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Enhancing informational strategies for supporting residential electricity saving: Identifying potential and household characteristics in Germany

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ABSTRACT

In the domain of electricity saving in households, a multitude of informational offers is readily available. However, these are commonly either not very well tailored to the actual living situation of consumers, i.e. do not take into account which tips are in particular relevant for a household or require consumers to answer multiple, detailed and therefore time-consuming questions. Hence, a method for tailoring information to groups of households by analysing the structure of electricity saving potentials was tested in a large sample in Germany. Here, substantial saving potentials were found. Utilising the assessed relevance of different electricity saving behaviours for each household, the sample was clustered into five groups: (1) family households, (2) pensioner households, (3) high-saving-potential households, (4) low-income households, (5) higher-educated households. Short lists containing the most suitable tips for each group were compiled. These had substantially more favourable properties than other lists, compiled by only utilising a single criterion. To allow for easy allocation of households to the different groups, an algorithm incorporating few questions was conceived by employing a discriminant analysis.

1. Introduction

In Europe almost a third of electricity consumption is attributed to the residential sector [1,2]. Whilst the consumption of electricity in such industrialized nations' households allows for a high standard of living, the production of electricity is often linked to various environmental problems with far reaching impacts. Nuclear waste, for example, affects several generations, and CO_2-emissions not only directly affect local residents, but also have worldwide indirect effects by fostering climate change [3]. Recent analyses [4,5] have shown that there is potential for substantial electricity savings in the residential sector of several European countries. Therefore, supporting the tapping of these potentials seems worthwhile to mitigate the aforementioned problems associated with electricity generation and consumption [6]. In addition, problems concerning the affordability of electricity in low income households [7] could be addressed by enhancing residents' options to reduce their power consumption.

Informational strategies are a central aspect of endeavours to foster saving electricity in households [8–10]. One major advantage of such strategies is that they are an inexpensive way to reach a great number of consumers and communicate which electricity saving actions can be taken. However, researchers in the field of social science commonly agree that these informational strategies often are not as successful as would be preferable and thus still require improvement [6,10,11]. One persisting problem is that informational offers, in many cases, do not sufficiently take into account the needs of different groups of customers [10,12]. Although insights into effective informational strategies for different customer groups have been gained [11], further social science research concerning the assessment and adequate consideration of such needs is required.

In this article a method for enhancing informational strategies to foster electricity saving in households is presented. This method incorporates both the technical aspects of electricity saving, i.e. the assessment of saving potentials in households, and the psychological aspects, i.e. the perceived and inferred difficulties, or preferences for, specific behavioural options (see [11]). The method involves selecting specific electricity saving advice according to a household's characteristics and determining groups of households, which share these characteristics. This method was tested in field study in a major city in Germany, the country with the highest electricity production in the EU [13]. As electricity in Germany is mainly generated by the use of fossil fuels (43.2% coal and 9.5%

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nuclear power [14]), gaining insights how a reduction of such consumption might be achieved is all the more critical. Germany's residential electricity consumption is also among the highest in the European Union (EU) [1] and a comprehensive assessment of the EU-residents' electricity usage has revealed that saving potentials in Germany are highest [5].

1.1. Potential, impact and types of electricity saving behaviour

Different conceptions of saving potential exist—each based on certain assumptions about how the potential is calculated. Thus, when analysing the structure of a saving potential, one first has to specify which conception is being implemented. In particular, it is important to specify which constraints are considered and which level of aggregation of actors and behaviours is regarded.

At the most liberal level, the 'physical' [15], or 'theoretical potential' [16], considers the highest feasible levels of efficiency, even if there are no indications how these levels of efficiency can be technically utilised. As such liberal conceptualisations are of limited practical use, more often the 'technological' or 'technical potential' [5,15,16] is reported. The technical potential usually considers the best currently available technology and innovations that are about to (or most likely to) become broadly implemented in the near future. However, the technical potential is commonly further reduced by economic and social constrains. The 'economic potential', therefore, takes into account which measures are economically viable, considering the entire lifespan of new products or technology and comparing these with existing options. Finally, the 'socioeconomic' [15], 'achievable' [5] or 'expected potential' [16] explicitly considers individual and social barriers that prevent actors from adopting new behaviours. This last concept is often considered as the proportion of the economic potential that can be tapped within a certain period of time by utilising political instruments and measures for disseminating new technologies [5,16].[1]

Concerned with the analysis of how the adoption of new behaviours can be supported, concepts concerning potentials have also been adapted in the social sciences. The concept of impact proposed by Dietz et al. [17] (see also [18]) focuses on the actual saving potential for a specific behaviour in a specific population and thus resembles the 'socioeconomic', 'achievable' or 'expected' potential. Stern [18] illustrates this concept with the formula $I = t \times p \times n$. This formula considers the total number of actors (n) in a certain population that could implement a certain electricity saving behaviour, regardless of its economic feasibility or other barriers to behaviour change. The technical potential (t) is conceptualized as the amount of electricity that can be saved in a certain period of time by each actor in this population on average by adopting this specific behaviour. The plasticity (p) is the parameter that incorporates a thorough behavioural perspective. This plasticity-parameter indicates the percentage of actors that so far have not implemented the behaviour of interest, but could be induced to do so when targeted with the most effective set of measures for this specific behavioural change. The impact (I) is then calculated as the product of technical potential and proportion of actors that are likely to implement a certain behaviour given the most favourable set of measures. The plasticity-parameter not only recognizes the need to consider specific measures (or sets thereof) for different behaviours (cfr. [17]) but can thus also be used to incorporate the (perceived) economic viability of the behaviour considered and other barriers.

A further differentiation that is relevant to the assessment of saving potential or impact is the type of electricity saving behaviour. Gardner and Stern [19,20] differentiate between so called efficiency and curtailment behaviour. Whilst curtailment behaviour refers to saving electricity by using equipment less often or less intensely, efficiency behaviours encompass all instances, where the equipment is used to the same extent, but less electricity is used due to changes of the context. This usually implies investing in more efficient appliances, but efficiency also incorporates maintenance behaviour to ensure equipment is working as efficient as possible. Also implied by Gardner and Stern [20], electricity saving behaviours can also be categorized according to the frequency with which they have to be carried out. This frequency based differentiation is often more relevant for the conception of interventions, as one-time behaviours tend to pose more complex decisions, while continuous behaviours often need to take into account habitual behaviour. A similar structure of behaviour types was also found in a study conducted by Barr et al. [21]. Here, a wider range of conservation activities was empirically separated into habitual behaviour and purchase decisions. Also, the technical potential of individual behaviours can differ substantially, with one-time behaviours commonly yielding higher savings than continuous behaviours [20]. Since the technical potential of any specific behaviour depends on the exact model of appliance and the way this is used, in order to calculate the precise potential or impact, those parameters would have to be assessed for each individual actor. As this procedure is usually only practicable for very small populations, commonly only estimated averaged potentials for a group of actors are considered.

1.2. Motivation for and barriers to saving electricity in households

Consumers in various countries differ in respect to their knowledge, efforts and motivation concerning saving electricity [22]. However, as saving electricity is a viable course of action for different reasons, especially protecting the environment and reducing expenses [10], in general a motivation to implement such behaviour seems to exist [22,10]. For example, in Germany more than half (57%) of households indicate that they have recently engaged in various activities to reduce their respective electricity consumption [23]. In another study [24], 85% of German households indicated that they try to keep the amount of water and electricity used low. This is supported by the fact that although the number of appliances in each household, especially concerning information and communication technology (ICT), has gone up [25,26], total electricity consumption, as well as number of residents in Germany has remained fairly stable in the last few years [26–28]. Also, the number of households with the highest average electricity consumption per person, i.e. those with one or two residents [25] has increased. However, studies also show that the willingness to engage in saving behaviour, i.e. purchasing energy efficient appliances and turning off lights and appliances currently not in use, has decreased in the last years [24]. Therefore, reductions in electricity consumption are likely mainly due to more efficient appliances disseminating into households' stock as old, inefficient appliances are gradually replaced when they cease functioning properly.

It essentially remains unclear, which barriers prevent consumers from engaging in more effective electricity saving behaviour despite the evidence for an existing motivation to do so. One feasible explanation is, that consumers do not know, which behaviours should especially be implemented to effectively save electricity [10,20]. Although provision of information by itself has proven to be of limited effectiveness ([9]; see also [18]), knowledge about possible behavioural alternatives is a necessary prerequisite for actively saving electricity [10]. Also, since limited financial resources are often regarded as one major obstacle [11], informational offers can help select behaviours that can be implemented

[1] Concerning the mitigation of greenhouse gas emissions, the Intergovernmental Panel on Climate Change [15] considers socioeconomic and economic constrains and thus the order of targets of interventions in a reversed order, i.e. poses to first tackle economical and then social barriers.