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Hansen, Anders Rhiger

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# The potential of quantitative sociological research on residential energy consumption in Denmark

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*This is a work in progress. Please do not quote.*

**Anders Rhiger Hansen**, arh@sbi.aau.dk  
Danish Building Research Institute, Aalborg University  
A.C. Meyers Vænge 15, 2450 København SV

## **Abstract:**

In this paper, I begin with a description of how a sociological perspective can be employed to understand energy consumption while taking into account that energy consumption is embedded in everyday social practices. Next, I describe how newly available data enhances the potential of quantitative sociological analysis into energy consumption, enabling researchers in Denmark to use information on energy consumption derived from the energy-supply companies. Furthermore, I present a preliminary research design that employs both a quantitative sociological perspective and the newly available data on actual energy consumption. The research design contains a descriptive analysis of how energy demand differs between different types of households.

In my conclusion, I claim that quantitative sociological research on energy consumption has great potential for obtaining more knowledge on energy consumption by contributing with more generalizable results to the general discussion on how various households consume energy, extend the breadth of current research questions and provide better opportunities for analysis concerning impacts on energy consumption over time.

**Keywords:** energy consumption, quantitative sociological research, register data

## **Introduction**

The residential sector is a significant contributor to the total energy use in Denmark, thus in 2011, it accounted for 31 % of the total energy use (Energistyrelsen, 2012, p.35). Therefore the sector must be considered as a valuable focus for study, when the political goals of reducing the total energy use in Denmark is to be met (*Energiaftalen 22. marts 2012*, 2012).

Residential energy consumption varies largely as a result of building characteristics. However, studies have shown that the role of the occupants also play an essential role for residential energy consumption (Andersen et al., 2009; Guerra-Santin and Itard, 2010; Lutzenhiser, 1993). Therefore, it is important to investigate how occupants consume energy to fully understand how energy consumption for households differs.

In addition, it can be argued that as a result of more energy efficient buildings and techniques, research on occupant-related energy consumption gradually become more important (Guerra Santin, 2010), for example as a basis for designing policies to meet political goals of reducing energy use (Braun, 2010).

The precondition for this article is that sociological research plays a central role in investigating how households consume energy, and that sociological research can contribute more to the research on residential energy consumption in Denmark by introducing more quantitative research projects. This type of research has been conducted in Denmark, but the field could be enlarged, especially as new quantitative data material is becoming available.

This paper presents the initial ideas of my PhD, and it is built up in three parts; first I present how energy consumption can be viewed from a sociological perspective. This includes both some sociological studies on energy consumption, and a theoretical frame on how to understand energy consumption. Next I present the extensive data material that it is possible for Danish researcher to acquire, and after that, I present an example of a preliminary research design that uses the quantitative data material. In the end, I give my opinion on what quantitative sociological research can contribute with in regard to analysis on residential energy consumption.

## **1. The role of sociology in regard to energy consumption**

A central figure in sociological research on energy consumption is Loren Lutzenhiser. In one of his articles, his starting point is that human behaviour plays a central role for residential energy consumption (Lutzenhiser, 1993), and from this he outlines the role of sociology regarding analysis of energy consumption. His focus is on how a sociological view can contribute to understand the demand-side of energy consumption, and to do so he has formed a cultural model of energy consumption. The underlying basis for this cultural model is that energy consumption is embedded in cultural processes where cultures are organized in social structures, including what he calls “styles” of life. In other words, the basis is that energy consumption as an economic activity is embedded in social structures, situations, and statuses. Thereby, he focuses on groups rather than individuals, and according to himself, he thereby offers “[...] an

*intellectually satisfying alternative to narrowly focused physical and individualistic approaches to the study of consumption*" (Lutzenhiser, 1992, p.54). Together with Bruce Hackett he has conducted an empirical study where they employ the cultural model of energy consumption. Here, they among other things generate an empirical model to predict energy use in a California apartment complex, where they add a cultural aspect by including a variable of "home continent" groups. They found some differences between the cultural groups, which they explain by differences in cultural practices and norms in the homelands (Hackett and Lutzenhiser, 1991).

The perspective presented by Lutzenhiser focus on how energy demand differ for different social groups, whereas much of the more recent sociological research on energy consumption are more interested in the social practices that are interlinked with energy consumption. This perspective is referred to as practice theory.

In practice theory, the focus of attention is on social practices rather than individuals, social groups and so forth (Shove and Walker, 2010). According to Reckwitz social practices are "[...] *sets of routinized* bodily performances" (Reckwitz, 2002, p. 251), meaning that the individual is body and minds that carry out a practice according to previous experiences and embedded routines. Moreover, consumption can occur within a social practice or for the sake of social practices (Warde, 2005). To put it another way, consumption can be hidden in a social practice or consumption can be necessary to carry out a certain social practice.

Much energy consumption is embedded in routinized practices such as adjusting thermostats and turning the light on and off. It can therefore be argued that energy consumption is a product of social practices or inextricably linked with social practices. In other words, energy consumption is something you do, when you are carrying out other practices. Consequently, the focus of the consumer should be more on the routinized bodily actions than the actual consumption.

For these reasons, practice theory is suitable for interpreting energy consumption because practice theory enhances the value and meaning of social practices in consumption. For example practice theory has been used to argue that policies should not only be based on the idea of a rational consumer, but also on the idea that consumption is interlinked with certain social practices (Gram-Hanssen, 2010). A range of studies have focused on specific social practices to understand energy behaviour. This is social practices such as energy renovation practices (Bartiaux et al., 2011), cooling practices (Strengers, 2010), green practices (Bartiaux and Salmón, 2012), and heating practices (Peeters et al., 2008), to mention a few. More generally, these practices can be referred to as every-day practices (Shove and Walker, 2010), and according to

Reckwitz the focus of practice “[...] seems to be tied to an interest in the 'everyday' and 'life-world'” (Reckwitz, 2002, p.244). To sum up, Lutzenhisers perspective was more on the demand side, what types of households display differences in energy demand, whereas practice theory is more interested in how energy consumption happen as a part of the everyday life. To understand a general consumption pattern, more quantitative methods tend to be more useful, whereas, to understand every-day life practices, more qualitative methods tend to be more useful. Therefore, many of the abovementioned sociological studies are based on a qualitative methodological perspective. However, there seems to be an untapped potential for studies based on a more quantitative methodological perspective. Not only in relation to studies of demand, but also in studies of social practices. Quantitative research on social practices can thus contribute to understand how social practices also can be understood in relation to consumption patterns and social structures like it is the case of energy demand. As Reckwitz writes: “After all: ‘practices’ form structures of action” (Reckwitz, 2002, p.244), and to empirically investigate these structures quantitative analysis are suitable. The potential for quantitative research on energy consumption is especially prevalent in Denmark, because of an extensive data material on energy consumption and household characteristics. In the next part of the paper, I will present this data.

## **2. Information on energy consumption**

It is a required task of the Ministry of Housing, Urban and Rural Affairs to collect information on residential energy consumption in Denmark. In June 2013, an amendment became effective that made this data available for research on energy consumption.

The law prescribe that all energy supply companies for heating have to report to the ministry how their customers consume. In addition, they need to report additional information such as heat supply.

Moreover, the law states that Energinet.dk, which is a company that collects information on electricity use in Denmark, also has to report the energy consumption of electricity to the ministry, which will become effective from 1th of December 2013.

The amendment enable researchers to conduct analysis on actual heating and electricity consumption for all Danish households, which forms a solid basis for quantitative analysis on residential energy consumption in Denmark. In other words, this information gives a unique possibility to do research on energy consumption, because this type of data must be considered more reliable than self-reported energy consumption. In addition, the data is much more extensive, and gives the possibility of conducting analysis on a total population at best.

The information on energy consumption will become a part of The Danish Building and Dwelling Register (BBR), which already contain extended information on buildings and dwellings in Denmark. Like the BBR, there is also registered information on family and individual level. This is information such as education, occupation, income, demographics and family composition.

One of the advantages with register data is that the researcher avoids problems with deficient questionnaires and reluctant respondents. Instead the researcher gets valid and detailed information on a total population of every individual, household or family in Denmark. Moreover, the register data contains information about previous occurrences as it is collected for each year. Such information about previous occurrences is often difficult to get information about otherwise (Hansen and Hjorth Andersen, 2009, p.96).

In contrast, it is a disadvantage that the data is collected for administration purposes and not for research purposes. This means that the researcher is restricted to use the administrative categories. However, I would argue that because of the magnitude of the data material and the level of details in each variable this problem can often be solved.

Another disadvantage is that the quality of the data can be questioned; who are responsible for reporting the information? Under which circumstances are the collecting of data taken place (Hansen and Hjorth Andersen, 2009, p. 97-98)? These questions are difficult to answer, and the transparency is lacking, which would have not been the same with self-conducted survey data.

Although there are some disadvantages by using register data, it is from a more general perspective an ideal way to get quite accurate information about individuals, households and families for a longer period of time. And together with information on energy consumption it forms a solid basis and an internationally unique possibility for analysis on residential energy consumption.

## **Survey data**

However, the register data lacks information on practices, attitudes, norms and so on, as well as does not contain information on detailed equipment in dwellings.

Therefore, the data is suitable for investigating the relation between household types and energy consumption, but it has its limits concerning analysis of attitudes, preferences, values, and practices. However, this can be solved by combining the data material from the registers with for example survey data.

In Denmark a lot of survey data is accessible through the Danish State Archives<sup>1</sup>, where many surveys conducted in Denmark are stored. It is possible to apply for using this data, which in some cases require accept from the researchers that conducted it. Another way to get useful information is to conduct the survey oneself, and thereby secure that the right questions can be asked. Here as well can the register data be useful to construct a sample that is representative for the population one wants to study. Likewise, the register data can be useful afterwards to weight the data so that the analysis becomes more valid and representative for the population.

### **3.An example of a research design**

In this last part of the paper, I will present a preliminary research design with the use of quantitative methodology. The idea presented here will eventually form a paper that will become a part of my PhD. The overall research question is: *Which types of households display differences in energy consumption for heating?* It is thus a descriptive analysis of how energy demand differs between different types of households.

The best way to investigate the relation between household characteristics and energy consumption level is to construct a multiple regression model. Multiple regression models can be used for investigating the association between two or more variables or to explain variation in a certain continuous outcome, which in this case is energy consumption. To put it another way, a multiple regression model describes how the mean energy consumption changes according to the value of one or more explanatory variables when controlling for other variables (Agresti, 2008, p. 266). In other words, a regression model estimate a mean conditioned on the independent variables. Moreover, the model can include control variables, which can improve the model and thereby get a better prediction of the outcome (Wooldridge, 2003, p.68). The regression model is frequently used to analyse correlation with a continuous outcome, which is also the case with energy consumption (Andersen et al., 2009; Guerra Santin, 2010; Hackett and Lutzenhiser, 1991; Leth-Petersen, 2003; Steemers and Geun Young Yun, 2009).

Contrary to Yun and Steemers (2011), who also use a multiple regression model to predict energy consumption, which in their case is for cooling, I have a more extended data on households determinant as for example educational status and occupational status of the households. Therefore, I will have a better basis for investigating the relation between lifestyle and energy consumption because I consider education and occupation as better predictors for lifestyle (source missing). However, I lack information on occupants

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<sup>1</sup> It can be found here: <http://www.sa.dk/dda/>

heating practices and behaviour like Steemers and Geun Young Yun (2009) and Guerra Santin et al. (2009) have.

### **Theoretical background**

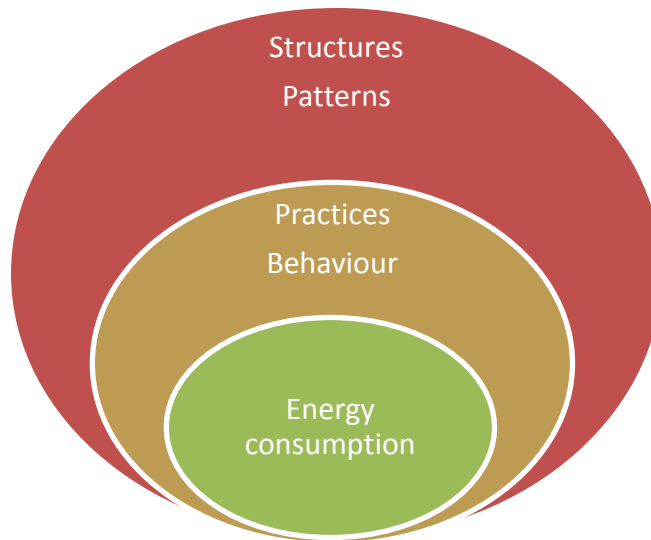
I understand energy consumption as embedded in social practices. Like I described in the first part of the paper; energy consumption happens when carrying out practices. Therefore, changes in energy consumption should be understood as different practices. For example if a household consume less energy than another household, this is caused by differences in practices.

I have illustrated this in figure 1. In the inner circle I have placed the energy consumption. This is what the households in the analysis do; they consume energy. However, this energy consumption happen as a result of or for the sake of routinized bodily practices, which I have placed in the next circle surrounding the energy consumption. Moreover, I have described this as behaviour. The last, outer circle contains the structures and patterns that influence the practices or behaviour, and thereby also the energy consumption. The structures delineate the differences between household in various fields, and it is possible to observe these structures by examining empirical differences in household characteristics. For example social structures can be observed as differences in income, which indicate the possibilities of behaviour and actions that the occupants in the household have.

The structures and patterns are thus a way to describe differences between households, and afterwards to put in relation to energy consumption level.



**Figure 1. Energy consumption embedded in practices and structures.**

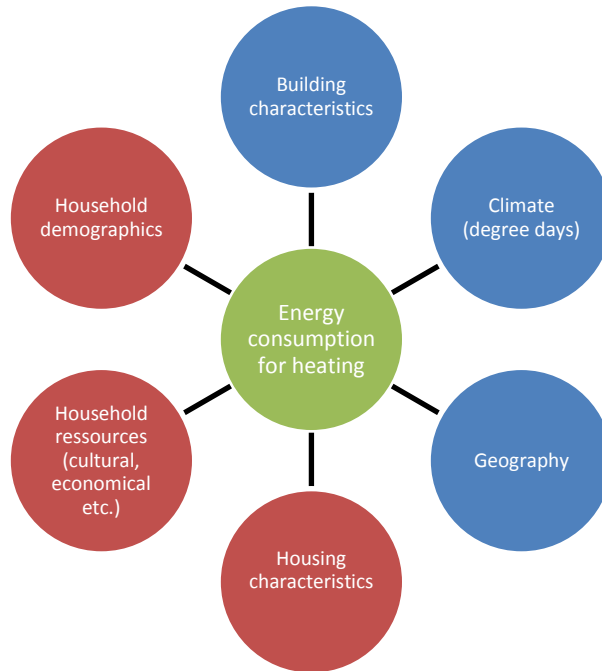


This is not a full explanatory model; it is just a way to illustrate how different concepts can be used to understand the theoretical idea of this paper. What I do in the empirical model is to explain energy consumption by skipping the middle circle and go directly from household characteristics to actual energy consumption. I have illustrated this in figure 2, where I present some of the possible determinants for explaining energy consumption. I have focused on the determinants that I have information about in the data material described in part 2 of the paper in figure 2<sup>2</sup>.

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<sup>2</sup> It is important here to point out that I have made this model before I have the final data material; therefore it is certain that the variables will change when I know the exact possibilities and limitations of the data material.

**Figure 1. Research model to explain variation in energy consumption.**



The blue circles contain what I in a sociological analysis will use as control variables. At first it is the building characteristics such as dwelling type, ownership, size and so forth. Degree days are important to correct for heating degree-days, because it has an effect on the need for heating a dwelling. This is also used by Guerra-Santin and Itard (2010). The last group of control variables is geography, which has a diverse meaning. It can thus both express differences in lifestyle, differences in energy price level or maybe even differences in climate. Further analysis will show how geography can be used.

The red circles are the explanatory variables. The first group of variables are household demographics, by which I mean household composition according to age, ethnicity, gender and civil status. Many of these factors do not change during a life-time, whereas the next group containing variables on household resources can change every year, as for instance yearly income. These variables state the options that the household has. At last, I have put in a group named housing characteristics, which is information such as how long they have lived in the dwelling, and maybe what kind of dwelling they have lived in before.

The variables can easily explain the same variance. For example; years of living in the same dwelling will probably be correlated with age and income will probably be correlated with education to name some examples.

There will be two results from this analysis; one, which household characteristics have a significant relation to energy consumption level? And two, how much of the variance in residential energy consumption do the household characteristics explain all together?

## **What does a quantitative sociological perspective bring to research on energy consumption?**

Overall, I think quantitative sociological research on energy consumption holds great promise. First, quantitative research can provide generalizable results that are representative for all households in Denmark, and thereby enhancing the utility of the results. Second, quantitative research provides the possibility of posing additional research questions. Whereas qualitative research questions addresses questions about how users implement specific practices and what users think about the practices they carry out in their everyday life, a quantitative research design can, for example, address questions about the specific individuals who carry out certain practices. As a further step, quantitative research can contribute to understanding what drives occupants to consume specific amounts of energy (less or more) and to understand the underlying structures that influence energy consumption patterns. Third, over the course of extended research, it would be possible to use quantitative research methodology and quantitative data to investigate changes in energy consumption for different types of households over specific periods of elapsed time. In the course of such research, it would be possible to do analysis on how residential energy demand evolves in relation to societal changes such as state of the market, energy discourses, technological improvements or/and specific energy policies.

Overall, more quantitative sociological research could both strengthen and validate the evidence on the field of energy consumption research. Moreover, quantitative research would bring more focus on patterns, social structures and live-styles as explanations for residential and individual energy consumption. These are all essential components in the academic study of human action and behaviour and are useful in the global analysis of energy consumption.

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