



Economy controls energy retrofits of Danish single-family houses. Comfort, indoor environment and architecture increase the budget



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ABSTRACT

A great energy saving potential is found in the 440,000 Danish single-family houses erected between 1960 and 1979, but the potential is not exploited. To utilize this potential, homeowners must be motivated to conduct energy saving retrofits. This paper presents results from a 2012 survey, in which 883 Danish single-family house owners completed a questionnaire about energy retrofit. The objective of this paper is, based on the survey results, to determine how Danish homeowners can be motivated to conduct energy retrofits.

The conclusion is that the financial aspect of an energy retrofit will always carry great weight for the homeowners and is often the reason why energy retrofits are not carried out. Improvements in comfort, indoor environment and architecture have nevertheless proven to be motivating for the homeowners and increasing the budget for retrofits. However, not much knowledge about the potential improvements within these parameters is found among the homeowners, and therefore, there is a vital need for more information about this. A combination of this knowledge of the non-economic improvements, a sensible investment size, and information and education about the current situation and consumption is concluded as the optimal motivation strategy for the homeowners to conduct energy retrofits.

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1. Introduction

The European Union has set up objectives for future energy savings across all sectors and countries and aims for a 20% decrease in the primary annual energy consumption by 2020. The building sector is responsible for around 40% of the total energy consumption. Therefore, there is a great need, not only to keep new erected buildings to a minimum in terms of energy consumption, but also for energy retrofit of the existing building stock if the objectives of the European Union should be realistic [1]. The current retrofit rate is much too low to attain the objectives, and some effective motivation is needed especially for the private homeowners who have to invest in the projects with private funding [2]. In Denmark, single-family houses are one of the most dominating housing types for private persons with close to 80% of all housing buildings [3], and therefore, this type is the underlying basis for the study about motivation factors for private house owners. Around 40% of the Danish single-family houses were erected between 1960 and 1979 (440,000 houses) [3]. In these and the coming years, these houses are ready for deep retrofit to different extents due to their age. Some have had renovation work done, but the majority has not been

renovated yet [4]. When these houses are retrofitted, it is crucial that energy saving initiatives are included in the processes both to future-proof the buildings and to cut down on the energy demand, but also to ensure better living conditions for the homeowners. The single-family houses built during the period mentioned total a probable saving potential of up to 7,811 Terajoule (10^{12} joules) (TJ) [5], and for this potential to be utilised the homeowners need to be motivated to incorporate energy saving initiatives in their future retrofit projects. The Danish building sector has in previous years been very focussed on, and successful in, the development of newly erected, low-energy buildings and the skills needed in this area. The sector is now facing the challenge of bringing the same skills into play in the existing buildings by retrofits. However, the homeowners need to be motivated to perform energy retrofits in order for the acquired skills to be utilised in an optimum manner and with the largest possible energy savings as a consequence.

This paper focuses on results from a survey carried out in January 2012 where 883 homeowners out of 4,000 invited completed a questionnaire about energy retrofits. The first part of the paper briefly describes the choice and design of the method and approach. The second part presents results from the questionnaire survey with attention towards the homeowners' view on energy retrofit, on important parameters in the home, and on the need and will to retrofit. A discussion about the results follows hereafter, and finally

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the paper finishes with a conclusion on how the homeowners can be motivated in the future.

The study is carried out in Denmark in the Northern Europe, but the questionnaire can nevertheless with some alterations according to country and building type be implemented in various countries facing the same issues as Denmark and among various building typologies. The majority of the questions is general questions and can be used as they are without attention to the present country and with equal relevance. The presented examples of architectural changes ought on the other hand to be adapted to the building traditions of the specific country. The questionnaire is developed with homeowners as respondents and would require some additional adjustments to be suited for a respondent group consisting of renters.

2. State of the Art

A previous literature review [6] concerning the barriers for energy retrofit deals with three different trade groups: homeowners, architects and contractors, and the different barriers and possible solutions to overcome these. This was done since it cannot be stated that the owners are the only ones to stop the process of retrofits; many other trade groups also experience barriers [7]. The studied literature have investigated and described the saving potential and barriers, and follow-up presented possible solutions to overcome these, mainly by gathering other reports and calculations, performing interviews or debates with key persons or groups and conducting a small questionnaire survey [7–12]. The literature survey concluded that the homeowner is the user group to focus on in order to change the current situation and increase the number of deep energy retrofits [6]. The barriers for the homeowners reach from economy and uncertainty about aesthetics and savings to lack of knowledge and interest, and therefore the solutions are not easily determined [7,9–12]. The authors trust nevertheless that if incentives are generated for the homeowners and they insist on deep energy retrofits, other trade groups such as architects, engineers, financial sector, politicians, manufacturers etc. will follow. It is seen as a question of supply and demand.

The survey and results presented in the present paper investigate via a questionnaire survey whether some of the proposed solutions are actual solutions to overcome the barriers faced by homeowners or if other initiatives could be more beneficial in the future. One of the main problems described in various surveys is related to the lack of interest and knowledge [7,9–12], and therefore the next step should focus on determining the knowledge level and finding potential motivation factors for the average Danish homeowner [6].

A 2012 German study [13] has examined the impact of one way of providing the homeowners information; the energy performance certificates (EPC) introduced by the European Union. EPCs were introduced by the European Union to overcome one of the barriers for energy efficient upgrading of the existing building stock: “imperfect information”. The EPC should help future homeowners and renters to incorporate energy efficiency in their decision-making process and thereby saving CO₂ due to more informed decisions. The study shows that the EPCs so far have had only little effect nonetheless it has a clear potential, but some barriers need to be removed before the full potential can be utilised. In the case of the EPC there were some issues of among others lacking trust in the information given, an economic side of the certificate which were not optimal, and the location and other house related aspects weighing more in the decision for the homeowners than energy efficiency [13]. This is an example of that although valid information is present it is not necessarily enough for the homeowners to be motivated for energy efficiency. It takes

more than just information and this survey examines what else is needed for the Danish homeowner to be motivated.

Tuominen, Klobut, Tolman, Adjei and Best-Waldhober have studied the barriers for energy retrofit in Europe and the potential if the barriers are removed [2]. The study included ten European member states. Some of the barriers found consistently for privately-owned dwellings in the ten member states are; lack of effect on property price, the consumers don't request energy efficiency, lack of (trustworthy) information, poor training and skills of the professionals and lack of appropriate, affordable financing. Different policy instruments have been utilised to overcome the barriers and among the most widespread are subsidies for energy efficient retrofits, information and tools, regulatory demands and ecological taxation. However, the profit of all the instruments is yet to show its true potential on the amount and depth of energy retrofits if the energy savings potential of 2020 and 2030 should be realistic.

“It seems that in most countries cost-effective energy savings of about 10% can be achieved by 2020 and 20% by 2030. A total annual energy saving of approx. 150TWh by 2020 and approx. 280TWh by 2030 appears possible.” [2]

That is the barriers faced are to a certain extent the same all over Europe, and the potential energy savings by retrofits are huge if the barriers can be removed. Therefore, the definition of the motivation factors for homeowners to perform deep energy retrofits are important and crucial, not only in Denmark, but all over Europe. This to utilise the potential defined and to fulfil the objectives established either by the European Union or by the respective governments in each country.

If the homeowners can be motivated to think about and include energy savings when they conduct retrofits, a big reduction in the Danish energy consumption could be made and also in other countries who are experiencing the same barriers. Previously, the Danish motivation strategy has mainly focussed on economy and payback time, but the time span has been too long for the homeowners [7,9], and therefore no action has been taken. Other parameters, which cannot be converted into money, are expected to motivate the homeowners [6,8–11]. This paper investigates whether or not homeowners will, in fact, conduct energy retrofits if they get visible and perceptible non-energy improvements or if they find energy savings in itself sufficiently motivating.

3. Method used

3.1. In general

There are different methods for use in social research, and the two main are the quantitative and the qualitative method which both contain various approaches. There is also a third method which is a combination of the two, known as mixed methods [14]. Whether one or the other method is used depends on the projects' framework conditions, resources and the data needed to fulfil the objective.

A previous study concerning the barriers for private energy retrofits of single-family houses can be followed by various different scientific methods. The main problems found were related to the lack of interest and motivation, and therefore the next step should focus on the identification of these for the average Danish homeowner [6]. The objective of the survey presented in this paper is to define the Danish homeowners' knowledge level, preferences and motivation factors for energy retrofits of approximately 440,000 privately owned single-family houses from the 1960s and 1970s. This means that the most useful result of the survey is a generalisation and a wide picture of a group of homeowners, their preferences and the factors that can be used to motivate them to

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