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Energy behaviour as a collectif: The case of Colonia: student dormitories at a Swedish university

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Introduction

In the past few years, the conditions and characteristics of energy systems have changed dramatically. One of the most significant aspects of this change is the broad coupling of environmental issues and energy consumption. An increasing number of voices from different viewpoints argue that substantial decreases in energy consumption are a prerequisite for a sustainable and environmentally friendly energy system. Households and their energy behaviour are important in the development of long-term efficient energy systems. An American study has shown that households account for 38% of electricity and heating consumption in the U.S.A. Thus, they contribute significantly to greenhouse gas emissions (U.S Department of Energy, 2005; Woolsey-Biggart & Lutzenhiser, 2007: 1072). Carlsson-Kanyama and Lindén (2002) state that the household sector in Sweden accounts for 25% of the total Swedish energy consumption. The Swedish construction and housing sector account for approximately one third of the total energy use (Statens Energimyndighet, 2004). How, when, and why households consume energy are thus crucial questions for developing environmental policies and designing energy-saving houses.

This paper presents an empirical investigation of households' energy behaviour with the conceptual support of actor-network theory (ANT). From an ANT perspective, energy consumption can be regarded as an emerging property of differences and relations: a mixture of heterogeneous materials such as humans, artefacts, lifestyles and practices. A later development of ANT has given birth to the concept of *hybrid collectif* (Callon & Law, 1995). This concept enables us to describe the relations between landlords and tenants as well as between humans and nonhumans. These relations constitute the collectif energy behaviour. We aim to test the notion of collectif as an alternative analysis of the heterogeneous and relational nature of a household's energy behaviour, and to suggest a method to builders and designers for implementing energy efficient buildings and environmental policies. By doing so, we will discuss energy behaviour as an emerging relational effect. A household's daily energy behaviour involves a web of processes and interactions, as well as the decisions and functions of several entities. Our focus lies on the *relations* between social, material and semiotic entities. Thus, the notion of collectif implies analytical symmetry between humans and nonhumans. We are interested in how relations and differences are established and come to matter in people's energy consumption. At the same time, a household's energy behaviour is shaped by different material and socioeconomic objectives. These objectives often conflict in terms of economic resources, political priorities, habits, aesthetics and technical potentials. As Skill (2008: 265) notes, everyday life is complex and different ambitions may clash when the weaving is enacted in practice.

In this paper, we will discuss how relations among humans, such as builders, landlords, users, and nonhumans, such as white goods, meters, climate and so forth, co-perform energy behaviour in the setting of a residential building. The building we focus on is Colonia, the new student dorm at Linköping University. These relationships affect and standardize ways of construction as well as patterns of consumption. We intend to reconstruct householders' everyday experiences regarding energy use as well as the views and intentions of builders and landlords regarding environmental goals and policies through their narrations. We have identified two fields of interest:

1. *Builders' and landlords' articulations.* How are goals and guidelines regarding sustainable energy systems formed and articulated? How do environmental goals shape the construction process and the production of behavioral patterns of energy use? How do experts and builders interact with tenants and the built environment?
2. *Households' and tenants' views on their everyday practices and lifestyles.* How do householders perceive their own energy consumption? What kind of information channels shape householders' choices in relation to energy issues? How do households communicate with builders and landlords?

Energy behaviour as a collectif

Our understanding of energy use patterns often rests upon traditional, one-dimensional economic approaches or behavioural modes which assume that rising energy prices lead to lower demand and that relevant technological innovations will become established when they become cheap enough to compete with existing technologies (Aune, 2007: 5457). Unfortunately, these approaches have proved of limited value in explaining or influencing the energy behaviour of the actors involved (Woolsey-Biggart & Lutzenhiser, 2007: 1071). Moreover, energy-saving actions are often seen as the consequences of informed action or economic considerations on the part of individual decision-makers. Aune (2007: 5458) argues that private energy use should not be understood as solely the product of economic considerations, adequate information or the existence of technologies. Guy and Shove (2000) maintain that it is also necessary to understand the social and cultural arrangements within which these decisions are made. In addition, Shove (1999: 1107) highlights the social and institutional context in which decisions concerning the acceptance of innovations and sustainable energy solutions are made. Following Science and Technology Studies (STS) scholars such as Callon and Bijker, Shove emphasizes that decisions concerning the implementation of energy efficiency measures or individuals' energy use are made in sociotechnical entanglements. Practitioners identify and make energy-related decisions within different sets of relations. However and according to Shove (ibid. 1109), "what qualifies as a reliable, cost effective, worthwhile energy-saving measure in one socio-cultural domain might count for nothing in another".

We argue that energy efficiency is affected both by socioeconomic or behavioural preconditions and by the relations of social actors with material and semiotic entities woven into the built environment. The built environment is poorly represented in social sciences, despite its obvious environmental and ecological significance (Woolsey-Biggart & Lutzenhiser, 2007: 1073). Within this framework, energy use is situated in sociomaterial practices that involve knowledge, lifestyles, institutions, semantics, artefacts and methods (Guy & Shove, 2000). Thus, we are to deconstruct dominant discourses that partially focus on either behavioural or economic/market aspects of energy use. Both the economic and the behavioural views fail to capture the complexity of energy-related decision-making (ibid. 64.). We argue that both social and technological entities as well as economic, policy, ideological, lifestyle, gender, and age dimensions are embedded in the energy behaviour of households. We treat energy behaviour as a co-performance of sociomaterial practices and experiences consisting of actors and relations – that is, social actors, symbols, architectures and artefacts – as well as different organizational arrangements (cf. Galis, 2006: 33). To put a name on this kind of co-performance, we employ the notion of *collectif*.

The concept of a collectif is inspired by the work of Michel Callon and John Law (1995). They used the notion of collectif to delve into joint associations of human and non-human actors in sociotechnical processes. A collectif describes all entities and relations that form sociomaterial practices. The form, content and properties of a collectif are not fixed but develop and change in the course of interaction (Callon & Law, 1997: 171). In other words, treating energy behaviour as a collectif implies that the analytical framework attributes symmetrical analytical significance to both human and nonhuman actors when it comes to energy use and household behaviour. This approach allows social scientists to talk about technologies, and technologies likewise become entitled to talk about humans (Berker, 2006: 65). As we will show in the empirical part of the paper, technologies and the design of the built environment often talks about (ascribes) human behaviour.

All entities are created *equal* within the collectif; what differentiate them are redistributions of *performative agency* (Callon & Law, 1995; see also Galis, 2006: 33). Human and nonhuman agency depends on the entity's role within the collectif, that is, agency can be continuously transferred from one entity to another (Pickering, 1995: 15). By adopting this approach, energy behaviour constitutes an emerging property of the collectif, that is, the relations between social and material semiotic actors. In this context, energy behaviour does not constitute a pure human or nonhuman phenomenon but is a relational effect enacted by the interaction of the heterogeneous parts of which it consists (cf. Callon & Law, 1995: 485). While humans are endowed with logic, choice and intentions, performative agency would not be possible was it not for the existence of material and semiotic surroundings. Agency in this context occurs as a co-performance between the material, the semiotic and the human (Pickering, 1995: 17). Things and humans do not act, but there are relations, negotiations, relations and effects between human and nonhuman entities (Callon & Law, 1995: 485). We will show how perceptions and choices articulated by tenants are produced together with technical goals or solutions and the means of implementing them (information, designs, and incentives, policies etc), described by builders and landlords.

The design and implementation of energy efficient buildings cannot be detached from the material environment or reduced to social interactions. Energy behaviour implies exchanges of agency between human and nonhuman entities. Setting aside considerations of intentionality, we treat buildings and artefacts as agentic powers, not reducible to or explained away by human action (Gieryn, 2002: 43). Being energy-saving is not only a matter of economic or ideological incentives but also depends on the existence (or non-existence) of a collectif of relations among social factors (such as gender and age) and technological factors (such as light-timers and towel-warmers). These relations enact and are enacted by specific lifestyles, such as being ecologically aware (or not), playing videogames or having a cosy indoor atmosphere. For example, Wilhite *et al.*'s (1996) comparison of the energy behaviour of Japanese and Norwegian households showed that energy sources and lighting methods can have different social symbolisms such as "socially appropriate indoor climate", "sad house versus happy house", "cosiness versus social failure" (p. 798). In these cases, technology becomes the mediator of social behaviour or status, that is, nonhuman attribute humans with performative agency ("sad" or "successful").

The notion of hybrid collectif is not restricted to the description of the modalities of delegation of agency. The household's energy behaviour is part of everyday life, where it is more important to reach specific goals than to be conscious of energy use. Much of our knowledge regarding energy is enacted by individuals' own experiences and perceptions. These kinds of experiences/perceptions occur in most ordinary situations. Consequently, what

is needed is a method to identify relations between humans and nonhumans within the collectif, and to describe householders' daily experiences as they are enacted through different practices, realities and sociomaterial configurations.

Method

ANT constitutes a method to learn from actors without imposing on them an *a priori* definition of their perception of the world (Latour, 1999: 20). Accordingly, the central methodological prescription of this investigation is to discuss narrations of sociomaterial relations that contribute to the construction of efficient buildings, the application of environmental solutions, and the production of ecological awareness, habits and lifestyles, as articulated by relevant informants (actors). This approach implies another way of being faithful to the insights of ANT: 'actors know what they do and we have to learn from them not only what they do, but how and why they do it' (ibid. 18). To do this, we applied ANT's methodological tenets, that is, we followed the actors' narrations, declarations and reflections on their own lifestyles and practices. Methodologically this implies that we identified relevant actors and conducted a number of interviews in an attempt to describe their understandings, frames, contexts, theories, metaphysics and ontologies regarding energy behaviour (cf. Latour, 2005: 147).

Although we recognize that ethnographic observation is one of the most essential methods for providing deep understanding of various practices, we chose to base our investigation solely on in-depth interviews. There are two reasons for this choice: first, we were not granted access to the student dorms we intended to study and few students showed interest in participating in the study. The students did not react positively to the idea of having two researchers in their flats/dorms observing their interactions with the household. They considered our presence intrusive and unnecessary. As Taylor and Bogdan (1998: 90) note, in-depth interviewing becomes indispensable when social researchers cannot gain access to a particular type of research setting. Secondly, in-depth interviewing is the paramount research environment since it provides the researcher with immediate access to witnesses of a sociotechnical process by asking and watching reactions, restating questions, following up details or pursuing significant points raised during the interview (Undheim, 2000: 3; see also Fontana and Frey, 2005: 698; Taylor and Bogdan, 1998: 90).

We conducted a number of in-depth interviews with informants representing key components of the collectif's energy behaviour, including landlords, architects, consultants and tenants. The selection of informants was based on two criteria. First, informants should have solid experience of energy issues and the construction of Colonia (builders/landlords). Secondly, informants should be able to shed light on energy issues and living in Colonia (tenants). This selection of informants allowed us to remain true to our effort to approach energy behaviour as a collectif, that is, to study the heterogeneous and relational nature of energy consumption choices articulated by relevant actors. The choice of informants accesses parts of the collectif's 'energy behaviour', but the lack of participant observation means that we could not integrate materiality in our analysis. This constitutes a serious methodological constraint. While it is relatively easy to theorize and indicate beforehand the significance of materiality in a sociological analysis, it is extremely difficult to employ analytical language that speaks on behalf of nonhumans. The language of social scientists tends to use dualisms (such as subject/object) and treats people as special, as the only entities that act, choose, decide, speak or vote (Callon & Law, 1995: 489). We have to admit that our situated ability to describe the

world is constrained by our humanness and our everyday conceptions of the world (cf. Galis, 2006). In this paper, the functions and qualities of technological artefacts are captured and described in the narrations of our informants.

Our investigation called for a flexible agenda rather than a narrow questionnaire with leading questions. Thus, we conducted semi-structured interviews with open-ended questions. In order to highlight and analyze narrations, competences, estimations and goals regarding a residential project as well as everyday practices and perceptions concerning energy consumption, we formulated questions that would allow our informants to provide extensive information regarding the construction of Colonia and their everyday experiences. Moreover, several of our questions focused on the informants' interactions with materiality. For example, we asked both landlords and architects to describe what concrete measures they implemented in Colonia to reduce energy consumption. With tenants, we discussed their everyday routines regarding lighting, laundry, and dishwashers. A number of tenants attempted to show us how and why they did things in certain ways, for example, preventing overheating by covering windows or adjusting the automatic ventilation under the windows. Their responses helped us to capture both discursive aspects of the collectif energy behaviour as well as relations with the material world.

We carried out ten interviews, three with builders/landlords and seven with tenants. The selection of informants was based on our approach to energy behaviour as a collectif of heterogeneous actors. Our point of departure was Byggvesta's¹ website, which stresses the company's focus on and cooperation with users regarding environmental issues and the management of their buildings, and its investment in innovative energy efficient solutions. Byggvesta's official website at <http://www.byggvesta.se> summarizes all the relevant actors in the collectif, both human and non-human: Byggvesta, users, managers, buildings, environmental issues, efficient solutions and so forth.

We located our informants by identifying important components of the collectif, starting with Byggvesta. We initiated the investigation by interviewing engineer Marcus Svensson, head of Byggvesta's business development department. He recommended other potential informants, such as an architect from the Stockholm-based White Architects and a construction consultant from WSP Sweden AB. Through Svensson, we also contacted Colonia's supervisor (see next section) who recommended relevant informants (student-tenants). Each interview was approximately one hour long and was conducted face-to-face. We chose to interview seven students: three males who lived in single flats (an economics student and two engineering students), and four females (an economics student who lives in a collective, an engineering student who lives on her own, and two speech therapy students, one of them living in a commune and the other living on her own). We aimed to have a gender-balanced sample of students in different areas (engineering, social and medical sciences), with different ages (ranging from 20 to 30 years old), and different living status (both single and shared flats).

All interviewers are influenced not only by their own interpretations but also by the reflections and descriptions of the informants. An interview is a social situation that inherently implies an exchange between the interviewer and the informant (Maxwell, 2002: 54). Thus, the analysis of the empirical material constitutes a synthesis of our reflections and the descriptions of our informants, interwoven into our theoretical understanding of energy

¹ Byggvesta is a private Swedish real estate company. It was founded in 1951 and is owned by Stellar Holdings – an American private real estate investment and development firm headquartered in Seattle. Byggvesta owns 23% of downtown Linköping.

behaviour. The limited number of interviews reduces the generalizability of the findings, but this study is exploratory and it is hoped that it will provide empirical and theoretical templates for broadening the debate on energy behaviour as a relational phenomenon, a collectif.

From a theoretical point of view, the actual number of interviews is of secondary significance. What is significant is the potential of each narration and interview to aid the researcher in developing theoretical insights into the field being studied (Taylor and Bogdan, 1998: 93). The case of Colonia has the potential to contribute new theoretical insights to our understanding of energy behaviour as configured within various sociomaterial settings. In what follows, we will first, discuss the views of builders and landlords regarding the development of Colonia and the embedded environmental and energy goals. Then we will present the tenants' reflections on their own energy consumption, their everyday routines, and the qualities of Colonia. Finally, we will summarize our conclusions and discussions on energy behaviour as a collectif, that is, how material and social agencies are distributed in the context of Colonia.

Colonia-izing students' energy consumption

Colonia is a student housing project at Linköping University in Sweden. The project was initiated and completed by Byggesta. In the early 2000s, a lack of rental housing construction in Linköping led Byggesta to restart production of housing properties under their own administration (Byggesta's official website). As part of this investment, the company negotiated with the state-established Akademiska Hus (which manages state properties) and bought land on the outskirts of the university's main campus in 2005. By 2007–2008, Colonia had 900 inhabited student flats (interview with Marcus Svensson, head of Byggesta's business development department). The design and construction of Colonia embodied several goals and strategies relating to quality of life.

Goals, demands and restrictions

Byggesta does not set out to build apartment for general tenants, but rather it seeks to provide flats for specific categories of tenants, such as the elderly or students. This approach allows the company to encourage the development of tenant's associations and to appoint specific tenants as 'landlords' or supervisors.² The goal is to create companionship among the tenants but also to establish a channel of communication between tenants and the landlords. Through this form of interaction, the company aims to achieve certain goals regarding the tenants' well-being, their studies at the university, and their quality of life. One of Byggesta's stated goals concerns environmental issues and energy-efficiency (interview with Marcus Svensson, head of Byggesta's business development department). Svensson stated that the company's ambition is to achieve environmental goals by influencing tenants' energy behaviour:

We have worked hard to create a strong environmental profile and we have defined specific environmental objectives regarding how our tenants should behave. These objectives refer to a wide variety of aspects such as waste management/sorting, use of public transportation, low energy consumption, as well as low consumption of hot water. In Colonia, we have initiated a project for measuring hot water and electricity consumption. This is something that you do not normally do with student flats. Usually at student dorms, tenants have free

²This idea was inspired by cooperation with the University of Washington in Seattle.

access to hot water and electricity. It is tragic that we teach our students that energy consumption is free (ibid.).

This citation provides important information about how Byggvesta regards the energy behaviour of students as a collectif of heterogeneous elements. It sets low energy use (defined as low use of hot water and electricity) as a concrete goal for the environmental/ecological behaviour of students-residents and engages specific material allies (water and electricity meters) and semiotics (metering) to translate this goal into a specific practice (reducing energy consumption). Energy behaviour materializes in a hybrid arrangement of goals, choices, practices (both material and social) and ethical considerations (it is inappropriate to teach students that energy is free). All these entities in the collectif are expected to exchange patterns of behaviour (performative agency) and to materialize the environmental goals of the company. In this context, energy behaviour constitutes a product of relations symmetrically enacted by humans and nonhumans: environmental goals set by designers are translated into energy use patterns of students as distributed by water and electricity meters. In other words, Byggvesta attempts to mediate normative programmes regarding energy consumption in a household (programmes that have been formulated elsewhere than the household itself) through technological apparatus (water and electricity meters).

Architect John Kirsch, who was involved in the Colonia project, explained that the design of the student dorms was a co-production of different actors. Byggvesta ordered an initial plan for the buildings from the firm known as White Architects (where Kirsch works) and described the kind of buildings they desired. This initiated an exchange process between the builder and the architects over a period of six months.

It was an interplay between the architects and the contractor, of course. But there were many actors involved. We started to design and construct the student dorms while the contractor interacted with the University of Seattle in Washington. They transferred knowledge and did a thorough study of the American way of living at universities. The way students live affects their performance at university. So, we took this into account when it came to designing the student area. Of course, we wanted to have as many flats as possible and to optimize the size of the rooms. This is also a process of increasing and reducing. Then there are many other things to take into consideration, such as the official rules and regulations. In the end, after we had worked for a while, we realized that we could not change so many things any more (interview with architect John Kirsch, employee at White-Architects).

Kirsch's words show that building-design begins with graphic and numerical representations of human needs as well as the enrolment of the necessary entities for the materialization of blueprints. Byggvesta initiated the designs for Colonia by enrolling different allies: an architectural firm, its own employees, an American affiliate and its connection to the local university, material potentials and restrictions, and rules and regulations. His words support Gieryn's (2002: 35) contention that buildings stabilize social life and give structure to energy use patterns. Infrastructures and technologies make a crucial difference to the type of normative practices/agencies they end up facilitating (Marres, 2007: 368). Those involved in the design of Colonia aimed at a sociomaterial arrangement that allowed for low energy-use patterns and prescribed energy-saving habits. This arrangement was to become an obligatory passage point,³ that is, an indispensable and unavoidable gate somewhere in the middle of the collectif, which must be passed by both the designers and tenants. How does material

³ An obligatory passage point constitutes a control station within the collectif that must be passed in order for specific actors to accomplish their interests (Galis, 2006: 27; see also Callon, 1986: 205).

semiotics distribute agentic power in the collectif? How did Byggvesta attempt to ascribe normative programs to its tenants?

Technologies of silence

The design and installation of specific artefacts materializes programs and goals (such as being environmental or energy-saving) and silently mediates energy behaviour in the sense that the tenants do not have to make any active decisions. For example, choices regarding insulation, windows, heating systems, automatically controlled technologies, white goods and the like enact silent preconditions for energy behaviour. In this context, technological artefacts constitute instruments for enrolling individuals in normative programmes (Marres, 2007: 373). Göran Werner, an engineer specialized in energy and thermodynamics who works for WSP and was involved in the design of Colonia, explained how the flats and specific technologies were expected to mediate energy behaviour:

What is the result of constructing energy-saving flats? Low operating costs as well as a good energy balance from an environmental perspective, and at the same time comfortable accommodation – good functionality. But there are many pitfalls when it comes to saving energy. For example, you can build a sick house [a house that causes energy leakages, *authors' note*] by using the wrong type of insulation. However, the most important aspect – independently of how you provide energy to the building – is to minimize energy losses. There is nothing new about that: constructing well-insulated buildings [...] and there window technology is very important (interview with engineer Göran Werner, employee at WSP).

These words indicate that many elements and materials (costs, functionality, insulation, windows) contribute to the performance of a collectif such as energy behaviour. What Werner describes is a distribution of roles/agency between technologies, infrastructure, humans, energy and inducements to produce the collectif energy behaviour. Energy behaviour comprises all the interactions between these entities. Insulation that minimizes energy/heat losses, energy-efficient windows, thermostats, and the like are mediators of agency. They actually enact a particular form of agency (saving energy), but they also transform a flat into a pleasant indoor area. The objective is to have a well-functioning house with energy-saving characteristics and a pleasant indoor climate. Doing this without being dependent on tenants' intentionality, or by creating the conditions to minimize certain actions (such as opening windows) appears to be a very important aspect of enacting the collectif energy behaviour.

Accordingly, technologies embody goals and project social interests (Gieryn, 2002: 41–44). The previous discussion shows that the flats have been optimized for energy efficiency (goals) but also shows that there are other values that create potential limits for acceptable living (social interest). These values and limits, as materialized by planners and builders, are embedded in the infrastructure and are expected to work as 'silent' preconditions; they do not demand active choices from the tenants. Rather, they passively prescribe a configuration of restrictions and potentials. What make the difference are the quality, structure, number, heterogeneity and diversity of agency delegations among the entities mobilized in the collectif. Nevertheless, what happens when infrastructures fail to mediate the goals of the designers? In other words, what happens when 'silent' technologies become 'loud'? Sofia,⁴ a student tenant at Colonia, explains how her kitchen sink works against Byggvesta's stated environmental goals:

⁴ All names of students are fictional.

When it comes to washing dishes, there is only one sink. ... You cannot have soapy water on one side and rinsing water on the other. All single flats at Colonia have only one sink in the kitchen. So, in a way Byggesta has a double standard. We have to pay for using more hot water, but there is no way we can optimize our behaviour. We have to wash dishes with the water running all the time. It feels a bit weird because it is a lose–lose situation for the tenant due to bad kitchen design (interview with Sofia, tenant at Colonia).

Sinks, insulation, windows, thermostats and so forth are nonhuman entities with specific functions that articulate and delegate energy (in)efficiency to potential tenants. To say this is not to imply that nonhuman actors intentionally choose to delegate energy efficiency. We are talking about entities that *enact* actions rather than construct or possess them. In a human-centred vocabulary, these actions are often called “intentions” or “goals” (being environmentally friendly, ecological) while in nonhuman terminology these are called “functions” (Latour, 1993: 8). However, it is possible that the intended action is not materialized by the tenants if, for example, the flats are not considered cosy or pleasant. In other cases, functions are badly designed and the collectif ascribes inefficient energy behaviour.

Creating incentives

An important part of ascribing energy efficient behaviour is the creation of incentives in areas where the collectif is performed by the use of electricity, water or heat. Our informants explained that by constructing high-density flats and installing individual meters they intended to enact efficient energy behaviour in the sense that they created potentials and restrictions that could constitute obligatory passage points in the collectif. Tenants living in flats with low heat leakage were aware that the more hot water they used, the more they would have to pay. The informants highlighted three different ways to create incentives for more efficient energy consumption, namely *visualizing*, *costs* and *information*.

Visualizing

In Sweden, water and heating bills are often separated from the rent for a flat, In the case of student dorms however, the electricity bill is often included in the rental. This sets up what is called the *landlord–tenant problem*: where energy costs are a fixed part of the rent, there is no economic incentive to change user behaviour (Nässén, Sprei & Holmberg, 2008: 3818). A lack of awareness of energy use eliminates any incentive for tenants to change their energy consumption behaviour (interview with Marcus Svensson, head of Byggesta’s business development department). The amount of electricity and hot water used is to a large degree dependent on individual behaviour. By measuring electricity and hot water consumption, the Colonia landlord aims to make tenants aware of their energy behaviour and thus create incentives to change it. Werner described the materialization of incentives as follows:

Another significant factor is the use of hot water, which is extremely dependent on individuals. It is demand-driven depending on whether a family with children lives in the flat or a retired couple. This makes it difficult to set a rate. This is where you have to create incentives for saving. Installing drains with heat recovery does not save much energy and is not cost efficient. A, example of creating incentives is what we did with Byggesta in Linköping. We investigated the possibility of initiating incentives for saving hot water. Every tenant was allocated a specific amount of hot water, and if they consumed more than that, they faced an extra cost. [...] In other words, when it comes to heated water it is easy to install a meter to show how much every tenant consumes, what they have to pay, and to issue invoices that show whether a tenant consumes a lot or not. Regarding individual measurement of heat, there are practical difficulties when it comes to being fair. What do

we do about corner flats? Should we insulate the middle flats so that it is difficult to steal heat from a neighbour; or should we measure the temperature or the real energy consumption? (interview with engineer Göran Werner, employee at WSP)

The installation of individual meters makes the use of energy visible and creates potential for enacting alternative energy use patterns by mediating normative programmes of energy behaviour, as defined by Byggesta. Every tenant had to either adjust to his or her energy allowance or pay an extra cost for consuming more. Nevertheless, there is often an important pedagogical constraint when energy consumption is presented in an invoice. The tenants may not comprehend or may not want to adjust to the landlords' energy use standard or economic goal. According to Marcus Svensson, it is almost impossible to design invoices that people fully understand or respond to. An invoice does not guarantee the enactment of energy-saving consumption. Nina, who lives in Colonia, argued that there are problems with the way Byggesta presents energy consumption. She made some concrete suggestions of ways to improve awareness of energy use:

The awareness of energy consumption does not improve since there is a bit of hocus pocus regarding the measurement methods and the invoice. Every now and then someone comes and reads the meters, but nobody really knows what this means. It would be much better if we got a report for each month, especially concerning electricity, about our consumption. We need an invoice that specifies what costs most: the computer, the TV or the stove? We need a better visualization and specification of energy consumption, especially regarding specific areas in the flat such the kitchen or the bathroom. (Interview with Nina, tenant at Colonia)

We have already mentioned that the materialization of energy behaviour depends on the structure and quality of the agency distributions among the entities of the collectif. When we consider that technologies prescribe substantive sociopolitical agency (such as being ecological, being energy-saving), an important question arises: To what extent do they succeed in doing so? Werner stated:

When it comes to technology, there are no machines that you can just install in a building and solve all problems. Rather, it is important to make everything a little bit better. [...] Technology does not make anything better if you do not know how to work with it: if you install a complex system, it is impossible for them [the tenants] to understand how it works. If you install a simple system that does not need any instructions, the tenants may misunderstand its function. (Interview with engineer Göran Werner, employee at WSP)

It is not enough to investigate whether these technologies enrol or fail to enrol entities within the collectif. It is also important to monitor whether these practices "work", that is, succeed in enacting specific ecological energy behaviour (Marres, 2007: 374). As we will show, tenants tend to ignore the goals and normative programs embedded in their visualized energy consumption, as enacted by the invoice.

Costs

Even if people both can 'see' and understand their energy consumption, this comprehension does not necessarily change their behaviour. In a more traditional economic study of energy efficiency in the Swedish building sector, Nässén *et al* (2008) conclude that engineering estimates of energy efficiency potentials often underestimate the actual costs of change (p. 3821). According to our informants, representing landlords and engineers, there is a need for stronger incentives. As we have already discussed, the design and construction of Colonia

aimed to perform a specific form of student life (creation of companionship among students) and enact an energy-saving collectif. Kirsch agreed with Marcus Svensson:

Another important factor is, of course, the use of water, especially hot water. We use individual meters, which is something we implemented in Colonia for the first time. This way, the tenants can always see how much they consume and how much they pay. It comes with the rent; the more one consumes, the more it costs. (Interview with architect John Kirsch, employee at White-Architects)

Water heating is considered a significant problem by landlords, for it is very energy demanding and expensive. To estimate what tenants should pay for their hot water, builders use standards for what is defined as a fair level of consumption. If the use of water exceeds this level, the tenants have to pay for the extra consumption. One of our informants representing the designers of Colonia went as far as to suggest that every household should have a “carbon dioxide share”, and when it was surpassed, there should be a fee (interview with engineer Göran Werner, employee at WSP).

Information

An important element of the collectif energy behaviour is the distribution of information. In Sweden and many other Western countries, there has been an increased focus on influencing households' energy behaviour through different kinds of informational practices (Gyberg and Palm, 2009). The distribution of information from Byggesta contributes to the delegation of agency among entities in the collectif, that is, how tenants comprehend technological apparatuses and their semiotics that mediate normative programs as well as how they react to these programmes. Do technological artefacts, as mediators of social behaviour, succeed in motivating tenants to be energy-saving? Werner from WSP noted:

It is very difficult to implement systems that provide a fair measurement, so it is important to spread information to influence behaviour. For example, ‘do not leave the windows open’, or ‘there is a technology that turns off the radiator when the windows are open’, and so on. (Interview with engineer Göran Werner, employee at WSP)

In the case of Colonia, the landlords used various semiotic methods to motivate tenants, including providing an intranet where the tenants could discuss matters and pose questions to landlords. Svensson from Byggesta explained the idea behind the intranet and this kind of information distribution:

[...] we held a barbecue where a representative of Byggesta came and gave information about the restrictions and services provided by the houses. We distributed leaflets, we put up signs, and we wanted to show what our goals are. We encouraged people: look, there is a carpooling service if you want to join it. In other words, we have different means and information campaigns to promote our goals. (Interview with Marcus Svensson, head of Byggesta's business development department)

One important insight from the above analysis is that technological artefacts and their semiotics do not constitute a *deus ex machina* – an improbable contrivance that enacts energy behaviour and automatically translates into meeting environmental goals. Instead, agency involves an exchange between humans and nonhumans. Tenants/users of technological artefacts play an important role in the configuration of the collectif energy behaviour. Several empirical studies have shown that the lifestyle and identity of tenants are equally significant factors for energy use (see, for example, Hallin et al. 1986; Yates 1983; Wild & Wilhite 1985; Palmberg 1986; Skill 2008). Shove explains that energy consumption constitutes a mirror

image of the collectif that individuals live in. Households' energy consumption is closely related to identity creation and what kind of "image" the household intends to maintain (Shove *et al*, 1998). In the following section, we will present what the Colonia tenants have to say about their own energy consumption patterns, as another component of the collectif energy behaviour. These narrations refer to tenants' lifestyles and interactions with technology, as well as to their reflections on their reactions to the normative programs that Byggestad embedded in Colonia.

"No other group wastes more energy than students..."

Our informants who were engaged with the design of the Colonia project maintained that the project represented an environmental challenge since "no other group wastes more energy than students" given that "students exercise a great deal and shower quite a lot". The lifestyle of students/tenants is an important element of the collectif energy behaviour, since it tends to locate normativity in the ways of life that the tenants enact; it refers to the sociomaterial practices that are performed, with their particular division of agency among entities, the particular objects that figure in them, their particular settings, languages and textures that propose a specific way of life by enacting it (cf. Marres, 2007: 372-373). In what follows, we discuss how Colonia tenants reflect on and enact their energy consumption in relation to their lifestyles and standpoints, technological/design potentials and constraints embedded in Colonia, and the environmental/economic programmes provided by Byggestad. The collectif also consists of relations between ways of living and technological installations, environmental awareness and lifestyle choices.

Ways of life versus normative programmes

Karin lives in a commune with three other students (two females and one male). This way of living implies the co-existence of different realities, lifestyles, and energy use patterns. Two of her flatmates are five years younger than she is while the third is in the same age. Speaking of energy consumption, Karin referred to water consumption as well as the use of electrical equipment:

When you think of energy in the household, then water consumption is important. Moreover, the commune is equipped with a dishwasher (which consumes a lot of energy) and then there are lamps, the TV, computers etc. However, each person's role in the energy system is relatively small. But if everyone thinks that it does not matter, that you do not make any difference, then the damage is huge. This is why I think that I have to accept my responsibility and consume as little as possible and try to influence those that I live with to be aware of environmental and climate issues. Partly for the environment in Sweden, but also in a global sense: what we do also influences developing countries, poor countries. (Interview with Karin, tenant at Colonia)

For Karin, it is imperative to shape the collectif by influencing the energy habits of her flatmates. She believes that even small things such as turning off the water tap while doing something else, or nagging about whether a lamp should be on or not, make a difference. Nevertheless, aspects such as age and gender are of crucial importance for her when it comes to the way people consume energy at home. She explained:

We are three girls here and one guy. I am pretty sure that the guy, who is five years younger, thinks that we are nagging. [...] Two of us are a bit older, me and another girl are twenty-seven, so I think we think of energy use and the environment more than the other two, who were born in 1987. I do not really know why it's like this. Partly due to age I guess, but then guys seem to think less about the environment when they talk. Not everyone of course, but generally I believe that guys think, 'It doesn't matter what I do' or 'Whatever. I can do that'. (ibid).

Karin claims that girls (specifically older girls) are more aware of environmental issues and care more about energy consumption in the household. Nina, who lives in the commune with Karin and is the same age, regards energy consumption in the flat as each person's own business. Nevertheless, she often goes around and turns off the lights, the TV and so on. Nina argued:

It is a bit different when it comes to boys and girls regarding energy use and things like cooking. Girls use the oven, while the boys use the microwave. (Interview with Nina, tenant at Colonia)

Khaled lives in a single 26 m² flat. He moved to Colonia a year before the interview and it is the first time he has lived by himself. Living on his own implies a totally new world where he has to think of details that he never cared about when he lived with his parents, such as washing the dishes without turning off the water tap or turning off the lights.

I don't think much about how much energy I consume. On the other hand, now I get a huge bill, right? But my role in the energy system, hmm... Yeah, you hear a lot about saving for the sake of the environment and so on, but it has to do with the fact that I moved here last year and it is the first time I have lived by myself, so I have not really thought in this way [about energy consumption and the environment]. I believe this is something that comes with time ... (Interview with Khaled, tenant at Colonia).

Sofia is in the third year of the speech therapy programme at the University of Linköping. She also moved directly from her parents' house to a single flat in Colonia. Sofia explained how her energy behaviour is enacted by different practices, but she also expressed a distinct ecological standpoint:

It is my first flat so I think about things like turning off the TV when I am not watching, showering for shorter times, loads of minor things. I am trying to save as much as I can both for my own budget and for the environment. At the end of the day, you have got to be the drop in the ocean... (Interview with Sofia, tenant at Colonia).

What does one make of the statements in which energy behaviour is regarded as irrelevant while gender, age and different standpoints are relevant? How does one think about such orderings of *different* differences, and about the relations and interactions between them (cf. Moser, 2006: 538)? Depending on age and gender, our informants enact their role in the collectif in different ways – as well as the potentials and restrictions with which that Colonia provide its tenants. In that sense, the structure of the collectif energy behaviour changes dramatically. Agency delegations as materialized by different technological apparatuses or invoices (in the form of normative programs) do not solely enact the collectif. Age and gender also affect energy behaviour.

Jenny is an engineering student living on her own. She claims that she is not aware of environmental issues, but at the same time “she gets a bit angry at other students when they do not turn off the light in the stairwell, or when they just put their bags with recycling stuff in the recycling room without sorting it” (Interview with Jenny, tenant at Colonia). Sometimes

she sorts it for them. She also thinks that the heating and ventilation systems are strange: “How can they put cold ventilation just above the radiator?” (ibid). Jenny’s perception of the flat’s design questions Byggestad’s ability to organize a material environment that enacts an energy-saving collectif. Again, environmental goals and intentions are cancelled out by material arrangements. Jenny also relates energy costs, lifestyles and environmental awareness. She told us that her electricity bill is probably above average for a student because she cooks and bakes a lot. Even though she admits that this seems bad because of the high electricity bill, she believes that homemade food is better for the environment. Moreover, food is cheaper when you cook it yourself (ibid). On the other hand, Karin does not see the level of energy costs as a relevant question. Important issues for her are how her lifestyle interacts with the resources and potentials that the flat provides, as well as how she influences her flatmates:

I have no idea whether the bills have risen or not, since they come so seldom. No bills have come since I moved in, so I do not know what they are – but I don’t care about it anyway. But, for example, turning the shower off while you wash your body, these kinds of small things make a difference. It is also such things – speaking about influence – which I usually comment on: “Oh, you shower for a long time”. Commenting on such things and making them obvious is a way to influence someone. Even when it comes to waste sorting I can say: “Why did you throw this out? You should recycle it instead of throwing it in the litter bin”. Also, I usually try to remember to turn off the lights, turn the radiator down, etc. (Interview with Karin, tenant at Colonia)

Johan, who also lives on his own, does not ascribe great importance to energy costs either. He referred to his bad conscience about not saving energy rather than to any specific environmental awareness. He consumes more energy (in terms of hot water and electricity) than the normal, as defined by Byggestad.

I didn’t consume more [energy] than the limit last year. But I think they have changed their measurement periods. [...] It doesn’t cost that much anyway. I mean, I have not been especially saving this year and I had to pay 150 SEK [approximately 15 euros] extra for water and 150 SEK extra for electricity. It isn’t a huge amount. I think it is mostly a question of conscience rather than cost. [...] I could shower for a shorter time but I still think it’s worth the extra cost. It is more worthwhile saving electricity than water: such as turning off the lamps, the computer is usually on all the time, but the TV – I should turn it off when I am not watching it. On the other hand, I don’t have a dishwasher so I do the dishes while I let the water run all the time. You cannot avoid this kind of stuff if you do not want to leave a pile of dirty dishes all over the place. [...] I don’t intend to save more. I believe that they [Byggestad] have been rather stingy regarding the definition of normal consumption. I don’t really know what qualifies as normal: most of the people who live in this building get an extra bill, as far as I know. Byggestad has taken a kind of recommendation from some consumer advisor or so, I guess. Again, it is a bad conscience on my part and not a cost effect. It is so cheap to consume electricity anyway. After all, you have to live in a certain way. That is a fact. (Interview with Johan, tenant at Colonia)

It was not only Johan who argued for the need to maintain a certain “way of life”. For Emil and Sofia, energy costs are an important aspect of their energy use. They attempt to adjust their consumption to an economical level and their behaviour to environmental standards but they also admit, “There is a limit. You have to use energy” (Interview with Sofia, tenant at Colonia). Emil admitted that despite his efforts to conserve energy, his energy consumption is often over the limit defined by Byggestad:

I used to live in a private flat [not a student flat] downtown, so I carry with me this way of thinking: to be saving and be economical. However, I went over the limit. I could not reduce my electricity consumption to the standards defined by Byggestad. I cannot adjust my everyday life more than I have done. For example, I think it's fun to play videogames while listen to music from my computer. (Interview with Emil, tenant at Colonia)

While Karin's way of living builds on some environmental awareness and a conscious effort to reduce energy consumption, Johan, Sofia, and Emil perceive energy-saving as an (inconvenient) transformation of their lifestyle. For them, what Byggestad performs as 'normal' collectif constitutes a disruption of their routines, practices and way of living, which is translated through an extra cost. Nevertheless, this extra cost is not high enough to make tenants, such as Johan and Emil, conform to Byggestad's environmental goal (low energy consumption). Nässen *et al*'s (2008: 3818) study of energy efficiency in the Swedish housing sector also pointed out that higher energy prices do not constitute a significant explanatory parameter for specific energy use. As Marres (2007: 373) notes, lifestyles and practices have a way of resisting normative programs that have been embedded in technologies. The measurements provided by the meters and the extra bills do not become an obligatory passage point for all tenants. Moreover, several tenants (like Jenny) juxtapose benefits to the environment with the benefits of an energy-saving behaviour. Tenants thus enact different environmental prioritizations by reshaping the collectif energy behaviour (e.g. homemade food is better for the environment than consuming less energy).

Lifestyle: Consciousness versus choice

Johan has lived at Colonia for a year and a half in a single 26 m² flat. He considers his part in the energy system very small, although his conscience does drive him to consume less energy.

Yes, a bad conscience for the environment. You do not turn off the TV because you feel that you are contributing to a better world, but because you feel that you have to. An individual does not make any difference in comparison to industry, for example. (Interview with Johan, tenant at Colonia)

Sofia also tries to save energy and expresses a certain awareness of environmental issues:

I save on my energy use in order to be economical, but of course also for the environment. Everywhere you go you hear talk about excessive energy consumption and global warming. (Interview with Sofia, tenant at Colonia)

Khaled, on the other hand, has no distinct ecological awareness and attaches great importance to a pleasant indoor environment. He considers energy prices relatively low, but recognizes that it is time for him to start thinking in environmental terms.

Sometimes I set the timer for the lights. I want the room to be a bit bright. Actually, my parents bought it for me when I moved in and I have used it since then. It has nothing to do with ecological awareness or cost. I just want to have a cosy room when I come home. We also have the luxury of warming our towels. I really like this. I also do the dishes with the water running. That's why I get such high bills – but if you compare it to the rent (4000 SEK), the extra costs for electricity and hot water are minimal. But I should start thinking of the future. It's time for me to think about such things. For example, it's totally unnecessary to do the dishes with the tap running. Moreover, I don't really need to turn the lights on so early with the timer. [...] I think this is stuff that I have to change. I got a real eye-opener with my last bill and I decided that I really have to do something about my energy consumption. [...] To be honest, I don't really know what the normal consumption is [...]. There are reasons to change one's energy behaviour, above all environmental

reasons. You hear so much about them, and if you count all households then it is a lot of energy that is being consumed, often unnecessary consumption. You get scared by all the things you hear regarding weather change and then you see pictures of how water levels have risen, etc. On the other hand, people don't want to change their energy behaviour because of their lifestyle. They have certain standards and they don't want to change them. It's difficult to change habits that you have lived with for a long time. (Interview with Khaled, tenant at Colonia)

Khaled wavers between different collectif. While he describes how important it is for him to live in a pleasant, warm and bright flat, he also expresses his worries about the environment. He recognizes that significant alterations are needed to adopt an environmental lifestyle. These alternations imply rearrangement of sociomaterial relations (turning off the water while doing the dishes, reprogramming the timer for the lights) but in his case, they are not enacted through high-energy costs or a conscious ideological standpoint (being ecological). As in Sofia's case, other actors ascribe him with agency and enact his consumption, namely fear of the future, which is stoked by reports and prognoses about climate change as well as images of environmental crises. Byggestad's definition of normal energy consumption has not succeeded in shaping Khaled's or Johan's (see previous section) energy consumption. On the contrary, the topology of Khaled's collectif is a scale-breaking combination of non-local and local entities (climate change, lights' timer) that enact his energy use.

Similarly, although Jenny claimed to have low environmental consciousness, she had strong ideas about what good versus bad energy behaviour is. She gave economic reasons for lowering her energy consumption, but actually, she did not want to waste resources. For Jenny, minimizing her use of resources and her impact on the environment was about taking responsibility for her own behaviour. She claimed not to know a lot about energy or environmental issues, but she does what she thinks is right in any situation (Interview with Jenny, tenant at Colonia). The interviews analysed here show that what is important for our informants is how they can enact their everyday life in a way that it is appropriate for them and in agreement with the co-performance of their lifestyles with material constraints and resources. What is appropriate or environmental friendly for the tenants does not always agree with Byggestad's enactments of the collectif energy-efficient behaviour.

Discussion

Employing the concept of a collectif enabled our analysis to accentuate the plurality of settings in which energy behaviour is enacted and to explore the richness of the relations that perform it (cf. Callon and Law, 1997: 179–180; Moser, 2003: 45; Galis, 2006: 34). In that sense, the collectif energy behaviour is not enacted by linear and simplistic attributions of agency: environmental/economic normative programmes embedded in infrastructures generate/ascribe energy-saving consumption/environmental awareness. Approaching energy behaviour as a collectif allowed us to create analytical space where we showed that the enactment of energy behaviour goes beyond rational/ideological (being ecological) or economic (high costs) interpretations of social behaviour. Energy behaviour depends on multiple realities and different materials. This kind of pluralism implies that while realities and practices may conflict at some points, elsewhere the various enactments of an entity may collaborate and even depend on one another (Mol, 1999: 83). As in the case of all collectifs, energy behaviour cannot be detached from the material and semiotic entities that constitute it. One of our main points is that energy behaviour in this context is co-produced or co-constructed of heterogeneous elements such as infrastructures and lifestyles.

Concretely, we showed how Byggesta and other actors involved in the design of Colonia attempted to mediate specific technocratic programmes (low energy consumption) to tenants through meters, higher energy costs, and invoices, as well as through the construction of energy-saving buildings. As landlords and builders they sought to shape and enact 'normal' energy behaviour by setting their views, standards and limits on energy consumption as obligatory passage points. However, not all tenants subscribed to their views. The metered use and the extra costs for energy use beyond normal consumption (as defined by Byggesta) never became an obligatory passage point for Johan, Khaled or Emil. To avoid disruption of their lifestyle, these tenants resisted Byggesta's normative programmes. On the other hand, Karin, Nina, Jenny and Sofia adopted ecological energy behaviour, but it is not clear that this was a product of Byggesta's methods. It was more an aspect of their everyday sociomaterial practices such as washing the dishes, cooking homemade food, turning off the lights, attempting to influence flatmates and so forth.

By approaching energy behaviour as a dynamic set of relations among heterogeneous materials and following the narrations of our informants, we managed to accentuate the multiplicity of the collectif. Energy behaviour is continually translated/enacted in dynamic interactions between humans, artefacts, ideologies, lifestyles and political/design programmes. This also has concrete consequences for the enactment of what is cost-profitable, what is environmental, and what is ecological. The narrations of tenants showed that what they often enacted as environmental, Byggesta and their meters classed as inefficient and uneconomical energy behaviour. Thus, is it enough to talk only in terms of co-construction/co-production of realities and sociomaterial arrangements/practices?

In line with Moser, our second point is that what is needed for a critical analysis of energy behaviour as a collectif is to "trace how social differentiation and ordering becomes durable and material, how such arrangements become stabilized and institutionalized, and how these processes of ordering or structuralization enter and enact themselves in situated interactions" (Moser, 2006: 558). In other words, in order to understand energy behaviour we need to locate differences among entities and critically analyze why and how these differences materialize, are reproduced, prioritized and become mobilized in specific relations between humans and non-humans. It is important to acknowledge that differences may be situated in specific cultural-social-material arrangements: in this case age, gender, lifestyle and ideological points of view, but also in restrictions and resources provided by infrastructures. Our study provides strong indications that gender and age, as entities of equal importance in the collectif (see the theoretical discussion in this paper), are generators of performative agency, that is, they may matter in the enactment of the collectif energy behaviour. For example, our analysis showed that being men in their early twenties manifested low environmental awareness, while female informants (especially older ones) showed higher engagement in ecological practices.

Finally, it is a challenge for landlords and builders such as Byggesta to design buildings, artefacts, measurement methods and incentives that imply a sustainable energy system while also including different realities, lifestyles, ages, gender, practices, and so forth. The design and implementation of energy-efficient buildings and the application of environmental policies constitute what Moser calls "enactments of difference in sociotechnical practices and relations" (ibid.: 558). Landlords and builders need to acknowledge differences and to study lifestyles before designing buildings. As Nässén et al. (2008: 3821) recommend, this could involve transfer of experiences between landlords and tenants from the use phase to the production phase of buildings, from one project to the next project, as well as from

demonstration projects to mainstream buildings. One has to bear in mind that differences are enacted through sociomaterial arrangements: to be ecological often implies an ideological problematization that is enacted through a specific lifestyle and a series of interactions with the material world, such as turning off the water, turning off the lights, showering for a shorter time, and recycling. Designers must follow and understand how these sociomaterial arrangements become stabilized routines integrated in individuals' lifestyles. The best way to study such arrangements, to monitor the collectif, is to interact with potential tenants and investigate their social status (age, gender), habits, lifestyles and everyday practices.

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