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Existing buildings – users, renovations and policy

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Abstract: This paper deals with the energy consumption of existing owner-occupied detached houses and the question of how they can be energy renovated. Data on the age of the Danish housing stock, and its energy consumption is presented. Research on the potential for energy reductions in the Danish housing sector is presented, and it is shown that there is a huge potential for reductions. It is a well-known problem that even if there are relevant technical means, and even if it is economically feasible, the majority of house owners do not energy renovate their homes. This paper intends to address what can be done with this problem. The paper draws on different sources of why, when, how, and why not people renovate their home. These results are then compared and discussed together with a presentation and discussion of the Danish policy measures that are put forward in order to encourage people to energy renovate their home. These policy measures include building regulations, energy tax and different types of incentives and information dissemination. The conclusion calls for new innovative policy measures to cope with the realities of energy renovations of owner-occupied houses.

Keywords: *Detached houses, Energy renovations, User practices, Energy policy.*

1. Introduction

In low-energy architecture focus is often on new buildings and their potential for reducing or eliminating energy consumption for heating purposes as is seen in zero-emission buildings and passive houses. Figure 1 shows the construction age of the Danish building stock in 2004. In the figure is seen that buildings typically have a lifetime of more than 50 years and if we envision the same level of construction activities for the next 20 years as seen for the last 10-20 years, for a very long time the majority of the Danish building stock will continue to be built before the era of low energy housing. This corresponds to British data suggesting that 70% of all homes that will exist in 2050 have already been built [1].

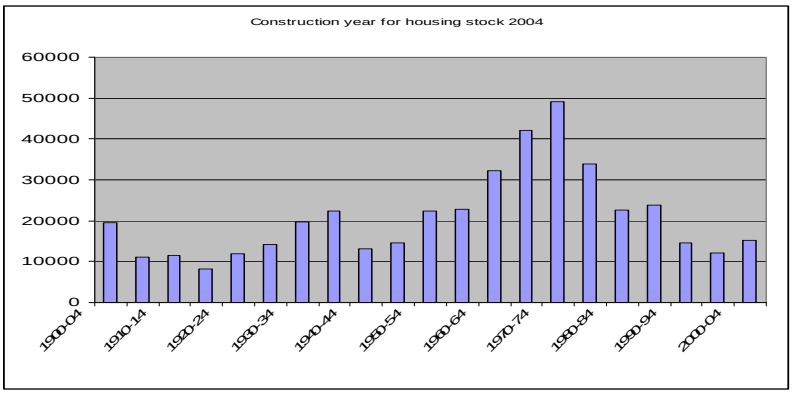

Fig. 1. The construction year of the Danish housing stock in 2004, source Statistics Denmark.

Questions have been raised whether it is better, from an environmental perspective, to demolish buildings and build new ones rather than to renovate, and a few case studies based on LCA analysis have been conducted; however, there does not seem to be agreement on the results [1], [2]. Furthermore there might be other arguments than energy and environment calling for renovating rather than demolishing, including the arguments of cultural heritage and people's personal relation to their homes.

Thus attention has to be paid to how energy reductions in existing buildings can be achieved. In 2009 the final energy consumption in households was 192,145 TJ, representing 30.4% of the total Danish energy consumption, and out of this approx. 83% was related to heating purposes in households [3]. Studies have documented the potential for energy savings if the existing building stock were proper energy renovated [4]. Here the Danish building stock is divided into five groups, including farm houses, detached houses, terraced houses, multi-storey buildings and commercial buildings. In a scenario where only energy renovations that have a payback time of less than 15-25 years are considered, the total amount of energy savings are calculated to 37 PJ, which corresponds to 23% of the annual energy used for the heating of buildings. The building type with the highest potential for energy savings is the detached house, which stands for 41% of the possible energy savings relating to energy renovation in all of the building stock. The reason for the high potential for energy savings in detached housing is a combination of the volume of this type of buildings - the majority of the Danish population lives in detached housing (the Danish housing stock consists of approx. 40% apartments, 46% single-family houses and 14% terraced houses) and these homes are typically considerably bigger compared with e.g. apartments in multi-storey buildings - and the fact that many of these houses were built in the 1960s and 1970s, or earlier, and thus before stricter energy requirements in the Danish Building Regulations came into force.

On the whole there are good arguments for having a closer look at how energy renovations of the existing housing stock, especially the detached owner-occupied housing, can be promoted. In the following, empirical investigations on why people renovate their home will be presented and compared with the policy measures that are put forward in Denmark to encourage energy renovation.

2. Methodology

Results presented in this paper have been conducted in two previously reported studies. The first study is from 2000 and focused on to what extent environment and architecture were considered when people renovated their homes [5]. This study deals with two middle class neighbourhoods from the 1960-70s and from the 1940-50s respectively and it contains a questionnaire survey and qualitative interviews with four house owners. Another study from 2005 included people who had bought a house within the last three years, and focused on what renovations they had so far carried out or planned to do, and to what extent the energy label on their home had influenced their buying of the home or the renovations they had done [6], [7]. This study included 10 qualitative interviews. All 14 interviews have been recorded, transcribed and analysed according to qualitative social science standards [8]. The survey questionnaire was mailed to approx. 350 households, approx. 50% of which responded, i.e. 170 house owners, and the answers have been analysed by the use of SPSS. The new approach in this paper is that these empirical findings are combined and analysed together with a review of Danish energy policy directed at house owners. Furthermore the majority of the empirical results have not been published in English before. As some of these data are more than 10 years old, they will be compared with more resent data on renovation, though, as will be shown, these types of data are rather scarce.

3. Results

The following will first present extracts from studies on house owners' renovation of their homes followed by a review of existing policy measures in Danish energy policy to induce energy renovations of detached single family housing.

3.1 Why, what and how households renovate their homes

According to the survey the renovations made by most of the house owners are kitchen and bathrooms, which 52% and 40% respectively of the house owners have done, whereas for example new windows or roof are only done by 32% and 22% respectively of house owners. Connection to district heating is also made by many of the house owners; however, this should be seen in light of Danish law where authorities can impose this connection. Furthermore Table 1 shows that more than one third of the households have insulated their house. Thus it is seen that renovations including the indoor aesthetics and functions are higher on the agenda than renovations which might save energy for heat consumption. Interviews with house owners supplement and support this: A new kitchen is something to dream about, make plans for and show to others. Renovation of the roof on the contrary is typically made because of necessity more than because of dreams and passion. In Figure 2 this tension is illustrated by an axis called Lifestyle vs. Wear and tear.

Table 1. Results from survey on what type of renovations the present house owners had made to their house. Results are divided between answers from the neighbourhood with houses built in 1960-70s, and in 1940-50s and show the overall percentages as well.

	1960-70s	1940-50s	Overall
Kitchen	44%	57%	52%
Bathroom	38%	41%	40%
Windows	21%	40%	32%
Extensions	30%	16%	22%
Roof	15%	27%	22%
Façade	15%	14%	14%
Patio	17%	8%	12%
Connection to district heating	48%	35%	40%
Radiators and pipes	22%	32%	28%
Insulation	34%	37%	36%
Electric installations	6%	21%	15%
Number of answering households	71	99	170

Table 2. Results from survey on the relation between how long people have resided in their house and whether they have made any renovations

How long have they lived in the house	Have not renovated	Have renovated
0-5 years	65%	35%
5-10 years	42%	58%
10-20 years	31%	69%
More than 20 years	19%	81%
Answers (numbers)	58	104

When looking at who is doing the renovations, the survey shows that in most cases the house owners do some or the majority of the renovations themselves and only in a minority of the houses are renovations made solely by craftsmen. Craftsmen might be involved in the DIY (Do-It-Yourself) renovations as well, because the house owners, or their friends or family helping them, are craftsmen as we heard in several interviews. Furthermore the survey shows that the longer people have lived in their house, the higher the possibility that they have done any renovations (see Table 2). This breaks with a myth indicating that when people buy a house, they renovate it before they move in. On the contrary, renovations are typically something that is done continuously during all the years people live in the house. Also from interviews we know that house owners often have a sort of imaginary list of renovations they

could do or would like to do, but as there is not always time, money or other resources, and as it is not always funny to live in a house that is being renovated, some renovations are postponed and others are carried out. From the interviews, however, we also know that for some families the renovations are not only a dull duty, it might be a creative task, which people appreciate. For several house owners it might even be part of the reason why they have bought a house that they wanted a house to work on and build and that renovating the house is an integrated part of living in it. This tension on the one hand between seeing renovations as something that is interesting in itself because of the process and on the other hand wanting to renovate the house primarily, because one is interested in the result of the renovation is shown in Figure 2, as the axis Process vs. Project.

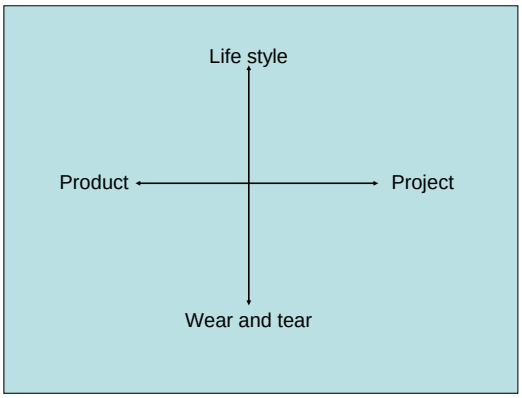

Fig. 2. Reasons for renovating. The figure distinguishes between whether house owners are primarily interested in doing the actual renovating (project) or in the result of (product) the renovation, or whether the renovation is primarily done because of necessity due to wear and tear or because house owners like to have something new (lifestyle). Different house owners, as well as different types of renovations, will be placed differently in the figure.

Different types of renovations thus might have to be interpreted in different terms. Some renovations are done because of aesthetics and dreams of having what friends or family have or what can be seen in catalogues. These renovations might best be understood within understandings of lifestyle, status and consumer choice [9]. This is often the case with kitchens and bathrooms that are renovated without it actually being necessary from a more functional perspective. Outdoor renovations like roofs and windows are more often done as maintenance resulting from wear and tear, though in some of the interviews there are also examples of this being done primarily because of aesthetics. In some families, an important aspect of why people renovate their house is that they actually like to work physically on their house, they enjoy the project and the process. This may include light maintenance like painting walls or it might include completely new construction work like building extensions etc. During these DIY projects people often feel that by working on their own house they get more attached to their home and feel that the house becomes more of a home, as compared with just buying a new and maintenance-free house. In other families, maintenance and renovation are, however, primarily seen as a dull duty that they would rather be without. When understanding this, it is important to see renovation as a part of the specific everyday life of every different family. For example, in some families and at some times living in a house being renovated is a big problem and at other times and families it is easily part of the everyday life. As an example, one of the interviewed families had just had quadruplets, and could thus envision not having any time at all for renovating for the next many years to come. Under other circumstances this family might have liked to renovate their house themselves, however, they had decided to have new windows installed by craftsmen before they moved in.

There might be different types of energy-related issues connected with the renovations. Renewing the windows or the roof most often also include improving the energy efficiency of the house, and renovating the kitchen might include buying new and more efficient technologies. However, in most of these cases energy concern is not part of the main reason for doing the renovation, even though the renovation includes improved energy efficiency. It is just something following from other wishes and dreams. On the other hand some renovations might also include higher levels of comfort, e.g. more heated square meters, a higher indoor temperature or bathrooms with spa, and thus involve increasing energy consumption.

As some of this empirical material is up to 10 years old, it is relevant to compare it with more recent results and with international results. A study comparing the residential building stock in eight European countries (AT, FI, FR, DE, NL, SE, CH, UK) observes that there is not any statistics on the renovation of the building stock in any of the countries [10]. Instead this study uses interviews with key stakeholders to estimate size and type of renovations, and they conclude that modernisation of kitchen and bathrooms is the most common renovation activity in all the studied countries, and furthermore that most of these modernisation activities take place before the end of the components' service life is reached. A recent German study based on a survey of 1000 households [11] and 44 qualitative interviews [12] gives a more solid base for comparison. In the qualitative studies as well as in the survey, it is found that the everyday life situation of the house owners is important for the decision to renovate, and that the reasons for renovating are diverse and include other arguments than a response to an urgent need and that the economy of energy renovation is not a main argument.

3.2 Danish energy policy directed at house owners

The following will present a review of the different elements of Danish energy policy which seeks to promote energy renovation of owner-occupied detached housing [13].

3.2.1 Danish Buildings Regulations

In 1979 for the first time, the Danish Building Regulations included minimum requirements for energy consumption for new buildings. Since then, the Building Regulations have been tightened several times and since 2006 they have also included provisions on the renovation of existing buildings. Here the Building Regulations distinguishes between whether activities include more or less than 25% of the building's physical surface or economic value. If it includes more than 25%, all renovation measures stated in the energy label that are economically profitable have to be implemented. Furthermore the U-values, as required in the Building Regulations for different types of building components, have to be kept, as well as do standards for heating supply etc. If the rebuilding includes less than 25% of the existing building, only the U-values and the standards for heating supply have to be kept.

3.2.2 Energy label and energy inspection schemes

The energy label system in Denmark dates back to the 1980s and since 2006 the labelling system follows the implementation of the EU Directive 2002/91 on the Energy Performance of Buildings (EPBD), which partly builds on the ideas and early experiences in Denmark with energy labels for buildings. The label has to be issued for houses sold as well as for new buildings, and the label includes grades from A1 to G, based on the calculated energy consumption, together with the grade that could be achieved if the house was renovated according to the recommendations. Recommendations are given in an energy plan where the proposals are divided into profitable improvements and "other improvements" respectively

and include estimates of necessary investments, annual savings from improvements (in DKK and energy units) and the payback period of investments.

3.2.3 Utilities' saving obligations

Utilities have been advising their customers on energy since the beginning of the 1990s, and the legal obligation for the utilities to promote energy savings has been part of the law since 1996. According to the energy agreement from 2009, the utilities are responsible for their costumers realizing 6.1 PJ in saved energy. Utilities are free to choose their methods which typically include different types of advice, communication and economic incentives. As regards heating consumption in detached housing, it is primarily the district heating companies that have had the responsibility to promote savings; however, as will be described later, they have primarily focused on change of type of heat supply, to more efficient technologies and to gas and district heating rather than electric heating. The energy authorities require documentation from the utilities that they actually reach these targets on energy savings.

3.2.3 Economic means

There have been energy taxes in Denmark since 1977, and today they represent a considerable amount of what households pay for their energy. Compared with other European countries, Denmark is among those with the highest energy taxes in per cent of GDP [14]. The Danish authorities estimate that over the last 30 years energy taxes have resulted in a 16% reduction in energy [14]. It must be assumed that this has been realized partly through energy efficient renovation.

Economic incentives to households have to a lesser degree been part of Danish energy policy towards households. Examples include a governmental "Growth Fond" with 1.5 billion DKK (200 million euros) to get the Danish construction sector going in 2009. The fond provided subsidy for renovation and building projects in private housing including energy renovations.

3.2.4 Information dissemination

Informative initiatives have been part of the utilities' saving obligations and obviously the energy label on buildings is also an example of an informative mean. However, there are also other initiatives in Denmark that use information as a means of promoting energy savings. Besides different types of campaigns aimed at households, throughout the years the most relevant to mention is a Knowledge Centre for energy savings in buildings. The purpose of the Knowledge Centre is to collect knowledge on how to reduce energy consumption in buildings and communicate it to the professional actors in the building sector, including craftsmen. In the years 2008-2011, 10 million DKK are allocated to the centre.

4. Discussion and Conclusions

As described in paragraph 3.1, energy renovations seen from the perspective of the house owner is an integrated part of living in and continuously renovating the house. Energy renovations are typically done as an integrated part of other renovations, and considering the tear and wear of e.g. roofs or windows, however, the renovation rate has so far been too slow, as the majority of the houses still lack sufficient insulation. This is partly because these types of renovations are prioritised lower than other renovations and according to available time, money and mental surplus. Most often indoor renovations of kitchen and bathroom are higher on the priority list, than renovations related to reducing energy consumption for heating. So a

relevant question is how to make people do more renovations on their home and how to make them prioritise those related to energy savings higher.

As described in paragraph 3.2, there have been political efforts over the last thirty years to make house owners energy renovate their homes. Apart from the mandatory elements of the Danish Building Regulations, all these efforts have focused on information on rational choices related to energy and economy and on economic incentives making it more economically attractive to choose the most energy efficient when renovating. Policy measures thus indirectly assume that economic and rational decision making is decisive when house owners decide what and how to renovate. As shown in paragraph 3.1 this is, however, not necessarily the case. Economy can be decisive in the sense that the amount of money that the house owner is able to, or interested in, spending on renovations is limited, though this does not imply that house owners also make an economic calculation on payback time. Kitchens and bathrooms do not pay back in any economic meaning of the word, and they are still at the top of the priority list. If the family has decided to change windows or renew the roof, then rational economic calculations on saved energy might be decisive for the decision on the amount of insulation material or the energy quality of the windows, however, when deciding to renovate or not, or what renovation to implement, economic payback time is very seldom included as grounds for decisions.

This can be elaborated by including Figure 2, summarising the different reasons that people have for doing renovations. Thus the majority of policy efforts so far can be said to have focused on the right bottom part of the figure: renovations done because of necessity owing to *wear and tear*, and because of an interest in the result (*product)* of the renovation, and on how it can be more economically attractive to include energy in this type of renovation. However, as the text in 3.1 describes and Figure 2 illustrates, there are other, and maybe stronger, reasons why people renovate their homes. They include that the house owner wants something new and more fashionable (*lifestyle*) and that they enjoy working on the house, and in this way appropriate it and make it their home (*project*). Based on the results presented in this paper, it is relevant to raise the question of how to make policy or in other ways to promote that energy renovation is also seen as something that is done because of fashion and lifestyle or because the project in itself is interesting.

I will conclude by giving two examples of what this might include. The first example comes from a Belgian project, which includes interviews with house owners having had an energy assessment [7]. Some of the interviewees indicated that they had thought about installing PVs, and they were rather disappointed because the energy adviser advised against it based on economy. These house owners found PVs interesting more from a lifestyle perspective than from an energy-economic perspective. PVs are visible from outside, you can show them to your neighbours and you can feel good about them – like a new kitchen. Insulation in comparison has none of these qualities. However, having an energy adviser arguing against installing PVs, made the house owners change their mind. This point to the need of energy advisers to be educated in other approaches than the simple economic rational approach as well as the informative materiel also appreciating lifestyle arguments for doing energy renovations. The other example calls for more user-oriented products in energy renovation. What would happen if insulation companies put more emphasis on developing new products with an explicit emphasis on making it interesting, fun and easy to insulate your building, and at the same time give people a possibility of putting a personal stamp on their home, through these products?

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