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Identification of key parameters determining Danish homeowners' willingness and motivation for energy renovations

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Abstract

In Denmark, around Europe and in the rest of the world there is a challenge of motivating homeowners to conduct private energy renovations despite a number of benefits. A particular great energy saving potential is present in the Danish single-family houses erected in 1960–1979, but the potential is not utilized for various reasons. However, survey results show that improvements in comfort, indoor environment and architecture combined with a reasonable project economy can motivate the average homeowner of these buildings. The objective of this paper is to further process the survey data from 883 homeowners and determine if all homeowners can be assumed as one homogeneous group in terms of motivation factors or if significant differences occur, what causes the differences and how does this affect the future motivation strategy.

The conclusion is that the homeowners cannot be assumed as one group, but must be addressed as individuals. The key parameters for determining the motivation factors are related to the homeowner's current position in life: age, presence and age of children, time of ownership, occupation and income. Most likely to be motivated to perform energy renovation is the younger generation of homeowners The older generation is hard to motivate, but results nonetheless show that it is possible with the right instruments.

Keywords: Energy renovation; Homeowners; Motivation survey; Willingness to renovate; Economy

1. Introduction

The European Union has set up targets for the size of the energy consumption and CO_2 emissions in respectively 2020 and 2050 (European Commission, 2011; Official Journal of the European Union, 2012), and all member states are in the coming years facing the huge task of reaching these goals. The 2020 objectives of the European Union are to reduce the energy consumption by 20%, reduce the greenhouse gas emissions by at least 20% compared to 1990 levels and have 20% of the energy consumption covered by renewable energy. By 2050 the goals are to reduce greenhouse gas emissions to 80–95% below 1990 levels (European Commission, 2011; Official Journal of the European Union, 2012). The energy saving potential in the building sector in both Europe and Denmark is very high and particularly in the existing building stock (Tuominen et al., 2012; Wittchen, 2009; Tommerup and Svendsen, 2006). If the building envelope of all existing

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buildings in Denmark erected between 1850 and 1998 are renovated to the level of the 2008 building regulation for new buildings a potential energy saving of 58 TJ/year is calculated (Wittchen, 2009).

The presented survey focuses on the Danish single-family houses erected in the 1960s and 1970s. This is where the highest energy saving potential is found in a housing typology, which is also economically sensible to renovate and where homeowners have a desire to live in the buildings in the future. In the approximately 440.000 buildings in question a potential energy saving of 7811 TJ/year is found purely by renovating the building envelope up to a level comparable to today's building regulations for new buildings (Building regulations 2008) (Wittchen, 2009). Furthermore the area of these buildings is 83 million m^2 thus a significant share of the total Danish building area of 343 million m^2 (Wittchen, 2009). In all single-family houses combined (erected 1850–1998) there is a total energy saving potential of 10,274 TJ/year purely by renewing and renovating the technical installations (Wittchen, 2009). All rational motives for researching how the renovation of these m^2 can be initiated in the best manner are explored.

In the 1960s and 1970s a building boom took place in Denmark and as many houses as those erected in the previous 100 years together were erected over this 20 year period (Lind and Møller, 1996). The industry of standard houses took its starting point and rapidly grew and spread across the country. At this point in Danish history, most people lived either in the city or in the countryside to be close to their work. With the sudden possibility of building a private home outside the city center, but still close enough to work there, and at a reasonable price, many families invested in a standard house and the suburbs developed. In a period of 20 years 440,000, primarily standard, single-family houses were erected and many families moved to the suburbs and the desired green areas. The Danish single-family house typology emerged. The traditional Danish single-family house is a detached house usually in a single plan, surrounded by a private garden and gathered in neighborhoods with similar buildings. The neighborhoods are known and loved for their peace and safety and for the perfect combination of privacy and solidarity among the homeowners in each little closed street (see Figs. 1 and 2).

In 2010 roughly 50% of the Danish population lived in the 1,037,091 occupied single-family houses. Of these houses 439,396 were erected between 1960 and 1979 corresponding to approximately 42% of all present single-family houses in Denmark (Statistics Denmark, BOL22). The building type is the absolute preferred type of accommodation in Denmark and is occupied by all types of family combinations.

These standard houses are due to their age in these years ready for renovation. The insulation level and materials used to build the houses was up-to-date at the time of construction, but is now outdated and the houses are in need of modernization to be futureproofed. The *U*-values of the construction parts (Fig. 3) clearly indicate why homeowners in these buildings are using a high amount of energy to heat up their house and also why many homeowners experience problems with draft and mold.

In order to utilize the energy saving potential energy savings ought to be considered and applied in the coming renovation work both to make the energy savings as cost effective as possible but also since many years will pass before these houses will need renovation again. The standardization of the houses furthermore makes them an obvious typology to start with, since many solutions can be applied to numerous identical houses without big alterations, which presumable can make the work less expensive than costume designed solutions.

> *"The rate of building renovation needs to be increased, as the existing building stock represents the single biggest potential sector for energy savings. Moreover, buildings are crucial to achieving the Union objective of reducing greenhouse gas emissions by 80-95 % by 2050 compared to 1990."*
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> [Official Journal of the European Union, 2012, p. 3]

To achieve the energy saving objectives put up by the European Union faith cannot only be put in renovating the publicly owned buildings. Since the majority of the dwelling stock in Europe is privately owned (74%) (Tuominen et al., 2012), the private homeowners too need to be motivated to renovate their houses and do so with the additional purpose of achieved considerable energy savings i.e. so called energy renovations. Various barriers have, however, prevented energy renovation of the private building stock. The most substantial barriers are related to economy (uncertainty about the savings, size of investment and lacking economic incentives) along with lacking knowledge and interest in the subject (Tuominen et al., 2012; The Danish knowledge centre for energy savings in buildings, 2009; Jensen, 2004, 2009). A previous study (Mortensen et al., 2014) has, nonetheless, shown that the average Danish homeowners of a single-family house from 1960s to 1970s can be motivated to conduct energy renovations of their homes by improvements in the quality of comfort, indoor environment and architecture. These parameters should, in order to be effective on the average homeowner, be supported by a sensible project economy (investment size vs. energy savings), since the economy is still seen as a deal breaker if not found reasonable by the homeowners.

A Danish study carried out in 1999–2001 (Almlund et al., 2002) examined the owners of single-family houses from the 1960s and 1970s. The objective of the study was to determine; Who are these people and how can they be convinced about the benefits from ecological renovation and maintenance? (Almlund et al., 2002) The project was limited to addressing renovation and maintenance of one room; kitchen, of one building part; windows and of resources flow: water (wastewater/water savings). The conclusion was that the homeowners due to their interest,

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