was a proper neighbourhood, we would have a place and a tradition for meeting and discussing such things and we could invite someone from the municipality to explain about the heating system.

Family 4: Want to save and know how

Jurek and Helena are immigrants from Poland who have lived in Denmark for 12 years, half of the time in this house. He is a blue-collar worker in the chemical industry and she is a nursery school teacher. They are in

their late 30s and have two children of eight and six years, respectively. They consider their house to be a good compromise between, on the one hand, social housing with a bad reputation, which they were offered years ago when they needed housing, and, on the other hand, buying a detached house, which would need much more maintenance. He likes to do some DIY, not too much, however, as they still have an old house in Poland to maintain and they want to have free time to spend with their children. They are often at home and primarily use the basement and the ground floor, whereas the first floor is used for sleeping. They also visit Poland a couple of weeks every year.

Depending on how cold it is outside, they normally turn off the heat every evening before going to bed or in the morning before leaving for work, and then turn it back on in the afternoon when they return home. It sounded like it is Jurek who determines this and Helena said: 'he gets quite upset if I forget to turn off the heat'. He argued that they can earn money for their skiing holiday by remembering, and that it is important not to waste money. On the first floor the heat is never turned on when they are at home and when they heat the ground floor, they always close the door to the staircase as they like to keep it warm in the living room. Jurek explained that he is allergic to cold after his time in the military. The bathroom is the only place where they heat constantly and they are very pleased with the underfloor heating in their new bathroom; sometimes they even do the bedtime reading for the children there. During the interview they started to discuss whether the new floor-heating system is good or bad for their cooling of the district heating water, and it was obvious that they are both very familiar with the technical aspects and importance of this.³ When asked where they obtained this knowledge, they referred to a folder that was distributed to all households some years ago.

For ventilation, Jurek and Helena are also quite conscious and articulate about what they do. The trickle vent in the bedroom is always open. When they are not at home, all doors within the house are open to provide good circulation and also because Helena wants to be able to see into the living room when she comes home in case of burglary. When Helena comes home she always airs the house by opening the door on each side of the house for a couple of minutes. She has learned this at a course arranged by the Danish asthma and allergy union and is very focused on obtaining a good indoor climate because of their daughter's allergy. Furthermore, Jurek opens the terrace door several times a day when he is home because he goes outside to smoke. Jurek also stated that 'after letting in fresh air, it is easier to heat the room fast'.

Both Jurek and Helena are concerned about their consumption and explained that where they were raised,

they were not familiar with the use-and-throw-away culture of Western countries. They have learned to save and think they can benefit from that. Jurek follows their heat consumption. He explained that his job entailed reading different types of meters, so it is just a habit: when he sees a meter, he reads it. They also compare their consumption with that of others through the eco-accounts provided by the municipality, and find it satisfactory to see that they are at the very low end. They primarily focus on the economic aspect of saving energy, though they also find the environmental aspect relevant. Especially Jurek is sceptical of aspects of environmental policy such as, for example, green taxes: 'they are only there to collect money for the Exchequer', and furthermore he thinks the municipality should focus more on its own behaviour than on citizens' behaviour.

Family 5: Just habits and a little concern

Helle and Erik are in their 50s and their son left home several years ago. Erik works as a railway official and often works evenings or nights, and Helle is a part-time chemist's assistant. They bought their house 30 years ago when they expected their son, and have been pleased with it. They are not often at home and even more rarely at home at the same time. If he works at night and sleeps during the day, she prefers to be away from home in order not to wake him, and she is often alone in the evening if he works. They enjoy going out together to the theatre, etc.; however, if they are at home, they also like to have visitors.

They like not having it too warm indoors and relate it to the fact that they are outdoor people who are often out in nature. 'When you then come home, it easily feels terribly warm.' This family does not have thermostatic valves on their radiators, which is quite unusual in Denmark. They manually regulate the radiators every day depending on whether or not they are at home. If they are not at home – or are asleep – they do not heat the house, except if it is very cold outside. It is not difficult to remember, they said, it is just a habit. Furthermore, they normally do not heat the basement because it is well heated by the hot water tank. Several times they have considered installing thermostats on their radiators, but never with enough enthusiasm actually to undertake the task.

When they are not asleep, they always have ventilation on the first floor from the trickle vent in the bedroom and a little window at the other end of the house. If they are not at home, all doors within the house are open to provide circulation. When Helle comes home, she closes the bedroom door before turning on the heat. In the evening they open the bedroom door and it easily becomes warm enough for sleeping. Helle said that she believes in nature, meaning that one should not have it too warm and substantial

fresh air is provided. For example, before a good lunch with friends or family, they always go for a walk first to get some fresh air and work up an appetite.

Erik follows their consumption, but it is Helle who is the most careful about turning off the valves. Erik does it out of interest, like he keeps a log of their fuel consumption for the car, but it is not really related to an interest in saving energy. He also compares their consumption through the eco-account, though it is not really important for them to know that their consumption is low. They just consider it to be a natural consequence of their way of living. I asked if it was the money that encouraged her to save heat, but Helle denied it:

No its not the money, because heating is cheap in these houses anyway [...] its just silly to heat and open doors and windows [...] why not save a little for the environment.

Helle believes that the habit of turning off the valves relates back to the energy crisis in the early 1970s and that it has just followed them since. For her it is the environmental argument that counts, but she also emphasizes that she is absolutely not 'religious' about it.

Comparing interview with measured data

Comparing Table 1 with the interviews, it is interesting to note that the two households with low energy consumption use less than one-third of what the households with the highest consumption use. In the households with low consumption, there is good correspondence between what they say, what they do and what is measured. Family 5 says that it only heats in the evenings and if at home at the weekends; this was actually verified. Also validated was that Family 4 turns the heating on and off every day, and has a high temperature every evening in the living room and the basement, but otherwise it keeps low temperatures. Family 3 has the lowest temperatures, though not the lowest energy consumption, which also corresponds to the family's explanation that they find it difficult to know how to regulate the heat. Family 2 thinks it has low temperatures and low energy consumption, though measurements show that both are actually quite high. This corresponds with the impression from the interview that they are not really concerned about what they do or what they consume. Finally, Family 1 has the highest energy consumption, which corresponds with the fact that they like to keep warm, and that they do not care whether consumption is high.

Empirical reflections on the theory

These five narratives about the practice of regulating the indoor climate show that there are differences between

the families but also display the collective structures of the practice. In the following, each of the elements holding the practice together will be discussed and the differences between the families exposed in the stories will be presented as different specific socio-material configurations of the collective practice.

Technology, product element

The house, the heating system and the district heating infrastructure are the material elements of the studied practices. It is important to understand the relation between the practice and this material structure. As this relation should not see technology as determining a certain practice, one approach, inspired by Giddens's structuration theory (Giddens, 1984), could be to consider material structures as enabling and constraining certain practices. Schatzki (2002) takes this further and uses the notion of 'prefigure' to describe the way that the social present channels forthcoming actions (p. xv). Prefigure makes some actions easier or harder, shorter or longer, acceptable or not compared with other actions (p. 225). First consideration will be given to how the layout of a house prefigures its use, and second on how ventilation and heating systems prefigure habits related to comfort.

That the arrangements of the houses prefigure certain ways of using them can be seen from the fact that all families seem to use the first floor for sleeping and the ground floor as a living room, which is both following the architectural layout of these houses and within the cultural norms of a modern Western arrangement of a home – individual bedrooms for parents and children and a common living room. The basements in these houses are, however, more flexible, and the interviewees appreciated and used them. As there is no cultural norm indicating the use of this room, it is open for interpretation and varies with both interests and household composition. Adults use basements for hobbies or work, or to sleep in if they work nightshifts and want more darkness and quiet. Smaller children use basements as playrooms, where toys do not have to be tidied up after use and later they are used as a teenager's room separated from the rest of the family. These houses were originally built with a sauna in the basement, but some have later removed it and even those who still have it never really use it. Thus, this is an example of how a certain design never comes into practice, even though the house was built for it. Culture might be an explanation as it is obvious to imagine that if the houses were built in Finland, where there is a strong sauna culture, the saunas would probably have been used much more. This case study thus presents examples of how the layout of the house strongly prefigures practice, how

the layout is open for interpretation, or how it does not influence practice at all.

Concerning how the heating system influences practices, there are also examples of habits that are common throughout the families and habits that represent individual differences. What is common and what seems to be prefigured by technology is the way the first floor is ventilated. All those interviewed always kept the trickle vent open in the bedroom and this, combined with the fact that heat rises from ground level to the first floor, gives some similarities in the way the houses are heated and ventilated. The differences are most strongly related to how radiators and doors are operated. Some always keep inside doors open or leave valves in the same position, whereas others open and close doors and valves regularly, either unconsciously or systematically. In both cases it relates to what in the theory is described as a practical understanding, embodied habits, know-how; these will be further described below. Another difference of how the heating system is used relates to how many radiators are used at the same time; as shown in the interviews, this relates to the question of technical knowledge of how to cool district heating water – a question that will also be dealt with below. Family 5 did not have thermostat regulation on its radiators, and this obviously shaped its practice as the family regulated much more than the other families. The family discussed buying thermostats as it was told that they are more energy efficient. However, the family's interest is insufficient to overcome its inertia to install thermostats, and furthermore the family thinks the heating system works well without thermostatic valves on radiators.

Practical understanding/embodied habits element

All the interviewed households are carriers of the practice of indoor climate regulation and they have different embodied habits with regards to how they interact with radiator valves, doors, trickle vents and windows every day. In the interview situation they were asked why they act as they do, and in this way they were asked to post-rationalize their routines. It is important to be aware that the interviewees' own rationalization is not necessarily the same, as what from a theoretical point of view can be called elements holding the practice together. For example, when Per in Family 1 says that they never turn on the radiator valves, 'because otherwise you cannot control anything', this is how the individual explains his routines so that they seem rational to themselves. However, in the interviews there are also examples of how people do not try to explain their habits as much as they associate them with other habits. Some of the interviewees thus recalled their experience of other practices as

part of the explanation why they act as they do. Two of the men thus related their indoor climate habits to experience with valves and meters gained at their workplace. Many people also recall their childhood experience of how their parents practised indoor climate regulation, and their own habits can be seen as either a reaction to or a continuation of this. One of the families related to their previous experience of heating a big, old and expensive-to-heat villa. Finally, the interviewees also stated that their habits are influenced by campaigns and other types of knowledge, which they have previously embedded, so that now they are part of their unconscious practice.

Rules, knowledge, language element

Rules, knowledge and language about indoor climate and comfort are established and disseminated within different institutions and channels, which influence practices in different ways, though not in any simple 'communication-change-behaviour' way. Institutions producing knowledge include research institutions, governmental bodies and energy or asthma non-governmental organizations (NGOs), and those who disseminate this knowledge into daily practices furthermore include local authorities, schools, news media and utilities. For example, some interviewees referred to campaigns in the 1970s to promote a lower indoor temperature when asked about their present practices, and others referred to courses on how to keep a healthy indoor climate in order to reduce allergies to house-dust mites. A special type of knowledge from this case study is the feedback from eco-accounts indicating how much energy the household consumes and how this compares with other households' consumption. Within energy studies in general, there are many different ways of providing this type of feedback to consumers (Fischer, 2008). An example of how knowledge and economic instruments might combine is the family explaining that it received a penalty tax for not cooling its district heating water enough. This family did not technically understand what this meant, though its members were quite eager to learn about it because they disliked the idea of receiving a penalty tax more than having a desire to save money.

In relation to knowledge, several of the interviewees also referred to the general knowledge received from television and newspapers, especially about the relation between heating, energy consumption and environmental problems. However, this type of knowledge dissemination might rather be viewed as information influencing attitudes and engagement.

The last aspect of knowledge relates to questions of indoor climate and health. Some of the families had family members with allergies and were therefore

very focused on an healthy indoor climate in a scientific meaning with a focus on low humidity preventing house-dust mites from surviving, whereas others had a cultural myth approach to what is healthy or unhealthy. Thus, several argued that having a lower indoor temperature is more natural and many associated sleeping with fresh air and low temperature especially with healthiness and naturalness.

Meanings/engagement element

The last element that holds practices together is engagements or meanings. In relation to indoor climate, the interviews point to several different sub-fields or related relevant practices including whether environment is important, whether saving money is important, the meaning and thus attachment to the home, and how it relates to heating, and a technical interest and satisfaction in doing the right thing technically. The question of the environment as a reason for saving energy was raised during the interview by several interviewees. This was not as something they normally think about when actually practising heat consumption, but as meaningful to them and as a background to how they have decided or chosen different ways of performing the practice. For Families 3 and 5, the environment was obviously an important part of understanding their practice. For Family 5, this resulted in much less energy consumption than for Family 3. This was in spite of Gitte and Hans being much more environmentally concerned, which is a reminder that engagements and meanings are only part of what holds practices together. Furthermore, it also highlights that engagements and meanings are different from knowledge and technical understandings. It is absolutely possible to be highly engaged in the environment without knowing technically how to influence the level of consumed energy, as it is also possible to be technically interested in doing 'the right thing' without being especially environmentally concerned, as seen in Family 4. Another aspect that sometimes relates to the environment, but not always, is how people feel about savings and money. For some this is related to a positive feeling of doing something morally or economically right, and often it is a deep-rooted feeling relating to childhood experience, resulting in a physical discomfort at overspending. This was evident especially in the case of Family 4 (who related their preference for saving rather than spending based on their economically less privileged background in Poland) and Family 3 (who act on a political and moral decision about consumption and environment).

Environmental, technical, and economic interest in saving are only a few aspects of the meanings and engagements that are important for practices of heating and indoor climate. The meaning and importance of the home thus also have a strong relevance

for understanding these practices. When Family 1 emphasizes the importance of maintaining a cosy and welcoming home, this also means maintaining a rather high indoor temperature, whereas Family 2 emphasizes that its home is only one of two places, where the family members enjoy staying. In summertime their sailboat is their place of preference and this also means an emphasis on fresh air rather than high temperature.

Conclusion

A combination of quantitative measurements and qualitative interviews has shown how different user behaviour in identical houses may result in a three times higher energy consumption for heating. A detailed analysis of everyday practices in residential comfort was employed to understand the different levels of energy consumption. Inspired by recent theoretical approaches, this analysis was used to explain differences within a socio-technical homogeneous group rather than by changes across time, space or culture.

Five ideal types of families and how they relate to residential heat comfort were presented. The advantage of these types is that they provide a detailed narrative to the different elements that sustain the practices in each of these families, and thus illustrate how complex is even a simple practice like regulating the residential indoor climate. These five types do not necessarily reflect all possible types; however, they do show important aspects and variations of comfort practices. To draw more general conclusions, the way ahead is not to identify more types or to quantify these types in a broader material. The learning for energy policy and other practical applications should rather be on the insights gained from the four elements holding these practices together, which are the technologies, knowledge, habits, and meanings of residential heat comfort.

The inclusion of practice theory into the study of residential energy consumption provides insights. Different relevant elements of understanding practice are brought together. Previously some studies have focused on technologies, others on science or folk theory or habits, etc. In practice theory these are all brought in as different elements of holding practices together. Where practice theory, as developed by Schatzki, might be a quite philosophical approach, it is transformed here into a more straightforward scheme for empirical analysis. What is important to remember in this scheme is the balance of the structure-actor perspective. Each of the four elements should be seen as a structure sustaining practices, at the same time as these elements are sustained and developed by the practitioners performing the practices. Compared with other theoretical approaches in the understanding of heat comfort practices, the

advantage of practice theory as presented here is therefore twofold: it combines the different elements that are relevant in the understanding of practices and it focuses on the structural nature of practices, though it is also still open for interpreting differences in the way different actors take part in a practice.

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References

- Danish Energy Authority (2003) *Energistatistik 2002*, Energistyrelsen, Copenhagen.
- Bourdieu, P. (1976). *Outline of a Theory of Practice* (trans. R. Nice). Cambridge University Press, Cambridge.
- Brown, S. and Walker, G. (2008) Understanding heat wave vulnerability in nursing and residential homes. *Building Research & Information*, 36(4), 363–372.
- Fischer, C. (2008) Feedback on household electricity consumption: a tool for saving energy? *Energy Efficiency*, 1(1), 79–104.
- Giddens, A. (1984) *The Constitution of Society*, Polity, Cambridge.
- Gram-Hanssen, K. (2002) Technology and culture as explanations for variations in energy consumption, in *Proceedings of the 2002 American Council for an Energy Efficient Economy Summer Study in Buildings*, American Council for an Energy Efficient Economy (ACEEE), Washington, DC.
- Gram-Hanssen, K. (2003) *Boligers energiforbrug – sociale og tekniske forklaringer på forskelle*. By og byg resultater 029. Statens Byggeforskningsinstitut, SBI, Hørsholm.
- Gram-Hanssen, K. (2004) Domestic electricity consumption – consumers and appliances, in L. Reisch and I. Röpke (eds.): *The Ecological Economics of Consumption*, Edward Elgar, Camberley, pp. 132–150.
- Gram-Hanssen, K. (2007) Practice theory and the green energy consumer. Paper presented at the Annual Conference of the European Sociological Association, ‘Conflict, Citizenship and Civil Society’, Glasgow, UK, 3–6 September 2007.
- Gronow, J. and Warde, A. (eds) (2001) *Ordinary Consumption*. Harwood, London and New York.
- Healy, S. (2008) Air-conditioning and the ‘homogenization’ of people and the built environments. *Building Research & Information*, 36(4), 312–322.
- Kempton, W. (1986) Two theories of home heat control. *Cognitive Science*, 10(1), 75–90.
- Kempton, W., Feuermann, D. and McGarity, A.E. (1992) ‘I always turn it on super’: user decisions about when and how to operate room air conditioners. *Energy and Buildings*, 18, 177–191.
- Kempton, W. and Lutzenhiser, L. (1992) Introduction. *Energy and Buildings*, 18, 171–176.
- Lutzenhiser, L. (1992) A question of control: alternative patterns of room air-conditioner use. *Energy and Buildings*, 18, 193–200.
- Parkhurst, G. and Parnaby, R. (2008) Growth in mobile air-conditioning: a socio-technical research agenda. *Building Research & Information*, 36(4), 351–362.
- Reckwitz, A. (2002a) Toward a theory of social practices. *European Journal of Social Theory*, 5(2), 243–263.
- Reckwitz, A. (2002b) The status of the ‘material’ in theories of culture. From ‘social structure’ to ‘artefact’. *Journal for the Theory of Social Behaviour*, 32, 195–217.
- Schatzki, T.R. (1996) *Social Practices. A Wittgensteinian Approach to Human Activity and the Social*, Cambridge University Press, Cambridge.
- Schatzki, T.R. (2002) *The Site of the Social. A Philosophical Account of the Constitution of Social Life and Change*, Pennsylvania State University Press, University Park, PA.
- Schatzki, T.R., Cetina, K.K. and von Savigny, E. (2001) *The Practice Turn in Contemporary Theory*, Routledge, London.
- Shove, E. (2003) *Comfort, Cleanliness and Convenience. The Social Organization of Normality*, Berg, Oxford.
- Shove, E., Chappells, H., Lutzenhiser, L. and Hackett, B. (2008) Comfort in a lower carbon society. *Building Research & Information*, 36(4), 307–311.
- Shove, E. and Pantzar, M. (2005) Consumers, producers and practices. Understanding the invention and reinvention of Nordic walking. *Journal of Consumer Culture*, 5(1), 43–64.
- Warde, A. (2005) Consumption and theories of practice. *Journal of Consumer Culture*, 5(2), 131–153.
- Wilhite, H., Nagakami, H., Masuda, T., Yamaga, Y. and Haneda, H. (1996) A cross-cultural analysis of household energy use behaviour in Japan and Norway. *Energy Policy*, 24(9), 795–803.

Endnotes

¹The interview was conducted at the end of November; the outside temperature was 5–10°C.

²To have an efficient district heating system, it is important that all households have as big a temperature difference as possible between the district heating water running into their house and leaving the house. To accomplish this, the households should use many radiators on a lower heating setting rather than a few on a higher heating setting. Thus, one radiator heating the whole house would need a very hot radiator, meaning that a lot of water would have to run through the radiator with a high in and an almost as high out temperature. In contrast, many radiators heating a house means that each radiator has to produce less heat and thus needs less water running through it. The heating consumption in these two cases is the same, but the cooling of the district heating water is different. Therefore, the heating company uses a penalty tax if households are not cooling their district heating water enough.

³For an explanation, see endnote 2.