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Visualizing energy consumption activities as a tool for making everyday life more sustainable

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ABSTRACT

The need to analyze and understand energy consumption in relation to households' activity patterns is vital for developing policy means that contribute to an energy efficient life and what people would deem as a "good" everyday life. To do this we need to learn more about how energy use is a part of everyday life; this article contributes to that objective. We use the time-geographic diary approach together with interviews to analyze everyday life as a totality. From household members' time diaries, we can analyze and learn about when, where, and what energy-related activities occur in a household context and by whom (and in what social context) they are performed. We discuss the importance of relating information and feedback to households' everyday activities, in order to make it relevant to households. Through our method we discover and visualize activity patterns in a household during a given period. The method is also useful to households as a reflective tool when discussing families' daily lives in relation to energy consumption. The method gives direct feedback to households and the information is relevant since it emanates from their own reported activities.

1. Introduction

The sustainability debate has become a climate debate, within which reducing CO_2 emissions is the highest priority. The International Energy Agency (IEA) has stated that current trends in energy supply and consumption are patently unsustainable and must be altered. In its efforts to stabilize and reduce emissions, the EU Commission has prioritized energy issues and set the so-called 20/20/20 goals: to obtain 20% of its overall energy mix from renewable sources, to reduce total primary energy consumption by 20%, and to cut greenhouse gas emissions by at least 20%, all by 2020 [1].

Policy aimed at promoting energy efficiency in the household sector must relate to and rely on individuals' daily choices and household routines – what they do in their everyday lives. Hence, individuals' values and knowledge about how their everyday activities influence energy use are important for the development of an efficient and ecologically sustainable energy system. Peoples' understanding of their responsibilities and willingness to shoulder them are seen as key factors in creating a sustainable society [2].

We will examine energy consumption in the household sector and discuss energy use from a household-level perspective. This represents a shift away from the conventional focus of energy supply in the household sector towards one of energy use in everyday life. This shift is urgent since deeper knowledge is needed on the part of households, policy-makers, housing companies and researchers about how energy makes necessary functions in peoples' daily lives easier. It is important to develop new paths to smart and climate-friendly energy use that continue to facilitate peoples' everyday lives. In this article, basic functions of everyday life are placed in focus and the energy needed to discharge them is discussed. According to Carlsson-Kanyama and Lindén [3], the functions of a good life are: a comfortable indoor climate, convenient hot water, a clean home, clean clothes and body, food and drink, opportunities to move from place to place, and information, communication and entertainment. We will discuss how to analyze energy use in households' activity patterns related to such functions.

The dominant methods for encouraging people to change their energy consumption behavior have long been information campaigns, the energy labeling of white goods, energy advice, and so on. The results achieved so far, however, have been insufficient [4,5]. Although at a rhetorical level people are aware of the importance of using energy efficiently, concrete action is lacking – household energy use has not decreased. This can be partially explained by people not relating the satisfaction of their daily needs to the energy demanded by the (increasing) stock of appliances in their homes. For example, there has been a rapid rise in demand for novel electronic devices (e.g., information and communication technologies and other electronic devices), a high turnover of white

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goods due to fashion trends, more use of lighting in architecture, and the spread of specialized and individualized appliances. In addition, the demand for air conditioning has increased while considerable energy is still needed for heating [6,7].

Another explanation of the non-decreasing energy demand in the household sector is that decreased energy use is often rhetorically connected with changing peoples' current lifestyles to ones that are less comfortable and convenient. But is it so? How can we know that a reduced energy use in a household does not rather *contribute* to the good life of its members? To draw any conclusions about how energy conservation will affect a household we must know more about how energy use contributes to everyday life today, which will be in focus in this article.

The purpose of this article is to discuss the importance of visualization and how to visualize households' members' energy consumption when striving for sustainability. To gain new knowledge in this area we need to know how life is lived today, not just in specific households but also in households at the aggregate level.

2. The household context

The housing sector accounts for approximately one-third of Sweden's total energy use, with the use phase accounting for approximately 85% of a building's total energy use [8]. From 1970 to the mid-1980s, housing sector energy use declined from 350 kW h/m^2 to 180 kW h/m^2. There are material constraints setting the outer limit for reducing energy use in the housing sector. Within these limits, the actions and choices of householders as inhabitants are crucial, and reductions were observed in both existing and new housing stock and applied to detached houses as well as apartment buildings. In the mid-1980s, however, this decline ceased [9]. Most energy use in the housing sector is used for regulating indoor climate and for heating water [10]. Household energy use for heating/cooling and running appliances is important for households, but it is equally important for municipalities and the enterprises developing and creating energy systems. Building codes and house/apartment layout and equipment (e.g., HVAC and appliances) exemplify material constraints that frame household energy use. There are opportunities to influence energy use within this framework, and this task mainly concerns households and local householders. This framework also delimits the scope of this article; now we approach the "opportunity space" within which households may influence their own energy use.

Since people spend most of their time at home, the physical context in which the functions of a good life as outlined above appear consists mainly of the home itself and the tools, appliances and social organization controlled by household members. On average, Swedes spend about 65% of their time in their homes on week days, and about 75% on weekends [11]. People undertake daily efforts that all entail energy use to various degrees, and we hope to increase knowledge of this complex issue and develop a knowledge base from where we can start discussing how the need to conserve energy can be turned into something positively valued and worth striving for.

We regard the household as a social unit in which its members negotiate (in talk and in actions) their interest in indoor climate and energy-related issues and appliance use. Consequently, taking household members in the context of their household as the starting point will increase our knowledge of whether, how, and for whom energy is an issue in daily life. This approach yields information about the relationships and mutually dependent activities in common household projects. We assume that the complex interrelational web produced when different activities in support of the same goal are performed by different household members will help us detect and understand both the factors underlying energy use and the potential to reduce it. We also investigate daily activity patterns at the aggregate level – the outcome of many households' negotiations – to identify what activities that need much energy and thus might have significant conservation potential.

3. A bottom-up approach to energy use and everyday life

Most research into energy use takes energy supply as its point of departure, and regarding energy as a scarce resource naturally leads to a focus on how to *increase* the energy supply [4]. Since this has long been the case, industrial production, the transportation of people and goods, and public and private services are expected to need more energy as economies grow. The users' utilization of the energy supply has not been an issue of discussion. From a climate perspective, however, we must rethink the one-sided focus on supply [12]. We will therefore take a comprehensive view of energy use and energy efficiency in everyday life. Such an approach regards everyday life as a totality that brings meaning to people, a totality in which the aspects addressed above are interwoven. Since the research subjects regard their everyday life as a totality, we too must do so if we are to truly grasp peoples' energy use in daily life. By taking a socio-technical system approach to energy use in households, we can gain admittance to what the field of system studies often calls the "black box" of households [2], and analyze energy use and efficiency from the household members' perspective. We focus on the household member as an energy user and view her or him as an active subject in both the household and a broader system context. Housing sector companies and householders are local decision-makers determining the material frames for households' energy behavior in their dwellings – their "opportunity space[1]" – and their actions influence politicians, planners and companies in determining the institutional frameworks for action.

We use a time-geographic approach, which allows looking at everyday life as a totality, and weaves individuals together in terms of them performing activities that make them pursue household projects aimed at achieving household goals. From household members' time diaries [14,15], we can analyze and learn about when, where and what energy-related activities occur in a household context and by whom (and in what social context) they are performed. Information is collected regarding who is involved in specific energy-use-related activities and routines that involve various constellations of household members [16,17].

The time-geographical approach underlines the importance of the material resources framing everyday life. Energy use is negotiated between the members of the households, and various material restrictions influence the outcome of the projects they undertake. Guy and Shove [18] criticized the view that energy-saving actions are straightforward consequences of informed rational action on the part of individual decision-makers. Rather, they argue that it is necessary to understand the social structures and networks within which these decisions are made. Shove [19] also highlights the social and institutional contexts in which decisions concerning the acceptance of sustainable energy solutions are made. Following science, technology and society (STS) studies, Shove emphasizes that decisions concerning, for example, the implementation of en-

[1] Bo Lenntorp [13] defined the physical space of possibilities" as the geographical area a person can reach, given a maximum speed for transportation, from a given location at time $t1$ when s/he has to be at the same or another location at time $t2$. This definition determines the space of possibilities without taking organizational and private restrictions into consideration, and we use of the term opportunity space" to also include the latter aspects.