Indoor climate perceived as improved after energy retrofitting of single-family houses

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Published in:
Proceedings Indoor Air 2014

Publication date:
2014

Document Version
Accepted author manuscript, peer reviewed version

Topic C6: Low energy buildings

INDOOR CLIMATE PERCEIVED AS IMPROVED AFTER ENERGY RETROFITTING OF SINGLE-FAMILY HOUSES

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Keywords: Energy retrofit, incentives and barriers, non-energy benefits, perceived indoor climate, occupant satisfaction

SUMMARY

The need for energy retrofitting of the Danish single-family houses is massive, especially for the high proportion of single-family houses built in the 1960s and 1970s. But even though the potential benefits are many, only few families embark on a major energy retrofit. There may be many reasons for this. An obvious one may be limited knowledge of non-energy benefits, e.g. in relation to the indoor climate. The objective of this study was to explain this limited effort to save energy by identifying barriers and incentives among house owners in relation to energy retrofitting of one's own house. Moreover, it was investigated among house owners, who had carried out energy retrofitting, whether a number of factors, including the perceived indoor climate, became better or worse after retrofitting. A questionnaire survey was carried out among 1,990 house owners in a municipality north of Copenhagen. It was found that energy consumption and indoor climate are ever more in focus when buying a house and important drivers for house owners' motivation for retrofitting their existing house. Energy retrofitting is complicated and it is also experienced as such by many house owners. There is uncertainty as regards choice of solutions, economic savings and financing. Nonetheless, most house owners, who have carried out energy retrofitting, have had a positive experience both in relation to energy consumption and perceived indoor climate, e.g. by more comfortable room temperature, less draught nuisances and less risk of mould growth. Hence a strategy to increase the number of house owners who embark on energy retrofitting of their house should include the communication of non- energy benefits like improved indoor climate. In addition, the strategy must include help for the house owners to overcome barriers by helping them find the retrofitting solutions appropriate for their house and their economy.

INTRODUCTION

The EU Directive on Energy Performance of Buildings (EPBD) requires that Member States develop policies and take measures to stimulate improvements of existing buildings' energy efficiency in order to reach today's standard of new buildings or even achieve lower energy consumption (nearly zero-energy buildings). National initiatives hold the same message. In Denmark, an energy agreement secured by broad political support approved an ambitious green transformation with a focus on energy savings throughout society and efforts, including energy efficiency improvements of buildings, to meet the target of being independent of fossil fuels by 2050 (Danish Ministry of Climate, Energy and Building, 2012).

Energy retrofitting and renovation of existing buildings is complex. This was already experienced in the wake of the energy crises in the 1970s. At that time, it was easy to save energy by insulating and tightening buildings. In practice, this often turned out to be difficult to do without a negative impact on the indoor climate, e.g. due to increased mould growth. This experience may have fostered a fear of energy retrofitting among house owners which together with an uncertain economy, make house owners hesitate to implement energy retrofitting that includes major changes of the building envelope.

In a resent literature review (Thomsen et al., 2012) on energy retrofitting of existing buildings it was identified that i.a. there is a significant need for energy retrofitting the Danish building stock, especially the high proportion of houses built in the 1960s and 1970s. Over the last ten years, many energy savings campaigns have been implemented. However, even though the benefits are many, only a few house owners embark on major energy retrofitting. Seen in this light, it may be considered whether lack of incentives are closing the way or barriers are blocking the way towards widespread energy retrofitting of single-family houses (Jensen, 2004).

The inertia among house owners can be attributed to the fact that energy savings rarely support conspicuous consumption, i.e. consumption that can be neither seen nor shown, and thus supports the accumulation of symbolic capital. Put in another way, most energy-retrofitting measures are invisible except on the energy bill (Jensen, 2005). When, at the same time, barriers like lack of interests, lack of knowledge and lack of solutions block the way for house owners to embark on energy retrofitting of their house, the picture of a standstill becomes clear. In that perspective, it was realised that incentives are crucial. The right incentives are necessary to remove the inertia of the house owners and at the same time important for breaking down barriers.

The primary motivations for implementing energy retrofitting and renovation among the group of house owners with a choice-rational-behaviour are cost saving and reasonable payback times. The primary motivations for that group of house owners with a value-belief-behaviour are CO_2 emission reduction and energy self-sufficiency. To both groups non-energy benefits (NEB) like improved indoor climate and comfort, increased property value, easy operation and appealing architecture can be important motivation factors as well (Mills and Rosenfeld, 1996).

Motivation, however, cannot stand alone. According to a classic theory on behaviour, the MOA theory, it is claimed that energy-saving behaviour requires equal amounts of Motivation, Opportunity and Ability (Ajzen and Fishbein, 1980). Motivation is so to speak the igniter of action, also when it concerns embarking on energy-saving measures. However, motivation cannot make it without the right situation of opportunity. Well-known situations of opportunity are moving to a new house, refurbishment, maintenance and building enlargement. But also a cold winter with a high energy bill, poor indoor climate, neighbour benchmarking of the energy consumption can make the house owner seize the opportunity (Svane, 2002). Finally, no energy saving measures will be embarked on without personal ability, economic, time wise and mentally. What several studies have disclosed is that most house owners consider an energy-retrofitting project to be very uncertain and chaotic when it comes to the final decision and this may frighten and even stress the house owner. As a consequence, helpful energy supervisors, good cases in the neighbourhood and start-up help from local authorities can be decisive for the implementation of the energy retrofitting of a single-family house (Jensen, 2013).

Objective

The objective of this study was to explain why only a few house owners embark on a major energy retrofit in spite of its many potential benefits by identifying barriers and incentives in relation to energy retrofitting of single-family houses. Moreover, it was investigated among the house owners, who had retrofitted their house, whether a number of factors, including the perceived indoor climate, became better or worse after retrofitting.

METHODOLOGIES

A questionnaire survey was carried out in November 2012 among 1,990 randomly selected house owners in Furesoe municipality located north of Copenhagen. The house owners were randomly selected from the total of 8,400 single-family houses in the municipality. The survey was carried out by sending letters to house owners by regular mail with a brief description of the project and an invitation to participate in the survey as well. The house owners accepted the invitation by filling in a questionnaire using an online survey system (SurveyXact). To encourage house owners to complete the questionnaire, they were offered to attend a drawn for one gift certificate of 270 euros for every 200 replies. By deadline, a total of 683 occupants had answered, corresponding to a response rate of 34.5%. The respondents constituted 73% (502) men. Among the responses, 22% came from house owners who had already implemented energy retrofitting (22%) and house owners who were in the process of some kind of energy retrofitting (19%).

Of the house owners, 70% responded that their house was built in the period 1960-1979. Two-thirds of the house owners had been living in their house for more than 13 years, one-third for more than 28 years. Of the house owners, 90% were more than 40 years old. One third of the house owners explained that they expected to stay in their house for the rest of their life. The average size of the houses was 163 m^2, of which an average of 10 m^2 was unheated.

The questionnaire survey focused on what mattered in the choice of house and barriers and motivations in relation to energy retrofitting. Besides, experienced benefits after retrofitting were studied with special focus on changes in perceived indoor climate parameters.

RESULTS AND DISCUSSION

More focus on energy and indoor climate

What originally had been essential to the house owners, when they purchased their house, was its location (70%), its price (70%) and the interior layout (64%), see Figure 1. Energy label and consumption only had a small impact with only 4-9% referring to it. It should be noted that the label was first introduced in 1979 and became really known among home buyers only from the mid-1980s. Similarly, the house's indoor climate was only important for 7% of the questioned. Considering only the relatively few house owners (29) who had bought houses in the last two years, 2011 and 2012, there seemed to be a trend that the house’s energy consumption/energy label and indoor climate had become more important (48/41% 28%).

As many as 86% answered yes to the question “If you were going to purchase a house today, would the energy label be included in your considerations of which house you would want to buy?”

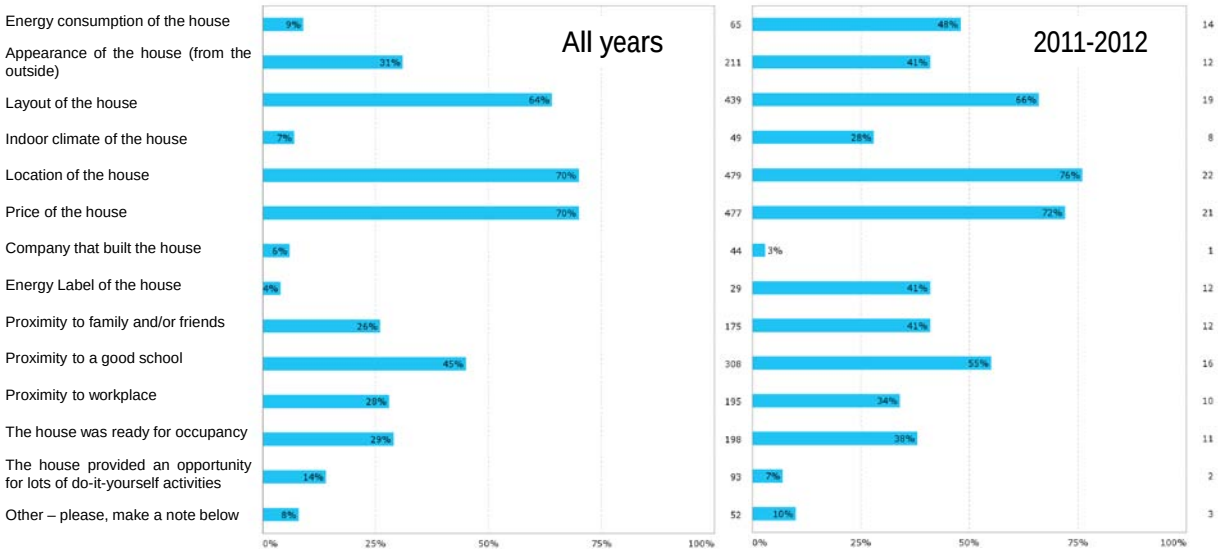

Figure 1. When you bought your house, what mattered most? (Please, tick one or more)

Energy retrofitting is complicated

Energy retrofitting is complicated and it is also experienced as such by many house owners. There is uncertainty as regards choice of solutions, economic savings and financing, see Figure 2. Therefore, there is a need to help house owners along both in terms of which solutions are applicable, and to clarify economic consequences and opportunities. The better the economy of energy retrofitting the easier the decision appears to be. Thus, subsidies and tax deduction are relevant (but costly for society) as instruments for promoting the decision to go ahead. It is worth noting that one third saw no major barriers. The comments showed that advanced age of house owners was considered an additional barrier.

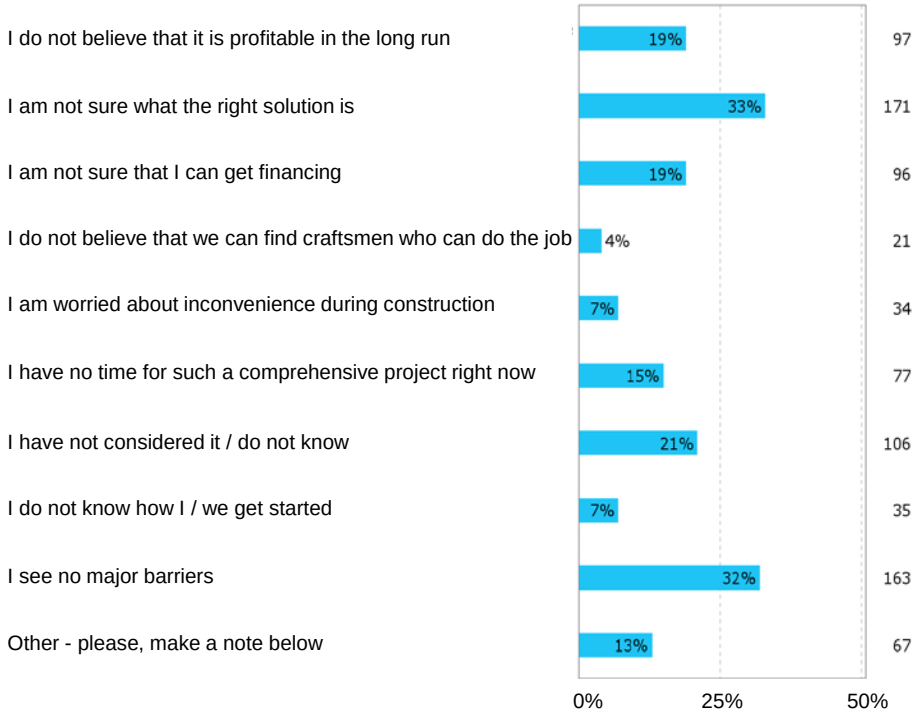

Figure 2. Based on your knowledge of energy retrofitting, what do you consider to be the main barriers? (Please, tick one or more)

Motivation

Among the 38% of house owners who were either in the process of or considering energy retrofitting, several types of retrofitting were considered, most relating to the building envelope in the form of insulation of exterior walls, ceiling and roof spaces and replacement of windows and glazing, and insulation of the roof and basement. There was also focus on producing one's own energy.

What mainly motivated householders to get started on energy retrofitting, was economy in the form of "the heating bill" and "the electricity bill", followed by "talks with family members, neighbours and friends." The comments by the house owners showed that remodelling, renovation and modernisation were seen as drivers of energy retrofitting.

Among the house owners who had completed energy retrofitting of their house, the following was the most motivating factors: "lower energy expenditure and overall savings in the long run" (89%) and "energy saving" (83%), see Figure 3. After energy savings, house owners were motivated by improved indoor climate, especially better temperature conditions (63%) and less draught conditions (36%).

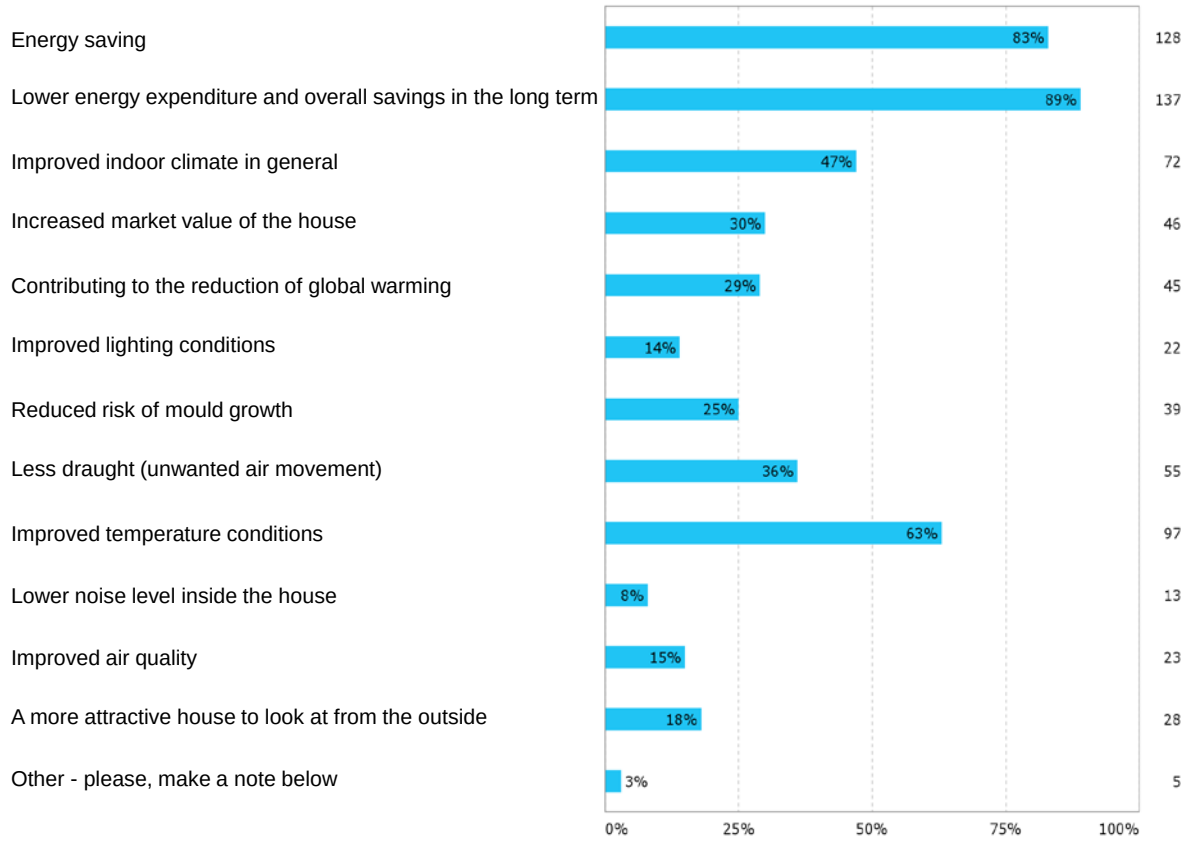

Figure 3. What motivated you to energy retrofit your house? (Please, tick one or more)

Positive experiences

The house owners who had carried out energy retrofitting were asked a series of questions to evaluate their observations in relation to energy retrofitting. Overall, the house owners had a positive experience of energy retrofitting their house. This was seen by the fact that as many

as 87% of house owners would recommend others to retrofit their house and that 93% were satisfied with how energy retrofitting was carried out.

House owners were also introduced to 21 factors, which both represent potentially ”energy economic benefits” and ”non-energy benefits”, which they assessed to be either better or worse after finishing energy retrofitting, Figure 4. Generally the factors were improved. Ranking with what was perceived as the most improved first (in bracket the percentage that found it became better): energy consumption (92%), energy costs (85%) and market value (69%). But also indoor temperature (64%), indoor climate (60%), periods when it was too cold (58%) and draught (unwanted air movement) (55%) were improved. Less than 5% found that factors were worse after energy retrofitting, except for condensation on the outside of the windows, with 12% of the house owners finding it to be worse. Between 8 and 86% rated conditions as "unchanged".

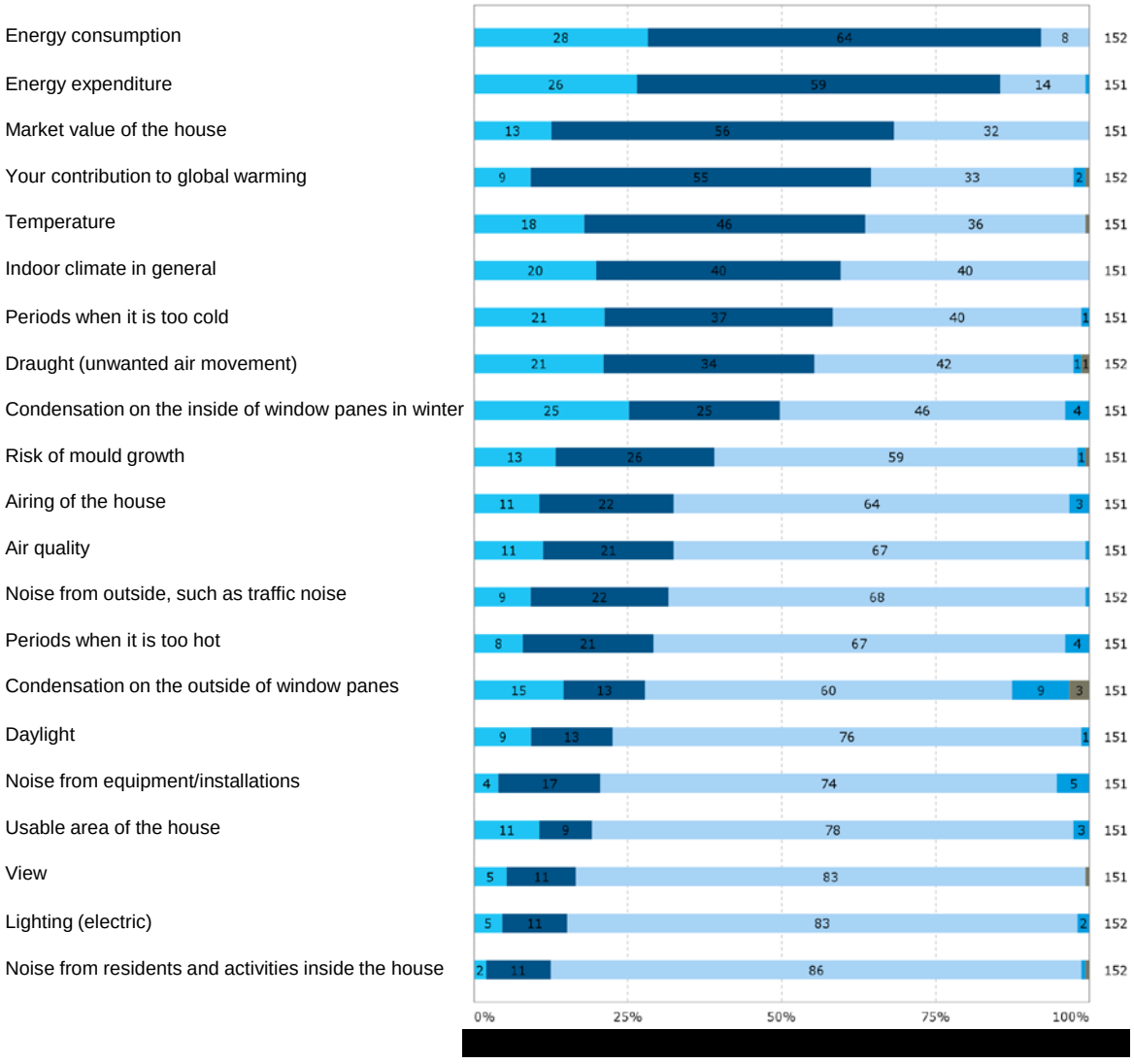

Figure 4. After energy retrofitting of your house: To what extent have the following factors become better or worse in your home?

If communicated, these positive observations might help to break down or compensate for some of the barriers that house owners are experiencing.

Final remark

Over half (56%) of the occupants found that the heat consumption after energy retrofitting lived up to expectations. Almost half (46%) expected that the investment would pay for itself in energy savings, while 28% did not. Only 11% of house owners found that heat consumption had not been as low as they expected. Of course, the question remains to be answered, how much of the "theoretically possible" energy savings that would be "converted" to improved (thermal) comfort in the houses.

It is important to learn from the in-depth energy retrofits that are carried out at present in order to assess the consequences both for occupants and in terms of real energy savings (in contrast to theoretical calculations). It will then be possible to benefit from the occupants' observations to develop robust energy retrofitting solutions that both lower Mr and Ms Denmark's energy consumption while at the same time improve their indoor climate.

CONCLUSIONS

- Among the relatively few house owners who have bought houses within the last two years, 2011 and 2012, there seems to be a trend that the houses' energy consumption/energy label and indoor climate have become more important than before.
- Energy retrofitting is a complex affair and is perceived as such. There is uncertainty as regards choice of solutions, economic savings and financing.
- The better the economy of energy retrofitting, the easier the decision appears to be. Thus, subsidies and tax deduction are strong instruments for promoting the decision to go ahead.
- After the implementation of energy retrofitting, the house owners made positive observations in relation to energy consumption and energy costs, but also in terms of non-energy benefits where there were improvements of factors such as room temperature, periods when it is too cold, draught nuisances and the indoor climate in general.
- Overall, the house owners had a positive experience of energy retrofitting their house.
- A strategy to increase the number of house owners who embark on major energy retrofitting of their house should include motivation of house owners by communicating the positive non-energy benefits. In addition, a strategy should quantify potential energy savings and reduce barriers by helping house owners select which retrofitting solutions are appropriate and clarifying economic consequences and opportunities.

ACKNOWLEDGEMENT

The study was part of a larger study of incentives, barriers and measures to promote energy savings in buildings partly supported by the Danish Energy Agency. All occupants who took time to answer the questionnaire are gratefully acknowledged.

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