Household energy use regarded as energy orders – practical implications for housing companies

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Keywords

passive houses, activities, appliances, household electricity, housing companies

Abstract

Building low energy housing is one way of reducing household energy use, particularly energy used for heating and warm water. Household appliance use, on the other hand, is often left out even though it contributes to overall energy use in households. Housing companies are therefore missing part of the potential in reducing energy use simply because the energy used for appliances not accounted for. However, research on household energy use in general is abundant, and the subject has been studied from different aspects and standpoints, for example, by regarding energy use as part of everyday practices. Another way of studying energy use in the home is to view energy use as energy orders. The energy order concept is based on time-geographical concepts and includes the concrete use of appliances and other material resources in the home as well as sequences of activities in their everyday context. With this approach, restrictions and possibilities for doing things differently in everyday life become clearer, making it easier to analyse where the possibilities for changed behaviour lie.

Interviews were conducted with 14 households, a total of 25 persons, to study how appliances and the design of low energy flats influence everyday activities. Results show that every household has unique energy orders, which means that households use resources in different ways depending on individual projects, capacities and everyday context. This leads to differences in energy use. On the other hand, the decisions made by housing companies have an impact on household energy behaviour, which means that households are able to influence energy use only to a certain degree. Housing companies should therefore communicate with their tenants in order to learn more about how tenants experience the material aspects of their flats and how they actually use both appliances and the flats in general. By doing this, housing companies would gain new knowledge and find opportunities to improve functionality in ways that enable different energy orders.

Introduction

> He: We have to use the dryer even if we don't want to, because there really aren't any other options. Instead, we run half the cycle and then let the clothes dry on a rack. At least we save a little by doing it that way. (H6)

The quote above is an expression of an energy order and how it is created. There are material settings (washing machine, dryer, rack), space (bathroom size), time, and constraints of different kinds (rental flats designed and equipped according to company rules, economic motives for saving energy) that influence the activity of drying clothes. As a result, in this household drying clothes uses a bit less energy than simply using the tumble dryer, but there could have been a better alternative, which is air drying on a rack or line from the beginning. This option was not chosen, however, because the members of the household did not want their drying of clothes to take up the whole bathroom for a long time. To successfully reach the goal of clean clothes, the household chose a set of activities in that particular space, adapting the activity to the constraints that the individuals in the house-

hold experienced. This paper will elaborate on what such an approach, the energy order, could give housing companies in their energy efficiency work, particularly in their efforts to include their tenants in that work.

Housing companies are responsible for building houses that have high energy performance, but due to building regulations and economic investments, electricity use inside the flats, which in this case mean using appliances, is often put to the background. Yet, this area is often highlighted when energy performance of buildings is being evaluated (Gill et al., 2010). Public housing companies, which this paper concerns, both own and manage buildings and are responsible for the installations in the flats. Having purchased and installed appliances, the housing companies leave the rest to the households. Since tenants pay for their own electricity use, housing companies often regard household electricity use as the responsibility of the households themselves (Karresand, 2014). From a housing company perspective, the threshold to start working more directly with household electricity use is often too high when investments in energy reducing technologies such as insulation pay off much more quickly.

From a social science point of view, household electricity use is complex. It is embedded in everyday practices and is largely invisible to the user (see for instance Shove, 2003; Gram-Hanssen, 2008). However, if practices are studied in detail, as energy orders, it is possible to detect where the opportunities for changed behaviour are.

An energy order is a way of describing electrical appliance use in a detailed and concrete way in the household context. This means following appliance use in the household setting by looking at who does what, when and in what way. By following the sequences of a specific household activity, for instance dishwashing, the particular way it is done within the household is revealed. How the activity is performed is dependent on several aspects. The physical setting, resources and the technology available comprise one aspect, and the timing and location of the activity comprise another. Furthermore, who performs the activity and what particular knowledge, values and experiences this person has are of importance. Finally, the couplings between household members have an impact on how activities are arranged. As a consequence, the way the activity of dishwashing is performed is to certain degree unique for every household. In relation to energy, the way an activity is performed influences the energy intensity of the activity. An energy order is, in other words, the performance of an activity and the energy consequence of that particular way of doing.

The aim of the paper is to show how the energy order concept can be used as a tool for housing companies when working to reduce energy use in households. What does the energy order concept say about household energy use, and how can housing companies use this detailed way of looking at energy use in practical daily operations?

The paper starts with a background section describing previous research and the theoretical framework. The next part describes the method and how the study was implemented, and it is followed by a results section, discussion and conclusions.

Background and theoretical framework

Public housing companies are an important actor in providing housing for households that either do not want to or cannot own their own homes. In Sweden, where the empirical data for this work was gathered, public housing companies own a large part of the housing stock and are a dominant actor in the housing market.[1] About 37 per cent of households live in rental housing compared to 41 per cent in privately owned housing and 22 per cent in housing co-operatives (Boverket, 2011). The public housing sector provides about 45 per cent of all rented apartments in the country, thus due to the high market share the actions of public housing companies have a great impact on the housing market as a whole. Their experiences are important for understanding how housing companies in general might work with tenants to improve energy efficiency.

Thoresson and Glad (2009) and Karresand (2014) showed that public housing companies rarely work directly with tenants when trying to reduce household energy use. The most effective way, according to the housing companies, is individual metering and billing of energy use, which means using technology to try to influence how households use electricity. Individual metering and billing is still rare in old buildings in Sweden but exists in new buildings. The effectiveness of individual energy metering in a Swedish context has been contested, though, due to its expense, and it is argued that it does not lead to desired energy efficiency (Boverket, 2014). Instead, working directly with households may be a more efficient way to reduce electricity use.

Housing companies do work with households in other forms than individual metering and billing of energy, but the measures taken are often limited to information initiatives, such as energy saving campaigns, targeted to households (Allmännyttan, 2014). One problem that also prevents housing companies from being more involved in reducing household energy use is that they do not always have access to figures on household electricity use, since utility companies charge households directly. Not knowing variations in electricity use among households, for instance, makes it more difficult to get an overall picture and to know where to start. It is likely that housing companies to a certain degree leave the households out of energy efficiency measures because they lack the tools needed to include them. In addition, building codes exclude household electricity use (International Energy Agency, 2008), which further places household electricity outside the housing company domain.

HOUSEHOLD ENERGY USE

Research on household energy use has been abundant in recent years. Previous research pinpoints the complexity of energy use in everyday life. It is embedded in cultural (e.g. Wilhite et al., 1996, Lutzenhiser, 1992), technological (e.g. Cowan, 1983; Aune, 2007) and everyday contexts (e.g. Spaargarten, 2003; Shove, 2003, 2004; Gram-Hanssen, 2008; Ellegård & Palm,

1. Public housing in a Swedish context is defined as non-profit municipal housing and differs somewhat from the corresponding international use of the term, which often implies social housing. In Sweden, public housing generally refers to housing companies that provide housing for the "public benefit" without restrictions on who can rent. Even if public housing companies may have a wider social mission, they operate like any other company on the housing market and offer housing of different sorts and standards (Boverket, 2008).

2011). Studies that reveal increasing energy use in everyday practices include Shove (2003) and Shove and Southerton (2000), who show how, with the use of air conditioners, washers and dryers, and freezers, technological systems are embedded in everyday routines and how the practices are dependent on systems of infrastructure. The practices that are part of "normal" life have become ever more energy consuming. Røpke and Haunstrup Christensen (2012) study domestic ICT use and state that energy use is likely to increase due to increasing dissemination of ICT into all sorts of everyday activities. This body of work shows that energy use needs to be understood within its broader context.

Energy use is also influenced by people and how, together, they negotiate the use of appliances. Green and Ellegård (2007) and Karlsson and Widén (2008) studied activity patterns concerning appliance use and how energy use is created by these patterns. They found different user patterns: *communal use* when two or more household members use one appliance at the same time, *use for common goals* when appliances are used to serve several household members, *serial use* when the same device is used at different times by different household members for individual use and, finally, *parallel use*, when many devices of the same kind are used at the same time by different household members. These findings indicate that individual user patterns are important for understanding why both appliance and energy use increases in households, but they do not focus on the couplings between appliances and people or between household members; for example they do not focus on why a particular form of appliance use occurs in a specific household. With regard to the need for context to understand energy use as well as user patterns in the household, I will focus on household energy use within the material and social setting of the *household*, meaning that technology as well as people and their relations and commitments to each other in the household also matter.

In this paper I will argue that some time-geographical concepts are useful for understanding the details in household electricity use and what this knowledge may bring forth in practical everyday operations in housing companies. The concept of energy order, which is based on time geography, will be described below.

TIME-GEOGRAPHICAL CONCEPTS

Time geography focuses on individuals and how they perform *activities* in the real-world environment (Hägerstrand, 1985). All activities are performed with a purpose; they are part of short- or long-term *projects* aiming at specific goals. In this study three main household projects were investigated: cooking, care of clothing and recreation. Performing activities in these projects requires *resources* which the individual, depending on the resources available, uses to fulfil the goals. Resources include appliances, knowledge, and obviously electricity. Not all projects are necessarily realized, or they may be realized in different ways depending on *constraints* that face the individual, including the time-space constraints, which are basic in time geography. Other constraints are the *steering* constraints, which have their basis at an organizational level (laws, rules of institutions etc.), and *capacity* constraints, which depend on physical human needs for sleep, nutrition, shelter etc. Special constraints within time geography are *coupling* constraints, which are the possibilities for people and objects to coordinate in time and space. They are affected by where people are located before the activity begins, where they are going and how much time they have (Hägerstrand, 1974, Åquist, 1992). Commitments and negotiations control how couplings may be handled, for instance, when family members have different tasks to perform. Coupling constraints occur, in other words, when projects are implemented and coordination in time and space is needed. Time geography is an ecological approach; there is only a certain amount of resources and space, which means that they have to be arranged in a way that, in a holistic perspective, there is a balance between them.

Also useful for understanding how activities are performed is the concept of *pocket of local order*. A pocket of local order may be described as a place where a certain order is created during a specific time period in order for people to perform activities within a project (Ellegård & Vilhelmson, 2004). It is a physical and social order valid in a specific place. Lenntorp (2004) describes it as follows:

> Almost all human activity requires a certain order for it to be successfully carried out. Among a number of considerations, such order requires that a specific defined section of time-space is endowed with particular infrastructure and that it has a more or less formal system of regulation to facilitate the execution of the aforementioned activities. The system of regulation both regulates the activities within pockets of local order as well as their interaction with the outside world. Activities thus demand a section in time-space that is well ordered to serve their function and that it can also be controlled such that this order may be maintained and respected (Lenntorp, 2004, pp. 224–225).

In other words, each project needs a pocket of local order, or maybe more accurately, a series of pockets of local order to be successfully fulfilled. The material settings in the form of the house itself, the technology and appliances form the physical conditions of the pocket of local order. All household members with their individual projects and couplings between them form the social conditions in the pocket of local order. Together they create a pocket of local order for the whole household.

ENERGY ORDERS

By combining the time-geographical concepts above, household energy use may be regarded as *energy orders*. In addition to examining household activities performed using resources under certain constraints in a pocket of local order, the resource of electricity is highlighted. By going into household activities in detail, it is possible to discover where and when activities take place, and who is doing them, using what appliances and for how long. By following all household members it is possible to study what resources are being used, what constraints occur when performing activities and what effect these conditions have on the way household activities are organized in general and how electricity use is affected in particular. Because the everyday life context varies from one person to another, different individuals are affected by different kinds of constraints, and so will perform activities in different ways. This will result in more or less electricity

use, and different households will therefore create different energy orders.

I will now move on to the empirical work that this paper is based on. The method and how the study was implemented are presented next.

The study

In order to understand how households use their electrical appliances, why there are differences among them and why some households manage to live fairly energy efficiently while others do not, the assumption was that by following the activities in their real-life setting, the circumstances in which households organize their activities would be revealed. This requires that households be allowed to tell about their experiences in their own words and preferably in their own household context.

Data come from qualitative interviews in two different public housing companies in two towns in the mid-south of Sweden, one in a smaller town of approximately 30,000 inhabitants and the other of 150,000 inhabitants. Fourteen interviews were conducted with tenants living in these flats. The household interviews were all done in the homes of the informants, and all adult household members were interviewed; altogether, 25 persons were interviewed. Interview guides were semi-structured according to three different household projects: cooking, care of clothing and recreation, including entertainment and household administration. The interviews were done while "walking around" in the flats discussing the specific appliances used in everyday activities. This made it possible to look at and touch the appliances and to talk about how they were used and where they were located in the room. An important question was also how the households conceived their own opportunities for acting differently and choosing other sorts of activities to achieve the same goals. What aspects, in their physical or social environment, prevent energy efficient alternatives? The interviews lasted between one and one and a half hour. The households are referred to as H1–H14 throughout the text.

The buildings in question are multi-family buildings of passive house standard. The houses are semi-detached with 2–5 room flats with either a balcony or a patio with a small garden, depending on were in the building the flat is located. District heating is used as the heating source in one of the residential areas, whereas the buildings in the other area use an electrical heating coil for extra heating and solar collectors for warm water. Both areas are popular and close to nature, which means fairly high rents. The informants included seven two-person households, three single-person households and four households with two adults and minor children.

The appliances in focus are household appliances, some owned by the housing companies and some by the informants. This means that the housing companies make the investment decisions for many of the appliances, including fridge, freezer, stove, washing machine and tumble dryer. The households, on the other hand, invest in coffee makers, kettles, food processors, TV's, computers, tablets, stereos, game consoles etc. Only electrical appliances are considered, excluding heating and warm-water installations, even though heating practices are obviously essential in household energy use. This study, however, focuses only on household electricity use, leaving some energy related activities out, for instance, bathing and showering.

All interviews were transcribed, followed by a thematic analysis of the material based on what projects households were engaged in, how the informants talked about energy, what form of appliance they chose, what prevented them from acting differently etc. Very early in the process it was obvious that households arranged everyday activities and their appliance use in different ways and that these differences did not always seem to depend on the technology available or on the households having particularly energy efficient attitudes, but had other origins. It became clear that households had to adapt their activities to all other activities within as well as outside the household, and the more people in the household, the more activities needed to fit into the same time and space. Thus, time and space seemed to be important for how the appliances were used. This in turn led to an analysis using time-geographical concepts, looking particularly at different kinds of restrictions, and how they control actions, but also how individuals overcome them. To capture the many aspects or components of appliance use and how, together, they form the conditions for how energy intensive appliance use is in specific households, the concept of energy order was formulated. The energy order therefore has its origins in the empirical findings and was further developed using the time-geographical concepts. The next section will go into detail on what aspects form energy orders in different everyday projects in the household.

Results and discussion

The results section is presented with reference to the three different household projects studied in the households: cooking, care of clothing and recreation. The chapter finishes with a discussion on what energy orders reveal about energy use in households in general and in relation to what housing companies can learn from them.

ENERGY ORDERS IN THE COOKING PROJECT

A regular activity among the interviewed households was cooking dinner. Cooking dinner consists of three basic categories of activities: preparatory work, cooking and after work. Some households cooked dinner every day, while others did so only on weekends. Other projects, particularly employed work, seemed to affect how often and what sort of dinner (how much time households were prepared to spend on cooking dinner) was prepared in households. To some extent family size and age of children also affected how often households prepared proper meals. In this sense cooking activities are not merely a way of fuelling the body, but are also a part of the project "caring for others" (Cowan, 1983; Åquist, 1992). With the focus on couplings between people and the time budgets facing household members, some aspects seem important for how the energy orders for cooking may develop in a household.

During weekdays a large part of Swedish households are engaged in work, school, day care etc. (SCB, 2012). They spend a considerable part of the day away from home, engaged in projects of different kinds (education, paid work, care). When they return home in the evening most household members join for dinner in the home. There is a typical time of day when most families sit down together at the dinner table to have some sort of meal. The time of day when people eat is therefore fairly fixed by institutional rules.

Some households prepared proper meals every night whereas others were satisfied with a light snack during weekdays:

> He: We don't use that much electricity for cooking purposes really. Compared to the families with children I suppose … they probably prepare dinner every evening for the kids because they have to. But we don't have to …
>
> She: No, not in the same way (laughs).
>
> He: You could say that we only cook on Fridays, Saturdays and Sundays, not more frequently in general.
>
> She: It's quite convenient. (H2)

This household concentrated all cooking to weekends and had the leftovers for lunch on weekdays. In this household there were no obligations to smaller children who might require the preparation of proper meals every day. Instead, the energy orders in the cooking project during weekdays were not very energy intensive because the project generally required little more than a coffee maker. On weekends, on the other hand, there was more cooking activity when they cooked larger amounts of food, not only for the weekends but also for the coming week's lunchboxes. These energy orders were instead more resource intensive during a few hours of the weekend. This is a more time-rational way of managing the cooking project that suited this couple well.

As a contrast, in households with several minor children, cooking was done twice a day on all days of the week, at lunch and at dinner. In these households cooking required considerable time, not only the cooking of food itself, but also the preparatory work and after work that are part of the cooking project as a whole. There was, in other words, more activity in this family's cooking project during weekdays compared to the household above. Even if the family did not actually cook, if they ordered ready meals, for example, they would still have to do some preparations and take care of the after work (doing dishes, for instance).

A large family that also has a lot of cooking events will therefore also produce work before and after the actual cooking takes place. There will be more grocery shopping, more chopping of ingredients, more things to put away and more dishes to wash. Some electrical appliances will facilitate work (the dishwasher) whereas others, interestingly enough, will only produce more work. When asked about the use of the food processor, one family explained why they did not use it much:

> Interviewer: Why don't you use the food processor?
>
> She: Partly because I don't want a lot of stuff lying around. Partly because there are so many parts that need to be assembled, then they all have to be cleaned and I don't want the appliance on the kitchen counter, and then they have to be put away again, so that's why it is easier doing everything by hand really.
>
> He: It's faster as well.
>
> She: The only time I use it is when I make a pie, then I do both the pastry and the pie filling using the food processor. It doesn't happen very often, and sometimes it is still easier to do it by hand. So that's one reason for not using the appliance. (H3)

Limited storage space and the assembly of the appliance, and then the need to clean it and put it away after use, were perceived as laborious by the household. Appliances are therefore not always a solution for saving time on household work, which, for instance, Cowan (1983) showed in *More work for mother*. Not only do they not save time, they also require space, which is a scarce resource in many flats. This family chose to prepare the ingredients by hand because that reduced after work. The experience of too many things in a limited space formed the energy order so that fewer appliances were used.

The dishwasher, on the other hand, was desirable for many households, and a majority of the interviewed households had one. The households that did not either own one or have it included in the rent were interested in acquiring one but met some obstacles:

> He: The strange thing is that you can buy the dishwasher for yourself and then you own it, but the housing company bills you a fairly large sum for installing it and then they bill you an additional sum every month on top of that arguing that it is a raise in standards. I can't understand their reasoning, because you own the dishwasher yourself, so I guess by the raise in standards they mean the connection of the dishwasher to the water. That's why we have hesitated; I mean, you could buy one of your own and install it for yourself, but should there be a leak, you are responsible for it, too.
>
> Interviewer: Okay, so those are the rules …
>
> He: That's why we have hesitated, but it is a bit strange because this is a passive house and you should be more energy aware, and as I have understood it, it is more energy efficient to use a dishwasher. (H8)

In this case the rent is raised because the standard of the flat is improved, which the tenant then must pay for. For some this means that the lower energy bill is eaten up by the higher rent. The individual initiative is counteracted by the rules of the company, which in this case is a steering constraint affecting the tenants' actions. In this household, the energy order for doing dishes by hand remained the same, even if there were ambitions to save both time and energy by using a dishwasher.

ENERGY ORDERS IN THE CARE OF CLOTHING PROJECT

The care of clothing project usually involves using a washing machine and a tumble dryer. How often washing is done very much depends on the size of the household. The frequency with which laundry is done also depends on what other activities persons in the household engage in. For example, if a person exercises regularly, he or she will probably have workout clothes that need regular washing. Some households did laundry as soon as there was enough laundry to fill up a machine; others did laundry once or twice a week, doing two or three loads in a row.

Many households in the study avoided using the tumble dryer because they perceived it as very energy consuming. These households used drying racks instead, in the bathroom or outside on the balcony or patio, to air dry wet clothes. For some households this was not a problem at all, but for others it was a problem:

> He: We have to use the dryer even if we don't want to, because there really aren't any other options. Instead, we run half the cycle and then let the clothes dry on a rack. At least we save a little by doing it that way. (H6)

In this case the housing company standard (drying using a tumble dryer) did not meet the energy goals of this particular household. Air drying, which this household preferred, was difficult since it took a lot of space in the bathroom or the flat. This is a typical steering constraint from the company side. Since tenants are not allowed to drill holes in the walls in the bathroom, there is no real option to install a drying rack in the ceiling either.

Energy orders might change without the household planning to do so. A change in the number of people sharing the flat will change the way things are done, for example, when a baby is born:

> She: We don't wash every day but somewhat more now than before … since we became three. Before, we used the 40 degree cycle and the short cycle [yes]. Now we wash more in 60 degree water [mm] …
>
> He: It depends a little …
>
> Interviewer: Why did you start washing in warm water?
>
> She: Laundry is dirtier now (laughs). The clothes are dirtier … [yes]. Before, the clothes were mostly just limp and needed to be refreshed, now they need washing [right]. (H9)

Before the baby was born the household could get by using cold-water cycles, but this option was not used as frequently now. Capacity constraints (babies need clean clothes in order to stay healthy) as well as coupling constraints (adults are responsible for providing for the needs of children) will affect the activity of washing clothes, making the energy order of washing a bit more energy consuming than before because care of the baby is more important than limiting energy use.

In households where one person is responsible for an activity, for instance washing and drying clothes, the project becomes dependent on that person:

> Interviewer: How about laundry, do you both do laundry or does one of you do it more often than the other?
>
> She: I am the only one who does laundry in this house; he is not allowed to do it anymore. He has done it a few times resulting in mixing of wrong colours, shrunken clothes, torn clothes, so … no, he is not allowed in there. (H3)

The result of such an arrangement is that coupling restrictions become more prominent when the activity is dependent on one person. In this case the clothes caring project gets more energy intensive because it requires one person to do several people's laundry, which means doing more washing in a shorter period of time. There is a coupling between that one person and the washing machine which makes the process of washing more time and space dependent. The tumble dryer is used to speed up the process and the eco cycle is avoided due to its longer process time. The energy order created is more electricity consuming than it perhaps has to be due to coupling constraints. If the activities were arranged in another way, sharing between more people, for instance, there might be more space and flexibility between washing loads.

Individual capacities also affect how activities are performed. For example, some of the households noticed that the eco cycle took much longer than the standard programs on the washing machine:

> He: We use the 40 degree cycle because I checked the instructions and realized that it was more energy efficient to use the 40 degree normal cycle than the eco cycle.
>
> Interviewer: Okay?
>
> He: What they compare is … obviously, the 60 degree normal cycle with the eco cycle, which apparently is a 40 degree cycle with longer run time. But if you use the normal 40 degree cycle, energy use is much more efficient than the eco cycle. [Right] (H9)

Here the knowledge and ability of one household member influenced how the activity was performed; the capacity of a household member was used to make the energy order less energy consuming. A steering constraint was offset by the capacity to figure out which cycle was more energy efficient. The energy order for laundry was in this case changed into a somewhat less energy consuming alternative.

ENERGY ORDERS IN THE RECREATION PROJECT

The recreation project involves different activities connected to entertainment and relaxation, most notably watching TV and films, listening to music, playing games, surfing on the internet, and socializing through different social media. This project is very interesting for a number of reasons. Firstly, the number of appliances in the project is growing, even though appliances are getting smaller, more mobile and integrated with ICT. Secondly, the appliances used are gradually spreading to other projects; hobbies of different kinds are increasingly becoming dependent on ICT devices which, for instance Røpke and Haunstrup Christensen (2012) also show. Thirdly, the resource of mobile internet has become as important as electricity. These aspects make activities within the recreation project more energy intensive, but at the same time the small mobile appliances also use less energy, which could actually reduce energy use. From the household point of view, appliance use in this project seems to become more fragmented and, due to new technology and services, more flexible, too. One problem households mentioned with internet access, though, was the devices needed to keep internet running and available in all rooms. These stay on all the time, much like a fridge, increasing energy use.

The households were quite aware of the increasing number of appliances in this project. Many of them had old stereos and DVD players that were still functioning but seldom used. Instead, new devices and services had taken their place in different activities. The laptop, tablet and smartphone were increasingly used in all sorts of activities. Because of new web services, streaming services etc., households no longer have to adapt to fixed TV schedules or other scheduled entertainment in the home. Instead, there is a vast amount of entertainment available at any time. In addition, because it is easily available on smaller devices as well, individual household members may have their own entertainment, a form of parallel use (Green & Ellegård, 2007). This is particularly visible among younger children who are now growing up with the new services (SVT,

2014). The amount of time spent on entertainment is likely to increase.

Activities, for instance participating in sports activities, that previously did not require internet access or an appliance now require both just to be able to get access to the activity:

> She: Well, I have to use the tablet to check out competitions and book golf tee times. (H1)

In this household the tablet was actually acquired in order to be able to easily handle sports activities in general. The small screen of the smartphone made it difficult to read and the desktop computer was too inconvenient to start up just to do small tasks like checking schedules. A new appliance facilitated the planning of sports activities because other appliances did not function well for the individuals.

A lot of information nowadays is available only via internet, which makes internet access and ICT devices a prerequisite for participating in certain activities. This applies to all sorts of activities. The need for internet is common for practically any hobby; photography, sewing, gaming etc. were some hobbies mentioned in the interviews that to a certain degree required internet access. The activities in themselves may not require internet access, but planning them and perhaps getting the right material may well require it. The activities become dependent on more appliances and electricity, resulting in a need for more resources. Because of how hobbies are organized around internet availability, the energy orders become more energy intensive. This is very similar to how Shove (2003) explains ever-increasing energy demands for air conditioning and bathing.

A very popular recreation activity is watching TV, which creates other forms of energy orders. A typical coupling constraint affecting energy orders is when children watch TV and do not turn it off when they stop watching:

> Interviewer: Do you watch TV every day?
>
> She: It depends …
>
> He: Well, the TV's on every evening …
>
> Interviewer: Okay.
>
> He: You could say that between 5 and 9 it is constantly turned on. While we are sitting here it is always on.
>
> Interviewer: I see, you watch sporadically …?
>
> He: Yes, for a while at least. When the kids come home from school they do their homework, and then they want to do something. They have something to drink and seat themselves in front of the TV. Then they watch for 10 minutes and go and do something else leaving the TV on …
>
> She: We are not very good at turning the TV off, it's always on.
>
> He: Yes, you pass it and turn it off sometimes; half an hour later somebody has turned it on again. (H3)

The parent has to turn the TV off every time, because the child does not think about it. If this happens time after time, the parent might not bother anymore and the TV stays on. A fairly simple activity, turning an appliance off, becomes laborious because the activities of children cause extra work in other people's (parents') projects. All people living in the same flat therefore influence each other's activities. They have to negotiate between them about what activities are prioritized in that particular space and so they form the pocket of local order together.

Desktop computers were still in use in many of the households even if they had been complemented with laptops and tablets. Desktop computers were often used for gaming, which entails long hours in front of the computer. In some households there was an idea that turning the computer off was not energy efficient. As a result, these households left the computer on even it was not in use. Leaving the computer on was also a result of the long start-up time on some computers. If a person planned to use the computer again later on, it was not turned off. This activity partly disappeared if the household had invested in a tablet, which was considered more convenient for this reason. Quick access to the internet was achieved by using another device, so the desktop computer was used less. The energy order in these households changed to a less energy consuming appliance due to upgraded technology.

Other activities in the entertainment project were listening to music, watching movies and playing video games. These activities were performed using a variety of appliances. Very often the same activity, for instance listening to music, was done using several appliances. Some households still owned a stereo, but often other devices, such as smartphones or tablets, were used for listening to music. The portability of these appliances was a desirable feature, allowing individuals to listen to music on their own without disturbing others. A much smaller device provided the service in a way that better matched the desires of the individual household members.

In some cases the entertainment project is getting more energy intensive because the amount and accessibility of entertainment is growing. At the same time the devices are getting "smarter" and smaller and may be used for several different activities, which in turn reduces energy use. For example, one woman managed all her entertainment activities with a smartphone and a TV, which reduced the number of appliances used for entertainment to a minimum. The energy orders have the potential to become less energy consuming because of smart technology. On the other hand, ICT is also spreading to other projects. For example, in many households the cooking project is complemented with the use of tablets for finding recipes, which increases the dependence on appliances in that project and adds to the resources needed.

DISCUSSION

From the projects described above, a conclusion to be made is that energy orders are formed by both material and social factors and that these factors influence households differently. Activities from different projects are intertwined with each other during the day and the week. They compete for space, time and resources, so to speak. Household members and their individual as well as joint projects have to fit into the same space, resulting in negotiations on how to use common resources in the home. Different types of restrictions will occur on different levels and place more or less fixed limitations on people's activities, but they do not affect all households the same way.

The interviews show that very often the intentions of trying to save energy fail for different reasons because constraints from other projects affect how households act. Some activities,

like air drying wet clothes, become difficult if there is not adequate space or no arrangements for hanging wet clothes on a line. Likewise, getting a dishwasher installed is difficult because the housing company has rules about how this should be done as well as additional service charges, which may not be acceptable to the tenants. As a result, activities that could be changed into less energy consuming ones will not change because of restrictions created by other organizations outside the household. These organizations have more power than the households to take steps that will improve energy efficiency (Hägerstrand, 1985; Lenntorp, 2004).

The energy orders are also built up by activities that occur in time and space, sometimes in a sequence and sometimes spread out during the day or the week. The cooking project may occur every day in a household but the care of clothing project perhaps only once a week. The entertainment project, on the other hand, may occur in short intervals in a number of places, both within other projects throughout the day and not necessarily in the home. Activities from different projects will mix during the day and energy use is therefore built up by several projects intertwined with each other. There is, however, a limit to how much activity a person can fit into the day even if appliances are used to help fulfil projects. Priorities therefore have to be made which will influence the formation of different energy orders in different projects. The cooking project may take priority over the entertainment project, and vice versa.

Other constraints than time and space are also influential in creating and shaping energy orders. Individual capacities may influence the sorts of activities chosen, and different rules and technologies may restrict how activities are performed. These restrictions can be changed by increasing knowledge and offering flexible solutions. The coupling constraints are also interesting because they are in many cases a result of steering constraints created by society. Working hours, school hours, public transport etc. are all forms of steering constraints that help create couplings in society (people are at the same time in the same place performing joint projects, for instance), but create restrictions in other projects, in this case the everyday projects engaged in at home. In order to tackle the coupling constraints within households, people try to speed up movements in time and space by taking different actions. Ready meals are a way of speeding up provision for food, using the tumble dryer speeds up the drying of clothes and checking e-mails while watching TV is an example of fulfilling multiple projects when time is scarce. In some cases the energy orders become energy intensive, such as when using energy to speed up the drying process. Sometimes working part-time is a way of creating flexibility for household projects, which is fairly common in households with younger children, but it results in lower income. Households thus become forced to compensate for rigid structures outside the home by creating flexibility in the household projects instead. Very often, appliances are used to create this flexibility, even if energy use increases. Again, the project of trying to use less energy has to move to the background.

Investing in energy efficient appliances will make some activities energy efficient without changing the activities themselves (freezing food, for instance) while other appliances do change the activities (the tablet reduces the habit of leaving the computer on). In some cases the appliance creates new activities (an appliance with an internet connection offers a variety of activities that were not accessible before), for instance, children playing games on tablets. It is therefore necessary to take into account the energy efficiency of the appliances and what sorts of appliances and infrastructure are needed in order to fulfil the projects. Technology plays an essential part in creating energy efficient energy orders.

From a housing company perspective the energy orders entail that household activities are embedded in the material and social orders, the pocket of local order that is created by a certain household in a specific flat (Lenntorp, 2004). To some extent households are able to influence the way they organize their activities, but in many cases the housing companies are responsible for the material settings, at least at an organizational level. The quality and energy efficiency of the appliances are to large extent a housing company responsibility, including the infrastructure choices (internet access points, fibre broadband etc.) which give the household a framework within which to arrange their own activities. The housing companies also decide on tenant rules that include specifying activities and improvements tenants are allowed to do in their flats. To avoid damage to the buildings, companies regulate how much tenants are allowed to do by themselves (they are not allowed to drill holes in the walls and install washing machines, for example) which means that some household initiatives become impossible to implement. A typical example is the lack of space to dry clothes, which many households would like to solve by using lines, but they instead have to settle for drying racks on the floor, which require space.

Since all households arrange their activities in different manners depending on available resources and different constraints, it is also obvious that different measures for trying to influence household energy use will be effective to different degrees. For example, a common suggestion to lower indoor temperature might have very different outcomes depending on the household. An elderly couple who are not so mobile may find the lower temperature uncomfortable because of lack of activity, compared to a household with younger children where the activity levels in many respects are much higher. Not only will these more active households generate more excess heat, they will probably also have more appliances and activities in general. In contrast, the elderly couple may need extra heating and their energy orders for heating the home may have to be somewhat more energy intensive. These differences are important for housing companies to acknowledge when they implement energy efficiency measures involving households, because it might be more difficult for some households to actually choose energy efficient activities without making everyday activities too complicated.

Housing companies cannot decide on what projects the households choose to do, but they could easily remove some constraints experienced by the households. The steering constraints in the form of rules and regulations could be made more flexible, or housing companies could offer services that help tenants with installations that they are not allowed to do themselves and thereby improve services. The companies could also offer guidance on appliance use to somewhat ease some of the coupling constraints, for example, offering instructions on how to use timer functions on dishwashers and washing machines. By reducing some constraints affecting the material settings, the housing companies could help households change some energy orders.

How can housing companies support efficient energy orders?

Since energy orders indicate that energy use in households is very individual and that households have different capacities and resources to change energy use, housing companies can help create conditions that open up for a variety of energy orders. This can be done by forming the material settings in the flats in new ways.

The first thing is to reduce constraints that prevent energy efficient activities. Household initiatives should not be counteracted by rigid rules. Housing companies obviously have an interest in keeping their housing stock in good shape and want to prevent tenants from damaging surfaces and installations. Instead of merely forbidding tenants from arranging their own space in ways that fit their household activities, the housing companies could offer services that help the households achieve a functional flat, to form the pocket of local order in a way that helps households fulfil their projects. This could be done by designing the flats from an energy point of view from the start, which implies that housing companies should install equipment for alternative ways of doing. It could also involve helping households with specific installations without adding too many extra costs. In relation to the three projects there are different solutions that housing companies could consider.

The cooking project involves a number of energy orders, and some of them could be more energy efficient just by installing energy efficient appliances. The fridge and freezer should always be of a high energy class because they are constantly on. A dishwasher is often asked for, which, if used correctly, is more energy efficient than doing dishes by hand. The stove is used frequently and there are different standards available on the market which tenants may choose from by paying some extra rent. Housing companies could offer better deals when households want to upgrade the appliances, though. Today it is common for the tenant to pay for the upgrade when a more energy efficient appliance is installed on the tenant's initiative, which is a somewhat contradictory practice from an energy point of view but makes sense from a business point of view. Perhaps other business solutions, for instance leasing, could offer a better deal for the tenant who actively chooses energy efficient appliances.

In the care of clothing project there was one activity for which many households wanted to change the energy order, and that was drying clothes. Households used a drying rack on the floor, but many thought it took up too much space. A possible solution might be for the housing company to install lines in the washing room ceiling. The common laundry room, which used to be standard in multifamily buildings, could also be revived. It may not be necessary to have large common laundry facilities if there are already washing machines in the flats, but perhaps housing companies could provide smaller facilities with adequate drying space, so that households could use them when they have larger amounts of textiles to wash and dry. Common laundry rooms should, in this case, have flexible "opening hours" and not the fixed schedules that sometimes cause unnecessary friction between neighbours and cause time pressure when people try to use the machines within specified time slots. Another "old" solution could be drying lines outside the flats on the balconies or patios or in common areas.

The recreation project is changing in a number of ways due to new technical solutions and services for consuming entertainment. Households have an increasing number of computers, tablets, smartphones and small devices for getting access to internet and all new forms of ICT-based services. Even though the appliances are getting smaller and energy use more efficient, the increased use of appliances in all sorts of projects causes more energy intensive energy orders. This is a trend that will not break in many years to come (SCB, 2014), so housing companies could make sure the infrastructure for efficient ICT services is both energy efficient and accessible in buildings. Households should be encouraged to find ways to enjoy their recreation activities with fewer appliances. Since housing companies increasingly use internet platforms themselves to communicate with their tenants, they could also make an effort to offer smart internet access points that also reduce the number of devices to keep connected.

On a more general level, as a societal institution, housing companies could make energy efficient living the "normal" way of doing things. They could make it their business to include households in their existing daily service commitments. The first step is to learn from the households how they perceive the material settings of the flats. What is working and what could be improved when households go about their everyday activities? What do new tenants want? Do they have specific requirements concerning energy services or energy use?

To make energy a "normal" topic when talking to the tenants, promoting energy efficiency should be included in all contacts. There are people in sales and marketing, area managers, service technicians and maintenance that are regularly in contact with the tenants and who could include energy efficiency issues in their everyday interactions. The first contact the households often have with the housing company is the sales department when looking for a flat. This first contact could already promote energy efficient living by asking what the households think about energy efficiency, heating, appliances etc. The companies could ask if the households have any preferences or requests and try to match household requirements of location, size etc. with energy requests depending on the housing stock and what is available. This would also give hints on what the market is looking for in terms of energy efficiency and what tenants want where energy is concerned. Do they look for low energy housing or look for certain technologies? What sort of appliances or services do they prefer?

The area manager, who is in contact with the households when they move in, could offer energy efficiency advice and an energy consultation on how the appliances and heating system work. He or she could offer the energy advice from previous tenants to the new ones and gradually build up a knowledge base on how particular flats work. In the same manner, when households move out, managers could ask what they think about the flat, and how it works in everyday life. How do the appliances and the heating system work? What works well and what could be better? Another important question is: What energy saving advice can be offered to the next tenant? Many housing companies already have questionnaires about why tenants move, what problems there might be with the flat etc., so the routines already exist.

Service technicians of different kinds are regularly called for, and they could also be equipped with advice for the households

they visit. For example, they might remind households about defrosting the freezer or setting the right temperature in the fridge, as well as checking the settings on the heating and ventilation system.

Doing all these small reoccurring activities would gradually make the people working in the housing company as well as the households used to talking and thinking about energy efficiency and how it may be realized in practice. By learning from each other, housing companies and tenants could make low-energy living the normal way of doing things, hence creating energy orders that are more energy efficient and based on the human factor and not only technology. In this way the potential of low-energy living becomes even greater.

Conclusions

The energy order concept emphasizes the material settings, people, and restrictions as well as time and space, and how all of these together create different levels of electricity use in households. Energy orders give a detailed view on what practices are built of, which is valuable for understanding where the possibilities are for change at an individual level. Energy orders are obviously also dependent on structures outside the home, which means that all institutions in society have an impact on household energy use. Since housing companies are largely responsible for the material settings in households' everyday lives, they are responsible for helping households create efficient energy orders.

By engaging households and using their experiences, housing companies could offer services and plan housing so that different energy orders become possible. This would entail households that are capable of using their own resources also getting opportunities to do so, and others, that might be restricted in different ways, also getting a broader spectrum of choices to try out. Not all households may necessarily be able to live energy efficiently in all possible ways, but many may be able to do something. By reducing some material and organizational obstacles, housing companies can start a process of normalizing energy efficient living. This process should have its starting point in people's experiences of everyday activities.

The energy order approach focuses on the individual and should be seen as the details in a practice. Even if the individual as a site of change has been highly contested in energy research, the individual still has a part to play when arranging everyday activities. The different energy orders give a hint as to what individuals can do in their own everyday context and what housing companies can do to create conditions for energy efficient activities. Using energy orders as a tool to understand the different aspects of household electricity use and how it is created is a way to include the human factor in practical energy efficiency work in housing companies. This paper has addressed some of these aspects and how housing companies can work with energy efficiency together with their tenants.

References

Allmännyttan. (2014). http://www.allmannyttan.se/energispartips/, retrieved 2014-12-17.

Aune, M. (2007). Energy comes home, Energy Policy, 35, 5457–5465.

Boverket. (2008). A history of the Swedish system of non-profit municipal housing. Karlskrona: Swedish National Board of Housing, Building and Planning.

Boverket. (2011). Regelsamling för byggande, BBR 2012 [Building regulations, BBR]. Regelsamling 1209–2408/2011. Karlskrona: Swedish National Board of Housing, Building and Planning.

Boverket. (2014). Individuell mätning och debitering vid ny- och ombyggnad. Rapport 2014: 29. Karlskrona: Swedish National Board of Housing, Building and Planning.

Cowan Schwartz, R. (1983). More work for mother: The ironies of household technology from the open hearth to the microwave. New York: Basic Books, Inc.

Ellegård, K. & Palm, J. (2011). Visualizing energy consumption activities as a tool for making everyday life more sustainable, Applied Energy, 88, 1920–1926.

Ellegård, K. & Vilhelmson, B. (2004). Home as a pocket of local order: Everyday activities and the friction of distance. Geografiska Annaler 86 B, 281–296.

Gill, Z. M. et al. (2010). Low-energy dwellings: The contribution of behaviours to actual performance. Building Research & Information 38 (5), 492–508.

Gram-Hanssen, K. (2008). Consuming technologies – developing routines, Journal of Cleaner Production, 16, 1181–1189.

Green, A. & Ellegård, K. (2007). Consumer behaviour in Swedish households: Routines and habits in everyday life. In Proceedings ECEEE 2007 Summer Study – Saving energy – Just do it!, Panel 9, pp. 1907–1916. 4–9 June 2007. La Colle sur Loup, France: eceee.

Hägerstrand, T. (1974). Tidsgeografisk beskrivning. Syfte och postulat, in Svensk Geografisk Årsbok, Vol. 50, Sydsvenska geografiska sällskapet, 86–94.

Hägerstrand, T. (1985). Time-geography: Focus on the corporeality of man, society and environment. In The Science and Praxis of Complexity, The United Nations University.

International Energy Agency. (2008). Energy efficiency requirements in building codes: Energy efficiency policies for new buildings. IEA information paper. Paris: OECD/IEA.

Karlsson, K. & Widén, J. (2008). Hushållens elanvändningsmönster identifierade i vardagens aktiviteter. Arbetsnotat 330. Linköping: Linköping University.

Karresand, H. (2014). Apparater, aktiviteter och aktörer. Lågenergiboende som resurs och restriktion för energiordningar [Appliances, activities and actors. Low energy housing – resources and restrictions for energy orders], Diss. Linköping Studies in Arts and Science No. 630. Linköping: Linköping University Electronic Press.

Lenntorp, B. (2004). Path, prism, project, pocket and population: An introduction, Geografiska Annaler 86 B, 4, 223–226.

Lutzenhiser, L. (1992). A cultural model of household energy consumption, Energy 17 (1), 47–60.

Røpke, I. & Haunstrup Christensen, T. (2012). Energy impacts of ICT: Insights from an everyday life perspective, Telematics and Informatics, 29, 348–361.

SCB (2012). Swedish time use survey 2010/2011. Örebro: Statistics Sweden.

SCB (2014). Use of computers and the internet by private persons in 2013. Stockholm: Statistics Sweden.
Shove, E. (2003). Comfort, cleanliness and convenience: The social organization of normality. Oxford: Berg.
Shove, E. (2004) Efficiency and consumption: Technology and practice, Energy & Environment, 15 (6), 1053–1065.
Shove, E. & Southerton, D. (2000). Defrosting the freezer: From novelty to convenience: A narrative of normalization, Journal of Material Culture, 5 (3), 301–319.
Spaargarten, G. (2003). Sustainable consumption: A theoretical and environmental policy perspective, Society and Natural Resources, 16, 687–701.
SVT (2014). Sveriges Televisions public service-redovisning. Stockholm: SVT.
Thoresson, J. & Glad, W. (2009). När tiden är mogen. Innovativ energieffektivisering hos fastighetsbolag – en analys av socio-tekniska regimer. Tema T Rapport Nr. 48. Linköping: Linköping University.
Wilhite, H. et al. (1996). A cross-cultural analysis of household energy use behaviour in Japan and Norway, Energy Policy, 24 (9), 795–803.
Åquist, A-C. (1992). Tidsgeografi i samspel med samhällsteori. Diss. Lund: Lund University.

Acknowledgements

The research for this paper forms part of the Energy Systems Programme, funded by the Swedish Energy Agency.