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Review Article

Energy use research in social sciences – introduction to a research topic

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Abstract: Energy use is surely among the most studied topic, factors influencing households' energy use and social determinants, the social context is energy use is obviously cannot be less interesting research topic. Despite it a recently conducted systematic literature review shows that while certain aspects are highly studied, like attitudes toward energy use and energy poverty, other perspectives of the topic are under-studied. The following paper gives a systematic review about the state of the art and offers further researches to fill the gap.

Keywords: energy use, social inequalities, climate change, attitudes, energy poverty

1. Introduction

In our paper we analyse the scientific perception of energy use in social sciences. To understand the issue in details, we conducted a systematic literature review [1]. As we will show in the following the literature on energy use is booming, despite it, the scientific literature focusing on energy use is less developed.

Although there is a proliferation in the prevalence of scientific articles in the last decades, the literature on energy use is less rich. If we focus on the articles discussing social aspects of energy use we can also see that the number of papers is continuously growing. But this growth is focusing on attitudes toward energy use and on energy poverty. In the following we systematically review the literature and also papers of the present Special Issue.

We conducted a systematic literature review on Web of Science using the five most important key words of our call for papers to sketch the context of the Special Issue on Factors Influencing Households' Energy Consumption.

The paper presents the result of the systematic literature review, then the main findings of the research papers on factors influencing households energy consumption, then shows some promising research directions.

3. Materials and Methods

The systematic literature review originates from the health and medical sciences, but now it is used in almost all other disciplines as well. In our analysis we conducted a scoping review [1] to understand how the defined terms appear in the scientific literature. The basis of the methods is to pre-define the selection criteria of the analysed papers [2].

In our analysis we defined the time-frame of the search and also the key-words based on the main topics of our paper: We involve the five most interesting key words of the special issue: energy use, households, energy poverty, attitudes and climate change to keep the focus of the paper. Using the systematic literature review our results are transparent and reproducible [3].

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In our review we used the database of the Web of Science between 4th of November and 15th of November 2022. We analysed a thirty year long period between 1991-2022 using the key words: "energy use". Then to focus on the sub-themes of the special issue we added the following key words: "energy use" AND "household", "energy use" AND "climate change", "energy consumption" AND "attitudes", "energy use" AND "energy poverty", "energy use" AND "social". We searched the terms among the title, abstract, author keywords, and Keywords Plus.

4. Results

After the first analysis we changed energy use to energy consumption in the search on "energy use" AND attitudes. In the following we will argue that the literature prefers the earlier expression. We decided to simplify the expression "social stratification", "social differences", social inequality*" because these expression resulted only very few results. We decided to split the term into a simple social and into energy poverty expression to assess the role of social factors in earlier researches on energy use. The results of the first search are presented in table 1.

Table 1. The prevalence of the terms is highly different (%).

		Three main web of science categories			
search term	**Number of publications containing the expressions**	**Environmental Sciences**	**Energy fuels**	**Environmental Studies**	**Social sciences**
"energy use" AND "climate change"	2267	37,19%	29,69%	19,98%	1,32%
"energy use" AND social	1288	31,75%	30,05%	28,49%	3,18%
"energy consumption" AND "attitudes"	342	18,71%	17,25%	15,50%	1,17%
"energy use" AND "household"	1475	33,29%	41,36%	30,44%	1,63%
"energy use" AND "energy poverty"	76	32,89%	55,26%	35,53%	1,32%

Source: own compilation based on the data from the Web of Science.

According to our table we found the most articles on energy use and climate change and the least on energy use and energy poverty. Looking at the disciplinary background of the articles it is clear that most of the papers were published in the field of environmental sciences, except for the energy use AND household search it is the most common category, and in each case almost, except for energy use AND attitudes it contains one third of the articles. We can also see from the table above, that the social aspects of energy use is an under examined topic, although we used search expressions with social relevance, like poverty, household, attitudes the search results never accede 4%. Our original aim was to explore the existing knowledge on social inequalities and energy use, but based on the systematic literature review we broadened our focus and decided to analyse the articles discussing social aspects of the above themes.

Our aim was to review the literature on social aspects of energy use in a broad term, thus we had to reduce our analysis to articles which contain the search topic "social". In the following we present the main results of the systematic literature review. The articles for the search "energy use" and social discuss the topic in very broad terms (for example: Taylor et al 2018, Abrahamse 2011, Darby 2006 [4–6]) covering a lot of different topics

from social psychology, social learning to factors influencing energy use and behavioural changes inducing a reduced energy use.

4.1. Energy use & energy poverty (originally: social stratification)

As we mentioned the search on energy use and social stratification resulted two papers [7,8]. Yang et al analysis in general the interconnections of social and environmental inequalities. Lutzenhiser-Hackett[7] analyse the effects of carbon taxes on energy prices and on energy use of the different social strata. Energy use and social inequalities resulted one paper [9]. The policy analysis states that social inequalities influence also inequalities of energy use, and without clear policies it will not change in Brazil. To have a deeper knowledge about the existing scientific knowledge on social inequalities and energy use, we decided to expand our research, and present also the results of the search on "energy use" and "energy poverty". As Table 1 shows, there are 76 articles on the Web of Science with a title, an abstract, or keywords containing both expressions. We overviewed the abstract of these articles and found that there are three main types: articles seeking for a definition of energy poverty, articles analysing the factors influencing energy poverty and articles revealing the connection between policies, energy use and energy poverty.

The bunch of articles still struggling with the definition of energy poverty (for example: Thomson et al 2017 [10]). Conceptualizing energy use and energy poverty using a capabilities framework; The energy austerity pitfall: Linking hidden energy poverty with self-restriction in household use in Austria) at the same time usually give a critique of the existing definitions, or highlight the controversies of certain definitions. Thomson et al reviews the different definitions and states that the consensual approach became widespread instead of the expenditure approach. The consensual approach asks whether someone is able "to afford items that the majority of the general public considered to be basic necessities of life" [11]. Despite it the authors [10] argue to use the so called direct approach, which "attempts to measure if sufficient levels of energy services are being achieved in the home, such as heating and lighting" [10]. They state that this method has never been used in Europe till then.

Analysing the factors influencing energy poverty and energy use in relation to energy poverty mainly focus on an exact country (for example: [12]). The articles analysing the effects of energy policy [13] argue that energy poverty can be reduced by better policies, which means a better energy mix and an energy production which considers regional differences.

4.2. Household energy use

As Table 1 shows there were 1475 results on household AND "energy use". We refined them to 20 by selecting the "soci*" category. and reviewed the abstracts of these 20 articles. These articles overview the factors influencing household energy use. Not only the socio-demographic, but also the psychological variables (for example Abrahamse & Steg [5,14]). Based on a survey analysis they found that household energy use is in strong connection with socio-demographic variables alongside with attitudinal variables and self-transcendence values. They also analysed the attitudes toward energy use and found that those are in positive interconnection with perceived behavioural control and attitudes toward energy conservation[5,14,15].

Verachtert [16] analysed ESS data from 2018 to reveal the factors influencing household energy use and found that gender, income and education has the highest effect on energy related behaviour, but also some attitudes can be important, like climate change concern, responsibility and awareness. At country level GDP and unemployment rate a low but existing effect.

4.3. Energy use and attitudes

From the above presented literature it is already clear that the research into the attitudes toward energy use are in the focus on social sciences interested in energy research. We analysed the 342 articles found for the search topic "energy use" and attitudes in the domain of social sciences. As we presented earlier Verachter [16] in her analysis of ESS data found that climate change attitudes play a crucial role in energy use behaviour. Steg and her co-author [17] also found that socio-demographic variables: income, household size, age influences households energy use, but argue that also attitudinal variables and self-transcendence values have an effect. They found that these latter are generally influence intentions to reduce household energy use. According to the theory of planned behaviour the best proxy for a behavioural change is the intention to preform it; that is the reason why so many authors decided to analyse attitudes toward energy use and environment and the value set of the respondents. Although value sets are influential, the final results of the multi-variate analysis is that finally still socio-demographic variables influence the most energy use at the household level.

4.4. Energy use & climate change

"Energy use" AND "Climate change" resulted more than 2200 results, but focusing the our search only on the social sciences the number of articles reduces to 30. Reviewing these articles we see that most of them focuses on tourism related travel, more precisely on attitudes toward travelling and actors influencing long-distance travel preferences and realized travels. A study from New-Zeeland proofs that international and domestic travels contribute to two thirds of the energy use of an average trip [18], thus by altering travel styles consumers can substantially reduce their energy foot print.

Another group of studies analyse the perspective of energy use at a micro or a macro level: Adua et al [19] argues, using U.S. national data that household characteristics (called political economy) and biophysical peculiarities (human ecology) influence household energy use, while technologies (ecological modernization) has a less impact on it.

York's study [20] is more straightforward arguing that there is no "free lunch", despite all efforts CO2 emissions are increasing, and all energy resources has an effect on CO2 emissions; without a radical change there is no possibility of reducing emissions. He also points out that the population growth also make it difficult to expect radical changes.

Some papers [21] compared energy use behaviour and attitudes of German and U.S. students. The found that in general German students act more environmental friendly. According to the authors it is linked to the biospheric environmental concerns of the German students and the more likely egoistic environmental concerns of the U.S. students. German students also more likely to think that ethical considerations to reduce energy use are important and accept that personal costs of energy reduction behaviours are important. „An assessment of cost–benefit considerations played less of a role in indirect than direct energy reduction behaviours." – as the authors argue".

Another set of papers analyse how policies can contribute to CO2 emissions; the results are contradictory. While some studies argue that those can also have effects, like Reksten's paper on companies voluntary climate reduction[22,23], others argue that policies are less effective.

After reviewing the literature on social determinants of energy use we found that the scientific evidence is growing it is still not a huge literature. Although the 8th round of the ESS collected [24] Europe wide data on climate change perception and linked to it also on energy use, there are still few studies about social determinants of energy use. After presenting the main points of the literature on the topic of the Special issue we review the most important papers dealing with similar topics as the authors of the special issue.

5. Discussion

The special issue reflects the versatility of household energy consumption research. The research published here focus on internal and external barriers to energy efficiency [25], the context between social differences in energy use, access, and consumer behaviour, and the acceptance of management services and technical innovations.

A constant theme of works with a sociological approach is the correlation between social inequalities and the way and amount of energy consumption. A general finding of the international literature is that the behaviour patterns of energy consumers are related to the socio-demographic characteristics of the households [26]. However, much less research has been done on whether consumer behaviour is more strongly influenced by the characteristics of the apartment or house or the differences in the socio-demographic composition of consumer households. Győri et al (in this special issue) [27] analyse Hungarian household energy consumption between 2006 and 2017 on a representative probability sample from 2006, 2012 and 2017. They used the "latent profile analysis" method (LPA) to find groups of households according to energy use the changes in their composition between the given time periods. They found 6 household groups according to the combinations and intensity of the use of energy sources. The characteristics of houses and apartments have the strongest influence on different energy consumption behaviours, however, the social differences measured by the social and demographic characteristics of the owners and users of residential buildings are also reflected in the ways of energy use. The size, equipment and physical properties of the residential buildings and apartment s determine the possibilities of energy use, but the housing property and availability of housing are socially distributed. As the Hungarian example shows, consumers with the lowest status (less than high school diploma, lower income, backward regions), who live in older, technically poorly equipped buildings, primarily in villages and use conventional fuel (coal and wood) and propane gas, while the high gas and electricity users with income and education typically live in apartments with a larger floor area in privileged districts of the cities. The degree of energy vulnerability follows the hierarchy of society accordingly, but authors also warn that the connection of energy consumer behaviour patterns to the socio-demographic characteristics of households does not necessarily follow a linear relationship.

To understand the very complex motivation of residential energy use, researches identify many components. According to Mills-Sleich [28], knowing the accessibility of knowledge forms is definitely an essential element of understanding which is closely related to the ability to recognize the chance of return and rationalization of the necessary investments of the population [29]. The values, patterns that can be followed [30–32], the behaviour of reference groups and friends [14] can all affect consumer habits [33]. Mapping the impact of social inequalities in the dimensions of energy use and access requires further complex and international research, which can deepen our knowledge of external and internal barriers of households' energy efficiency.

Park and Jeong's paper (in this special issue) [34] contributes to the research of social inequalities affecting energy consumption by analysing a special dimension. Their theoretical innovation is that, compared to previous research, in the investigation of what factors influence the use of the Internet of things (IoT) in the services of the home energy management (HEM) system, as they separate the concepts of passive and active acceptance. Passive acceptance refers to simple personal use of the technology, while active acceptance means that the consumer who personally uses technology also encourages others to use the technology system. According to the results of a series of empirical studies conducted on Korean data, three important conclusions were reached. This study identifies consumer perceptions, propensities, and demographic characteristics that influence the active and passive acceptance of HEMS with IoT. The majority of consumers assessed that the use of HEMS and IoT could improve home energy efficiency and this belief was essential in increasing active adoption. Older people proved

to be more open to accept and use of new technologies. The correlation between gender and passive acceptance is not relevant, but higher active acceptance was statistically significant among women.

Csizmady et al (this special issue) [35] presents the questions and indicators of measuring energy poverty, the most serious social factor related to residential energy use. Guided by theoretical considerations, they argue that going beyond the conventional classification of households as energy poor and non-energy poor, it is worthwhile to introduce the transitory category in terms of household energy vulnerability as well. Their empirical analysis found statistically relevant differences between the three household categories using a Hungarian database. Their well-founded recommendation is that it is necessary to extend sustainability policies to encourage and support transitory households, which are not in a much better financial position than energy poor households, but are much more sensitive to the environment, climate change and pollution.

A paper presents research on the energy choices for cooking and lighting of rural households in Pakistan (Ahmar et all - in this special issue [36]). The significance of the multivariate empirical analysis is given by the fact that there are many households in developing countries that do not have access to electricity and therefore use traditional energy sources for cooking and lighting. Since clean energy is unaffordable or inaccessible for technical reasons (lack of mains electricity or gas) for hundreds of millions, they are forced to use energy sources that burden the environment and air. The high proportion of the rural population and the intensively growing investments of the governments of developing countries in the development of the electricity network give special emphasis to the understanding of household decisions related to the use of energy sources. The research uses the recognition of the relevant literature that it is advisable to include a multitude of possible variables in the analysis, and not only the various socio-economic, demographic and infrastructural characteristics, but also, for example, the role of women, or the geographical distance of available clean energy utility lines.

The results show that the energy used for cooking is obtained from traditional fuels, primarily firewood, followed by agricultural residues and biomass pellets. The energy choices for lighting are equally divided between clean (ie grid-connected electricity and solar systems) and traditional (kerosene oil) sources. Female heads of households, access to credit facilities, higher education, and a higher number of school-age children make it more likely to choose clean energy sources. In contrast, the distance from the market/road, the larger size of the household and the older age of the household head have a negative effect on the use of clean energy sources. Henzel et al (in this special issue) [37] present the advantages of forecasting the energy consumption and the elimination of possible measurement errors.

5. Concluding remarks and further research

Our systematic literature review shows that although there is a huge literature on energy use, still the social factors, especially social inequality, social integration and social stratification are an under researched field. The papers of this special issue partially fill this gap.

In summary, we can quote the results of the study by Kim and Park [34], who provide an overview and statistical analysis of the studies on household energy use published between 2011 and 2020 in this special issue. In the given time interval, the microgrid system, smart-home, energy digitization, solar energy production systems, household batteries, energy measurement and forecasting, energy breakdown, renewable energy supply are the intensively researched topics. Analyses related to household energy consumption focused the advantages of new technologies, smart-homes, clean renewable energy technologies in the household sector, carbon neutral policies, improving energy well-being and quality of life, energy efficiency and carbon neutrality and related energy

policies. The studies of the special issue emphasized the social, demographic and value factors of residential energy use through their new results and reinforced the need for a multidimensional study of the factors affecting the adoption and acceptance of new techniques. Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions could highlight the social differences linked in the differences of energy use.

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