Tenants' experiences and satisfaction in social housing subject to comprehensive retrofitting

A Danish case study

Knudsen, Henrik Nellemose; Thomsen, Kirsten Engelund; Rose, Jørgen; Bergsøe, Niels Christian

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

TENANTS' EXPERIENCES AND SATISFACTION IN SOCIAL HOUSING SUBJECT TO COMPREHENSIVE RETROFITTING

A DANISH CASE STUDY

SBI 2015:20

Tenants' experiences and satisfaction in social housing subject to comprehensive retrofitting

A Danish case study

Henrik N. Knudsen
Kirsten Engelund Thomsen
Jørgen Rose
Niels C. Bergsøe

SBi 2015:20
Danish Building Research Institute, Aalborg University · 2015

Title	Tenants' experiences and satisfaction in social housing subject to comprehensive retrofitting
Subtitle	A Danish case study
Serial title	SBi 2015:20
Edition	1 edition
Year	2015
Authors	Henrik N. Knudsen, Kirsten Engelund Thomsen, Jørgen Rose, Niels C. Bergsøe
Language	English
Pages	89
References	Page 24
Key words	Social housing, residential buildings, retrofitting, building improvement, energy savings, tenants, indoor climate, user experience, user satisfaction
ISBN	978-87-563-1733-7
Photos	Front page: Ove Mørch Figure 1, 2, 3 and 4: Søren Østergaard Jensen Figure 5.1, 5.2, 5.3, 5.4 and 5.7: Niels C. Bergsøe
Publisher	SBi, Statens Byggeforskningsinstitut, Aalborg Universitet, Danish Building Research Institute, Aalborg University A.C. Meyers Vænge 15, 2450 Copenhagen SV E-mail sbi@sbi.aau.dk www.sbi.dk

Preface

The objective of this project was to study tenants' overall satisfaction with how the retrofitting of their dwellings was carried out and more specifically their experiences and satisfaction with their dwellings after the retrofits. Therefore a questionnaire was developed that included questions to assess possible co-benefits e.g. improved perceived indoor climate parameters and new balconies. Tenants were also asked if they have changed their habits regarding airing of their flat and the level of the indoor temperature.

The tenants were generally satisfied with the retrofitting of their flats/buildings. The majority found that the result of the retrofitting live up to their expectations and they can recommend retrofitting with focus on reducing energy consumption to others.

The perceived indoor climate was clearly improved by the retrofitting in particular the temperature conditions, i.e. eliminating periods where it is too cold and reducing discomfort from draught (unwanted air movement). Similarly the perceived air quality was improved after retrofitting.

The authors would like to thank the Danish Energy Agency who supported the Danish participation in the International Energy Agency (IEA) programme Buildings and Communities Programme (Annex 56) through the Energy Technology Development and Demonstration Programme (EUDP).

Danish Building Research Institute, Aalborg University Copenhagen
Energy and Environment
December 2015

Søren Aggerholm
Research Director

Content

Summary

The need for retrofitting of the Danish residential buildings is massive, especially for the large proportion of buildings built in the 1960s and 1970s. The potential benefits are many but only few undertake retrofitting projects with a strong focus on reduction of energy consumption. There may be many reasons for this. An obvious one may be limited knowledge of the many valuable non-energy benefits that can be achieved, e.g. in relation to indoor climate.

The objective of this project was to study tenants' overall satisfaction with how the retrofitting of their flats/buildings was carried out and more specifically their experiences and satisfaction with their flats and the building after the retrofits. This included assessments of possible co-benefits like e.g. improved perceived indoor climate parameters and new balconies. Tenants were also asked if they have changed their habits regarding airing of their flat and how they set the indoor temperature.

A questionnaire survey was conducted in October 2014 among 65 tenants living in a block of social housing in Hvalsø municipality located 45 km west of Copenhagen.

The tenants were generally satisfied with the retrofitting of their flats/buildings. The majority find that the result of the retrofitting live up to their expectations and they can recommend retrofitting with focus on reducing energy consumption to others. This satisfaction shall be seen in relation to the fact that half of the tenants experienced some kind of inconvenience, including noise, dust and the presence of craftsmen. Despite of this only 8% were overall dissatisfied with how the retrofitting was carried out. 68% were satisfied. This may reflect that the communication about the retrofitting process has secured an alignment of expectations.

The perceived indoor climate was clearly improved after the retrofitting in particular the temperature conditions, i.e. eliminating periods where it is too cold and reducing discomfort from draught (unwanted air movement). Similarly the perceived air quality was improved after the retrofitting. Nearly no change was seen for noise in the flats. The satisfaction with daylight was slightly reduced mainly because more tenants experienced too low daylighting levels after the retrofitting probably due to the new balconies in front of their living room.

A little less than half of the tenants express that the temperature in their flat is higher after the retrofitting, indicating that some of the energy saving has transformed into a higher level of thermal comfort.

The tenants were introduced to 19 possible co-benefits, mostly related to the perceived indoor climate, which they assessed to be either better or worse after the retrofitting. Generally, the factors were improved, with the most improved being temperature, periods when it was too cold, problems with mould and mildew, draught, cold areas in the flat, air quality, indoor climate in general, possibility of ventilation of the flat, condensation on the inside of the windows in winter, periods when it's too hot and warm areas in the flat. The picture is different for the view, daylight and condensation on the out-

side of windows, where more tenants found that it was worse after retrofitting.

If communicated, the positive co-benefits mentioned above, building improvements and energy savings might help to motivate and break down or compensate for some of the barriers that tenants may have and that building organisations that embark on major retrofitting of their building stock therefore need to overcome.

In order to limit recourses parts of the appendices in this report are in Danish, but to help the English speaking reader each numbered question of the original Danish questionnaire (Appendix 2) is translated into English (Appendix 3).

1. Introduction

1.1. Background

There are a lot of ongoing retrofitting projects resulting in energy savings. However, only very few examples are followed up by a proper evaluation of the energy consumption and even fewer with an evaluation of user experiences and user satisfaction. This makes it very difficult to draw general and valuable experiences from completed retrofitting projects. Therefore, systematic collection of knowledge and measurement results from retrofitting projects are missing, that could have enabled a holistic assessment of the realized energy consumption, user experiences and user satisfaction, including user evaluation of possible co-benefits.

It should therefore be considered, how we can prospectively implement a more systematic collection of experiences with retrofitting projects focusing on reducing energy consumption in the various parts of the existing building stock. This should be seen in the context of the EU Directive on Energy Performance of Buildings (Directive 2010/31/EU) stipulating that Member States shall develop policies and take measures to stimulate the transformation of buildings that are retrofitted into nearly zero energy buildings (nZEB). In addition to documentation of energy consumption and technical measurements of the indoor climate, it is relevant to examine the building user satisfaction with the perceived indoor climate and expectations (before) and their redemption (after) and how they experience the retrofit process, including the periods before, during and after retrofitting. Collecting data on building users' experiences and satisfaction in new low-energy buildings show, that there are often problems where technical installations are not performing satisfactory to begin with. To reduce/avoid similar problems in connection with retrofitting projects in existing buildings there should be some form of handover (commissioning) that includes verification of technical installations proper functioning from day one.

Denmark is participating in IEA EBC Annex 56 and the research described in this report was undertaken as a part of Subtask C in the IEA project (IEA Annex 56 webpage). The Annex 56 project has also produced a report on co-benefits (Subtask A) describing how these additional benefits resulting from comprehensive retrofitting can be taken into account when planning, evaluating and ranking different retrofitting strategies from both a private and societal perspective. The co-benefits that arise from energy and carbon emissions related building retrofitting can be independent from energy, carbon emissions and costs (e.g. less outside noise), or can be a direct consequence of these (e.g. less risk of exposure to energy price fluctuations), and the benefits can impact at the private level (e.g. increased user comfort) or/and at the societal level (e.g. impact on climate change or air pollution). Often the co-benefits can be a lot more valuable to the building users than the actual energy savings and sometimes the projected energy savings are also transferred into co-benefits, e.g. raising the indoor air temperature will reduce the realized energy savings but instead increase the thermal comfort. The comprehensive retrofitting with focus on energy savings of Traneparken not only reduces energy costs, it may also lead to a wide range of positive co-benefits. The financial value of the co-benefits is difficult to establish, but they are often more appreciated by the tenants than the actual energy sav-

ings themselves. These positive effects of retrofitting measures may be: Improved indoor climate, e.g. higher indoor temperature, less draught, less radiation from cold surfaces, reduction/removal of thermal bridges etc. When comparing alternative solutions, there is a risk that co-benefits are ignored/forgotten or not taken into consideration as there are no costs or savings directly available for these co-benefits that can be used in the ranking of different competing solutions.

The objective of this project was to study tenants' overall satisfaction with how the comprehensive retrofitting of their flats/buildings with a special focus on reducing energy consumption was carried out and more specifically their experiences and satisfaction after their flats/buildings were retrofitted. This included assessments of possible co-benefits like e.g. new balconies and improved perceived indoor climate parameters. Tenants were also asked if they have changed their habits regarding airing of their flat and how they set the indoor temperature.

1.2. The investigated blocks of flats

Traneparken was chosen as a Danish case study for IEA Annex 56. Traneparken consist of 3 multi-storey blocks of flats situated North-West of Hvalsø in the municipality of Lejre, approximately 45 km west of Copenhagen. The blocks with a total of 66 flats are typical examples of Danish buildings from the 1960s with prefabricated sandwich concrete elements with only little insulation. The buildings are located north of the railroad and bordered by residential neighbourhoods to the South and West and by green fields to the north.

The purpose of the activities carried out in Traneparken was to renovate the buildings because they were worn down and the external concrete walls were weakened by deterioration. At the same time the housing association wanted to make the apartments more attractive by adding balconies to each individual flat and beautify the surroundings. Therefore, the overall intention was to renovate worn down parts of the buildings, improve the indoor climate, increase the attractiveness of flats by adding balconies, improve outdoor areas and reduce energy consumption of the buildings.

In order to achieve this goal, the exterior walls were renovated by adding supplementary thermal insulation to the outside. This insulation was continued to the base of the building to reduce/avoid thermal bridges at the base. The roofs were also renovated and insulated and windows and doors were replaced by triple-glazed low-energy windows/doors. The flats are now ventilated by a demand-controlled (humidity) balanced mechanical ventilation system with heat recovery and there is exhaust air from bathroom, toilets and kitchens and supply air to the living rooms. In addition to these actions the housing company also added a 33 kWp PV system on the roof of one of the blocks to supply electricity to the common laundry.

1.2.1 Construction and systems of the building before renovation

Building envelope
The buildings were typical 1960s buildings made with prefabricated enforced sandwich concrete elements with approx. 50 mm insulation. Some of the façade consists of panel walls with 45 mm insulation. Floor insulation to basement was approx. 45 mm. The roof was insulated with approx. 190 mm. Windows were double-glazed with U-value of 2.4 W/m^{2}K.

Figure 1. Two of the three blocks at Traneparken. The photo shows the end wall of one block being renovated and the facade of the other which has not yet been renovated.

Heating, ventilation, cooling and lighting systems before retrofit
The buildings are heated by district heating let into the basement of one of the blocks to a 200 kW plate heat-exchanger and from there it is distributed to the other blocks. There were pre-insulated domestic hot water tanks in each block. In total, there were 8 tanks holding 300 liters each.

The flats were ventilated by a mechanical exhaust air system from bathroom, toilets and kitchens.

There were energy-saving bulbs in all indoor lights on the staircases. They were equipped with automatic switch-off controls with presence detectors. The outdoor light had automatic daylight switch-off.

The buildings seemed rather “grey and boring” and had problems with facades, windows, roofs, etc. The indoor climate was unsatisfactory and the energy consumption was unacceptably high. The intention was that the renovation project would make Traneparken more attractive for both existing and new residents.

1.2.2 Energy retrofitting measures
Traneparken has undergone a thermal rehabilitation process where 190 mm insulation material is added to the outside of the exterior walls. The original construction of the exterior wall was prefabricated concrete elements consisting of 100 mm concrete, 50 mm mineral wool insulation and 140 mm concrete. The concrete facades were worn down and had to be renovated. The 190 mm insulation was continued below ground level to reduce/remove any thermal bridges. Furthermore, the roofs and panel walls have also been insulated and windows have been replaced with triple-glazed energy efficient windows. In addition to the energy renovation of the facade, a new ventilation system and solar photo voltaic panels have been installed.

Table 1. Renovation measures for one block. Calculations of U-values are done in accordance to Dansk Standard 2011; DS 418:2011.

Element	Area, m^2	U-value before renovation, W/m^2K	U-value after renovation, W/m^2K	After renovation, description
Exterior walls	486	0.66	0.15	Plus 190 mm insulation plus exterior standard bricks, now totalling 240 mm
Panel wall	106	0.7	0.11	Plus 285 mm insulation plus exterior standard bricks, now totalling 330 mm
Windows, doors	205	2.4	0.8	Triple-glazed low energy windows with aluminium-wood frame
Roof	333	0.2	0.09	Plus 250 mm insulation, now totalling 435 mm

Mineral wool was used for the insulation of the external walls and the roof. Mineral wool is produced at high temperatures with some energy consumption, but when compared with the energy saved by its use, this is close to negligible. It has a very high durability and will last for the rest of the buildings lifetime.

Plastic window frames have been the object of some debate over the years. However, today the quality of plastic windows has greatly improved so their lifetime is now comparable with that of other types of windows. Unlike wooden windows, they need no protective treatment every 5 - 7 years. The windows can be completely taken apart and materials recycled after end-of-service-life. Thereby the plastic can be recycled for new plastic products – for example plastic windows.

Nothing was changed concerning the heating and lighting systems. After renovation, a balanced mechanical ventilation system with heat recovery was installed. The air was supplied to the living rooms and bedrooms and exhaust air from bathroom, toilets and kitchens. For the installation of the new demand-controlled balanced mechanical ventilation system with heat recovery, the existing exhaust air ducts were reused – thereby minimising costs and material use. Available space was identified and utilised for the supply air system. A PV system was installed on the roof to produce electricity.

Figure 2. The 33 kWp south-facing PV system and the coverings for the new mechanical ventilation systems located above each stairway.

In addition to the energy retrofitting of the facade, a new ventilation system and solar cell panels were installed. The tenants have not been given information on how the ventilation systems work, and they have no possibility to regulate it.

Figure 3. Photos of the building before (left) and after the retrofit.

In connection with the retrofitting meters were installed on hot and cold water, as well as electronic cost allocators on the radiators. All meters can be read online and the results are presented on a website where tenants can go and see their own consumption when they like.

Before the retrofitting, there were French balcony doors in the living rooms, Figure 3. As seen in the pictures below, it seems that the glass area in the doors have been reduced slightly due to a slightly wider frame. There is now a filling between the doors and the windows next door. This was, before the filling, on the other side of the windows. The parapet of the new balconies is made of frosted glass.

Figure 4. Photos of the old facade (top), new facade before the balconies were mounted (middle) and the new balconies (bottom).

1.2.3. Increase of rent

The retrofitting of Traneparken also meant a rent increase for the tenants.

The increased running costs for the ventilation system is 13,300 €/year, and the expected PV electricity production is 30,000 kWh corresponding to savings of approx. 8,000 €/year.

The expense for district heating is approx. 45,500 €/year. The savings in district heating due to energy retrofits corresponds to around 20,500 €/year. For the tenants, the overall results of the energy retrofit is an annual increase in rent of 11.8 €/m² from 93.7€/m^2, corresponding to an increase of the rent of around 13%. The decrease in energy costs is around 4.2 €/m² (a 31% decrease of energy costs), corresponding to around one third of the increase of the rent. This means that the total cost (rent and energy) of living in the flats has increased around 8%.

2. Method

2.1. Questionnaire survey

A questionnaire survey was conducted in October 2014 among 65 tenants living in a block of social housing in Hvalsø municipality (Traneparken) located 45 km vest from Copenhagen. There are 66 flats, but it was not possible to include all in the survey as some of them were new tenants.

The questionnaire survey focused on the tenants' overall satisfaction with how the retrofitting was carried out and more specifically their experiences and satisfaction with the perceived indoor climate etc. as well as possible changes in their behaviour after the comprehensive retrofitting. Possible experienced co-benefits of retrofitting were studied with special focus on changes in perceived indoor climate parameters.

All the original Danish questions are presented in Appendix 2 and a translation into English is found in Appendix 3.

The survey was carried out by sending letters to the tenants of Traneparken by regular mail with a brief description of the project and an invitation to participate in the survey. The tenants accepted the invitation by filling in a questionnaire using an online survey system (SurveyXact). To encourage tenants to complete the questionnaire, they would receive a gift certificate of 13 euros (100 DKK) if they participated in the survey. One week after they received the letter, a poster was hung in the stairwells with a friendly reminder to those who did not respond yet.

By the final deadline, a total of 25 tenants had answered, corresponding to a response rate of 38%. The respondents constituted 72% (18) women. Of the tenants, 20% were below 40 years old, 32% between 40 and 59 years old and 44% were above 60 years old. Around 76% were living as single. Among the tenants, 50% moved into their apartment in the period 2010 to 2014 and 27% in the period 2005 to 2009. Around one third of the tenants explained that they expected to stay in their flat for the rest of their life and another third expected to stay in their flat for less than ten years.

3. Results and discussion

Answers to all the questions of the questionnaire survey are presented in Appendix 4. In the following the main results are presented.

3.1. Occupants' overall satisfaction with the retrofitting

The tenants were generally satisfied with the retrofitting of their flats/buildings. The majority (72%) find that the result of the retrofitting live up to their expectations and 76% can recommend retrofitting with focus on reducing energy consumption to others.

Another way of assessing the tenants' satisfaction with the retrofitting was to put the outcome of the retrofitting in relation to the rent increase of around 13% (of which around one third is saved due to a lower energy cost). As many as 64% found that the rent increase after retrofitting was reasonable in relation to the heating cost savings, and the other improvements (e.g. indoor climate, ventilation, balcony and green areas). Only 4% disagreed with this. When the rent increase after retrofitting was put in relation to the heating cost savings alone, somewhat less, 44%, found the rent increase reasonable whereas 24% did not find it reasonable.

The above satisfaction shall be seen in relation to the fact that half of the tenants experienced some kind of inconvenience, including noise, dust and the presence of craftsmen. Despite of this only 8% were overall dissatisfied with how the retrofitting was carried out and 68% were satisfied. This may reflect that the continuous communication about the retrofitting process has secured an alignment of expectations.

3.2. Perceived indoor climate

The tenants were asked to evaluate the perceived indoor climate in their flats before and after the retrofitting concerning the five individual parameters temperature, draught (unwanted air movement), air quality, noise and daylight, see Figures 5 to 22.

3.2.1. Temperature

Figure 5-6 show that 72% of the tenants had problems with the temperature being too low before the retrofitting. After the retrofitting nobody experienced this problem and as many as 76% have no problems with the temperature compared with only 16% before. The satisfaction with the temperature, Figure 6-7, changed from 78% of the tenants being dissatisfied before to 84% being satisfied after the retrofitting.

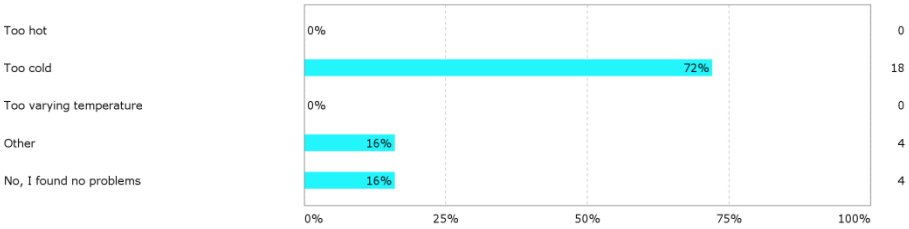


Figure 5. BEFORE retrofitting: Did you have problems with the temperature?

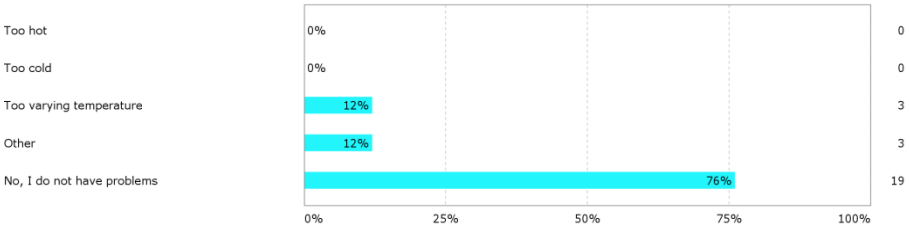


Figure 6. AFTER retrofitting: Do you have problems with the temperature?

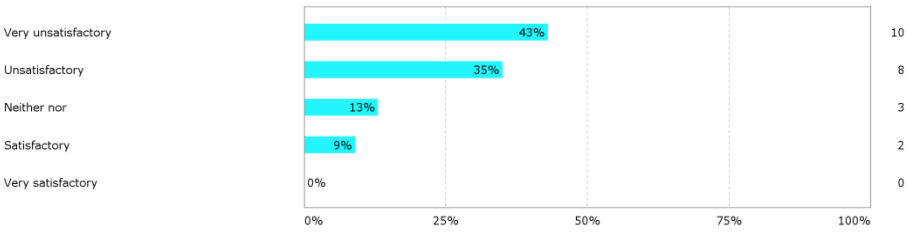


Figure 7. BEFORE retrofitting: How did you find the temperature conditions in your flat?

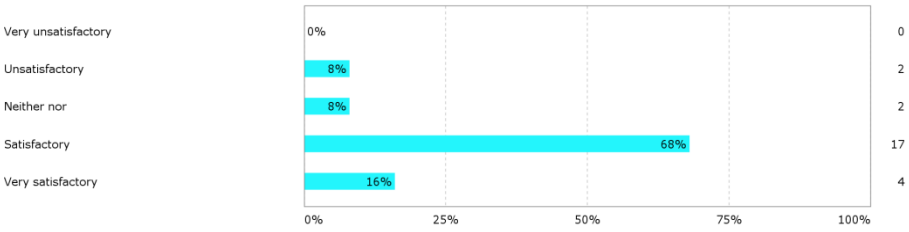


Figure 8. AFTER retrofitting: How do you find the temperature conditions in your flat?

3.2.2. Draught (unwanted air movement)

Figure 9-10 show that the satisfaction with the draught changed from 71% of the tenants being dissatisfied before to 84% being satisfied after the retrofitting.

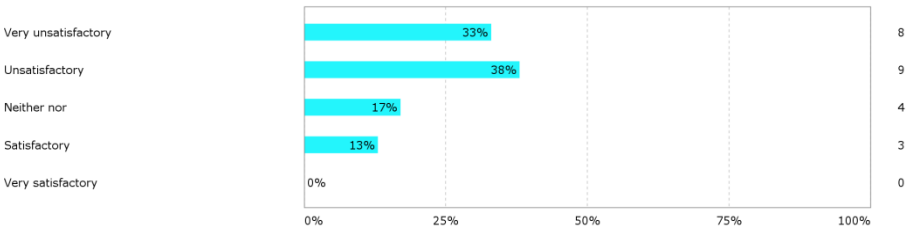


Figure 9. BEFORE retrofitting: How did you find the draught conditions in your flat?

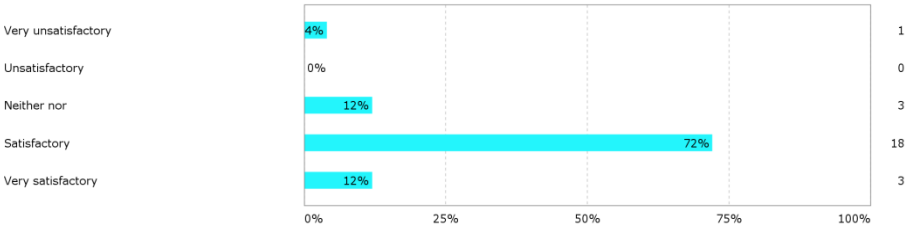


Figure 10. AFTER retrofitting: How do you find the draught conditions in your flat?

3.2.3. Air quality

Figure 11-12 show that 24% and 12% of the tenants had problems with stuffy air and unpleasant smells respectively before the retrofitting. After the retrofitting nobody experienced stuffy air and only 4% (1) experienced unpleasant smells. The satisfaction with the air quality in the flat Figure 13-14, changed from 33% and 21% of the tenants being dissatisfied and satisfied respectively before to 4% and 83% being dissatisfied and satisfied respectively after the retrofitting.

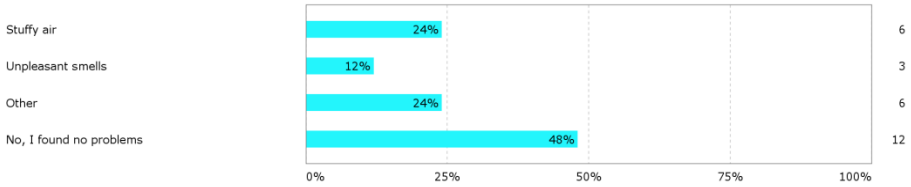


Figure 11. BEFORE retrofitting: Did you have problems with the air quality?

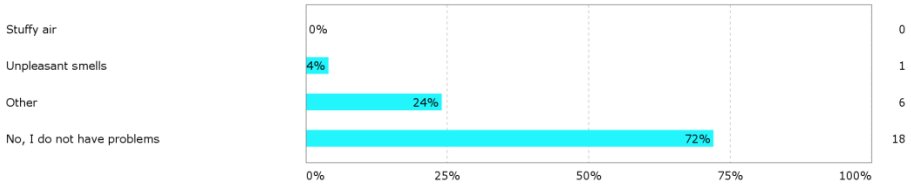


Figure 12. AFTER retrofitting: Do you have problems with the air quality?

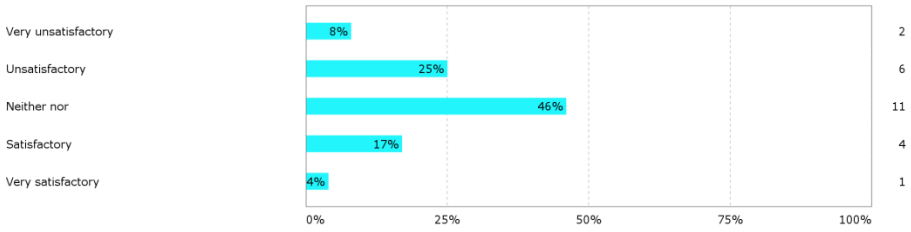


Figure 13. BEFORE retrofitting: How did you find the air quality in your flat?

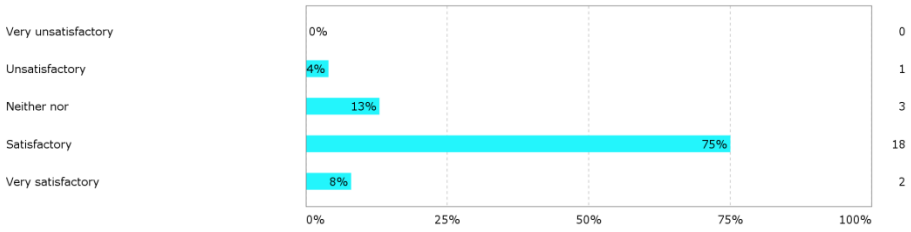


Figure 14. AFTER retrofitting: How do you find the air quality in your flat?

3.2.4. Noise

Figure 15-16 show that about half of the tenants had no problems with noise both before and after the retrofitting and that the experienced problems are similar before and after the retrofitting. The satisfaction with noise, Figure 17-18, changed from 25% and 37% of the tenants being dissatisfied and satisfied respectively before to 12% and 68% being dissatisfied and satisfied respectively after the retrofitting.

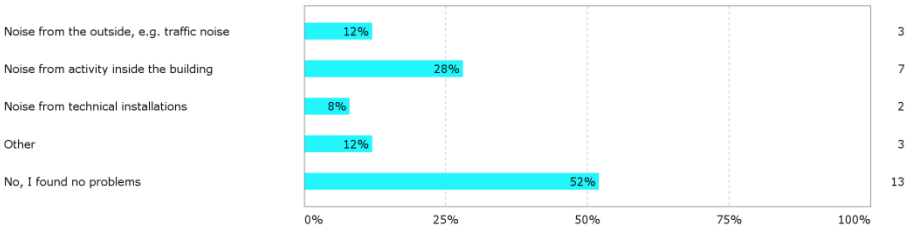


Figure 15. BEFORE retrofitting: Did you have problems with noise?

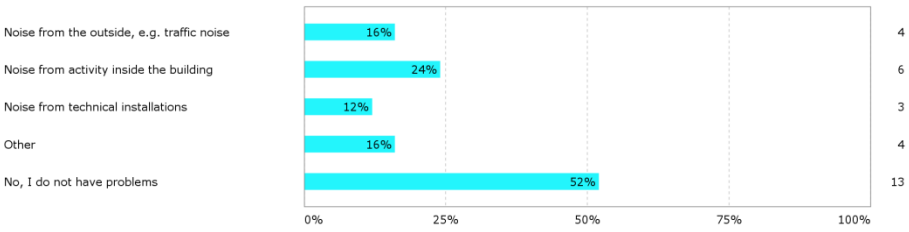


Figure 16. AFTER retrofitting: Do you have problems with noise?

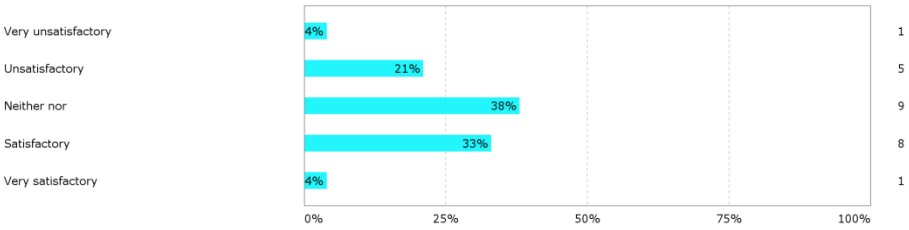


Figure 17. BEFORE retrofitting: How did you find the level of noise in your flat?

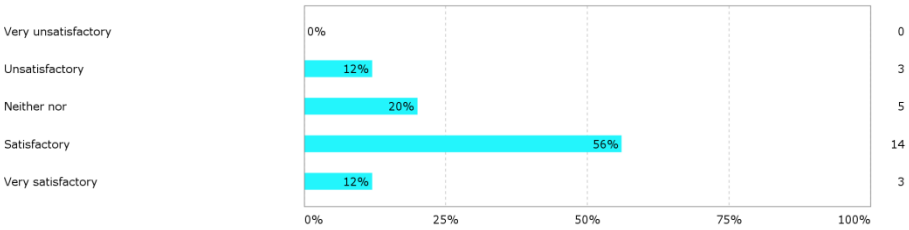


Figure 18. AFTER retrofitting: How do you find the level of noise in your flat?

3.2.5. Daylight

Figure 19-20 shows that 8% of the tenants had problems with too little daylight before the retrofitting. After the retrofitting 40% experienced this problem and there was a slight decrease from 72% before to 56% after that experienced no problems with daylight. The satisfaction with daylight, Figure 21-22, fell slightly from 72% of the tenants being satisfied before to 64% being satisfied after the retrofitting. The obvious reason for the tenants to perceive less daylight after the retrofitting is the new balconies partly made of frosted glass, that allow less daylight into the living rooms than before with the French balconies. The new balconies give rise to additional shading to the flats below. As also seen in Figure 4, the glass area in the doors and windows seem to have been slightly reduced due to an increase in the width of the window frame.

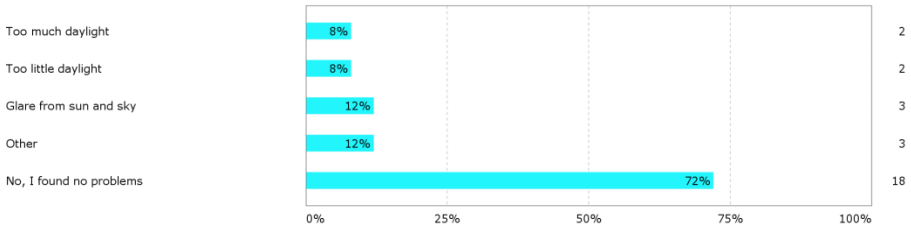


Figure 19. BEFORE retrofitting: Did you have problems with the daylight?

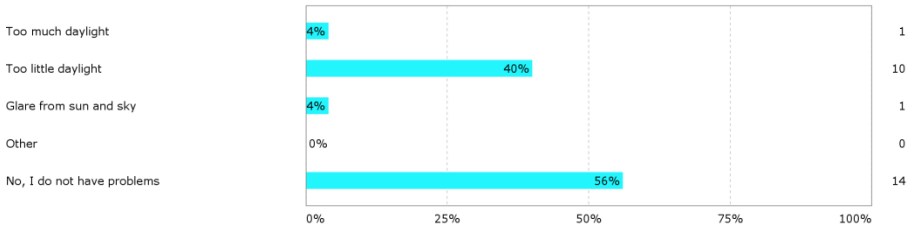


Figure 20. AFTER retrofitting: Do you have problems with the daylight?

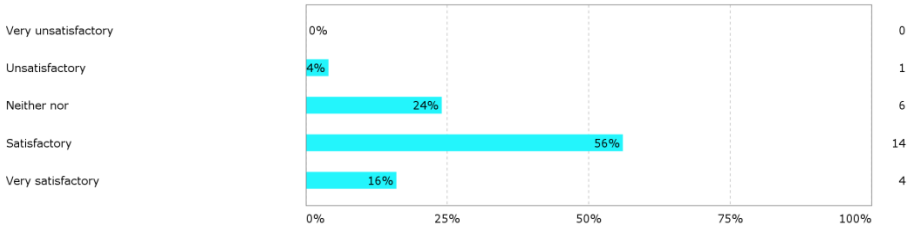


Figure 21. BEFORE retrofitting: How did you find the daylight in your flat?

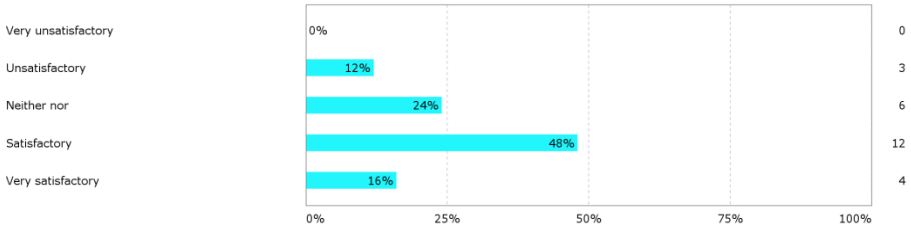


Figure 22. AFTER retrofitting: How do you find the daylight in your flat?

3.2.6. Indoor climate as a whole

After introducing the five individual indoor climate parameters, the tenants were asked to evaluate the perceived indoor climate in their flat as a whole before and after the retrofitting, Figure 23. The satisfaction with the indoor climate rose from 20% of the tenants being satisfied before to 88% being satisfied after the retrofitting.

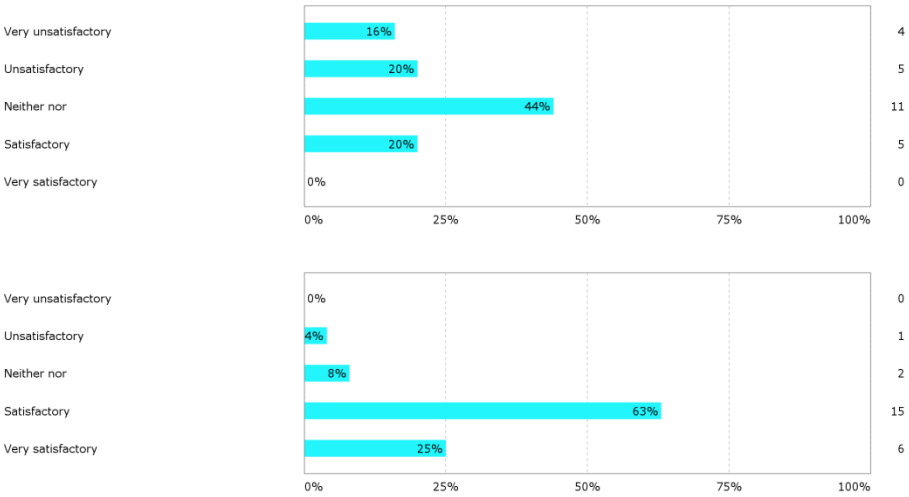


Figure 23. All things considered, how would you assess the indoor climate in your flat before (top)/after(bottom) retrofitting?

To summarize, the perceived indoor climate was clearly improved after the retrofitting in particular the temperature conditions, i.e. eliminating periods where it is too cold and reducing discomfort from draught. Similarly the perceived air quality was improved after the retrofitting. Nearly no change was seen for noise in the flats. The satisfaction with daylight fell slightly mainly because of more tenants experiencing too little daylight after the retrofitting due to the new balconies in front of their living room.

3.3. Co-benefits when retrofitting

The tenants were introduced to 19 possible co-benefits, which they assessed to be either better or worse after the retrofitting, Figure 24. Generally the factors were improved. Ranking with what was perceived as the most improved first (in bracket the percentage of tenants that found it became better): temperature (76%), periods when it was too cold (76%), problems with mould and mildew (72%), draught (unwanted air movement) (68%), cold areas in the flat (68%), air quality (64%), indoor climate in general (64%), possibility of ventilation of the flat (64%), condensation on the inside of the windows in winter (64%), periods when it's too hot (56%), warm areas in the flat (56%), sound and noise from the outside, e.g. traffic noise (48%), possibility of airing (open windows) the flat (40%). The picture is different for the view, daylight and condensation on the outside of windows, where 16, 30 and 32% respective found that it was worse after energy retrofitting. Internal noise was unchanged for a majority of the tenants.

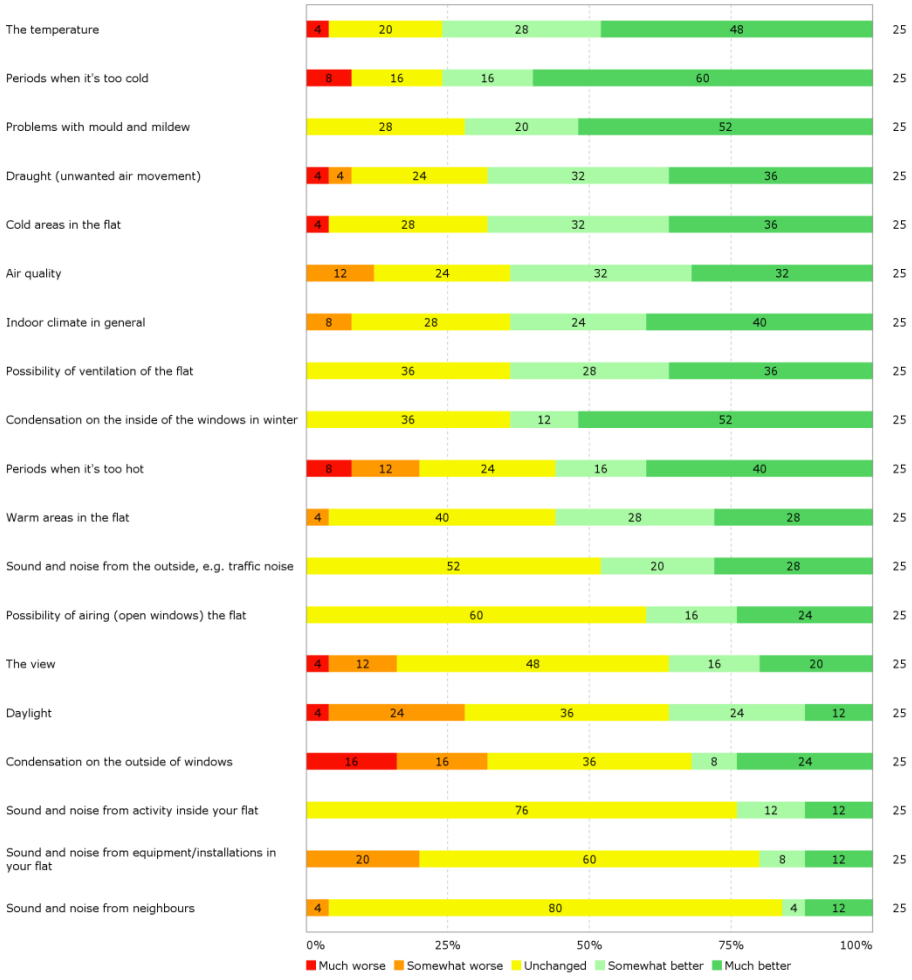


Figure 24. After your flat was retrofitted, to what extent has the following factors become worse or better?

In continuation of this the tenants were asked to assess the importance of seven different improvements achieved by the retrofitting, by ranking them with numbers from 1 to 7. "1" indicated what they appreciate most and “7” indicated what they appreciate the least. The ranking starting with what was appreciated the most: New balcony, The cost of energy, New windows, Better indoor climate, Building appearance, New ventilation and Green areas.

If communicated, the above positive co-benefits, building improvements and energy savings might help to break down or compensate for some of the barriers that tenants are experiencing in relation to retrofitting their flats/buildings.

3.4. Tenants and their consumption

Nearly half (48%) of the tenants found that their heat consumption after retrofitting was as low as they expected. This number, however, must be seen in relation to 36% answering that they do not know. This may be explained in the tenants’ comments which reveal that some tenants have not yet received a valid statement of heating expenses.

On the question “How interested are you in energy-efficient behaviour in your everyday life?” 64% express that they are “Interested” and 28% that they are “Very interested”. In addition 80% answer “yes” to the question “If you were going to find a new apartment today, would the energy consump-

tion then be included in your thoughts/considerations about which apartment you would like?"

This apparent interest of the tenants in energy-efficiency seems to be in contrast with how often the household's follow or read (on individual meters) their consumption of electricity, heat and water. Less than one third follows or read their consumption monthly or more often. More than two thirds only follow or read their consumption annually or never.

3.5. Changes of habits after retrofitting

The tenants were asked if they have changed their habits after retrofitting in relation to temperature and airing of the flat.

After retrofitting 52% of the tenants have changed their habits regarding how the temperature is set in their flat. Among the tenants 44% express that the temperature in their flat is higher after the retrofitting, and 12% that the temperature is lower. This may indicate that some of the energy saving has been transformed into better thermal comfort.

After retrofitting 32% of the tenants have changed their habits regarding airing of the flat. Among the tenants 28% express that they air their flat more after the retrofitting, and 4% that they air their flat less. This may indicate that some of the possible energy saving has been transformed into better air quality. The majority (68%), however, air their flat as before.

4. Conclusions

A questionnaire was developed to study tenants' overall satisfaction with how the comprehensive retrofitting of their flats/buildings with a dedicated/special focus on reducing energy consumption was carried out and more specifically their experiences and satisfaction after their flats/buildings were retrofitted. This included assessments of possible co-benefits like e.g. improved perceived indoor climate parameters and new balconies. Tenants were also asked if they have changed their habits regarding airing of their flat and how they set the indoor temperature.

The tenants were generally satisfied with the retrofitting of their flats/buildings. The majority find that the result of the retrofitting live up to their expectations and they can recommend retrofitting with focus on reducing energy consumption to others. This satisfaction shall be seen in relation to the fact that half of the tenants experienced some kind of inconvenience, including noise, dust and the presence of craftsmen during the retrofitting process. Despite of this only 8% were overall dissatisfied with how the retrofitting was carried out and 68% were satisfied. This may reflect that the continuous communication about the retrofitting process has secured an alignment of expectations.

The perceived indoor climate was clearly improved after the retrofitting in particular the temperature conditions, i.e. eliminating periods where it is too cold and reducing discomfort from draught (unwanted air movement). Similarly the perceived air quality was improved after the retrofitting. Nearly no change was seen for noise in the flats. The satisfaction with daylight fell slightly mainly because of more tenants experiencing too little daylight after the retrofitting due to the new balconies in front of their living room.
A little less than half of the tenants express that the temperature in their flat is higher after the retrofitting, indicating that some of the energy saving has transformed into better thermal comfort.

The tenants were also introduced to 19 possible co-benefits, most related to the perceived indoor climate, which they assessed to be either better or worse after the retrofitting. Generally the factors were improved, with the most improved being temperature, periods when it was too cold, problems with mould and mildew, draught, cold areas in the flat, air quality, indoor climate in general, possibility of ventilation of the flat, condensation on the inside of the windows in winter, periods when it's too hot and warm areas in the flat. The picture is different for the view, daylight and condensation on the outside of windows, where more tenants found that it was worse after energy retrofitting.

If communicated, the above positive co-benefits, building improvements and energy savings might help to motivate and break down or compensate for some of the barriers that tenants may have and that building organisations who embark on major retrofitting of their building stock therefore need to overcome.

5. Acknowledgements

The authors would like to thank the Danish Energy Agency who supported the Danish participation in the International Energy Agency (IEA) programme Buildings and Communities Programme (Annex 56) through the Energy Technology Development and Demonstration Programme (EUDP). All tenants who took time to answer the questionnaire are gratefully acknowledged. A special thank you goes to Preben Holtz, a tenant in Traneparken, who was of big help during the collection of data for the survey.

6. References

Dansk Standard. (2011) *Calculation of heat loss from buildings* (DS 418:2011). Charlottenlund, Denmark.

European Parliament, Council of the European Union. (2010). *Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings*. The EU Energy Performance of Buildings Directive (EPBD).

SurveyXact: www.surveyxact.com.

IEA Annex 56 webpage: http://www.iea-annex56.org/

Appendix 1. Letter to tenants

STATENS BYGGEFORSKNINGSINSTITUT
AALBORG UNIVERSITET KØBENHAVN

BOLIG SELSKABET SJÆLLAND

Beboer i Traneparken
Traneparken y
4330 Hvalsø

Sjællandsvænget 1
Postboks 269
4000 Roskilde
CVR 42008419

6. oktober 2014

Spørgeskemaundersøgelse om renoveringen af Traneparken

Kære Beboer i Traneparken,

I Boligselskabet Sjælland vil vi gerne fremme energibesparelser. Derfor samarbejder vi med Statens Byggeforskningsinstitut, Teknologisk Institut og rådgivende ingeniørfirma Cenergia om gennemførelse af en spørgeskemaundersøgelse i Traneparken. Formålet er at indsamle jeres oplevelser og erfaringer med den gennemførte energirenovering af Traneparken.

Den indsamlede viden skal bl.a. bruges til at kortlægge de fordele og ulemper, som I beboere har oplevet i forbindelse med renoveringen.

Vi har inviteret samtlige husstande i Traneparken til at deltage i undersøgelsen. For at få et godt resultat er det vigtigt, at så mange som muligt deltager. Derfor håber vi meget, at du eller en anden i husstanden vil udfylde spørgeskemaet, på hjemmesiden: www.datafabrikken.dk

Her skal du bruge **nøglen: 83J9-G2SE-FADK**, for at starte besvarelsen.

Hvis du udfylder spørgeskemaet **inden d. 20. oktober** 2014, vil direktøren for SuperBrugsen i Hvalsø personligt levere dig et gavekort på kr. 100 til sin butik.

Det er vigtigt, at du svarer på egne vegne, da det er **DIN mening**, vi ønsker at kende. Det tager ca. 15 minutter at udfylde skemaet. Alle besvarelserne vil forblive anonyme, og vil kun blive brugt i en samlet statistik for hele bebyggelsen.

På forhånd tak for hjælpen.

Eventuelle spørgsmål kan rettes til Henrik.

Med venlig hilsen

Henrik N. Knudsen
Seniorforsker
Statens Byggeforskningsinstitut, www.sbi.dk
Telefon: 2662 2128, e-mail: hnk@sbi.aau.dk

Søren Peter Nielsen
Projektchef
Boligselskabet Sjælland, www.bosj.dk
Telefon: 4630 4780, e-mail: spn@bosj.dk

Appendix 2. The original Danish questions

On the following pages the original Danish questions are shown. The layout in SurveyXact is not exactly as shown here. The numbering is added subsequently to help compare the original Danish questions, with the English translation in Appendix 3.

STATENS BYGGEFORSKNINGSINSTITUT
AALBORG UNIVERSITET KØBENHAVN

Kære beboer i Traneparken,

Vi er glade for, at du vil hjælpe os ved at udfylde spørgeskemaet.

Hvis du svarer **inden d. 20. oktober 2014,** vil du modtage **et gavekort på 100 kr. til SuperBrugsen i Hvalsø.**

Det er vigtigt, at det er **DIN egen mening** om renoveringen, du giver til kende ved besvarelsen. Alle besvarelserne vil forblive anonyme, og vil kun blive brugt i en samlet statistik.

Det tager ca. 15 minutter at udfylde skemaet. **Du skal trykke på "Næste" nederst på siden for at komme videre,** og du kan komme tilbage til et allerede besvaret spørgsmål ved at trykke på "Forrige". Spørgeskemaet er først færdigudfyldt, når du har trykket på **"Afslut" til sidst**. Du kan når som helst lukke spørgeskemaet og vende tilbage til dine besvarelser på et senere tidspunkt, da svarene gemmes automatisk.

Eventuelle spørgsmål kan rettes til Henrik.

På forhånd tak for hjælpen

Med venlig hilsen
Søren Peter og Henrik

Henrik N. Knudsen, Seniorforsker
Statens Byggeforskningsinstitut, www.sbi.dk
Telefon: 2662 2128, e-mail: hnk@sbi.aau.dk

Søren Peter Nielsen, Projektchef
Boligselskabet Sjælland, www.bosj.dk
Telefon: 4630 4780, e-mail: spn@bosj.dk

Din lejlighed

1. Hvornår flyttede du ind i din nuværende lejlighed?

(1)❑ Før 1980
(2)❑ 1980-1984
(3)❑ 1985-1989
(4)❑ 1990-1994
(5)❑ 1995-1999
(6)❑ 2000-2004
(7)❑ 2005-2009
(8)❑ 2010-2014

2. Hvor længe forventer du/I at blive boende i lejlighed?

(1)❑ Mindre end 5 år
(2)❑ Mellem 5 og 10 år
(3)❑ Mellem 11 og 15 år
(4)❑ Mellem 16 og 20 år
(5)❑ Mere end 20 år
(6)❑ Resten af mit liv
(7)❑ Ved ikke

Energiforbrug

3. Hvor ofte følger/aflæser du din hustands forbrug af el?

(1)❑ Dagligt
(2)❑ Ugentligt
(3)❑ Månedligt
(4)❑ Årligt
(5)❑ Aldrig

4. Hvor ofte følger/aflæser du din hustands forbrug af varme?

(1)❑ Dagligt
(2)❑ Ugentligt
(3)❑ Månedligt
(4)❑ Årligt
(5)❑ Aldrig

5. Hvor ofte følger/aflæser du din hustands forbrug af vand?

(1)❑ Dagligt
(2)❑ Ugentligt
(3)❑ Månedligt
(4)❑ Årligt
(5)❑ Aldrig

6. Hvor interesseret er du i energirigtig adfærd i dagligdagen?

(1)❑ Meget interesseret
(2)❑ Interesseret
(3)❑ Hverken eller
(4)❑ Ikke interesseret
(5)❑ Slet ikke interesseret

7. Hvis du skulle ud og finde en ny lejlighed i dag, ville energiforbruget så indgå i dine overvejelser om hvilken lejlighed, du kunne tænke dig?

(1)❑ Ja
(2)❑ Nej
(3)❑ Ved ikke

Renoveringen

8. Havde du/I nogen gener imens renoveringen blev gennemført?

(1)❑ Ja
(2)❑ Nej

9. Hvilke gener havde du/I?

_____
_____

10. Samlet set, er du tilfreds med hvordan renoveringen blev gennemført?

(1)❑ Ja
(2)❑ Nej
(3)❑ Ved ikke

11. Forklar gerne nærmere:

_____
_____

Indeklimaet i din lejlighed FØR og EFTER renoveringen

Temperaturen i din lejlighed FØR renoveringen

12. FØR renoveringen, oplevede du da problemer med, at der var…
Gerne flere svar

(1)❑ For varmt
(2)❑ For koldt
(3)❑ For varierende temperatur
(4)❑ Andet
(5)❑ Nej, jeg oplevede ingen problemer

13. Forklar evt. nærmere:

_____

14. FØR renoveringen, hvordan oplevede du da temperaturforholdene i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Temperaturen i din lejlighed EFTER renoveringen

15. EFTER renoveringen, oplever du så problemer med, at der er…
Gerne flere svar

(1)❑ For varmt
(2)❑ For koldt
(3)❑ For varierende temperatur
(4)❑ Andet
(5)❑ Nej, jeg oplever ingen problemer

16. Forklar evt. nærmere:

_____

17. EFTER renoveringen, hvordan oplever du så temperaturforholdene i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Trækforholdene (uønsket luftbevægelse) i din lejlighed FØR renoveringen

18. FØR renoveringen, hvordan oplevede du da trækforholdene i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

19. Forklar evt. nærmere:

_____

Trækforholdene i din lejlighed EFTER renoveringen

20. EFTER renoveringen, hvordan oplever du så trækforholdene i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

21. Forklar evt. nærmere:

_____

Luftkvaliteten i din lejlighed FØR renoveringen

22. FØR renoveringen, oplevede du da problemer med, at der var…
Gerne flere svar

(1)❑ Indelukket luft
(2)❑ Ubehagelig lugt
(4)❑ Andet
(5)❑ Nej, jeg oplevede ingen problemer

23. Forklar evt. nærmere:

_____

24. FØR renoveringen, hvordan oplevede du da luftkvaliteten i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Luftkvaliteten i din lejlighed EFTER renoveringen

25. EFTER renoveringen, oplever du så problemer med, at der er…
Gerne flere svar

(1)❑ Indelukket luft
(2)❑ Ubehagelig lugt
(4)❑ Andet
(5)❑ Nej, jeg oplever ingen problemer

26. Forklar evt. nærmere:

_____

27. EFTER renoveringen, hvordan oplever du så luftkvaliteten i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Støjniveauet i din lejlighed FØR renoveringen

28. FØR renoveringen, oplevede du da problemer med, at der var…
Gerne flere svar

(1)❑ Støj udefra, fx trafikstøj
(2)❑ Støj fra aktivitet inde i bygningen
(3)❑ Støj fra de tekniske installationer
(4)❑ Andet
(5)❑ Nej, jeg oplevede ingen problemer

29. Forklar evt. nærmere:

_____

30. FØR renoveringen, hvordan oplevede du da støjniveauet i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Støjniveauet i din lejlighed EFTER renoveringen

31. EFTER renoveringen, oplever du så problemer med, at der er…
Gerne flere svar

(1)❑ Støj udefra, fx trafikstøj
(2)❑ Støj fra aktivitet inde i bygningen
(3)❑ Støj fra de tekniske installationer
(4)❑ Andet
(5)❑ Nej, jeg oplever ingen problemer

32. Forklar evt. nærmere:

_____

33. EFTER renoveringen, hvordan oplever du så støjniveauet i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Dagslyset i din lejlighed FØR renoveringen

34. FØR renoveringen, oplevede du da problemer med, at der var ...
Gerne flere svar

(1)❑ For meget dagslys
(2)❑ For lidt dagslys
(3)❑ Blænding fra sol og himmel
(4)❑ Andet
(5)❑ Nej, jeg oplevede ingen problemer

35. Forklar evt. nærmere:

_____

36. FØR renoveringen, hvordan oplevede du da dagslyset i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Dagslyset i din lejlighed EFTER renoveringen

37. EFTER renoveringen, oplever du så problemer med, at der er...
Gerne flere svar

(1)❑ For meget dagslys
(2)❑ For lidt dagslys
(3)❑ Blænding fra sol og himmel
(4)❑ Andet
(5)❑ Nej, jeg oplever ingen problemer

38. Forklar evt. nærmere:

_____

39. EFTER renoveringen, hvordan oplever du så dagslyset i din lejlighed?

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

40. Er der oftere kondens (fugt) på indersiden af ruderne EFTER renoveringen?
(1)❑ Ja
(2)❑ Nej

Kondens på ruderne?

41. Hvor er der kondens?

_____

42. Er der oftere kondens (fugt) på ydersiden af ruderne EFTER renoveringen?

(1)❑ Ja
(2)❑ Nej

43. Hvor er der kondens?

_____

Indeklimaet i din lejlighed samlet set

44. Alt taget i betragtning, hvordan vil du så vurdere indeklimaet i din lejlighed før renoveringen?

	Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
Marker et af felterne	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

45. Alt taget i betragtning, hvordan vil du så vurdere indeklimaet i din lejlighed efter renoveringen?

	Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
Marker et af felterne	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Din vurdering af renoveringen

46. Efter at din lejlighed er blevet renoveret, i hvilken grad er følgende forhold blevet dårligere eller bedre?

	Meget dårligere	Noget dårligere	Uændret	Noget bedre	Meget bedre
Temperaturen	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Perioder hvor det er for varmt	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Perioder hvor det er for koldt	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Træk (uønsket luftbevægelse)	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Kolde områder i lejligheden	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Varme områder i lejligheden	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Lyd og støj udefra, fx trafikstøj	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Lyd og støj fra naboer	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Lyd og støj fra ud-styr/installationer i din bolig	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Lyd og støj fra aktivitet inde i din bolig	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Luftkvaliteten	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Dagslyset	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Indeklima generelt	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

	Meget dårligere	Noget dårligere	Uændret	Noget bedre	Meget bedre
Mulighed for ventilation af boligen	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Mulighed for udluftning (åbne vinduer) af boligen	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Problemer med mug og skimmel	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Kondens på indersiden af ruderne om vinteren	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Kondens på ydersiden af ruderne	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Udsigten	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

47. Er der andre forhold, der er blevet dårligere eller bedre efter energirenoveringen?
Beskriv gerne forholdet og om det er blevet dårligere eller bedre:

_____

48. Samlet set, lever resultatet af renoveringen op til dine forventninger?
(1)❑ Ja
(2)❑ Nej
(3)❑ Ved ikke

Er der noget, du/I gør anderledes EFTER renoveringen?

49. Har du/I ændret vaner i forhold til at lufte ud?

(1)❑ Ja
(2)❑ Nej

50. Lufter du/I mere eller mindre ud nu?

(1)❑ Mere
(2)❑ Mindre
(3)❑ Som før

51. Er der andet du/I har ændret i forhold til at lufte ud?
Så beskriv det her:

_____

52. Har du/I ændret vaner i forhold til hvordan du/I indstiller temperaturen i jeres lejlighed?

(1)❑ Ja
(2)❑ Nej

53. Er temperaturen blevet højere eller lavere?

(1)❑ Højere
(2)❑ Lavere
(3)❑ Ingen ændring

54. Er der andet du/I har ændret i forhold til temperaturforholdene?
Beskriv det kort her:

_____

55. Har du/I i øvrigt ændret vaner efter renoveringen (fx i forhold til lys, støj, ...)?

(1)❑ Ja
(2)❑ Nej

56. Beskriv ændring(er):

_____

Det nye ventilationsanlæg

57. Har du eller andre i husstanden modtaget information om hvordan ventilationsanlægget fungerer?

(1)❑ Ja, skriftligt
(2)❑ Ja, mundtligt
(3)❑ Nej
(4)❑ Ved ikke

58. Hvad er din mening om denne information

Meget utilfreds-stillende	Utilfreds-stillende	Hverken eller	Tilfreds-stillende	Meget tilfreds-stillende
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

59. Hvad var positivt og hvad var negativt ved denne information?

_____

60. Har du/I haft positive og/eller negative oplevelser med ventilationsanlægget?
Beskriv det kort her:

_____

Jeres varmeforbrug

61. Er jeres varmeforbrug efter renoveringen blevet så lavt som I forventede?

(1)❑ Ja
(2)❑ Nej
(5)❑ Ved ikke

62. Uddyb gerne:

_____

Huslejeforhøjelsen i forhold til udbyttet af renoveringen

63. Finder du huslejeforhøjelsen efter renoveringen rimelig i forhold til varmebesparelsen OG de andre forbedringer (f.eks. indeklima, ventilation, altan og grønne områder)?

(1)❑ Ja
(3)❑ Nej
(4)❑ Ved ikke

64. Uddyb gerne:

_____

65. Finder du huslejeforhøjelsen efter renoveringen rimelig i forhold til varmebesparelsen alene?

(1)❑ Ja
(3)❑ Nej
(4)❑ Ved ikke

66. Uddyb gerne:

_____

67. Vi vil gerne vide hvordan du/I vurderer betydningen af de enkelte forbedringer opnået ved renoveringen. Derfor vil vi bede dig om at rangordne nedenstående syv forhold, med tallene fra 1 til 7, fra det du/I har haft mest glæde af (angivet med "1") til det du/I har haft mindst glæde af (angivet med "7"). Du skal bruge alle tallene fra 1 til 7.

Bedre indeklima _____

Grønne områder _____

Nye altaner _____

Ny ventilation _____

Bygningers udseende _____

Nye vinduer _____

Udgiften til energi _____

68. Samlet set, kan du anbefale andre at få energirenoveret deres ejendom/bolig?

(1)❑ Ja
(3)❑ Nej
(4)❑ Ved ikke

69. Uddyb gerne:

_____

70. Er der andet, positivt eller negativt, som du ønsker at fremhæve eller blot gerne vil nævne, kan du skrive det her:

_____

Til sidst vil vi bede om lidt information om dig/din familie.
Husk at vi behandler alle data helt anonymt.

71. Dit køn?

(1)❑ Mand
(2)❑ Kvinde

72. Din alder?

(1)❑ 18-29
(2)❑ 30-39
(3)❑ 40-49
(4)❑ 50-59
(5)❑ 60-69
(6)❑ 70+
(7)❑ Vil ikke svare på dette spørgsmål

73. Civilstand?

(1)❑ Enlig
(2)❑ Gift
(3)❑ Samboende
(4)❑ Andet
(5)❑ Vil ikke svare på dette spørgsmål

74. Hvor mange voksne og børn bor der i din/jeres lejlighed?

Antal voksne __

Antal børn (evt. 0) __

75. Hjemmeboende barns/børns alder? (Vælg gerne flere)

(1)❑ Ingen hjemmeboende børn
(2)❑ 0-1 år
(3)❑ 2-5 år
(4)❑ 6-15 år
(5)❑ 16-19 år
(6)❑ 20-30 år
(7)❑ Vil ikke svare på dette spørgsmål

76. Hvor mange timer er der en eller flere personer tilstede i lejligheden på en normal/gennemsnitlig hverdag?

77. Hvor mange timer er der en eller flere personer tilstede i lejligheden på en normal/gennemsnitlig dag i weekenden?

78. Senere i projektet vil vi måske gerne have mulighed for at kontakte dig for et uddybende interview.
Hvis det er i orden, har vi brug for dit navn, e-mailadresse og telefonnummer.
Hvis du ikke ønsker det, springer du bare spørgsmålet over.

Navn _____

E-mail adresse _____

Telefon nummer _____

Du kan udskrive din besvarelse ved at trykke her:

Tak fordi du ville deltage i undersøgelsen.

Du vil om kort tid modtage et gavekort som tak for hjælpen.

Du afslutter din besvarelse ved at trykke på "Afslut".

Appendix 3. The questions translated into English

On the following pages the questions are translated into English. The layout in SurveyXact that respondents met, was not identical to how it looks here. The numbering is added subsequent to help compare the English translation with the original Danish questions in Appendix 2.

STATENS BYGGEFORSKNINGSINSTITUT
AALBORG UNIVERSITET KØBENHAVN

Dear resident of Traneparken,

You are very kind to help us by filling in the questionnaire.

If you answer **before 20 October** you will receive **a gift voucher of DKK 100 to** be used in **SuperBrugsen in Hvalsø.**

When answering, it is important that it is **YOUR own opinion** about the retrofits that you express. All responses will remain anonymous and will only be used in aggregated statistics.

It takes about 15 minutes to complete the questionnaire. **You need to press "Next" at the bottom of the page to move forward,** and you can get back to already answered questions by pressing "Previous". The questionnaire is not completed until you press **"Finish" at the end.** You may at any time close the questionnaire and return to your answers at a later stage, as your answers are automatically saved.

Any questions can be addressed to Henrik.

Thank you in advance for your help

Sincerely,
Søren Peter and Henrik

Henrik N. Knudsen, Senior Researcher
Danish Building Research Institute, Aalborg University, www.sbi.dk
Phone: 2662 2128, e-mail: hnk@sbi.aau.dk

Søren Peter Nielsen, Projektchef
Boligselskabet Sjælland, www.bosj.dk
Telefon: 4630 4780, e-mail: spn@bosj.dk

Your flat

1. When did you move into your current flat?

- ❑ Before 1980
- ❑ 1980-1984
- ❑ 1985-1989
- ❑ 1990-1994
- ❑ 1995-1999
- ❑ 2000-2004
- ❑ 2005-2009
- ❑ 2010-2014

2. How long do you expect to stay in the flat?

- ❑ Less than 5 years
- ❑ Between 5 and 10 years
- ❑ Between 11 and 15 years
- ❑ Between 16 and 20
- ❑ More than 20 years
- ❑ The rest of my life
- ❑ Do not know

Energy consumption

3. How often do you follow/read your household's consumption of electricity?

- ❑ Daily
- ❑ Weekly
- ❑ Monthly
- ❑ Annually
- ❑ Never

4. How often do you follow/read your household's consumption of heat?

- ❑ Daily
- ❑ Weekly
- ❑ Monthly
- ❑ Annually
- ❑ Never

5. How often do you follow/read your household's consumption of water?

- ❑ Daily
- ❑ Weekly
- ❑ Monthly
- ❑ Annually
- ❑ Never

6. How interested are you in energy-efficient behaviour in your everyday life?

- ❑ Very interested
- ❑ Interested
- ❑ Neither nor
- ❑ Not interested
- ❑ Not at all interested

7. If you were going to find a new apartment today, would the energy consumption then be included in your thoughts/considerations about which apartment you would like?

- ❑ Yes
- ❑ No
- ❑ Do not know

The retrofitting

8. Did you experience any inconvenience while the retrofitting was being carried out?

- ❑ Yes
- ❑ No

9. What inconvenience did you experience?

_____

_____

10. Overall, are you satisfied with how the retrofitting was being carried out?

- ❑ Yes
- ❑ No
- ❑ Do not know

11. Please explain:

_____

_____

The indoor climate in your flat BEFORE and AFTER retrofitting

The temperature in your flat BEFORE retrofitting

12. BEFORE retrofitting: did you have problems with...
Multiple answers possible

- ❑ Too hot

- ❑ Too cold
- ❑ Too varying temperature
- ❑ Other
- ❑ No, I found no problems

13. Please clarify your answer:

_____

14. BEFORE retrofitting: how did you find the temperature conditions in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

The temperature in your flat AFTER retrofitting

15. AFTER retrofitting: do you have problems with...
Multiple answers possible

- ❑ Too hot
- ❑ Too cold
- ❑ Too varying temperature
- ❑ Other
- ❑ No, I do not have problems

16. Please clarify your answer:

_____

17. AFTER retrofitting: how do you find the temperature conditions in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

The draught conditions (unwanted air movement) in your flat BEFORE retrofitting

18. BEFORE retrofitting: how did you find the draught conditions in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

19. Please clarify your answer:

_____

The draught conditions in your flat AFTER retrofitting

20. AFTER retrofitting: how do you find the draught conditions in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

21. Please clarify your answer:

_____

The air quality in your flat BEFORE retrofitting

22. BEFORE retrofitting: did you have problems with...
Multiple answers possible

- ❑ Stuffy air
- ❑ Unpleasant smells
- ❑ Other
- ❑ No, I found no problems

23. Please clarify your answer:

_____

24. BEFORE retrofitting: how did you find the air quality in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

The air quality in your flat AFTER retrofitting

25. AFTER retrofitting: do you have problems with...
Multiple answers possible

- ❑ Stuffy air

❑ Unpleasant smells
❑ Other
❑ No, I do not have problems

26. Please clarify your answer:

_____

27. AFTER retrofitting: how do you find the air quality in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

The noise level in your flat BEFORE retrofitting

28. BEFORE retrofitting: did you have problems with...
Multiple answers possible

❑ Noise from the outside, e.g. traffic noise
❑ Noise from activity inside the building
❑ Noise from technical installations
❑ Other
❑ No, I found no problems

29. Please clarify your answer:

_____

30. BEFORE retrofitting: how did you find the level of noise in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

The noise level in your flat AFTER retrofitting

31. AFTER retrofitting: do you have problems with...
Multiple answers possible

❑ Noise from the outside, e.g. traffic noise
❑ Noise from activity inside the building
❑ Noise from technical installations
❑ Other
❑ No, I do not have problems

32. Please clarify your answer:

_____

33. AFTER retrofitting: how do you find the level of noise in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Daylight in your flat BEFORE retrofitting

34. BEFORE retrofitting: did you have problems with...
Multiple answers possible

- ❑ Too much daylight
- ❑ Too little daylight
- ❑ Glare from sun and sky
- ❑ Other
- ❑ No, I found no problems

35. Please clarify your answer:

_____

36. BEFORE retrofitting: how did you find the daylight in your flat?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Daylight in your flat AFTER retrofitting

37 AFTER retrofitting: do you have problems with...
Multiple answers possible

- ❑ Too much daylight
- ❑ Too little daylight
- ❑ Glare from sun and sky
- ❑ Other
- ❑ No, I do not have problems

38. Please clarify your answer:

_____

39. AFTER retrofitting: how do you find the daylight in your flat?

	Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Condensation on windows?

40. Is condensation (moisture) on the inside of the windows more frequent AFTER retrofitting?

❑ Yes
❑ No

41. Where is the condensation?

42. Is condensation (moisture) on the outside of the windows more frequent AFTER retrofitting?

❑ No

43. Where is the condensation?

_____

The indoor climate as a whole in your flat

44. All things considered, how would you assess the indoor climate in your flat before retrofitting?

	Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
Select one of the fields	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

45. All things considered, how would you assess the indoor climate in your flat after retrofitting?

	Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
Select one of the fields	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Your assessment of the retrofitting

46. AFTER your flat was retrofitted, to what extent has the following factors become worse or better?

	Much worse	Somewhat worse	Unchanged	Somewhat better	Much better
The temperature	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Periods when it's too hot	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Periods when it's too cold	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Draught (unwanted air movement)	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Cold areas in the flat	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Warm areas in the flat	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Sound and noise from the outside, e.g. traffic noise	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Sound and noise from neighbours	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Sound and noise from equipment/installations in your flat	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Sound and noise from activity inside your flat	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Air quality	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Daylight	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Indoor climate in general	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Possibility of ventilation of the flat	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Possibility of airing (open windows) the flat	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Problems with mould and mildew	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Condensation on the inside of the windows in winter	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Condensation on the outside of windows	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
The view	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

47. Are there other factors that have been worse or better after energy retrofitting?
Please describe the factor and whether it has become worse or better:

_____

48. Overall, does the result of retrofitting live up to your expectations?

- ❑ Yes
- ❑ No
- ❑ Do not know

Is there something you do differently AFTER retrofitting?

49. Have you changed your habits regarding airing your flat?

- ❑ Yes
- ❑ No

50. Do you air your flat more now, or less?

- ❑ Less
- ❑ As before

51. Is there anything else you have changed regarding airing your flat?
Please describe it here:

_____

52. Have you changed habits in relation to how you set the temperature in your flat?

- ❑ Yes
- ❑ No

53. Is the temperature higher or lower than before?

- ❑ Higher
- ❑ Lower
- ❑ No change

54. Is there anything else you have changed in relation to the temperature conditions?
Please describe it briefly here:

_____

55. Have you otherwise changed habits after retrofitting (e.g. in relation to light, noise, ...)?

- ❑ Yes
- ❑ No

56. Please describe the change(s):

_____

The new ventilation system

57. Have you, or anyone else in your household, received information on how the ventilation system works?

- ❑ Yes, written
- ❑ Yes, orally
- ❑ No
- ❑ Do not know

58. What is your opinion about this information?

Very unsatis-factory	Unsatisfactory	Neither nor	Satisfactory	Very satis-factory
(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

59. What was positive and what was negative about this information?

_____

60. Have you had any positive and/or negative experiences with the ventilation system?
Please describe it briefly here:

_____

Your heat consumption

61. Is your heat consumption after retrofitting as low as you expected?

- ❑ Yes
- ❑ No
- ❑ Do not know

62. Please clarify:

_____

The rent increase compared with the outcome of retrofitting

63. Do you find the rent increase after retrofitting reasonable in relation to the heating savings AND the other improvements (e.g. indoor climate, ventilation, balcony and green areas)?

- ❑ Yes
- ❑ No

❑ Do not know

64. Please clarify:

_____

65. Do you find the rent increase after retrofitting reasonable in relation to the heating savings alone?

❑ Yes
❑ No
❑ Do not know

66. Please clarify:

_____

67. We want to know how you assess the importance of the individual improvements achieved by retrofitting. Therefore, we will ask you to rank the following seven items/ conditions, with numbers from 1 to 7. "1" indicates what you appreciate most and "7" indicates what you appreciate the least. You must use all numbers from 1 to 7.

Better indoor climate _____
Green areas _____
New balcony _____
New ventilation _____
Building appearance _____
New windows _____
The cost of energy _____

68. Overall, can you recommend energy retrofitting of flats to others?

❑ Yes
❑ No
❑ Do not know

69. Please clarify:

_____

70. Is there anything else, positive or negative, that you want to highlight or just want to mention, you can write it here:

_____

Finally, we would like you to give some information about yourself and your family. Please remember that we treat all data confidentially.

71. Your gender?

- ❑ Male
- ❑ Female

72. Your age?

- ❑ 18-29
- ❑ 30-39
- ❑ 40-49
- ❑ 50-59
- ❑ 60-69
- ❑ 70 +
- ❑ Do not want to answer this question

73. Marital status?

- ❑ Single
- ❑ Married
- ❑ Cohabiting
- ❑ Other
- ❑ Do not want to answer this question

74. How many adults and children live in your flat?

Number of adults

Number of children (e.g. 0)

75. Age of children living at home? (Select all that apply)

- ❑ No children at home
- ❑ 0-1 year
- ❑ 2-5 years
- ❑ 6-15 years
- ❑ 16-19 years
- ❑ 20-30 years
- ❑ Do not want to answer this question

76. For how many hours are one or more persons present in the flat during a normal weekday? __

77. For how many hours are one or more persons present in the flat during a normal day in the weekend?
__

78. Later in the project, we might like to be able to contact you for an interview.
If it's OK, we need your name, e-mail address and phone number.
If you prefer not to answer, just skip this question.

Name _____

E-mail address _____

Phone number _____

You can print your answers by clicking here:

Thank you for participating in the survey.

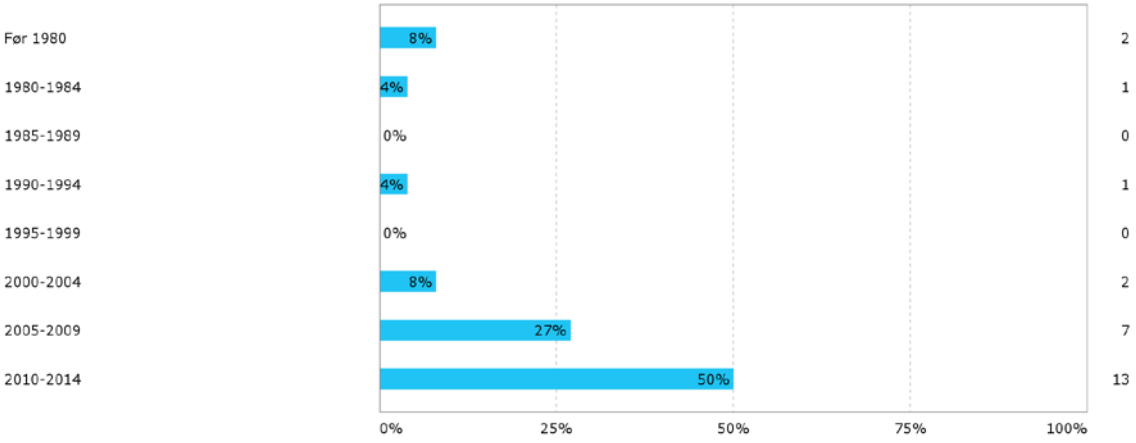
You will shortly receive a gift voucher of Dkk 100 as a thank you for your help.
You finish your answer by pressing the "Finish"-button.

Appendix 4. Questions and answers of the questionnaire survey

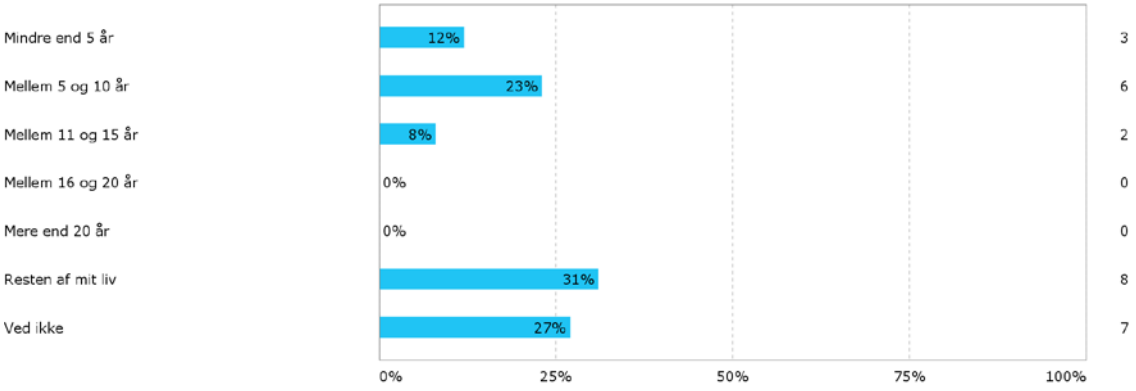
In appendix 4 all answers and results are presented in the same order as the questions were asked in the Danish electronic questionnaire, see Appendix 2. To save recourses the appendix is in Danish. To make it readable for the English speaking reader each question (in Danish) is numbered so that it is possible to find the corresponding English translation of the question in Appendix 3.

Din lejlighed

1. Hvornår flyttede du ind i din nuværende lejlighed?

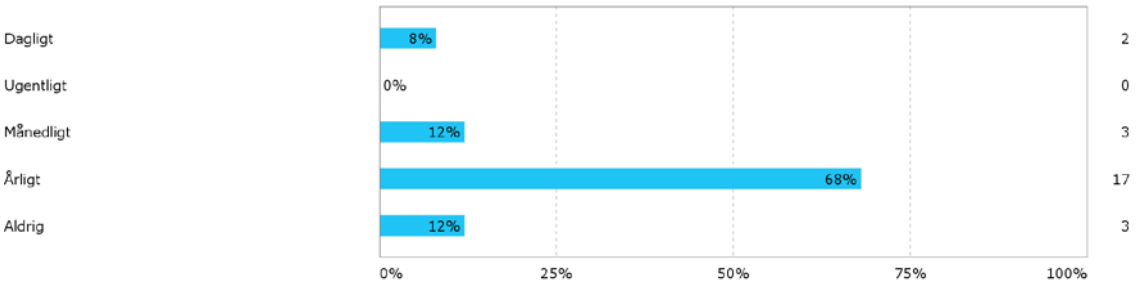


2. Hvor længe forventer du/I at blive boende i lejlighed?

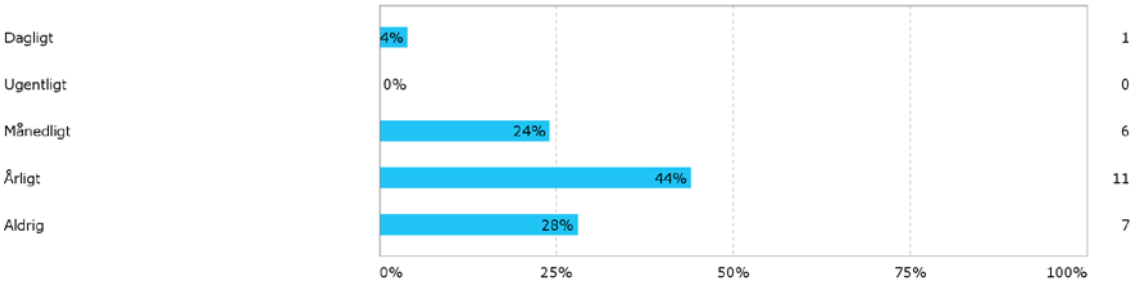


Energiforbrug

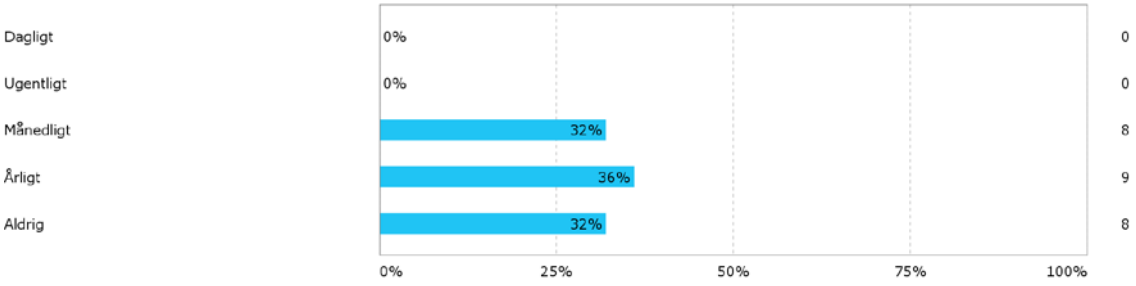
3. Hvor ofte følger/aflæser du din husstands forbrug af el?



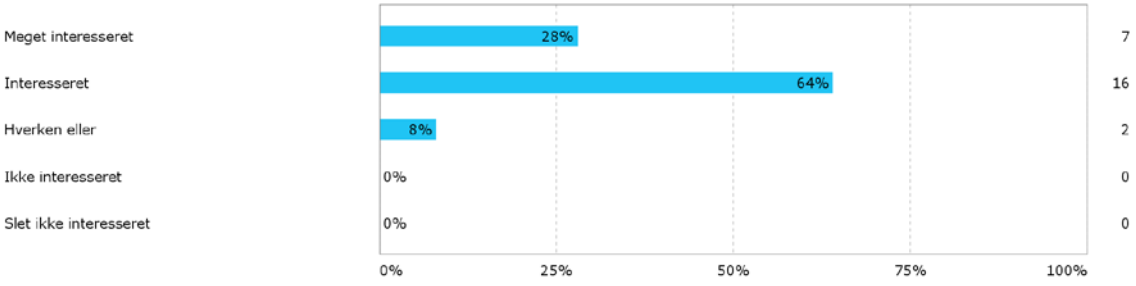
4. Hvor ofte følger/aflæser du din husstands forbrug af varme?



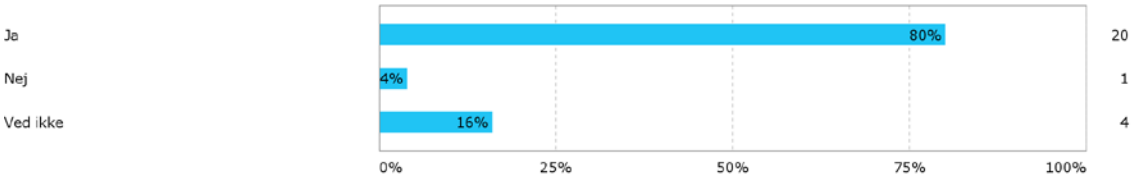
5. Hvor ofte følger/aflæser du din husstands forbrug af vand?



6. Hvor interesseret er du i energirigtig adfærd i dagligdagen?

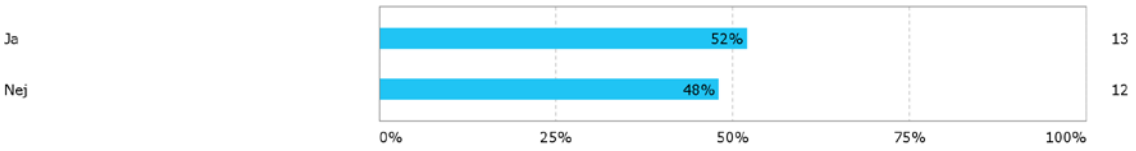


7. Hvis du skulle ud og finde en ny lejlighed i dag, ville energiforbruget så indgå i dine overvejelser om hvilken lejlighed, du kunne tænke dig?



Renoveringen

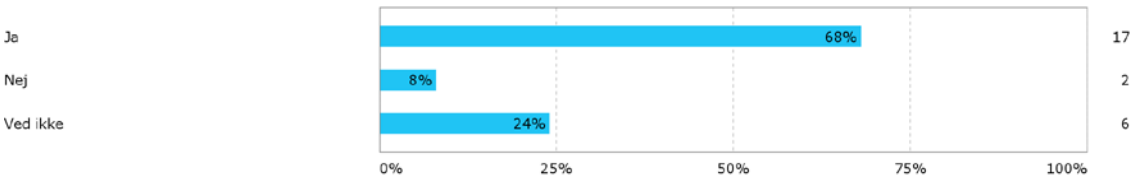
8. Havde du/I nogen gener imens renoveringen blev gennemført?



9. Hvilke gener havde du/I?

- fejlmontering af vinduer og altandør
  (selvfølgelig støv allevegne)
- Støj, støv og pladsmæssige. Der manglede varsling af og til.
- De helt sædvanlige med støj - håndværkere, der skulle leveres nøgle til med jævne mellemrum - støv i hjemmet efter isætning af nye vinduer - helt almindelige ting.
- vi måtte flytte i 14 dage, støjproblemer!
- 2 gange glemte håndværkerne at låse dør efter udført arbejde.
- Huller i støvvæggen.
- Fodkoldt samt ikke muligt at varme ordentlig op.
- Larm
  Håndværkere der gik ind og ud af lejligheden i ugevis uden at man vidste hvornår de var der. Det skal siges at det uheldigvis faldt sammen med vores sommerferie.
  Stilladserne uden for vinduerne, hvor der i mange måneder gik håndværkere rundt foran ens vinduer uden gardiner
  Masser af murstøv. Jeg fik ikke at vide hvornår de kom ind i lejligheden, så jeg kunne ikke dække møbler og elektronik af inden der blev skåret i beton og trægulve. Det krævede mange hovedrengøringer når man kom træt hjem fra arbejde
- Boligen, 1'ste sals gavllejlighed, var meget fodkold.
- Da vinduer/altandør blev skiftet tog det flere dage. Vi havde 13 gr - i weekenden måtte der varmeblæsere til.
- Der var støv alle vegne, jeg havde hul i væggen i flere uger, da de pillede den gamle altan ned. Da der skulle skiftes vinduer satte de en støvvæg op og selv om der var sat denne væg op havde de formået at vælte billeder ned fra min kommode. Der var beskidte hænder på nymalet væg og malerklatter på gulvene. Da de satte mit vindue op i stuen klagede jeg over utætheder og der gik et helt år før der stod en håndværker og ville lave det. Imens havde jeg foret utæthederne med viskestykker og trusseindlæg :(
- Larm, støv
- Håndværkere som gik ud ind og hvornår det passede med planlægningen
- meget støv i lejligheden dårlig planlægning fra byggeledsen dårlig parkring og info var så dårligt

10. Samlet set, er du tilfreds med hvordan renoveringen blev gennemført?



11. Forklar gerne nærmere:

- Vi er først flyttet ind efter renoveringen var færdig, men den er flot udført.
- Dejligt med isolering
- Jeg var godt klar over, at der ville være gener, mens renoveringen stod på. Vi startede med én byggeleder, der var kompetent, men fik en anden efter kort tid. Den nye kunne ikke rigtig overholde aftaler, men det gik jo alligevel.

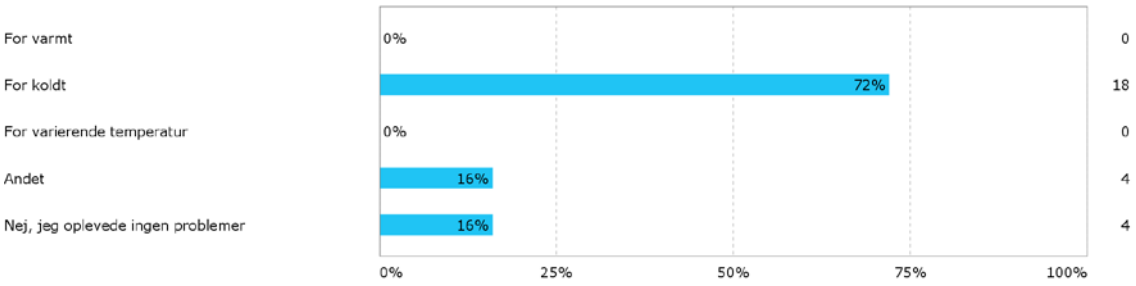
- Jeg synes informationsniveauet var fint. Der blev varslet i god tid, så vi havde mulighed for at forberede os eller rømme hjemmet helt. De håndværkere, der gik rundt på pladsen var super hjælpsomme og behandlede i øvrigt mit hjem med respekt.
- Er flyttet ind efter renoveringen, derfor havde jeg heller ikke gener ved selve renoveringen.
- Jeg er flyttet ind i lejligheden, da renoveringen stort set var færdig
- Fordi resultaget bliv godt.
- Jeg var overhovedet ikke berørt af det, da jeg var på arbejde mens de var der.
- Da min lejlighed blev renoveret om sommeren var der ikke de store gener. Så alt i alt er jeg meget tilfreds med forløbet.
- Det var ofte et problem at håndværkerne var østeuropæere som man ikke kunne kommunikere med
- Synes ikke der var styr på tingene. For meget "hovsa" over det. Tænker et sådan projekt har andre gjort på bedre vis!!!
- Syntes det var mærkeligt at de bare forlod pladesen hernede fra den ene dag til den anden, på trods af at der var mange der havde en masse problemer der ikke var lavet
- Jeg boede ikke i afdelingen under renoveringen.
- Beboerne blev overhørt, svært at få hverdagen til kører, der blev gjort alt for at beboerne skulle have det så svært som muligt under hele renoveringen igennem. Varslinger når håndværkene skulle i lejligheden kom al for sent og flere gange kom de slet ikke, byggelederen var ligeglad med beboerne.

Indeklimaet i din lejlighed FØR og EFTER renoveringen

Temperaturen i din lejlighed FØR renoveringen

12. FØR renoveringen, oplevede du da problemer med, at der var…

Gerne flere svar

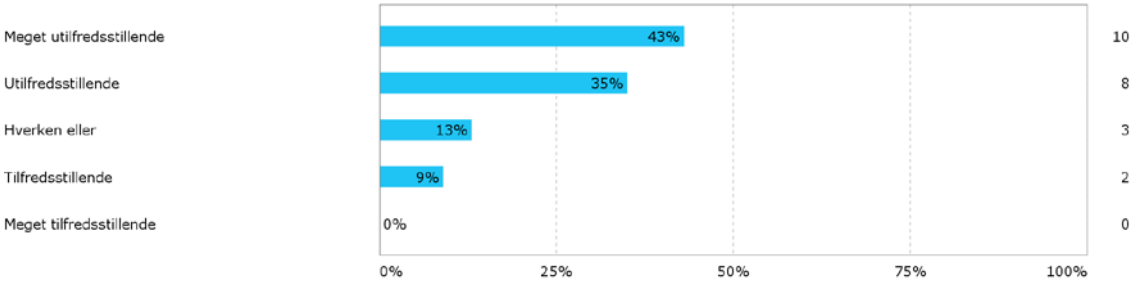


13. Forklar evt. nærmere:

- ikke flyttet ind endnu
- Træk fra vinduer, døre, og der var fodkoldt.
- altid koldt - selvom der var skruet helt op for varmen
- Der var meget fodkoldt og vægen i køkkenet var tit våd om vinteren. Tapetet slog fra. Det var lidt bedre i de andre rum.
- Ydervæggene var som is pga dårlig/for lidt isolering og der var svært at varme lejligheden op og holde en jævn temperatur.
- Hvor er ved ikke ! jeg er flyttet ind efter !!!
- Jeg har ikke boet i lejligheden før renoveringen. derfor kan jeg ikke besvarer det
- Fordi der var åben ud til det fri luft
- P.g.a. dårlig isolering
- Der var træk fra døre og vinduer. På sv. vendte vinduer var der fugtigt når det regnede kraftigt.

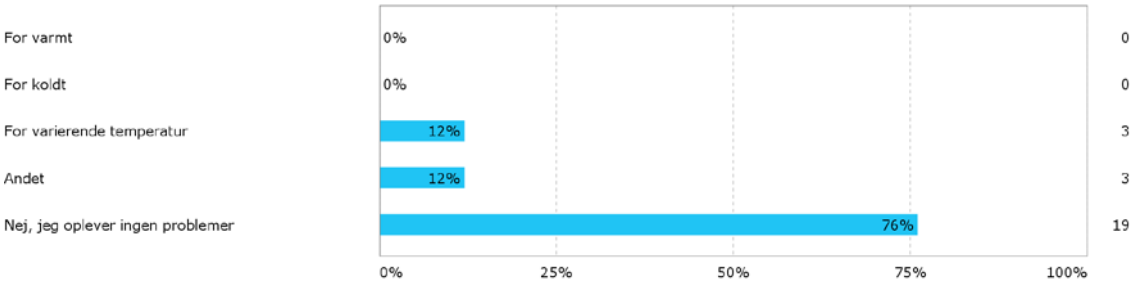
- Da jeg bor øverst og i en ende lejlighed kom kulden fra flere sider og det trak ved vinduer samt altandøren. Det var svært at varme lejligheden op.
- Kolde gulve og meget kolde vægge
- Træk fra hoveddøren samt fodkulde.
- Jeg flyttede ind i juni, som renoveringen starter op et par måneder senere. Men ved fra flere beboere, at varmen altid har været et problem. Altså manglende varme.
- Temperaturen i lejligheden var tilpas mine gardiner stod ikke og blafrede når det blæste
- Jeg boede ikke i afdelingen.
- Her var meget utæt det trak ind alle steder

14. FØR renoveringen, hvordan oplevede du da temperaturforholdene i din lejlighed?



Temperaturen i din lejlighed EFTER renoveringen

15. EFTER renoveringen, oplever du så problemer med, at der er…
Gerne flere svar

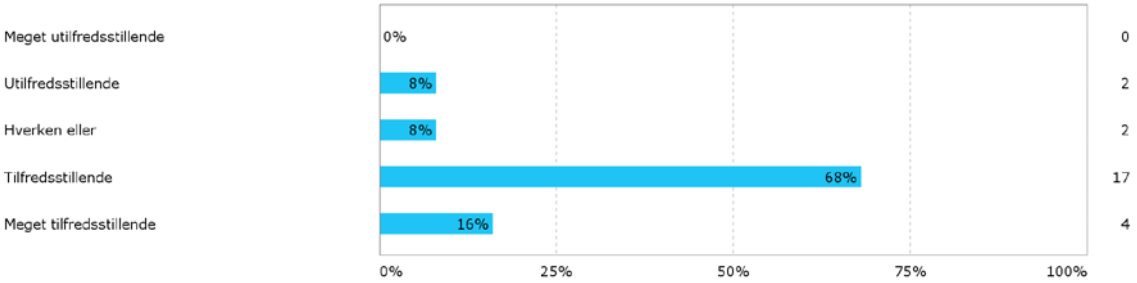


16. Forklar evt. nærmere:

- Det trækker, når man sidder ud for ventilatoren i stuen. Der en konstant summende lyd, som kan være irriterende.
- Ydervæggene er stadig kølige, men den bedre/yderligere isolering gør, at det er nemmere at varme rummene op og holde en mere stabil temperatur. Alene det, at altanen er kommet på, gør, at temperaturen er lettere at holde i stuen - det er som en gang ekstra isolering :-)
- Jeg syntes temperaturen er ok, dog er det ubehageligt med ventilations udpustning i stuen. Det virker somme tider som træk p. gr. ventilationen
- Med det nye ventilations system der skifter luften ud i lejligheden x flere i løbet af døgnet, er luftfugtigheden blevet meget lav om vinteren. Så lav at jeg får stød på lyskontakterne og det slår gnister...
- Fyrede kun ganske lidt i vinteren 2013/2014. Den luft der blæses ind bidrager til at holde en god temperatur
  Ingen kolde vægge og gulve
- Samme behagelige temperatur i hele boligen, fordi dørene til de enkelte rum kan stå åbne.
- Har indtil nu ikke haft problemer med temperaturen.

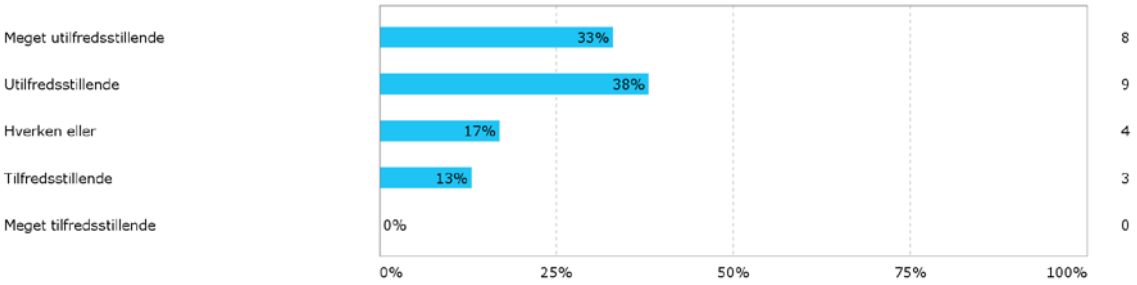
– Når det er koldt udenfor har jeg problemer med at holde en konstant temperatur, i varmen kan jeg slukke alle radiator og have vinduerne åbne hele tiden uden at det har en indvirkning på temperaturen. Iær når det blæste kunne jeg mærke hvordan temperaturen var forskellig i hvert rum.

17. EFTER renoveringen, hvordan oplever du så temperaturforholdene i din lejlighed?



Trækforholdene (uønsket luftbevægelse) i din lejlighed FØR renoveringen

18. FØR renoveringen, hvordan oplevede du da trækforholdene i din lejlighed?

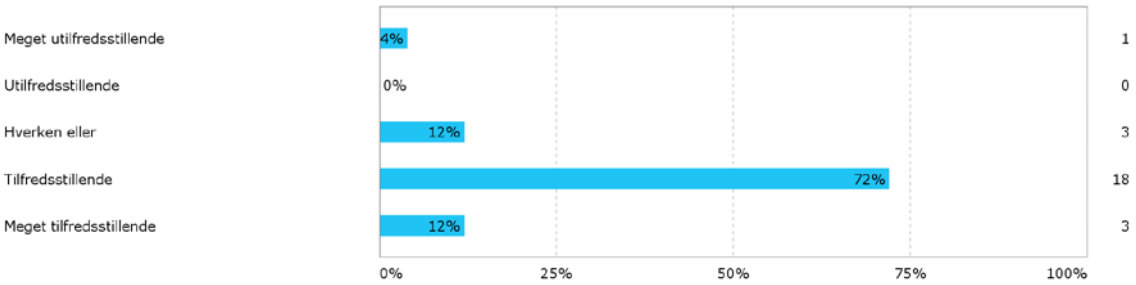


19. Forklar evt. nærmere:

– Ikke flyttet ind
– Det trak især fra under vinduerne, specielt i køkkenet.
– Det trak rigtig meget fra hovedøren og også ved nogle af vinduerne. Alle døre skulle hele tiden holde lukkede for at mindske træk.
– Kan ikke besvares se tidligere
– Træk alle vegne fra!
– Se tidligere beskrevet
– Træk fra hoveddøren samt fodkulde. Dørene til entreen, hvor hoveddøren er placeret, var nødvendig at holde lukket, hvis temperaturen skulle over 20 grader i opholdsrummene.
– Flyttede ind i juni.
– jeg lagde overhovedet ikke mærke til at det blæste udenfor og jeg havde ingen problemer

Trækforholdene i din lejlighed EFTER renoveringen

20. EFTER renoveringen, hvordan oplever du så trækforholdene i din lejlighed?

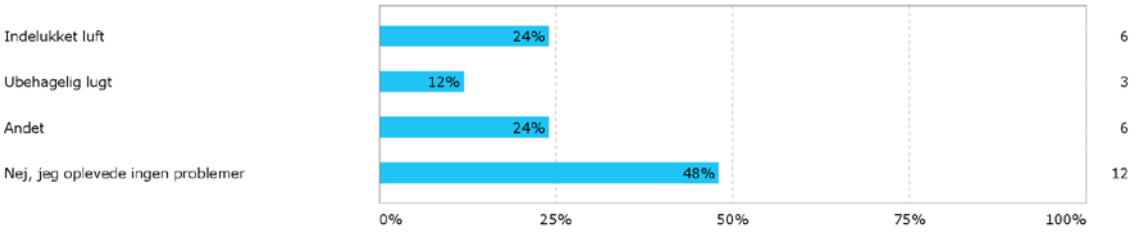


21. Forklar evt. nærmere:

- Det trækker stadig fra hoveddøren. Jeg fik lovet ekstra isolering, men det skete aldrig. Jeg kan se lyset ude fra trappen, når der er mørkt i min entre. Det trækker dog ikke så meget som før pga af vindfanget udtil. Det trækker ikke mere ind ved nogle af vinduerne.
- se tidligere
- Det trækker fra luftkanalerne når der blæses luft ind. Luften føles koldere end temperaturen i rummet...
- Ventilerne på udblæsningen fra genveksnlæget skulle have været muligt at retningsbestemme. Nuværende ventiler blæser ud hele vejen rundt om ventilhovedet, hvilket kan, afhængig af møbler placering i boligen, visse steder føles som "træk".
- Havde et problem med et vindue på værelse, som blev løst.
- Jeg kunne ikke have tændt stearinlys i lejligheden fordi mange gange blev de blæst ud(fyrfadslys)og bloklys osede og blafrede som om et vindue stod åben

Luftkvaliteten i din lejlighed FØR renoveringen

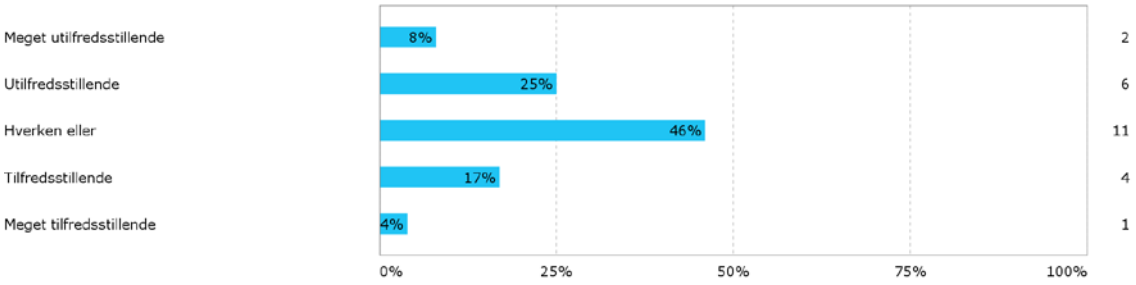
2. FØR renoveringen, oplevede du da problemer med, at der var…
Gerne flere svar



23. Forklar evt. nærmere:

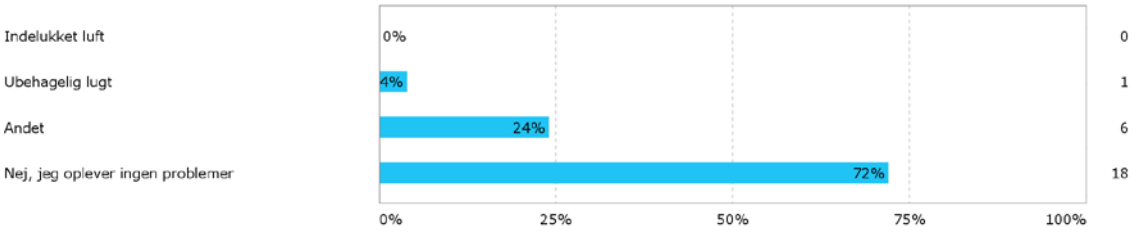
- ikke flyttet ind
- Det var dyrt at varme op, da der var luftpassage under gulvene.
- se tidligere
- på grundet af træk
- Luftede dog meget ud
- Meget fugtig luft, hvis der ikke blev udluftet tilstrækkeligt.
- Flyttede ind i juni - var ok.
- havde ingen problemer med indeklimaet før renoveringen og lagde ikke mærke til noget

24. FØR renoveringen, hvordan oplevede du da luftkvaliteten i din lejlighed?



Luftkvaliteten i din lejlighed EFTER renoveringen

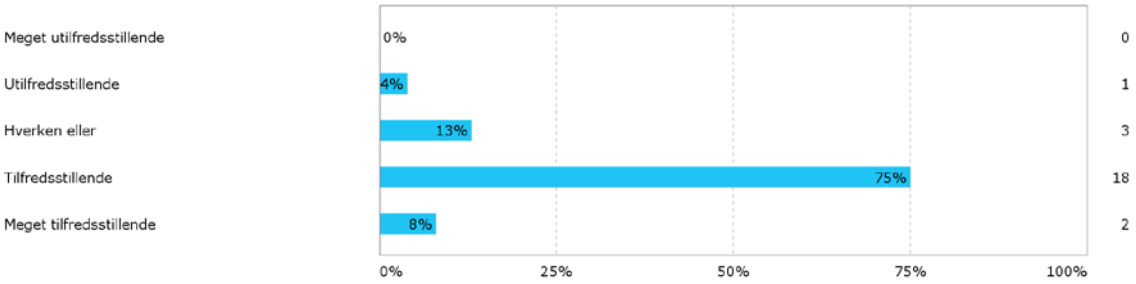
25. EFTER renoveringen, oplever du så problemer med, at der er…
Gerne flere svar



26. Forklar evt. nærmere:

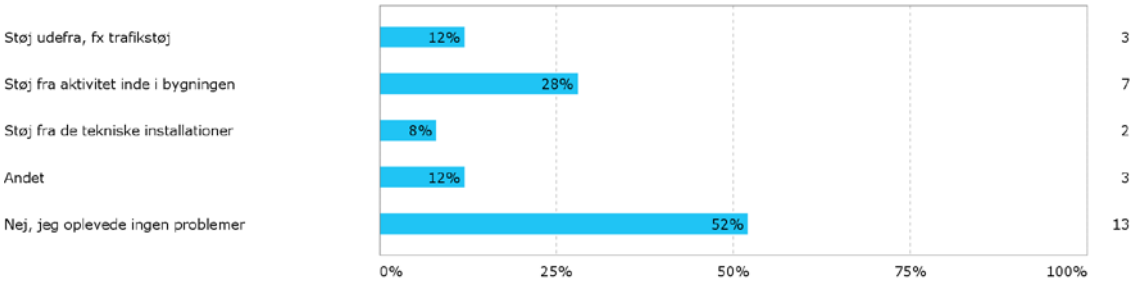
- Tør luft.
- Nej der er kun træk fra ventilatoren i stuen.
- i vinter halvåret, suges der en del brændelugt fra omegnens boliger, kan være lidt træls, nu når man ikke selv har brændeovn.
- Indsugningsluft kan være dårlig.
- Luft tørhed.
- Væsentligt nemmere at bo med en ildelugtende teenager på det lille værelse, da der bliver blæst luft ind, så der sker en automatisk udskiftning af luften
- Genveksanlæget har virkelig forbedret indeklimaet. Til tider er fugtighedsprocenten alt for lav. Personlig har jeg registreret under 30% luftfugtighed i boligen.
- Der var MEGET tørt til at begynde med, p.g.a. genvekssystem. Det har udlignet sig nu.
- har ingen problemer med indeklimaet nu heller
- Lugtgener på grund af ventilationen som kører automatisk

27. EFTER renoveringen, hvordan oplever du så luftkvaliteten i din lejlighed?



Støjniveauet i din lejlighed FØR renoveringen

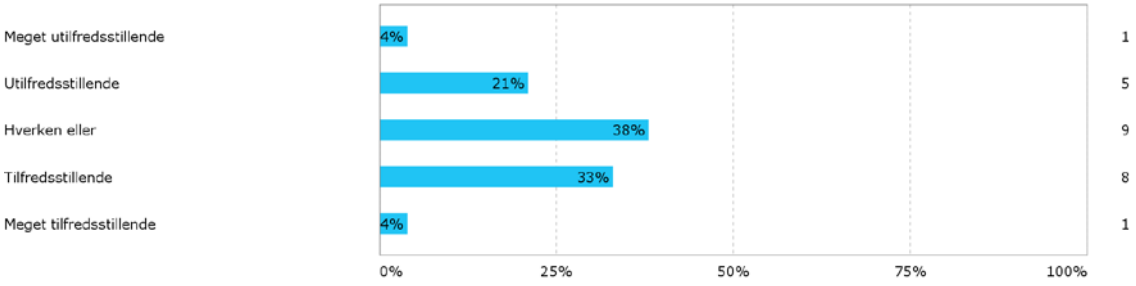
28. FØR renoveringen, oplevede du da problemer med, at der var…
Gerne flere svar



29. Forklar evt. nærmere:

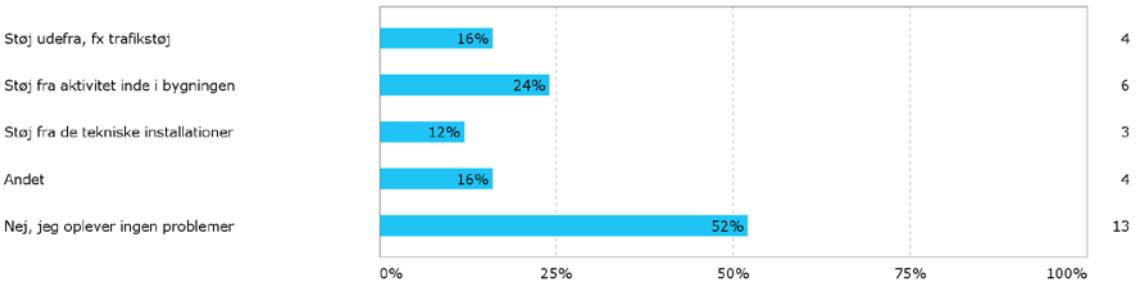
- ikke flyttet ind
- Der var mere støj i opgangen. Det skyldtes brevsprækkerne og en mindre isoleret hoveddør. Støj fra naboer er det samme som før.
- Jeg bor i stueetagen lige ud til renovationscontainerne og når de tømmes støjer det meget kl. meget tidligt om morgenen. Der kører en knallert/scooter med aviser om morgenen kl. ca. 5, som støjer helt vildt. Der er meget lydt her - jeg tror ikke jeg længere har specielt støjende overboer, men jeg kan høre alt, hvad de foretager sig og jeg kan høre naboens tv og skænderier.
- se tidligere
- der er ikke støjisoleret i vægge og etage adskilles
- Flyttede ind juni!!!

30. FØR renoveringen, hvordan oplevede du da støjniveauet i din lejlighed?



Støjniveauet i din lejlighed EFTER renoveringen

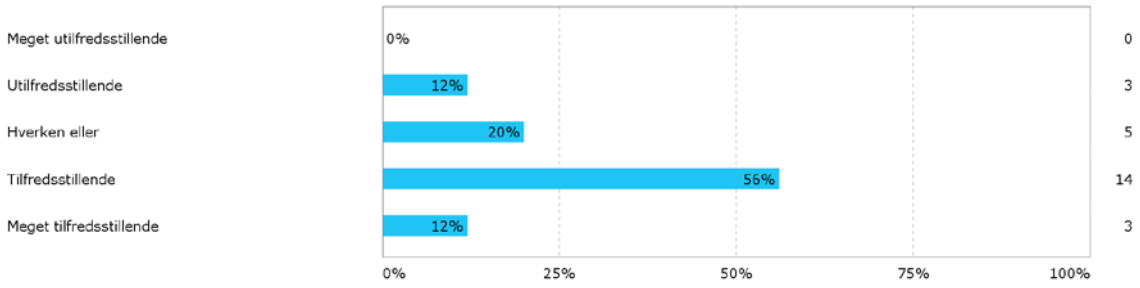
31. EFTER renoveringen, oplever du så problemer med, at der er…
Gerne flere svar



32. Forklar evt. nærmere:

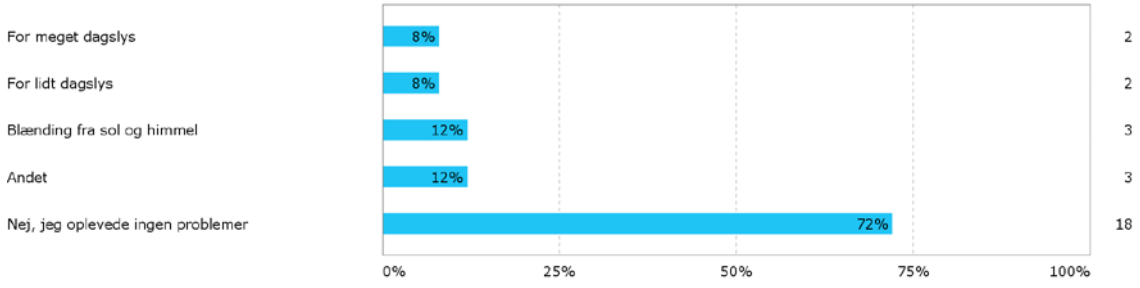
- Det summer.
- Samme som før renoveringen.
- man kan høre lidt af hvert, banen og barnegråd ind imellem men betragter det som bo-lyde!!
  har dog oplevet ged i klimaanlægget der er gået amok med bankelyde og synes der er blevet reageret lidt for langsomt.
- Hvis vinden er kraftig er der en irriterende klapre lyd, ellers utroligt stille
- der er jo stadigvæk ikke støjisoleret i vægge, gulv og loft
- jeg kan i mit køkken langs faldstammen jo stadig høre overboen tisse
- Hvis støjniveauet skal kommenteres, så kan det udtrykkes ved, at når alle vinduer og altandør er lukket, trænger der ingen former for lyd udefra og ind i boligen.
- Underboen kan altid høres. "Støj" fra anlæg/genveks afgiver tit lyde... Det er lejligheder - der er lyde, har lært at overhøre det. Med mindre det er højt ell anderledes.
- jeg kan hører alt hvad mine naboer gør hvilket nogle gange kan skabe nogle konflikter, f.eks. når overboens søn vælger at høre høj musik kl. 20 om aften. det er der mine to små børn kommer i seng
- Lidt støj fra ventilation

33. EFTER renoveringen, hvordan oplever du så støjniveauet i din lejlighed?



Dagslyset i din lejlighed FØR renoveringen

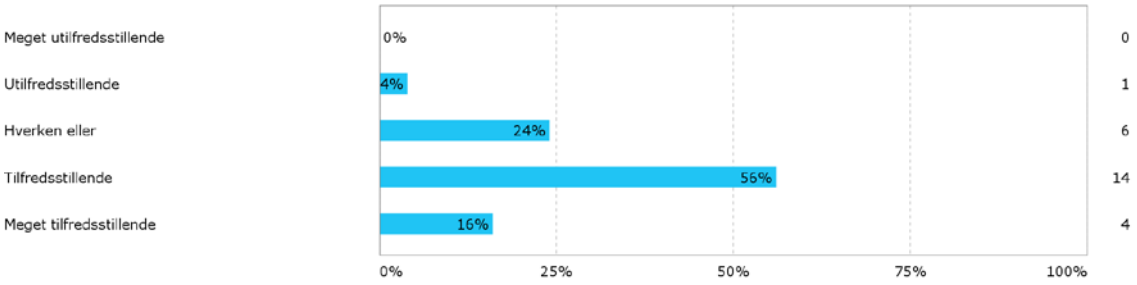
34. FØR renoveringen, oplevede du da problemer med, at der var ...
Gerne flere svar



35. Forklar evt. nærmere:

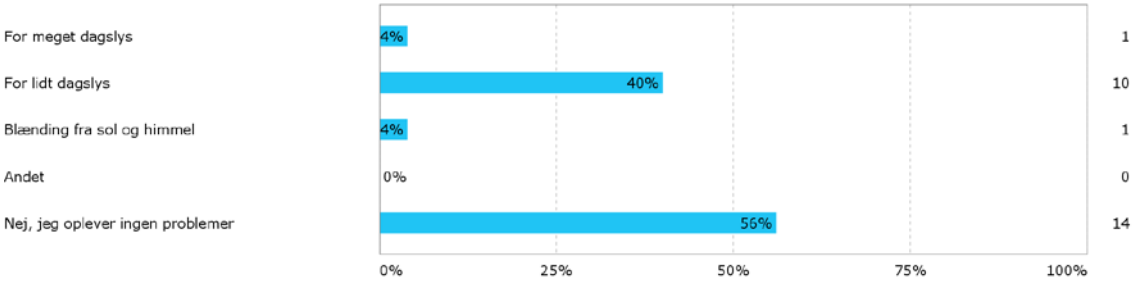
- ikke flyttet ind
- i stuen er der blevet meget mørkerer på grund af altanen
- Der var mere lys i lejligheden. Det er lidt trist at det er blevet mørkere.
- se tidligere
- Boligen ligger nord/syd, hvilket betyder at samtlige rum mod øst har solen om morgenen, medens de vestvendte rum har glæden om eftermiddagen. Opholdsstue samt køkken er vestvendt, hvilket giver et både varme- samt lysproblem i sommermånederne. Problemet må kaldes et "luksusproblem".

36. FØR renoveringen, hvordan oplevede du da dagslyset i din lejlighed?



Dagslyset i din lejlighed EFTER renoveringen

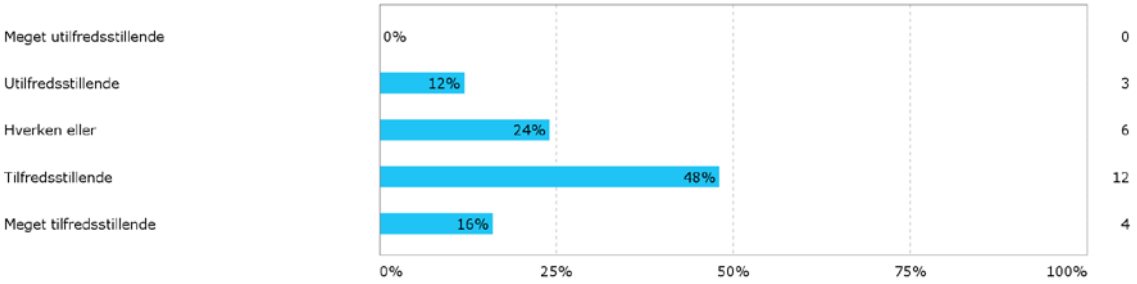
37. EFTER renoveringen, oplever du så problemer med, at der er...
Gerne flere svar



38. Forklar evt. nærmere:

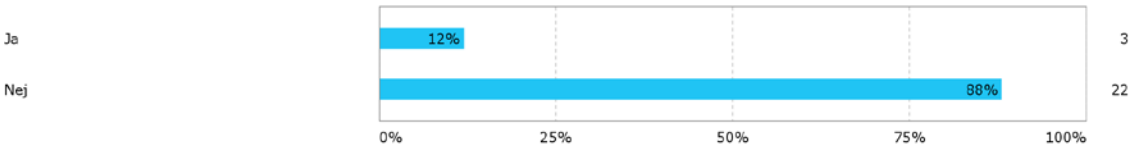
- Der er blevet markant mørkere i stuen på grund af altanen.
- Altanen har taget virkelig meget lys fra stuen
- Snes at daglig stuen virker ret mørk, hvilket vel skyldes altanerne og vores høje og meget tætte skov!
- Jeg er meget glad for en dejlig lys lejlighed, og efter vi har fået solafskærmning på altanen er det helt i top
- på grund af mange højde træer foran vinduerne
- Altanen har taget noget af dagslyset i stuen.
- Altanen er placeret i forbindelse med opholdsstuen, hvilket har bevirket et mindre lysindfald end tidligere.
- De store træer tager for meget lys

39. EFTER renoveringen, hvordan oplever du så dagslyset i din lejlighed?



Kondens på ruderne?

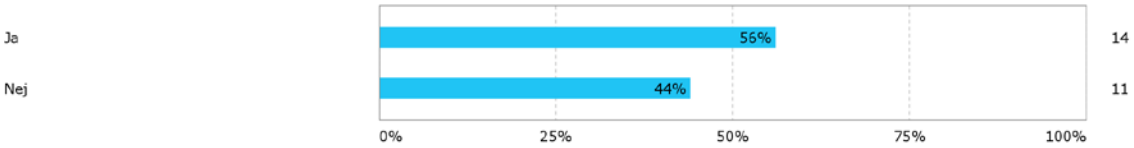
40. Er der oftere kondens (fugt) på indersiden af ruderne EFTER renoveringen?



41. Hvor er der kondens?

- tror jeg nok - dug på vinduerne ud til gaden, de står åbne "på tip"
- Der er ingen kondens på indersiden - det sørger genveks systemet for, og virker super fint
- Der er ikke observeret kondens i boligen, undtagen badeværelse, efter renoveringens afslutning.
- soveværelset
- Det er mellem ruderne og mest ud mod parkeringspladsen

42. Er der oftere kondens (fugt) på ydersiden af ruderne EFTER renoveringen?

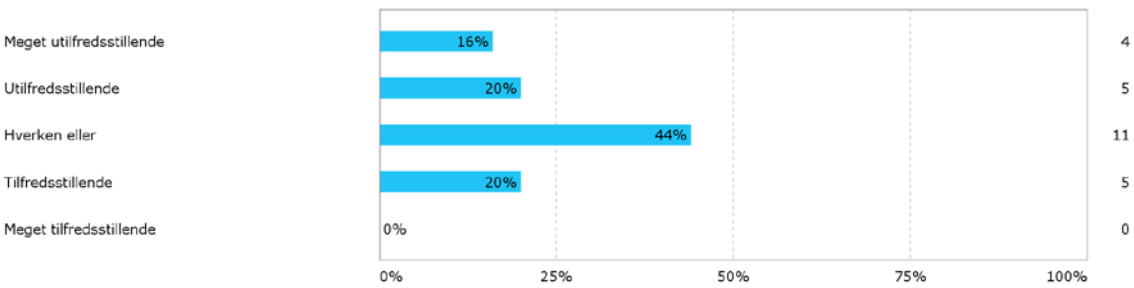


43. Hvor er der kondens?

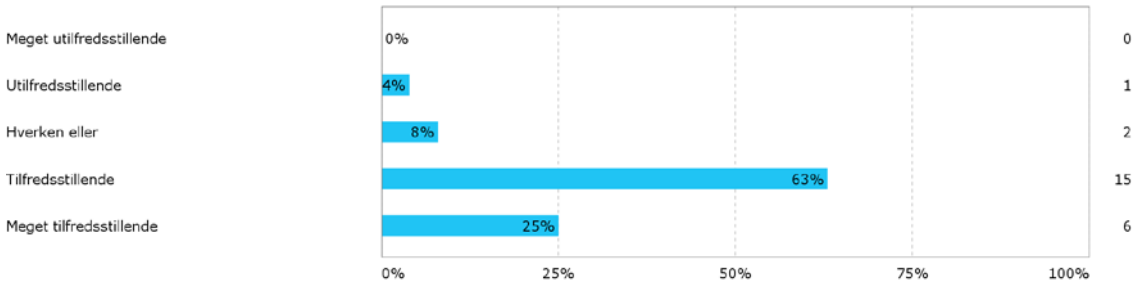
- på ydersiden
- Alle vinduer. Der var intet, da det var højsommer.
- Når der er koldt kan der forekomme kondens på ydersiden, men ikke et problem i mine øjne
- alle ruder
- på samtlige ruder i lejligheden
- Kondensen forekommer udvendig på vinduerne, men dette er bestemt af vejrforholdene, temperatur kontra luftfugtighed.
- Hele ruden er tildækket med kondens. Specielt når det er koldt/fugtigt. Op af dagen forsvinder det.
- alle vinduer i lejligheden

Indeklimaet i din lejlighed samlet set

44. Alt taget i betragtning, hvordan vil du så vurdere indeklimaet i din lejlighed før renoveringen? - Marker et af felterne

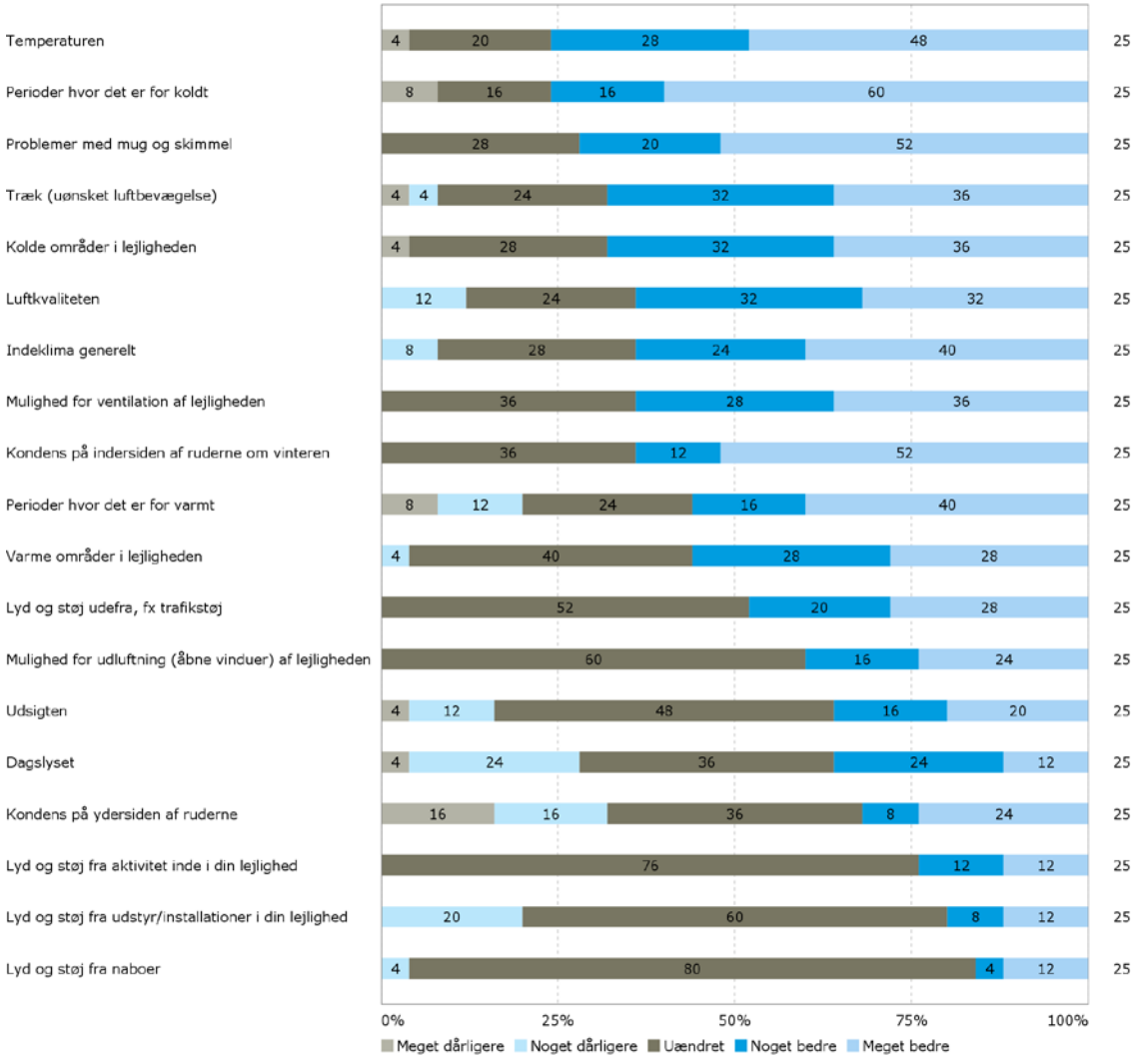


45. Alt taget i betragtning, hvordan vil du så vurdere indeklimaet i din lejlighed efter renoveringen? - Marker et af felterne



Din vurdering af renoveringen

46. Efter at din lejlighed er blevet renoveret, i hvilken grad er følgende forhold blevet dårligere eller bedre?

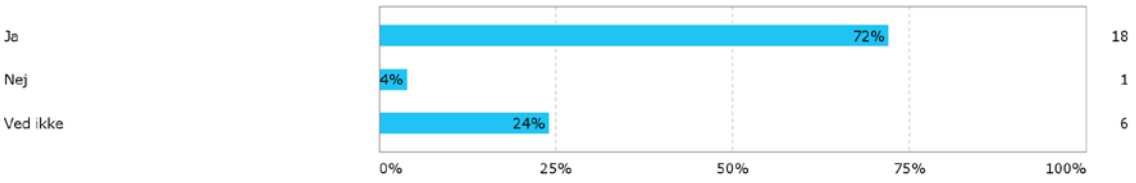


47. Er der andre forhold, der er blevet dårligere eller bedre efter energirenoveringen?
Beskriv gerne forholdet og om det er blevet dårligere eller bedre:

- bedre
- Jeg savner rampen ude foran indgangsdøren. Nu skal man gå længere, for at få en barnevogn eller lignende op. (Jeg ved det skyldes, at hældningen skal være på en bestemt måde og så kunne den ikke være der. Men det er alligevel ærgerligt).
- Jeg har det godt med alt og jeg er rigtig glad for min område.

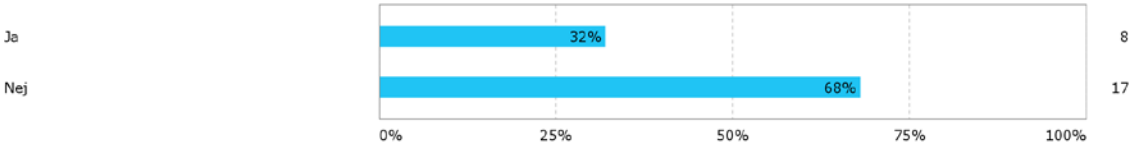
- Hele ejendommen er blevet så pæn efter facaderne er blevet skiftet. Legepladsen har fået en overhaling og bliver flittigt brugt af børnefamilierne.
  Alt i alt er jeg faktisk rigtig godt tilfreds.
- Traneparken er blevet rigtig flot og indbydende at se på
- Jeg har valgt at besvarer neutralt, da jeg ikke boede i lejligheden før og derfor ikke kan svarer på forskellen.
- det er blevet bedre
- altanen er et kæmpe plus
- Dørene i vindfanget i opgangen er meget tunge og lukker meget hurtigt. Det kan være svært at komme ind og ud med tunge indkøb, vasketøj og bagage. Samme problem til kældrene.
  Tapetet bliver sort ved indblæsningskanalerne
  lækkert med aftrækket over komfuret
- det er dejligt med altanen at man nu kan gå ud på en altan hvor der før bare var trem-mer for døren.

48. Samlet set, lever resultatet af renoveringen op til dine forventninger?

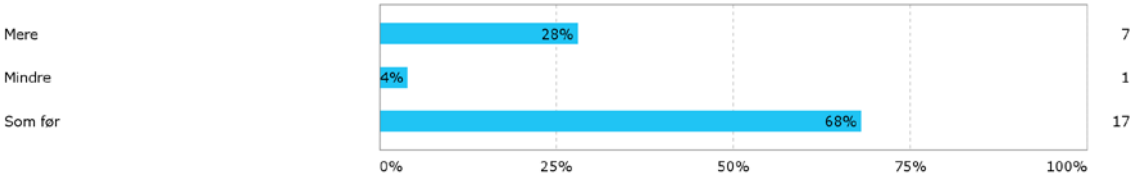


Er der noget, du/I gør anderledes EFTER renoveringen?

49. Har du/I ændret vaner i forhold til at lufte ud?



50. Lufter du/I mere eller mindre ud nu?

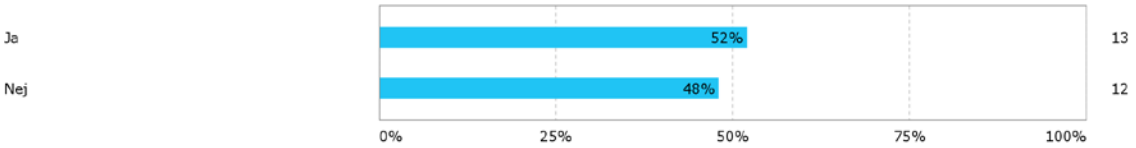


51. Er der andet du/I har ændret i forhold til at lufte ud?
Så beskriv det her:

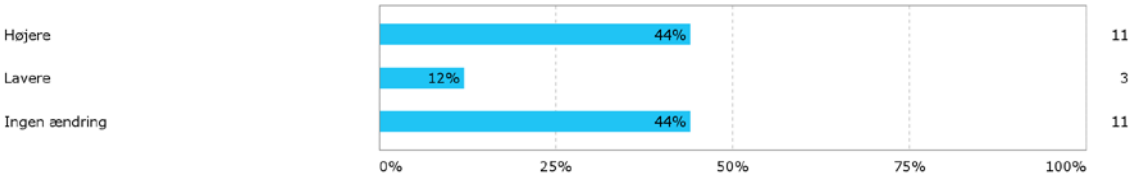
- Nej.
- nej
- Jeg lufter ud i soverummet 10-20 min morgen og aften.
  I den dejlige sommer der er gået har vinduerne på altan siden stået åbent i meget af tiden. Ligeledes har jeg sovet med åbne vinduer.
  Stadig er der svaret i forhold til jeg ikke boede der før
- Det kan være for varmt på altanen om eftermiddagen til at man kan have åbent ind til stuen (om sommeren)

- Ved mere skal forstås, at mod tidligere kan altandøren stå åben uden at det vil regne ind ad døren, men friskluftspalterne i altanen sørger for, at der hele tiden kommer frisk luft ind gennem altandøren.

52. Har du/I ændret vaner i forhold til hvordan du/I indstiller temperaturen i jeres lejlighed?



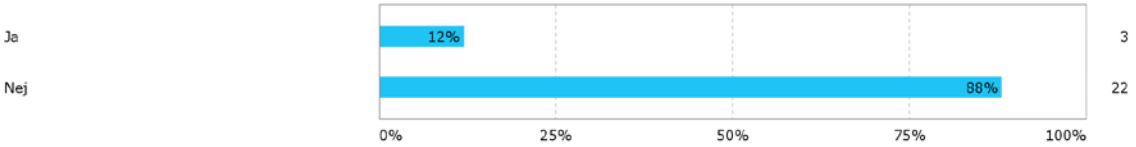
53. Er temperaturen blevet højere eller lavere?



54. Er der andet du/I har ændret i forhold til temperaturforholdene?
Beskriv det kort her:

- Nej.
- Jeg har ikke så tit tændt for varmen. Det er ikke nødvendigt mere.
- Jeg prøver altid at ramme en temperatur som er behagelig i løbet af dagen - så tager vi en trøje eller et tæppe på om aftenen:-) Det er fint.
- Der skal ikke skrues så meget op for termostaterne for at holde en god temperatur i lejligheden
- vi vælger at sætte temperaturen i lejligheden ned og så tager vi mere tøj på og hvis det virkeligt er koldt så putter vi med dynerne
- Her er blevet varmere da det trækker mere

55. Har du/I i øvrigt ændret vaner efter renoveringen (fx i forhold til lys, støj, ...)?

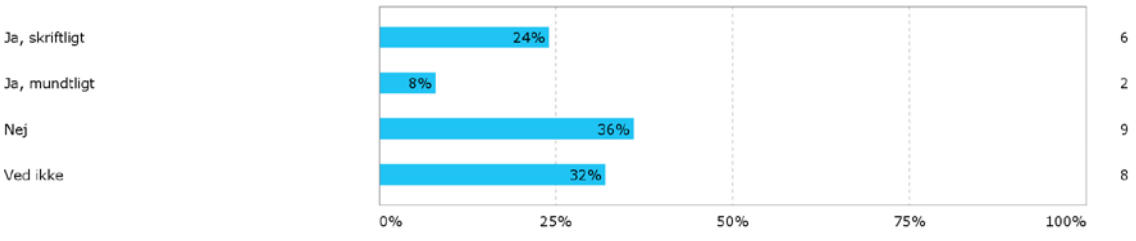


56. Beskriv ændring(er):

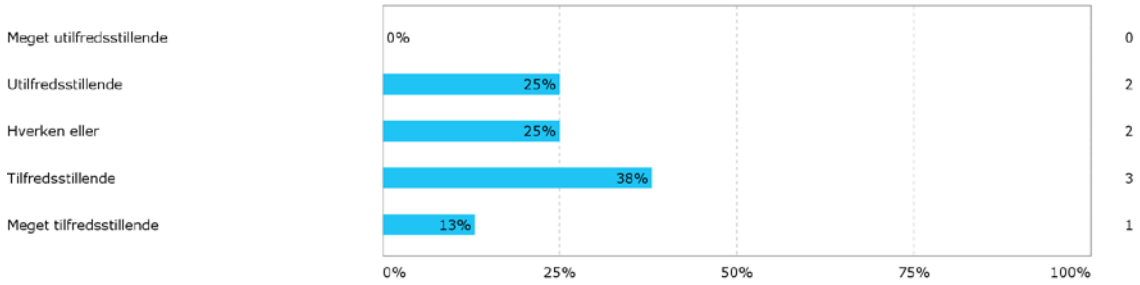
- Jeg tænder oftere lamper.
- Jeg holdt op med at ryge. Alle dørene holdes åbne om natten for at holde den samme temperatur i alle rum
- bruger ikke så meget varme

Det nye ventilationsanlæg

57. Har du eller andre i husstanden modtaget information om hvordan ventilationsanlægget fungerer?



58. Hvad er din mening om denne information



59. Hvad var positivt og hvad var negativt ved denne information?

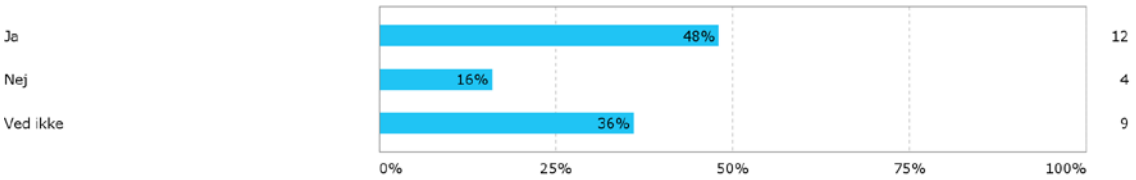
- spørgsmålene om "mine oplevelser" var lidt svære at svare på
- Ved faktisk ikke om den puster koldt luft ud om sommeren og varm luft om vinteren?
- Hvordan lukker man for ventilationen hvis der kommer gift udslip

60. Har du/I i øvrigt haft positive og/eller negative oplevelser med ventilationsanlægget?
Beskriv det kort her:

- Nej, og Jeg tror det er ligesom før.
- De ca. 20 graders luft, der blæses ind kan virke koldt, men er til gengæld behageligt med aircondition om sommeren.
- positive
- Ja. kort tid efter renoveringen var færdig, begyndte ventilationsanlægget at hamre og banke, så det var umuligt at holde ud. Jeg kontaktede P. Holst, og der kom en elektriker, som slog anlægget fra. Det blev siden lavet og der har ikke været noget siden.
- Jeg har det positive
- Bortset fra de mange lyde, der kommer fra tid til anden fra anlægget oplever jeg ingen problemer.
- Har nævnt et andet sted at det kan være generende at anlægget trækker brændelugt ind fra nabolaget og er i tvivl om det gør det samme med pollen om sommeren.
- Jeg kender genveks fra min tidligere bolig, men har ikke fået info om systemet ved indflytning. Det kunne være en god ide at fortælle f.eks at der ikke må skrues helt ind på ventilationerne
- der var på et tidspunkt det lugtede af "brændeovn", men det var vist noget med et filter der manglede.
- Det giver luft tørhed i min lejlighed om vinteren. Det trækker der fra hvor luften pustes ind i lejligheden. Synes også det er irriterende at den "suger" luft ud hele tiden i emhætten.
  Det positive er at det forebygger kondens og skimmelsvamp.
- Det fungerer rigtig godt men igen er det lidt ærgerligt at det luft der blæses ind sviner tapetet til
- når der bliver tændt op i brændeovne hos parcelhusejerne kan der godt lugte af røg i lejligheden.
- I starten var luften meget tør, som i meget tør.
- en gang prøvede det at suge luften ud af lejligheden
- Lugt gener og støj
- har ikke fået at vide hvordan det virker

Jeres varmeforbrug

61. Er jeres varmeforbrug efter renoveringen blevet så lavt som I forventede?

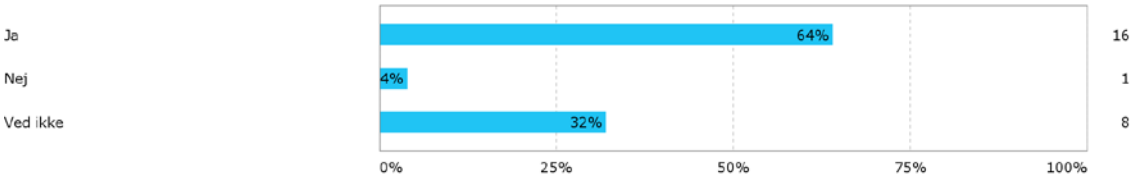


62. Uddyb gerne:

- Vi har lige modtaget varme- og vandregnskab, men der er fejl i beregningerne.
- Opgørelse ikke færdig på nuværende tidspunkt p.g.a. regnefejl.
- der mangler et gyldigt varmeregnskab til at sammenligne med
- Tror jeg - venter på det rigtige varmeregnskab
- Bruger max det halve af, hvad forbruget var sat til ved indflytning.
- ved jeg godt kunne spare meget mere på varmen hvis bare vinduerne var tætte
- har ikke tændt for varmen endnu

Huslejeforhøjelsen i forhold til udbyttet af renoveringen

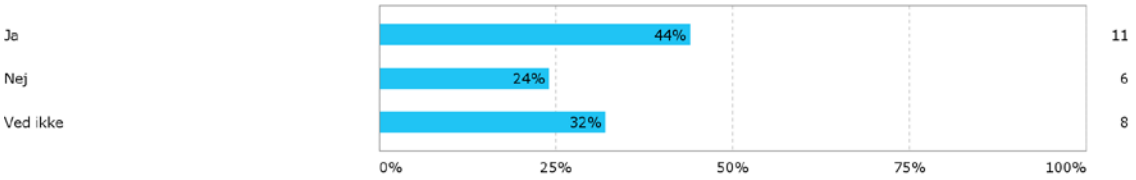
63. Finder du huslejeforhøjelsen efter renoveringen rimelig i forhold til varmebesparelsen OG de andre forbedringer (f.eks. indeklima, ventilation, altan og grønne områder)?



64. Uddyb gerne:

- Jeg har ikke noget forhold til, hvad der er rimeligt. Jeg oplever dog ikke den samlede stigning så stor, som jeg havde frygtet inden renoveringen gik i gang.
- Jeg syntes der er rigtig rart, at bo i Traneparken, og jeg syntes ejendomsfunktionærerne holder ude områderne i fin orden.
  Legepladsen er blevet fantastisk. Jeg er uddannet motorikvejleder og glædes meget over at der er så super en legeplads
  på arealet. Det opfylder virkelig mange legemuligheder for såvel store som små børn. Den er udfordrende for børn på alle niveauer. Med en "fagmand" øjne et fantastisk område, og det bliver brugt meget. Selv har jeg store teen-age børn, der også syntes legepladsen er sjov.
- Huslejeforhøjelsen blev dækket ind af reduceringen i varmeudgiften. herved har undertegnet økonomisk ikke mærket til renoveringsomkostningerne.
- Med en så stor renovering, følger en stigning. I Traneparkens tilfælde er det en lille stigning, trods alt.
- syntes det er i orden at sætte huslejen op eftersom der er kommet flere kvadratmeter på lejligheden, legepladens er ikke fair at sætte pris på, da det er alle børn i området der kan komme til at lege på den, jeg syntes ikke der er kommet mere luksus på lejligheden efter renoveringen.

65. Finder du huslejeforhøjelsen efter renoveringen rimelig i forhold til varmebesparelsen alene?



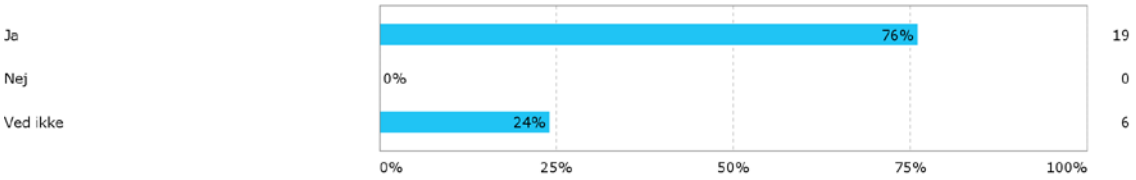
66. Uddyb gerne:

- Det var virkelig skidt før. betalte jo ligeså meget i varme som et parcelhus på 150 kvadratmeter
- Ud fra min besparelse, så ville det være en for lille gevinst på det.
- det jeg er faldet i besparelser, er næsten det samme jeg er steget i husleje.

67. Vi vil gerne vide hvordan du/I vurderer betydningen af de enkelte forbedringer opnået ved renoveringen. Derfor vil vi bede dig om at rangordne nedenstående syv forhold, med tallene fra 1 til 7, fra det du/I har haft mest glæde af (angivet med "1") til det du/I har haft mindst glæde af (angivet med "7"). Du skal bruge alle tallene fra 1 til 7.

Forbedring																									Min	Maks	Middel	Rang
Nye altaner	7	7	5	3	5	1	6	6	7	1	4	2	2	1	1	5	4	4	3	2	2	3	2	1	1	7	3,4	1
Udgiften til energi	5	3	6	7	2	6	2	1	1	3	5	5	1	3	3	1	2	1	6	7	4	7	1	3	3	7	3,5	2
Nye vinduer	2	6	1	2	4	3	1	3	6	5	1	4	5	2	2	7	3	5	4	4	7	5	3	2	4	7	3,6	3
Bedre indeklima	1	4	7	4	1	2	4	4	5	4	6	1	4	5	6	2	1	2	7	5	6	1	5	4	5	7	3,8	4
Bygningers udseende	4	5	4	6	6	4	7	2	3	2	2	3	6	6	4	4	5	6	2	3	1	4	6	7	2	7	4,2	5
Ny ventilation	3	2	2	5	3	7	3	5	2	6	3	6	3	4	7	3	6	3	5	6	5	6	4	5	7	7	4,4	6
Grønne områder	6	1	3	1	7	5	5	7	4	7	7	7	7	7	5	6	7	7	1	1	3	2	7	6	6	7	5,0	7

68. Samlet set, kan du anbefale andre at få energirenoveret deres lejlighed?



68. Samlet set, kan du anbefale andre at få energirenoveret deres lejlighed?

- Men det tror jeg da!
- Alene den økonomiske besparelse samt forbedret indeklima i boligen. Samfundsmæssig som omfatter CO_2 besparelse og færre udgifter til fossile brændstoffer.
- Når det virker optimalt, så ved man det er godt for miljø og helbred. M.h.t. skimmel/svamp - så ved man hvorfor det evt. kommer i en bolig.

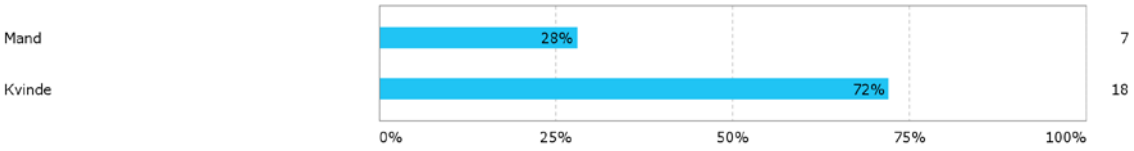
70. Er der andet, positivt eller negativt, som du ønsker at fremhæve eller blot gerne vil nævne, kan du skrive det her:

- Nej :)
- alt er positivt - undtagen de grønne områder
- Ved eftersyn af altanen fik jeg lovet en rengøring af min altan, fordi materialerne havde ligget og var blevet pænt beskidte, inden de blev sat op. Den rengøring har jeg aldrig fået.
  Gennemgående har det været fint og med forventelige gener. For mig er det vigtigt at blive informeret og varslet i god tid og det synes jeg, jeg er blevet.

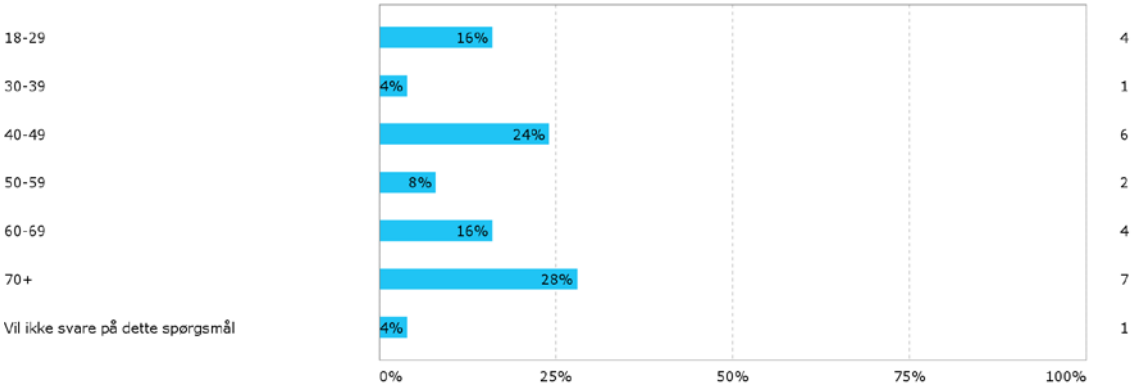
- betydningen af skemaet fra 1 til 7 er uforståeligt
- Under byggeriet steg min elregning med ca. 600 kr. jeg har mistanke om at polakkerne har haft en varmeblæser el. vandkoger med op og har brugt min inst. Men det er ok, som min mester siger "det koster at bygge"
- Loven overhalede renoveringen indenom. Ved projektplanlægning besluttedes på baggrund af daværende gældende lov, at selv om der blev renoveret opgangsfacader samt monteret vindfang skulle der installeres radiator i opgangene af hensyn til isolering. Denne radiator med tilhørende rørtilslutninger kunne have været sparet, hvis vi havde vidst at der skulle installeres genveksanlæg. I bunden af trappeopgangen blæses 20,5 grad varm luft ud, og i toppen af opgangen sidder indsugningen til anlægget. Det er konstateret at i vintermånederne, uden varme på radiatoren, er der 20 grader celsius på trappeopgangen.
- jeg finder det negativt at man sender et brev ud med posten hvor der står at der kommer håndværkere og kigger på lejligheden og at man skal være hjemme. Så er man hjemme hele dagen og der kommer ikke øje. Jeg finder det også negativt at man klager over et problem og der så skal gå et helt år før problemet bliver lavet. Jeg er super glad for lejligheden og legepladsen jeg kunne have ønsket mig at vores altaner vendte ud mod det grønne areal så vi kunne sidde på altanen og se børnene lege
- mangler stadig at blive rettet op på fejl og mangler
- dårligt service ved utætte døre og vinduer de er utætte

Til sidst vil vi bede om lidt information om dig/din familie. Husk at vi behandler alle data helt anonymt.

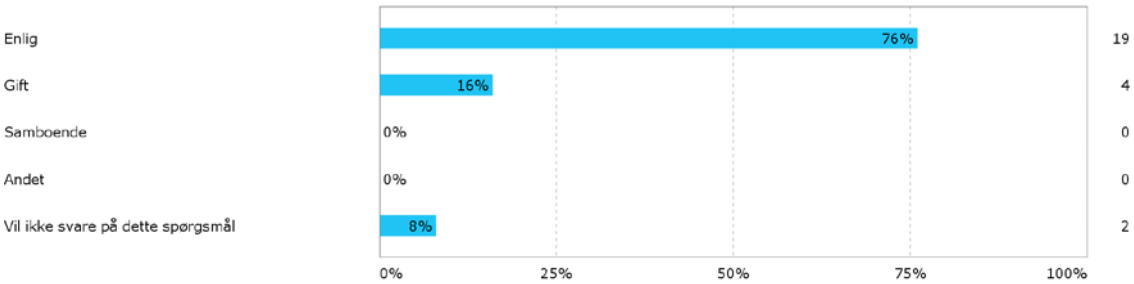
71. Dit køn?



72. Din alder?



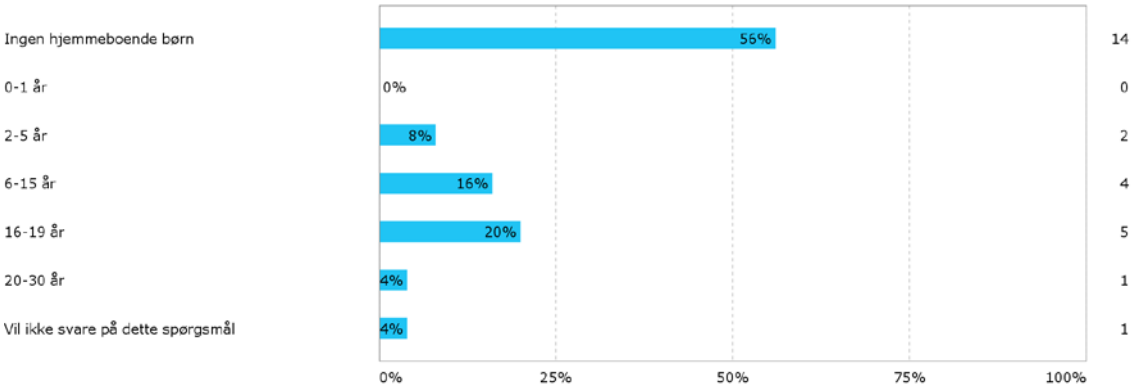
73. Civilstand?



74. Hvor mange voksne og børn bor der i din/jeres lejlighed?

Antal voksne	2	2	1	2	1	2	1	1	1	2	2	1	0	1	0	1	1	1	1	1	1	1	1	1
Antal børn (evt. 0)	2	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	2	1	2	1	0	0	0

75. Hjemmeboende barns/børns alder? (Vælg gerne flere)



76. Hvor mange timer er der en eller flere personer tilstede i lejligheden på en normal/gennemsnitlig hverdag?

77. Hvor mange timer er der en eller flere personer tilstede i lejligheden på en normal/gennemsnitlig dag i weekenden?

																									Middel	Min	Maks
76. Hverdag	8	12	24	18	13	6	22	15	8	24	19	24	10	14	12	16	0	20	16	24	15	15	0	0	14	0	24
77. Weekend	20	12	24	18	20	5	22	15	5	24	20	24	15	12	12	14	3	20	24	20	24	20	0	10	16	0	24

78. Senere i projektet vil vi måske gerne have mulighed for at kontakte dig for et uddybende interview.

Hvis det er i orden, har vi brug for dit navn, e-mailadresse og telefonnummer.

Hvis du ikke ønsker det, springer du bare spørgsmålet over.
- Navn
- E-mail adresse
- Telefon nummer

Appendix 5. Measurements in three flats in Traneparken, Hvalsø

Introduction

Measurements have been performed in three flats in Traneparken, a residential area in the city of Hvalsø located in Lejre municipality outside Greater Copenhagen area and close to Roskilde.

Traneparken consists of three residential buildings each with three storeys holding a total of 66 flats. One of the buildings is facing south while the two other buildings – one equal in size and one slightly smaller – are facing west. The buildings were built in the late nineteen sixties according to standard of that time. During 2011 and 2012 the buildings have undergone a major renovation including installation of new facades, new windows and glazed balconies, additional insulation, mechanical ventilation with heat recovery and a PV plant on the roof.

The present study is centred on the ventilation conditions in three of the renovated flats. In each of the flats the ventilation conditions are characterised through detailed measurements of the room air temperature, the relative humidity and the CO_2-concentration together with the average ventilation rate.

The measurements were conducted from 8th to 15th December 2014.

New ventilation system

Before the renovation the flats were ventilated through mechanical extract from kitchen and bathroom/toilet together with passive outdoor air supply in the living rooms. After the renovation the flats are ventilated through mechanical ventilation including heat recovery. The ventilation rate is partly demand controlled as described below.

The ventilation units are housed in custom made shelters placed on the roofs of the buildings, cf. Figure 5.1.

Figure 5.1. The ventilation units are housed in custom made shelters placed on the roofs of the buildings.

Figure 5.2. One of the renovated buildings. The ventilation units are placed on the roof. Also shown is the new glazed balconies.

In each flat air is extracted through a cooker hood in the kitchen and through extract valve in bathroom/toilet. Outdoor air is supplied to the living rooms.

The cooker hood in the kitchen is equipped with a motorised damper which is partly manually controlled by the occupants. The damper can be either “off” or “on” where position “off” is equal to base extract rate and “on” is equal to increased extract rate. In the bathroom/toilet there is a presence sensor. The state of the sensor can be “off” or “on”. In the main supply air duct there is a LeanVent damper for adjusting the supply air flow. A LeanVent damper is using a droplet-shaped built-in closing element that allows the air to pass turbulence free around the closing element. This makes a LeanVent damper more energy efficient than a conventional damper. In addition, in a LeanVent damper there is a known relation between the position of the closing element and the air flow through the damper. As the movement of the closing element is controlled via a step-motor, air flow through the damper is known through the position of the step-motor.

A controller in each flat is responsible for adjusting the closing element in the LeanVent damper, i.e. the supply air flow rate, according to the state of the motorised damper in the cooker hood and the presence sensor in bathroom/toilet, respectively. Thus, the ventilation rate in the flat can be either base ventilation (motorised damper “off”, presence sensor “off”), increased ventilation step 1 (motorised damper “on”, presence sensor “off”) or increased ventilation step 2 (motorised damper “on”, presence sensor “on”). If the presence sensor is in state “on” the motorised damper in the cooker hood is automatically set to “on”.

Figure 5.3 below shows an example of the presence sensor and an extract terminal in the bathroom/toilet. Figure 5.4 shows examples of air supply terminals in the living rooms.

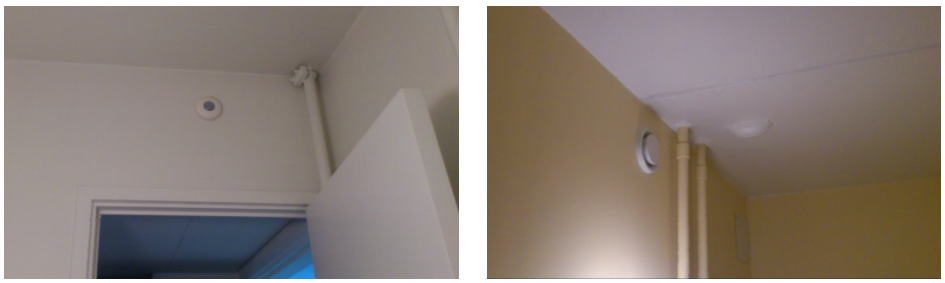


Figure 5.3. Example of a presence sensor (left) and an extract terminal in the bathroom (right).


Figure 5.4. Examples of supply air terminals.

Measurements

The measurements comprised continuous registration of the room air temperature, the relative humidity and the CO_2-concentration. Registrations were made using programmable data loggers logging every 30 minutes and registrations were done both in the living room and in the bedroom. The ventilation in the flats was measured using passive tracer gas technique, the so-called PFT-technique. Generally, measurements using the PFT-technique are performed over a period, and the result of such a measurement is the average ventilation rate during the measurement period. In this case the measurement period was about 168 hours equaling 7 days.

Results of measurements

Table 5.1 below shows average values of room air temperature, relative humidity and CO_2-concentration as obtained from the data loggers. Table 5.2 shows the measured average ventilation rate in the flats. Figure 5.5 and Figure 5.6 show examples of the continuous measurements of room air temperature, relative humidity and CO_2-concentration. Similar figures for other rooms and flats can be found in appendix.

Table 5.1. Average room air temperature, relative humidity and CO_2-concentration in living room and bedroom, respectively.

	Living room			Bedroom		
	Temp. [°C]	Rel. Hum. [%]	CO_2-conc. [ppm]	Temp. [°C]	Rel. Hum. [%]	CO_2-conc. [ppm]
Flat 1	22.1	31	460	20.3	34	450
Flat 2	22.0	33	- 1)	21.6	32	550
Flat 3	20.4	33	470	16.5	44	580

1) The occupants had by mistake switched off the power to the logger.

Table 5.2. Average ventilation rate (PFT-technique).

	Outdoor air supply	Air change rate
	[L/s per m^2 heated area]	[h^{-1}]
Flat 1	0.73	1.1
Flat 2	0.82	1.2
Flat 3	0.58	0.8

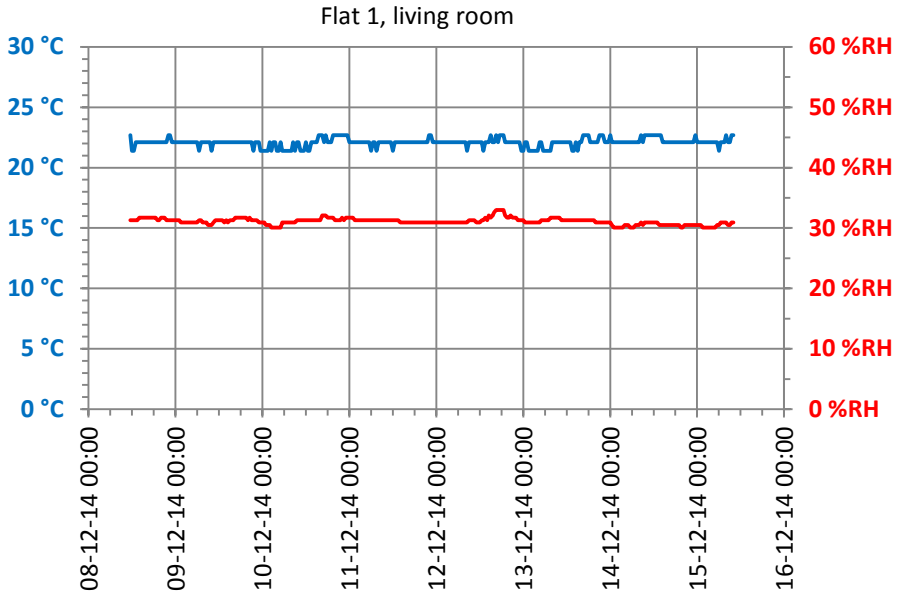


Figure 5.5. Room air temperature [°C] and relative humidity [%] in the living room in flat 1.

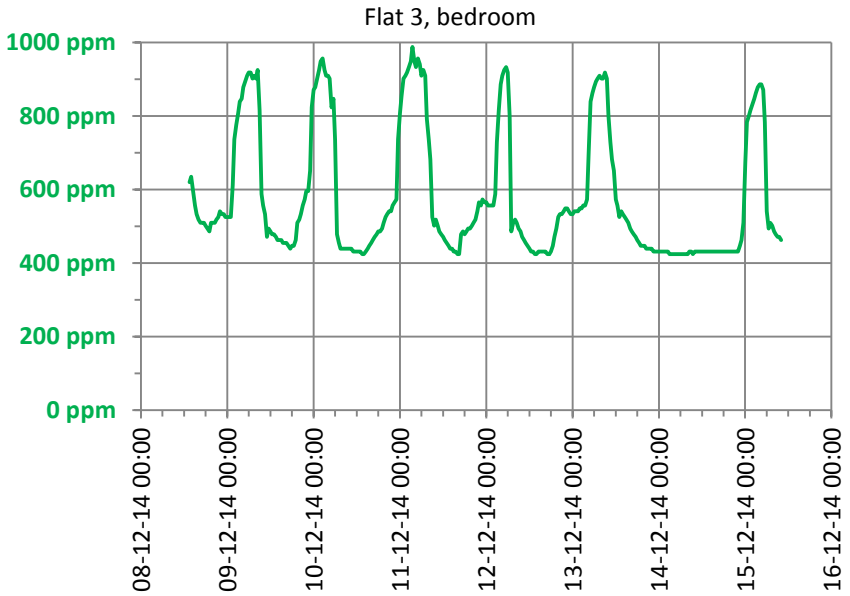


Figure 5.6. CO_2-concentration [ppm] in the bedroom in flat 3.

Discussion

The results of the measurements of the ventilation in the flats (based on the passive tracer gas technique) are that on average the ventilation conditions are above general requirements according to the Danish building code. The requirement in the building code regarding ventilation in dwellings is that the outdoor air supply must be at least 0.3 L/s per m^2 heated area. In dwellings with typical room height the requirement is equivalent to an air change rate of 0.5 [h^{-1}]. As seen from Table 5.2 the measured ventilation rates are roughly twice the required rate.
Some of the occupants had mounted self-made solutions on the supply air terminals in order to prevent draught, cf. Figure 5.7. This may be regarded as a result of the rather high ventilation rates.

Figure 5.7. Examples of supply air terminals with partly blocked openings due to draught.

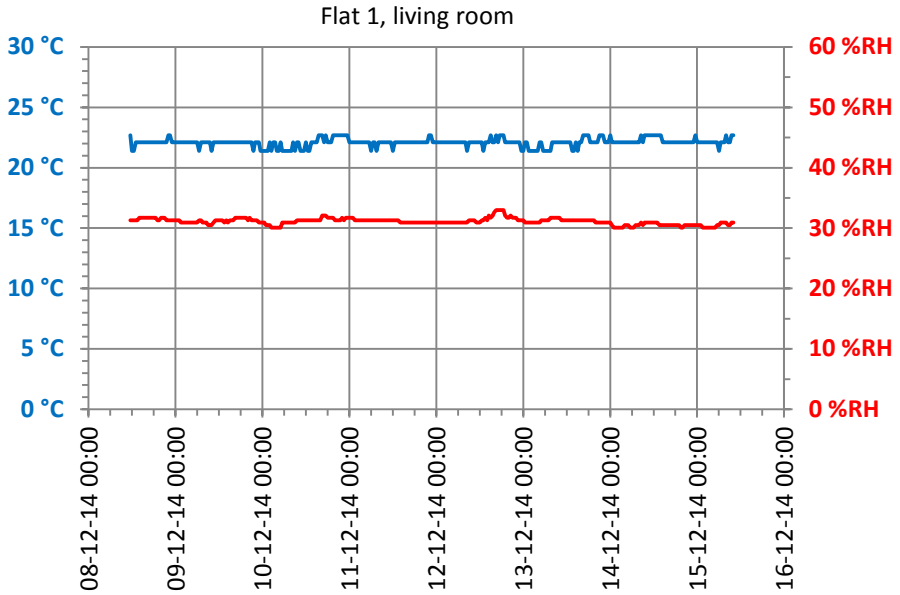
Furthermore, the rather high ventilation rates may be reflected in the results of the measurements of the CO_2-concentration in the flats. Table 5.1 above shows that generally the average CO_2-concentrations are just above typical outdoor level. However, the individual figures (see appendix) reveal that peaks do occur particularly in flat 3. This is the flat having the lowest ventilation rate. In the bedroom during night the CO_2-concentration peaks at almost 1000 ppm. In the living room the CO_2-concentration reach about 700 ppm. There is only one person living in the flat.

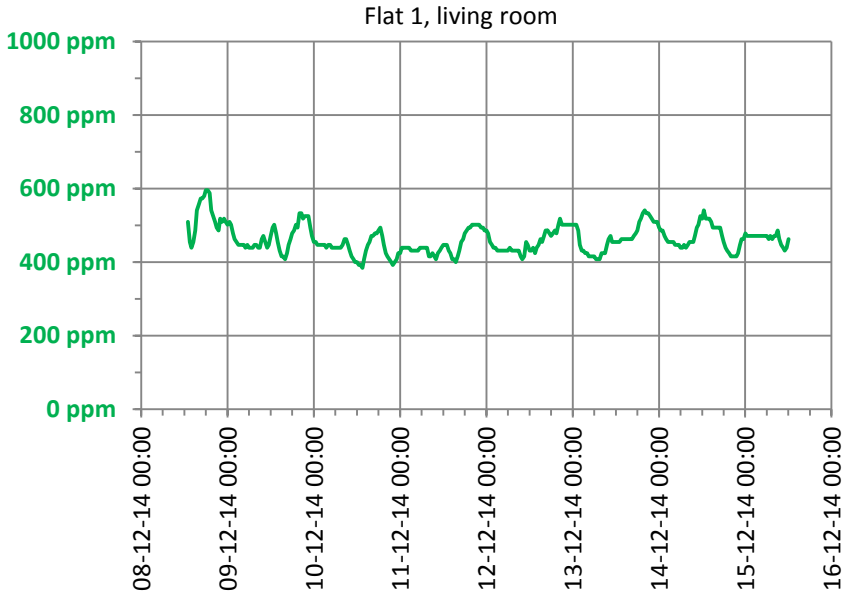
The measured room air temperatures can be regarded as typical for Danish dwellings except for the bedroom in flat 3. In this room the temperature is rather constant and between 16°C and 17°C.

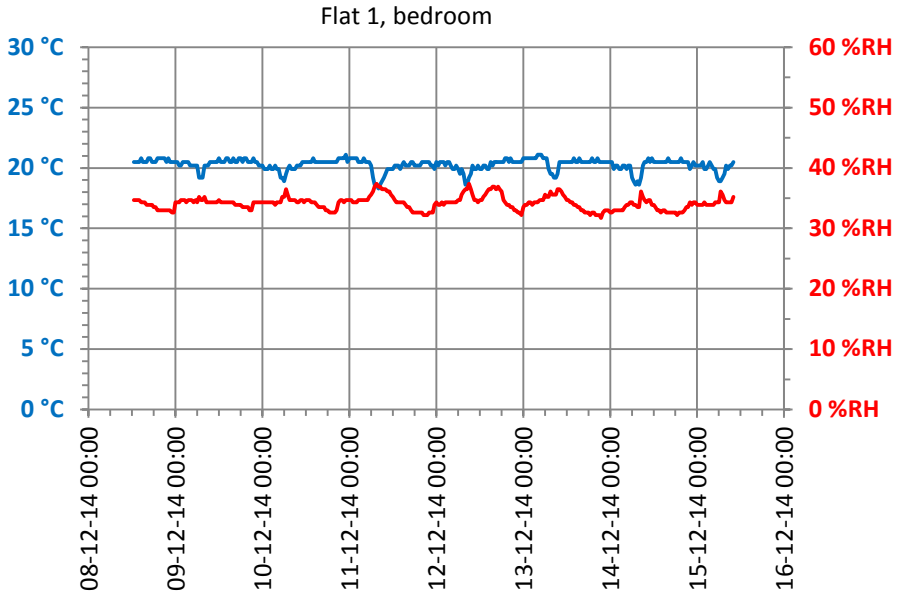
As a consequence of room air temperatures generally above 20-21°C and somewhat high ventilation rates the relative humidity in the flats is quite low – about 30%. Again, the measurement results from flat 3 and in particular from the bedroom is different from the other measurement results. The average relative humidity in the bedroom in flat 3 is 44% and as can be seen from the following figures, the relative humidity may occasionally reach almost 50%.

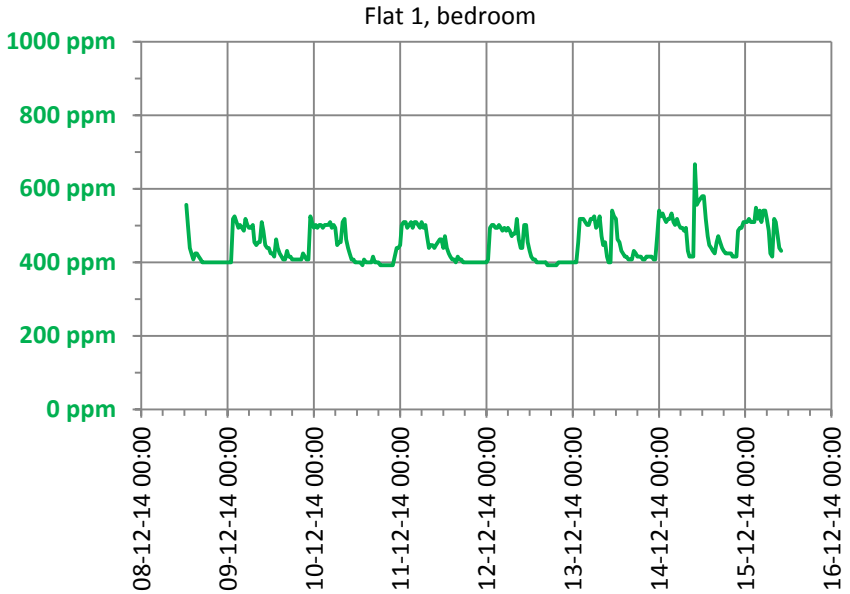
Figures showing results of measurements of room air temperature, relative humidity and CO_2-concentration

Flat 1

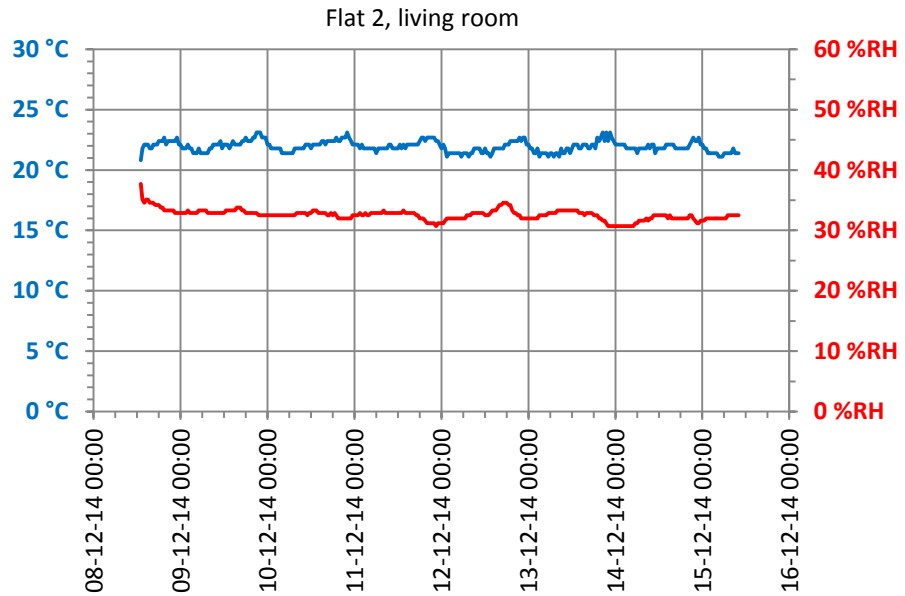


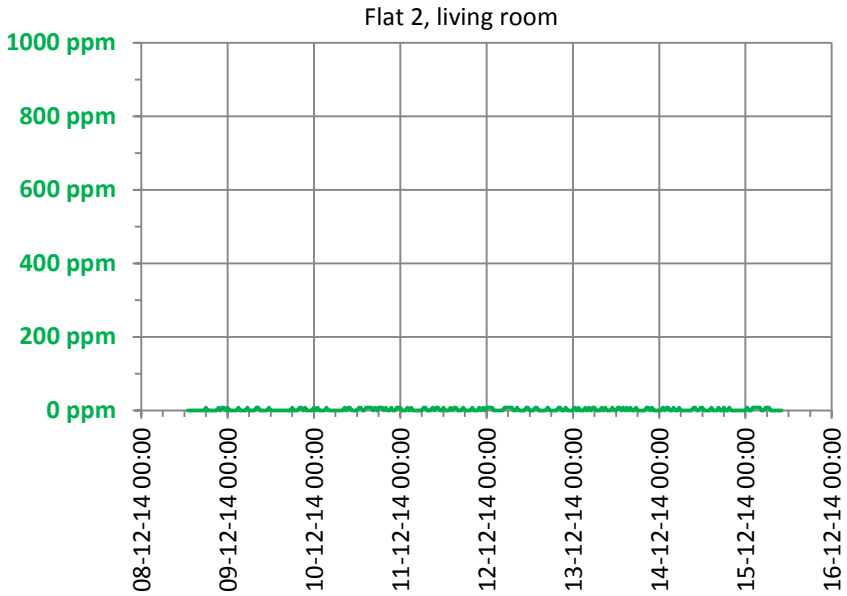


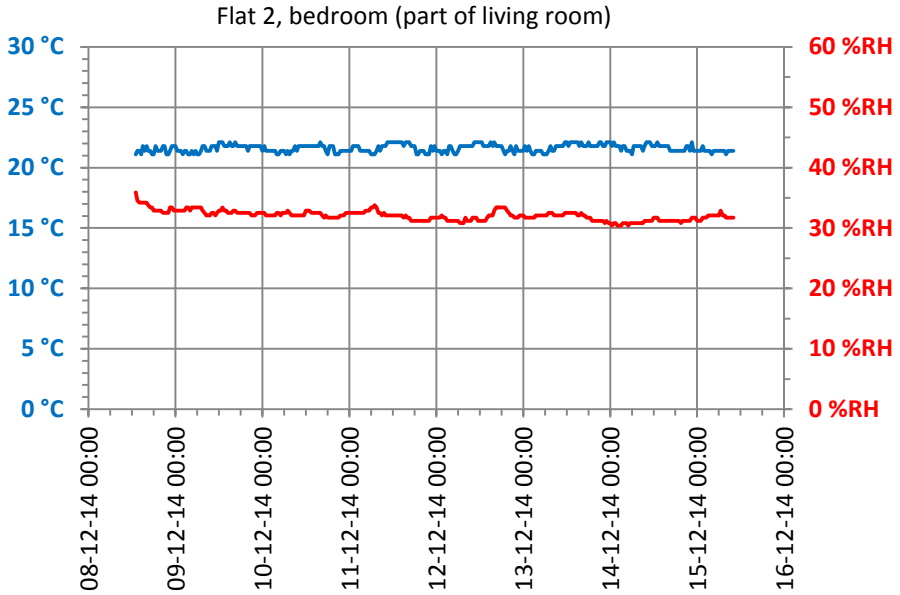

Flat 1, bedroom
30 °C
25 °C
20 °C
15 °C
10 °C
5 °C
0 °C
60 %RH
50 %RH
40 %RH
30 %RH
20 %RH
10 %RH
0 %RH
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

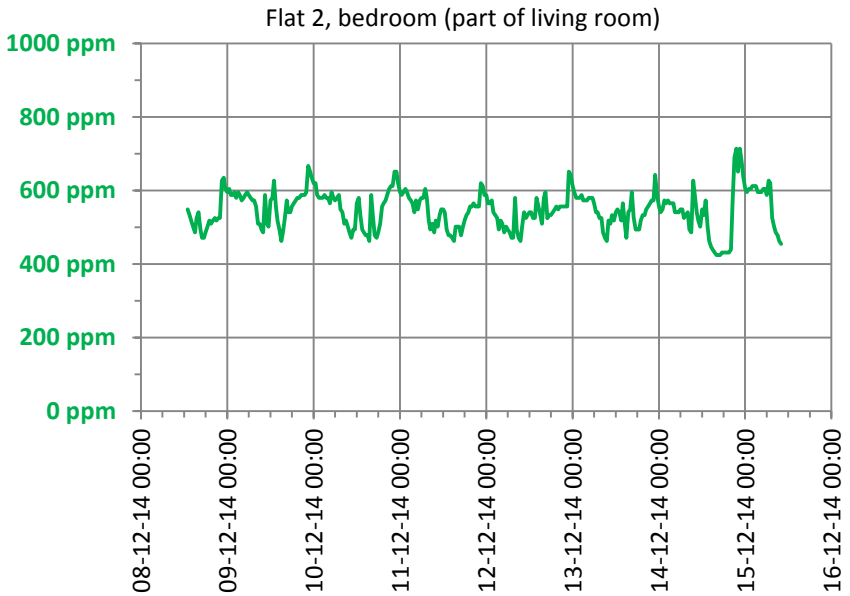

Flat 1, bedroom
1000 ppm
800 ppm
600 ppm
400 ppm
200 ppm
0 ppm
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

Flat 2

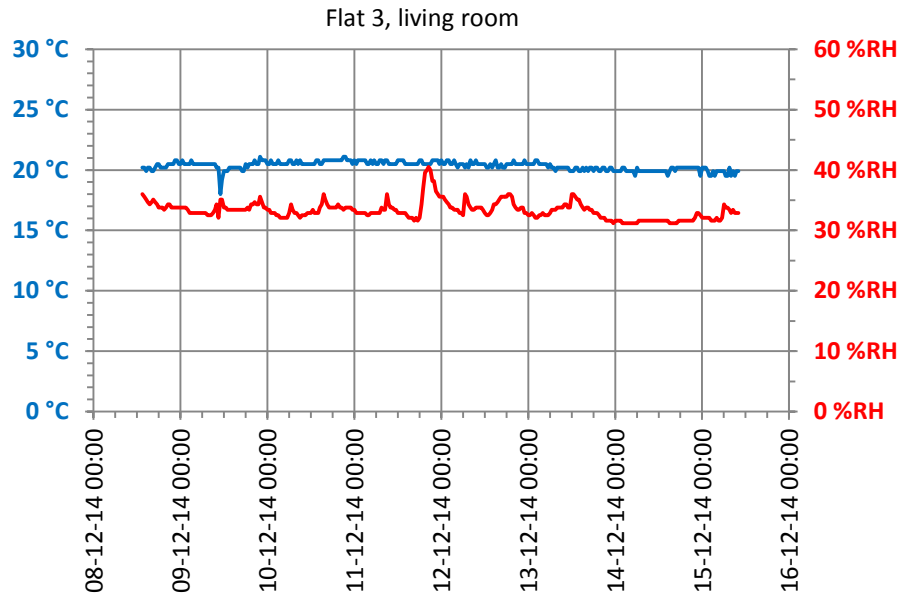

Flat 2, living room
30 °C
25 °C
20 °C
15 °C
10 °C
5 °C
0 °C
60 %RH
50 %RH
40 %RH
30 %RH
20 %RH
10 %RH
0 %RH
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

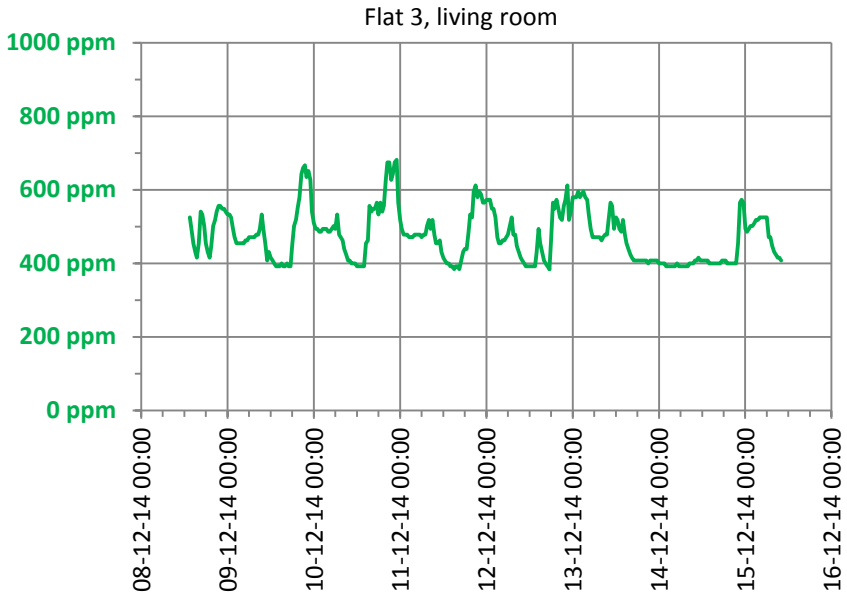

Flat 2, living room
1000 ppm
800 ppm
600 ppm
400 ppm
200 ppm
0 ppm
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

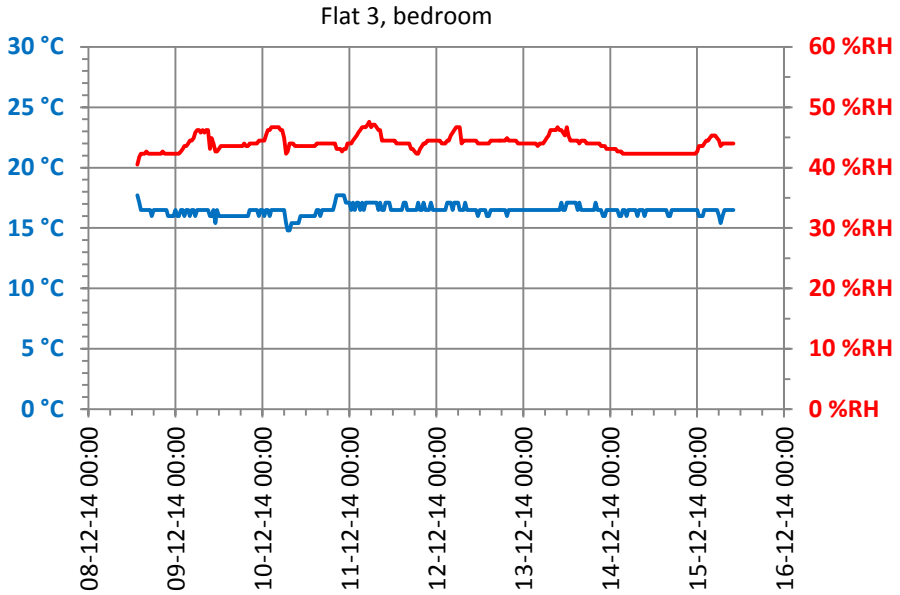

Flat 2, bedroom (part of living room)
30 °C
25 °C
20 °C
15 °C
10 °C
5 °C
0 °C
60 %RH
50 %RH
40 %RH
30 %RH
20 %RH
10 %RH
0 %RH
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

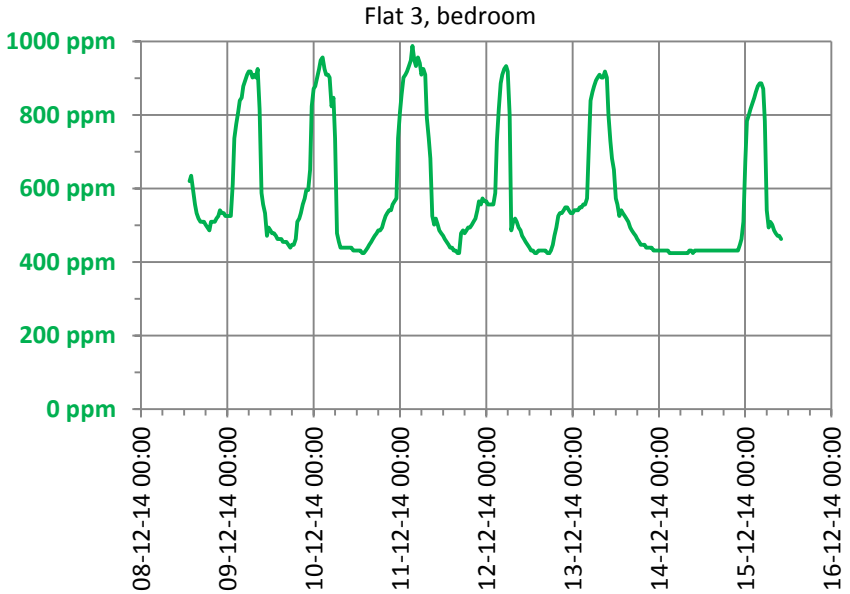

Flat 2, bedroom (part of living room)
1000 ppm
800 ppm
600 ppm
400 ppm
200 ppm
0 ppm
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

Flat 3


Flat 3, living room
30 °C
25 °C
20 °C
15 °C
10 °C
5 °C
0 °C
60 %RH
50 %RH
40 %RH
30 %RH
20 %RH
10 %RH
0 %RH
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00


Flat 3, living room
1000 ppm
800 ppm
600 ppm
400 ppm
200 ppm
0 ppm
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00


Flat 3, bedroom
30 °C
25 °C
20 °C
15 °C
10 °C
5 °C
0 °C
60 %RH
50 %RH
40 %RH
30 %RH
20 %RH
10 %RH
0 %RH
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00


Flat 3, bedroom
1000 ppm
800 ppm
600 ppm
400 ppm
200 ppm
0 ppm
08-12-14 00:00
09-12-14 00:00
10-12-14 00:00
11-12-14 00:00
12-12-14 00:00
13-12-14 00:00
14-12-14 00:00
15-12-14 00:00
16-12-14 00:00

Appendix – PFT-results

Flat 1

v. 50

PFT-measurement

Building	: Flat 1			Date:	12.03.2015
Project	: Traneparken			Enclosure:	1
Measurement Start:	08.12.14 at 12:30	Duration:	167,7 hours		
Measurement End :	15.12.14 at 12:15			Analysis:	22.12.2014

Results

Total infiltration rate: 239,6 m^3/h (32,9) [14%]
Total air change rate: 1,06 h^{-1} (0,15)
Outdoor air supply: 0,73 l/s pr. m^2 (Gross floor area: 91 m^2)

	Infiltration			Exfiltration			Total		
Zone	[m^3/h]	SD	SD%	[m^3/h]	SD	SD%	[m^3/h]	SD	SD%
1	65,8	15,3	[23]	54,8	17,3	[32]	100,9	20,7	[20]
2	173,9	36,3	[21]	184,9	40,1	[22]	220,0	45,2	[21]
3									

	Interzone				Interzone			
Zone	[m^3/h]	SD	SD%	Zone	[m^3/h]	SD	SD%
1 → 2	46,1	14,2	[31]	2 → 1	35,1	11,8	[34]
2 → 3				3 → 2			
1 → 3				3 → 1			

Analysis

		Average Zone Concentration [pl/l]				
Zone		PMCP	SD%	PMCH	SD%	
1	Bedroom	22,4	[13]	7,4	[15]	
2	Flat excl. bedroom	4,7	[9]	21,3	[13]	
3	Not defined					

		Zone and emitter data					
Zone		Volume [m^3]	Type	Number	Ref. rate [nl/h]	Temp. [°C]	Est. rate [nl/h]
1	Bedroom	27,0	PMCP	1	2600	20,3	2094
2	Flat excl. bedroom	200,0	PMCH	3	4965	22,1	4349
3	Not defined						

Rackfactor(s):	PMCP: 1,000	Uncertainty GC:	10 %	Uncertainty concentration matrix:	0,16
	PMCH: 1,000	Uncertainty mixing:	5 %	Uncertainty air flow matrix:	0,20
		Uncertainty samplers:	2 %	Condition number of conc. matrix:	1,17
		Uncertainty emitters:	10 %		

Samplers

	Measured Volume [pl]											
	Zone 1			Zone 2			Zone 3	Excluded samplers			
	Sampler	PMCP	PMCH	Sampler	PMCP	PMCH	Sampler	Sampler	PMCP	PMCH	PDCH
1	4158	36,5	9,3	4207	7,4	33,4					
2	4340	30,4	11,6	4220	6,7	25,7					
3				4172	7,7	27,6					
4				4092	6,3	33,1					

v. 50

PFT-measurement

Building : Flat 2 — Date: 12.03.2015
Project : Traneparken — Enclosure: 2
Measurement Start: 08.12.14 at 13:00
Measurement End : 15.12.14 at 12:30 — Duration: 167,5 hours — Analysis: 22.12.2014

Results

Total infiltration rate: 243,5 m^3/h (57,8) [24%]
Total air change rate: 1,19 h^{-1} (0,28)
Outdoor air supply: 0,82 l/s pr. m^2 (Gross floor area: 82 m^2)

	Infiltration			Exfiltration			Total		
Zone	[m^3/h]	SD	SD%	[m^3/h]	SD	SD%	[m^3/h]	SD	SD%
1	243,5	57,8	[24]	243,5	57,8	[24]	243,5	57,8	[24]
2									
3									

	Interzone				Interzone		
Zone	[m^3/h]	SD	SD%	Zone	[m^3/h]	SD	SD%
1 → 2				2 → 1			
2 → 3				3 → 2			
1 → 3				3 → 1			

Analysis

		Average Zone Concentration [pl/l]	
Zone		PMCH	SD%
1	Whole flat	17,6	[19]
2	Not defined		
3	Not defined		

		Zone and emitter data					
		Volume	Type	Number	Ref. rate	Temp.	Est. rate
Zone		[m^3]			[nl/h]	[°C]	[nl/h]
1	Whole flat	205,0	PMCH	3	4965	21,8	4292
2	Not defined						
3	Not defined						

Rackfactor(s): PMCH: 1,000

Uncertainty GC: 10 %
Uncertainty mixing: 5 %
Uncertainty samplers: 2 %
Uncertainty emitters: 10 %

Uncertainty concentration matrix: 0,21
Uncertainty air flow matrix: 0,24
Condition number of conc. matrix: 1,00

Samplers

	Measured Volume [pl]									
	Zone 1		Zone 2	Zone 3	Excluded samplers			
	Sampler	PMCH	Sampler	Sampler	Sampler	PMCP	PMCH	PDCH
1	4222	32,4						
2	4341	24,1						
3	4199	25,1						
4	4108	21,7						
5	4299	20,4						

v. 50

PFT-measurement

Building : Flat 3 — Date: 12.03.2015
Project : Traneparken — Enclosure: 3
Measurement Start: 08.12.14 at 13:20
Measurement End : 15.12.14 at 12:45
Duration: 167,4 hours
Analysis: 22.12.2014

Results

Total infiltration rate: 148,5 m^3/h (29,6) [20%]
Total air change rate: 0,84 h^{-1} (0,17)
Outdoor air supply: 0,58 l/s pr. m^2 (Gross floor area: 71 m^2)

	Infiltration			Exfiltration			Total		
Zone	[m^3/h]	SD	SD%	[m^3/h]	SD	SD%	[m^3/h]	SD	SD%
1	148,5	29,6	[20]	148,5	29,6	[20]	148,5	29,6	[20]
2									
3									

	Interzone				Interzone			
Zone	[m^3/h]	SD	SD%		Zone	[m^3/h]	SD	SD%
1 → 2					2 → 1			
2 → 3					3 → 2			
1 → 3					3 → 1			

Analysis

		Average Zone Concentration [pl/l]	
Zone		PMCH	SD%
1	Whole flat	18,0	[14]
2	Not defined		
3	Not defined		

		Zone and emitter data					
Zone		Volume [m^3]	Type	Number	Ref. rate [nl/h]	Temp. [°C]	Est. rate [nl/h]
1	Whole flat	177,0	PMCH	2	3310	20,4	2676
2	Not defined						
3	Not defined						

Rackfactor(s): PMCH: 1,000

Uncertainty GC: 10 %
Uncertainty mixing: 5 %
Uncertainty samplers: 2 %
Uncertainty emitters: 10 %

Uncertainty concentration matrix: 0,17
Uncertainty air flow matrix: 0,20
Condition number of conc. matrix: 1,00

Samplers

	Measured Volume [pl]									
	Zone 1		Zone 2	Zone 3	Excluded samplers			
	Sampler	PMCH	Sampler	Sampler	Sampler	PMCP	PMCH	PDCH
1	4263	22,9			4026	0,7	81,7	0,0
2	4244	26,6			4165	0,8	87,8	0,0
3	4119	22,0						
4	4260	29,5						

This report describes a Danish retrofitting project with focus on reducing the energy consumption in social housing.

The objective of the project was to study tenants' overall satisfaction with how the retrofitting of their dwellings was carried out and their experiences and satisfaction with their dwellings after the retrofits. This was studied by a questionnaire survey that included assessments of possible co-benefits like e.g. improved perceived indoor climate parameters and new balconies and questions about the tenants' changes of habits in relation to indoor temperature and airing of the flat.

The project is a part of the International Energy Agency (IEA) programme Buildings and Communities Programme (Annex 56).

1st, 2015
ISBN 978-87-563-1733-7