Designing effective and acceptable energy policies for a low carbon heating consumption

Elena López[a], Ibon Galarraga[a,b] and Sébastien Foudi[a]

[a]Basque Centre for Climate Change (BC3), 48940 Leioa, Spain
[b]Economics for Energy, Doutor Cadaval 2, 3E, 36202 Vigo, Spain

Email addresses: elena.lopez@bc3research.org (E. López); sebastien.foudi@bc3research.org (S. Foudi); ibon.galarraga@bc3research.org (I. Galarraga);

Abstract

The residential building sector is a major driver of current and future energy consumption and associated CO2 emissions. The main use of energy by households is for heating their homes. Consumers' heating behaviour results from the interactions of internal and external drivers which make it a complex system. We used Fuzzy Cognitive Mapping (FCM) to represent key drivers and interactions of this system. Maps were collected in a series of focus group representing different social groups - citizens, academics and energy experts – in order to capture the heterogeneity of behaviours. Maps aimed at identifying, drawing and the factors influencing heating costs as well as private and public adaptation measures to minimise this cost. All the focus groups considered that economic variables such as energy prices and income of households determined the heating bill. Other factors mentioned were lifestyle factors or education in energy saving behaviour. The most significant differences between the groups were that, academics and expert groups considered that taxes could improve energy savings. This study can be helpful for the design of effective policies on heating consumption.

Keywords: consumer behaviour, fuzzy cognitive mapping, energy savings, energy policies.

1. Introduction

Understanding behavioural aspects of energy use and energy saving complement technological approaches. Socolow (1978) showed that the energy consumption of dwelling depended not only on the physical features of the buildings, but also on the occupants' behaviour. Indeed, large differences in energy consumption for similar buildings have been observed due to the occupants' behaviour (Guerra-Santin and Itard, 2010; Terés-Zubiaga et al., 2018). Even, consumer's behaviour could have more importance in energy consumption than the building characteristics or other factors (IEA, 2013). The total reduction in residential energy consumption is therefore a result of the interplay of technological change and household's behaviour (Blasch et al., 2017).

2. Methodology

In this paper, we obtain cognitive maps using Fuzzy Cognitive Mapping (FCM) methodology. It is a participatory semi-quantitative method (Jetter and Kok, 2014; Kosko, 1986; Olazabal et al., 2018a; Özesmi and Özesmi, 2004). It comprises of concepts representing key drivers of a system, joined by directional edges or connections representing causal relationships between concepts (Kok, 2009). It allows the possibility of identify unexpected effects (Olazabal et al., 2018a). To reflect the strength of these causal links, weights are assigned to the arrows (Jetter and Kok, 2014). It allows a quantitative analysis of the relationships identified to aid decision making (Jetter and Kok, 2014; Olazabal et al., 2018a). Moreover, FCMs allows the integration of views from different participants and construction of a belief system, in our case in heating behaviour, that can then be used to analyse scenarios (Olazabal et al., 2018b).

3. Results

We captured knowledge and experiences from households, academics and experts in causal diagrams. All of them consider that economic variables such as energy price and income of households influence the amount of heating bill. Infrastructure variables, such as number of rooms, insulation or orientation of houses are also

important. Other factors mentioned were lifestyle factors, such as turn on the heating system at night or if graduate the temperature. Education in energy savings is another important factor to reduce the heating bill.

The complexity of the maps, reflected here with the number of concepts and connections, can vary with professional background (Olazabal et al., 2018a). Our study seems to confirm this. The number of concepts provided by academics and energy experts is higher than concepts and connections provided by citizens. Citizens maps have higher density; they see a large number of causal relationships among the variables. We observe that participants tend to provide more positive than negative relations, 64% of connections in all FGs are positive.

4. Conclusions

The most significant differences between the groups were taxes and energy poverty. Academics considered that taxes could be used to reduce energy poverty, while citizens group think that subsidies may provide energy poverty alleviation, in line with different quantitative and qualitative studies mentioned before. Moreover, citizens group incorporated in the discussion people with economic difficulties to pay their energy bill and the issue of energy poverty was recurrently brought to the discussion. Note also that citizens group expressed a strong preference for having policies that could help them to understand the energy bill. It could be effective to reduce the bill by promoting more careful or sustainable use of the heating system. Another important difference is that energy experts mentioned taxes to achieve more sustainable heating behaviour and energy efficiency of heating systems.

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