



D5.6. Post-Occupancy Evaluation



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BEEM-UP

Building Energy Efficiency for Massive market Uptake

Integrated Project EeB-ENERGY-2010.8.1-2

Demonstration of Energy Efficiency through Retrofitting of Buildings

Deliverable D5.6: Post-occupancy evaluation

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Illustration on cover page: partner meeting in the pilot dwelling in Delft

Deliverable description

This report is part of the work carried out within the BEEM-UP project concerning tenant satisfaction about the renovation. The report presents the post-occupancy evaluation carried out at the three pilot sites;

- Cotentin Falguière in Paris, France (ICF Novedis is the building owner)
- Van der Lelijstraat in Delft, the Netherlands (Woonbron is the building owner)
- Brogården in Alingsås, Sweden (Alingsåshem is the building owner).

The overall goal regarding the tenant involvement in the BEEM-UP project is to ensure that renovation projects are successful from a social point of view as well and to encourage energy saving behaviour of the tenants. The post-occupancy study is done at least one year after the renovation, except in the French case, where the execution has only been finished in the summer of 2014. The post-occupancy study has taken the shape of home visits with interviews based on a questionnaire. The main goal is to determine whether the tenant's expectations of the achieved results of the conducted renovation are met, and how they interact with the retrofitted home and the provided solutions.

The results of the post-occupancy study will provide input for D3.4 - the evaluation of the monitoring results - to analyse whether the tenant experience coincides with the measured data, and how the tenant behaviour might have influenced the final performance of the building.

OTB has used the post-occupancy study together with the report of D5.4 to develop a final evaluation of WP5, including an improved protocol for other retrofitting projects, suggestions for technology adaptation to tenant expectations, and how to further impact tenant behaviour for successful energy savings.

Contribution of partners

The building owners (Alingsåshem, Woonbron and ICF Novedis) have executed the interviews. BEEM-UP Partners Involved are Alingsåshem, Nobatek, ICF Novedis, Woonbron, OTB and SP. OTB of Delft University led the task. Part of the report is a short video about the use of the home energy management system in the pilot site in Delft (copy this link in webbrowser <http://youtube/pMUggJQLNZM>).

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Executive summary

Three pilot projects were included in BEEM-UP, namely: Cotentin Falguière in Paris, France, Van der Lelijstraat in Delft, the Netherlands and Brogården in Alingsås, Sweden.

The main objective of the post-occupancy evaluation described in this report is to investigate how tenants perceive the renovation process, its user aspects and energy savings. The research analysis is based on interviews with tenants mainly, but the authors were deeply involved in the project as well and have added valuable insights based on participative observations.

The interaction between partners have resulted in strategies with some resemblance:

A pre-renovation analysis based on personal interviews with many tenants, to understand the needs and to start a communication process that will increase involvement in and support for (temporary) relocation and the measures to be taken;

A pilot house is to be renovated first, after the interactive design process, to have a showcase for all tenants and a location for tenants to meet each other;

Much attention is given to a variety of communication channels, both in paper and digital and with focus on face-to-face interactions. The interaction lead to input in renovation plans, solve support issues, promote social interaction in the neighbourhood and make the renovation process a means to build trust between the owner and tenants and among the tenant communit;

A dedicated person is available for al kinds of questions and need of help during the execution of the renovation, while in the design pahase and in the manintenance phase the low threshold in contacting the dedicated person is importantas well;

Long term involvement of the owner in energy saving is being promoted, with energy feedback systems as the key application.

A post-occupancy study after the renovation, to evaluate the results, has been executed in the renovation proojects.

Many tenants express that they are aware of saving energy already before the renovation. Energy performance improvement is very welcome. Also, the renovation solves many complaints and maintenance issues and provides a modern comfort. Looking back to the barriers, most tenants are satisfied with the results. Especially better insulation provides a comfortable new indoor climate. New innovative sustainable technologies caused some problems, but the projects have resulted in improvements, which is important for market uptake. Some new complaint issues relate to not complete delivery of the renovation, while many relate to new (digital) user interfaces that the tenants still need to learn or that the owner needs to make more user friendly and without experienced breakdowns.

Solar hot water systems have been applied in Delft and are effective.

A suggestion is to finish the renovation project like it started in Brogården: with a get-together of all tenants and the project representatives including the owner.

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Chapter 1 Introduction

Both a pre-renovation study and post occupancy evaluation (POE) are essential in renovation projects. The impact of a renovation on the users is high and the investment level for the homeowner is enormous, so to know if needs and expectations of the tenants are fulfilled is of great importance. In this report the tenants' experiences of the executed renovation work within the EU project BEEM-UP are described. In this project, the results of the pre-renovation evaluation are used as input for the design phase and for the continuous dialogue with the tenants. In the post-occupancy evaluation the satisfaction of the tenants about the renovation is investigated. The post-occupancy evaluation is the focus of this report.

The overall objective of the BEEM-UP project is to realise substantial energy savings in renovation of dwellings and to promote large-scale market uptake of successful strategies. To make the renovation strategies ready for large-scale uptake they must be economically feasible, practically applicable and socially acceptable. To discuss and realise this, the performance after the renovation has been evaluated in different contexts: monitored output, performance testing, evaluation of user satisfaction and behaviour, and evaluation of processes. The approach towards the tenant investigation is to first get to know the tenants and pay attention to their needs and ideas about their living conditions. Based on the tenants' views and preferences, strategies to improve acceptance of and involvement in renovation projects and for energy saving changes are applied. Interaction with tenants continued in the design phase and during the construction phase, mainly informing about what is going on at the building site and for solving complaint issues. All the building owners follow certain protocols of interaction with tenants during design, execution of works and maintenance after the renovation. The aim in BEEM-UP is to investigate how these processes can be used to ensure optimal energy performance of the building as well as tenant satisfaction.

Three pilot projects were included in BEEM-UP, namely:

- Cotentin Falguière in Paris, France (ICF Novedis is the building owner)
- Van der Lelijstraat in Delft, the Netherlands (Woonbron is the building owner)
- Brogården in Alingsås, Sweden (Alingsåshem is the building owner).

The processes of these pilot projects are being studied.

1.1 Objectives

The main objective of the post-occupancy evaluation described in this report is to investigate how occupants perceive the renovation process and energy savings. The overall issues to be evaluated are:

- Tenant experiences and tenant involvement

- Are tenant expectations of the renovation met? How is the general satisfaction (difference compared to before renovation)?
- Aspects of tenant energy awareness and energy consumption related behaviour.
- How people interact with their homes and the energy saving solutions.

The overall goal of the evaluation is to see if the projects are accepted among tenants; if the final building including its technical services meets occupant needs and if the strategy support tenants in taking energy efficiency measures.

1.2 Methodology

In the three pilot projects of the BEEM-UP project the tenants' experiences are gathered by interviews with a number of households (for details see each section describing the POEs of the pilot projects). In addition, energy data collected from the monitoring and metering activities of the project are compared with household characteristics and user behaviour. The replication potential of applied tenant involvement strategies is evaluated as well (final evaluation of Work Package 5).

1.3 Outline of the report

Chapters 2, 3 and 4 are dedicated to the post-occupancy evaluations of the three pilot projects. The description starts with a short overview of the reference condition, the measures taken, the process that was followed and the results of the POEs

The partners that executed this evaluation are:

- Couleurs d'Avenir for the project in Paris (Chapter 2)
- Evert Hasselaar for the project in Delft (Chapter 3)
- Jenny Bengtson for the project in Alingsås (Chapter 4)

Each chapter ends with a short conclusion, based on the local results.

Chapter 5 serves as a discussion, with the goal to advance the lessons learnt and includes final conclusions.

Chapter 2 Evaluation of Cotentin Falguière in Paris

2.1 Information about the project

The building of the Paris pilot project constitutes 87 apartments built in the 1950s and is owned by ICF Novedis.

The renovation was decided on in 2009, after years of complaints by the tenants on the poor quality of the heating system. There were also major complaints about the state of collective areas in and around the building, as well as about installations, appliances, etc. inside the flats (e.g. bathrooms, hot water tanks, floor coverings, electric installations). In the pre-renovation phase the collective heating was monitored per house, not per apartment. The hot water was provided by electrical boilers, which led to high energy use.

The motivation to renovate the building was to take away complaints concerning the condition of the building, to adapt the building to modern standards and to raise the property value, making it fit for market needs. Improving the comfort of the building including its energy efficiency is inherent to this renovation. After the renovation each apartment is supplied with individual heat monitoring and billing that includes domestic hot water from a collective system.



Figure 1. General information meeting for the tenants about the plans of the renovation project in Paris, held in October 2011

ICF Novedis decided to have the tenants involved in the planning process, Pre-renovation interviews were held with all tenants and the main results are:

- Before the renovation there was a relatively high turnover of tenants.
- A number of people have lived in the building for a long period of time.
- Many households are single persons and couples with no or one child.
- 20% of the tenants are working “odd hours” (railway employees).
- The location near the train station and near the centre is being appreciated.
- Some disadvantages include noise problems, improperly installed windows and problems with the heating system.

- Domestic hot water from the electrical boilers is too hot with too small water flows and the capacity of the hot water tanks is too low.

Tenants are aware of their energy use, mainly for economic reasons. Energy saving behaviour included behaviours like switching off the light as much as possible and the use of efficient light bulbs.



Figure 2 and 3. PVC windows with metal blinds (before renovation) and individual electric boilers in bathrooms (before renovation)

The pre-renovation activities resulted in a good dialogue with the tenants. ICF learned to know the tenants and built up trust with them. ICF acted differently from previous projects by starting one year before the renovation with tenant communication, dedicating both time and personal resources. Much insight is gained through the individual interviews. A majority of the tenants are employees at the French railway company, which means that they have a second relationship with ICF, which is linked to the railway company. Some people wanted to move out because they did not support the renovation, but a majority is staying; ICF has paid “moving out costs”. The housekeeper plays an important role throughout the renovation process and was participating in meetings with the tenants in the pre-renovation phase. Training of housekeepers on energy issues has been carried out during the renovation process.

Showcase

A 3-room apartment of 55 m² of floor space has been used as a showcase apartment to allow tenants to understand the scope of the work in their own dwelling. Demonstrated are for example: change of joinery, installation of double flux collective mechanical ventilation, entrance door replacement, new sink cabinet, bathtub and toilet, painting of the walls.

ICF-Novedis strived for a Low Energy Building (LEB) certification. This renovation started in 2013 and was completed in October 2014. In this context, Couleurs d’Avenir carried out a survey of tenants in order to evaluate their levels of satisfaction with the work done and the installation of new facilities in their accommodation and also to define their habits in terms of energy consumption and savings.



Figure 4. The pilot project at Cotentin Falguière in Paris, France - before renovation



Figure 5. Courtyard at Cotentin Falguière (before renovation)

2.2 Post occupancy evaluation of Cotentin-Falguière

2.2.1 Methodology of the survey

A questionnaire was compiled based on requirements formulated by ICF-Novedis and adapted to the interviews while the survey was conducted. The interviews were held only 4 months after completion of the renovation. This short period was due to the late ending of the construction and the ending of the final reporting period of the BEEM-UP project.

Working from the list of 68 current tenants provided at the start of the assignment, appointments were made by phone with tenants of whom contact numbers were available. A letter was also sent by ICF-Novedis to the tenants with a request to contact Couleurs d'Avenir staff to carry out the survey. Two door-to-door sessions were carried out to contact those tenants who did not respond or because of missing contact details.

On average, the survey lasted between 30 and 45 minutes. Appendix A presents the topics that were used in the questionnaire. 47 interviews were actually carried out: 38 at home and 9 by phone (at the request of the tenants). 7 people refused the interview for various

reasons (about to move out of the accommodation, unavailability, lack of interest, etc.) and 2 people were absent on the agreed date and could not be contacted afterwards.

Tenants interviewed:

- 37 rue du Cotentin: 23 people
- 97 rue Falguière: 24 people

Of which 50% live in a 3-roomed flat and 28% in a 2-roomed flat (the remainder either in a duplex, 4-roomed flat or studio).

2.2.2 Survey results

Tenants and the BEEM-UP project

Nearly one-third of n=47 moved into the residence in 2014, during the renovation work.

- Tenants since:

Less than a year	16	of which less than 6 months	8
Between 1 and 5 years	13		
Between 6 and 10 years	3		
Over 10 years	15		
TOTAL	47		

Table 1. Period living in the house

Composition of households in the survey:

- 14 people who live alone (i.e. 30% of the households)
- 15 couples without children (33%)
- 12 couples with children (26%, generally 1 to 2 children)
- 3 single-parent families (6%, with children permanently or intermittently)
- 2 other households (4%, joint occupancy or living with friends or family)

Age of those surveyed:

- 23 - 35 years: 15 people (36%)
- 36 - 50 years: 11 people (26%)
- 51 - 64 years: 13 people (31%)
- Over 65 years: 3 people (7%)

The perception of the renovation programme and tenant involvement

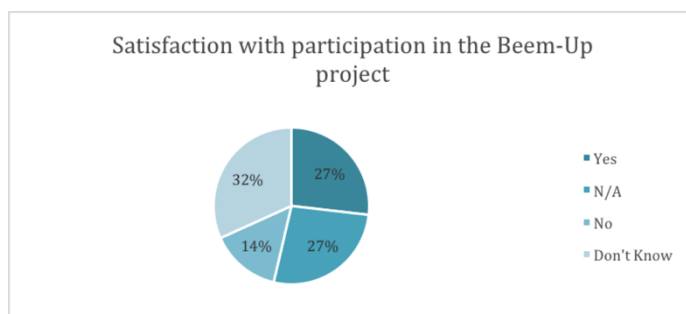


Figure 6. Satisfaction with participation, specifically in BEEM-UP

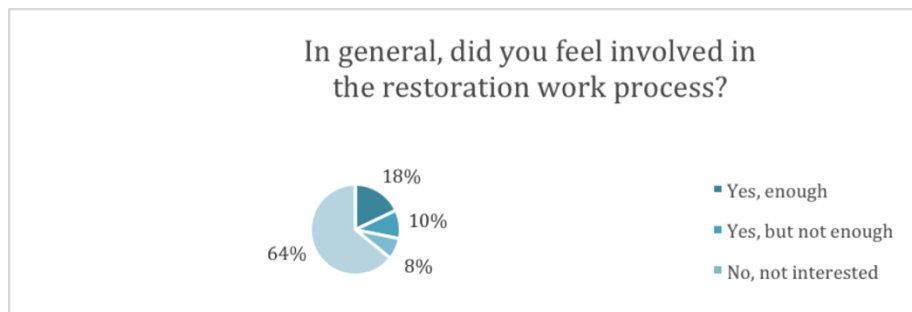


Figure 7. Perception of involvement in renovation process

Not all tenants have been aware of the BEEM-UP project. It appeared that the benefits and principles of the BEEM-UP project were insufficiently communicated. Indeed, nearly one-third of tenants said they were not aware of the name "BEEM-UP", whereas over one-quarter of the sample was indifferent to the project (Figure 6). However, when looking more closely at those tenants who seem to be unaware of the research project or who did not answer the question, an over-representation of tenants who moved in less than a year ago (50% of non-respondents) is discovered.

As far as the tenants' sense of involvement in the restoration project is concerned, two-thirds of tenants say they did not feel sufficiently involved in the project (25 out of 39 tenants), shown in Figure 7. Those households who did not participate in public meetings in 2011 are more likely to feel less involved. This is in particular the case with new tenants in the residence: several did confirm being aware of the renovation work at the time of the visit to the apartment. In general, they believed that the work would be completed before they moved in.

Concerning households who have lived in the residence for a longer period of time, their participation in public meetings did not necessarily go hand-in-hand with an actual sense of involvement. Two-thirds of those surveyed who had participated in public meetings said they were not sufficiently involved in the project. Two reasons were given:

- A certain **difference between the results of the renovation and forecasts** (this concerned for example disappointment with the implementation of the bay windows, time and disturbance of restoration work, quality of bathroom and kitchen furniture deemed poor, etc.).
- A feeling of **lack of consultation**: some unhappy tenants feeling that the project was not necessary (windows in good condition, bathrooms fine, etc.). Others were particularly concerned about not being able to negotiate the placement of equipment including radiators or certain electrical or telephone sockets.

Satisfaction with new equipment installed



Figure 8. Overall satisfaction with new equipment

Tenant satisfaction is generally mixed in terms of work done in their apartment. A small majority of tenants are generally dissatisfied (23 out of 45 responding households), shown in Figure 8. However, satisfaction is based more on how the work was managed and the appreciation of the quality of contractor work than the choice of equipment itself. Indeed, three tenants only express this dissatisfaction criterion. Disturbances and problems due to the restoration work were also highlighted, together with the feeling of a lack of consideration on behalf of the landlord when faced with these issues.

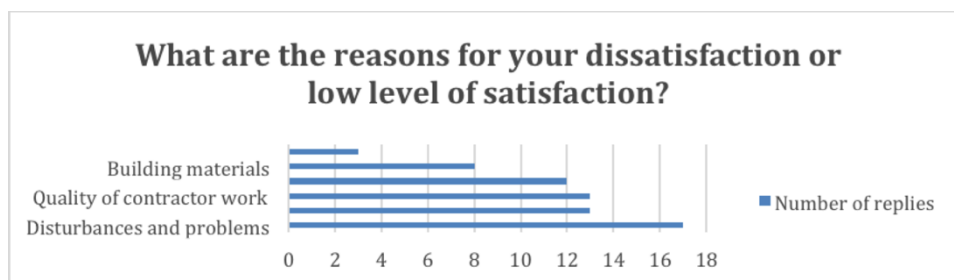


Figure 9. Reasons for low satisfaction with equipment

The tenants are generally quite satisfied with the equipment installed in their apartments. Dissatisfaction with some equipment is mainly due to the functioning of the equipment:

- Several collective mechanical ventilation systems (CMV) are described as "seem to function but noisy"
- A considerable number of videophones were not configured at the time of the survey (black screen, no statistical data on consumption, etc.)

The heating did not seem to have been used at the time of the survey (some tenants starting to worry as winter approaches).

The quality of the **windows** is acknowledged by 75% of tenants, pointing out their better thermal and acoustic properties. The improved insulation of the apartment gives higher temperatures without heating: for example 20-21°C without heating in November. The 25% dissatisfied respondents generally complain about the fitting of these windows, which is not always done properly. Or they complained about the ventilation units as some tenants were feeling permanent draughts (three tenants actually blocked the units with adhesive

tape). Some tenants also complained that the bathroom window misses the function of “tilt and turn” (which would have been more practical in this room).

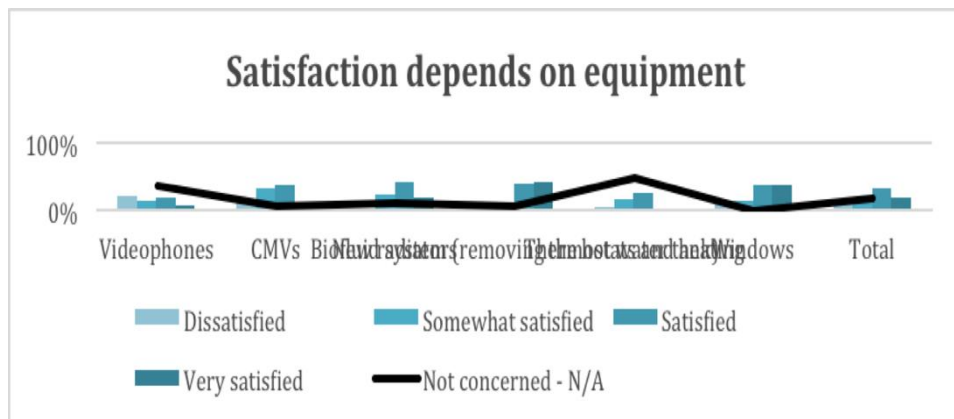


Figure 10. Satisfaction level per measure relating to equipment

The collective mechanical ventilation (**CMVs**) show a high level of dissatisfaction (47% of the sample). Several tenants complain about the noise they make (hissing noise in some apartments), as if they were "set too high", whereas the exhaust capacity cannot be adjusted by tenants.

Concerning the **radiators**, 64% of those interviewed were quite or very satisfied, but some radiators were not yet turned on.

The removal of the hot water tank is appreciated: 82% of tenants are satisfied anxious to see the electricity savings. However, a dozen tenants mentioned a problem with the hot water supply since the installation of the **biofluid** system because of long waiting times.

A majority of tenants mentioned the good improvement of the front door without being asked and for their insulation performance.

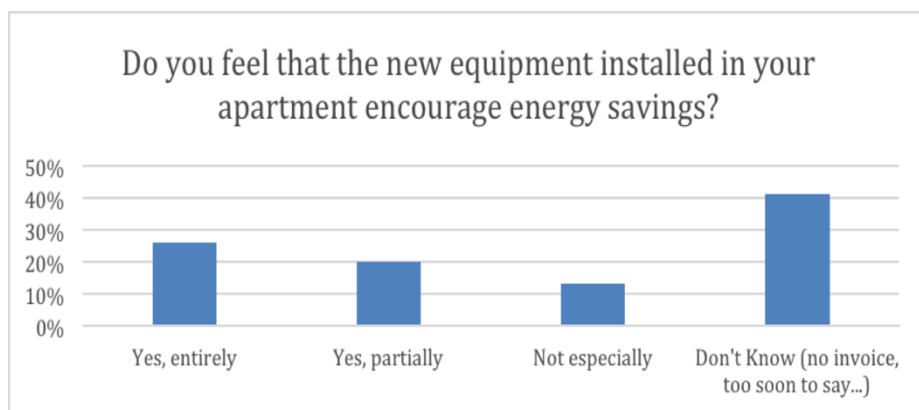


Figure 11. Perception of contribution of equipment to energy savings

In general, only 13% of tenants consider that the equipment installed does not generate energy savings. 46% believe that it does, or at least in part, and 41% are waiting to receive their energy bills before commenting (see Figure 11).

Using the videophone and thermostat

37% of tenants said that they do not or no longer use the **videophone** and 22% say they were dissatisfied with this equipment. Indeed, some tenants were unable to have it work and only used it as an intercom. Some tenants do not find the device user-friendly, "too high-tech" or afraid to use it, etc..

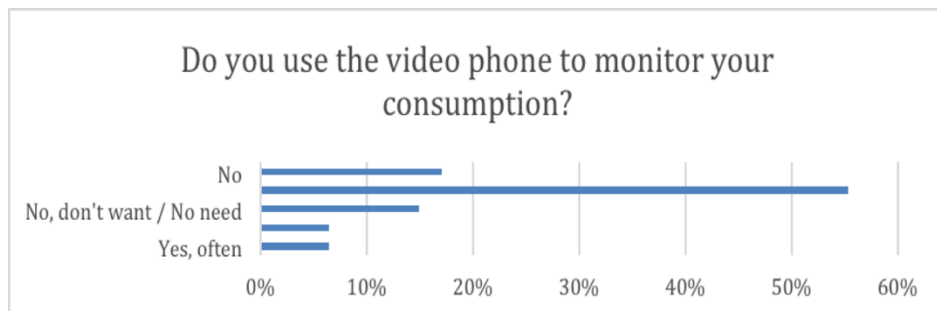


Figure 12. Use of videophone

Half of the tenants say they do not use the **thermostat** (Figure 14). As with the videophone, dissatisfaction or non-use is above all associated with the equipment being difficult to use. 72% of tenants use the **individual thermostats on the radiators** to regulate the temperature.

Of tenants that currently do not use the videophone many lack user instructions. And 80% of tenants interviewed did not respond to the question "Which consumption do you monitor with your videophone?" because in the majority of cases they do not use it for this purpose.

A similar observation can be made for the thermostat (Figure 14), 15% of tenants use it as a thermostat (looking at the temperature displayed), and 66% say they lack information on how to use it or the instructions for the equipment. Some tenants (those who have tried to use the equipment) complained that there are no advanced settings on the thermostat, which could have enabled them to make additional energy savings by lowering the temperature at night, for example.

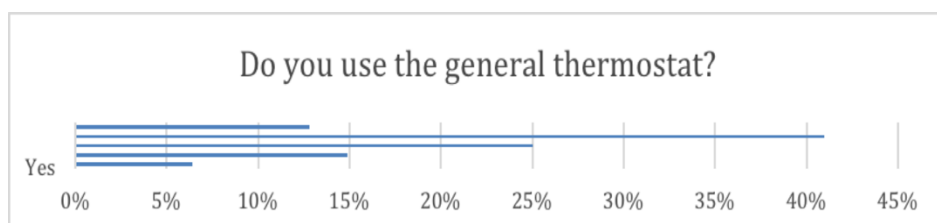


Figure 13. Use of thermostat

The majority of tenants also feel they lack information on the benefits and use of the videophone and thermostat. Twenty people say they participated in **information workshops**, including 12 on the monitoring workshop, but with little effect and they should have been followed up with written information (guide, user manual).

Tenants' energy saving habits in the apartment

The BEEM-UP project in itself did not particularly encourage tenants to save more energy. 80% of those surveyed **already were aware of saving energy** before the renovation (Figure 15). A majority of households have adopted habits designed to save energy, such as waste sorting, low-energy light bulbs and household appliances, etc.

The "Other" response in the following diagram concerns other actions and eco-habits: mainly being more attentive about heating or hot water, in particular.

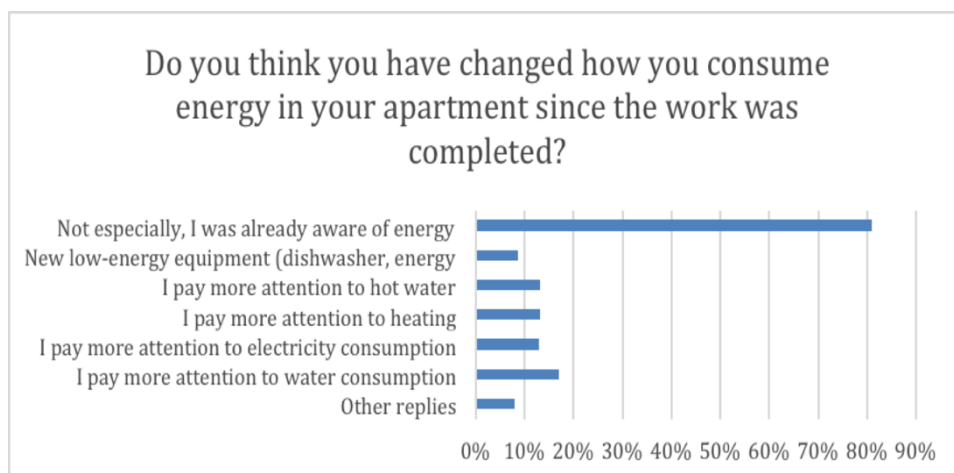


Figure 14. Perception about change of behaviour

Lower energy bills in the future?

The large majority of tenants were not able to comment on savings made since the equipment was installed: at the time of the survey, nobody had received **water bills**, for example (hence 87% non-responses or "don't know"). The only tenants who have noticed a decrease are those whose household have changed in number of people or the few who monitor their consumption via the videophone.

As far as **electricity** is concerned, the non-response rate is lower (66%). Some tenants are on a non-provisional electricity bill system and indicated a decrease in their consumption. They represent 20% of those interviewed. They said their savings are mainly due to the hot water tank being removed. However, several tenants mentioned the "downside" of removing the hot water tank: the tank contained a limited amount of water and obliged tenants to limit the time spent taking a shower. Now, with the central boiler and biofluid system, hot water is virtually unlimited and some tenants are worried they no longer realise how much time they spend taking a shower.

The feeling of comfort: an uncertain estimation

Questions regarding indoor comfort were too early after the renovation works and not including a summer or winter period: the experience of tenants were so limited that evaluation is not yet useful. Preferred temperature give an idea of the comfort expectations, though (figure 15)

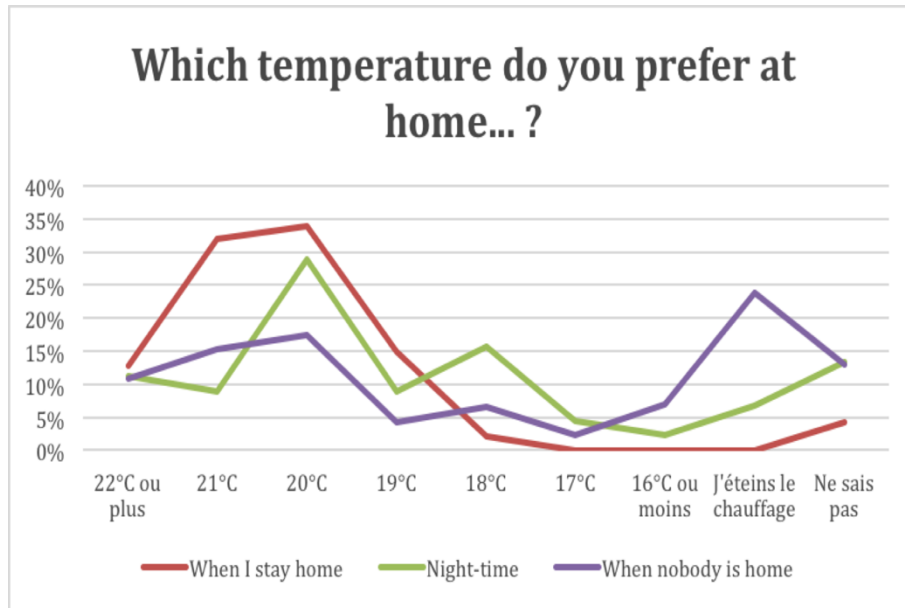


Figure 15. Preferred temperatures

"Senior" tenants in particular prefer higher temperatures in their apartments. Before the renovation the floors were heated at quite high temperatures, after the renovation radiators were used. The floor heating system is often described as providing "too much heat", and this is likely the reason behind the preference of higher temperatures. Several people now complained about the cold. In particular, certain older tenants complained about temperatures being stuck around 20°C, without really being able to increase these temperatures.

Other energy saving and pro environmental habits

Certain best practices have become fixed habits for a majority of those surveyed. 76% have installed low-energy light bulbs or LEDs, and multi-socket adapter with switch,

Most of those surveyed (62%) have relevantly new electrical appliances (less than five years old). They were also aware of household waste sorting and some tenants complained about insufficient sorting bins. It is difficult to say whether tenant consuming habits have changed due to the project. A new survey after the winter period would therefore be useful to monitor tenant progression in terms of energy consumption and for measuring the impact of equipment.

Satisfaction with work and tenant expectations of their landlord

The renovation of shared areas was positively received by the tenants, nobody was completely dissatisfied. Address base means that tenants were asked about the shared spaces that actually have a function for the specific apartment.

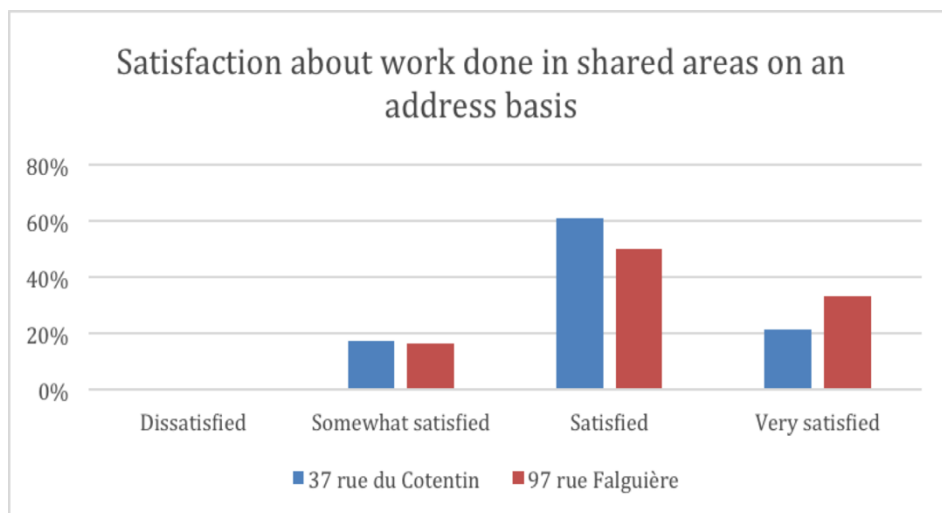


Figure 16. Satisfaction about improvements of collective spaces

In Figure 16 the intercom system and flooring in the corridors attracted the most negative opinions: the flooring was not changed while tenants consider it "a little old-fashioned". Only one access point for persons with limited mobility per building is provided. 30% of tenants are dissatisfied with the **new intercom system**, due to a lack of experience with the new system. Missing an intercom for the second door is annoying and the code needs to be given through the intercom.

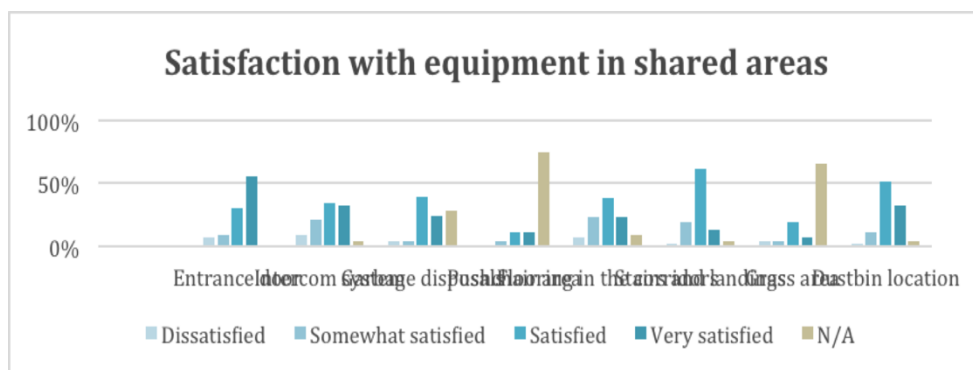


Figure 17. Satisfaction about equipment in collective areas

The **entrance door** is well appreciated: the looks of the entrance lobbies with the reorganised letterboxes and notice boards add a certain standing to the residence.

In general, many tenants were disturbed by the renovation work. Some of this dissatisfaction is directed at the companies that carried out the work.:

- Communication difficulties, lack of cleanliness or damage
- A lack of respect (smoking in the apartment)
- A lack of finishing and an impression of sloppy jobs: see Figure 19 and 20.

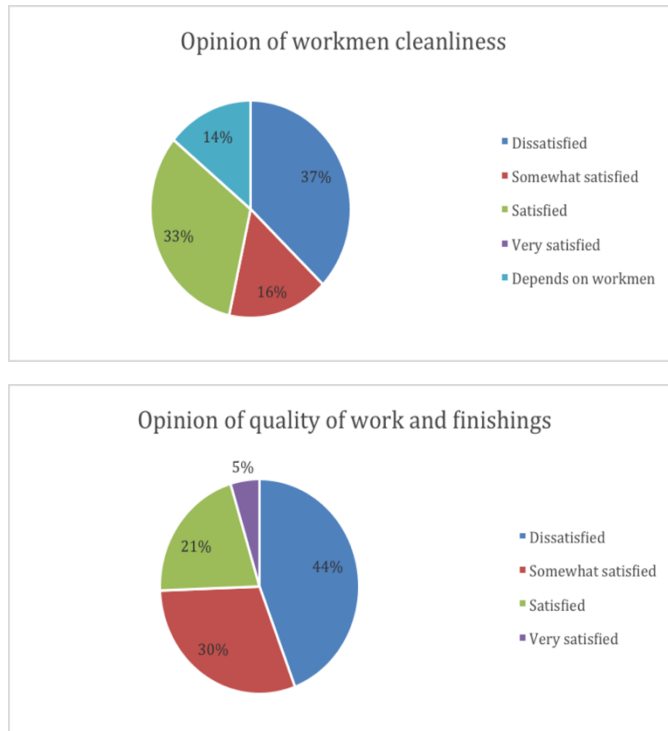


Figure 19 and 20: Opinion on workers

The responsiveness and cordiality of the Brézillon team members were generally appreciated. Brézillon's door was often left open and tenants were generally well received. The majority in the survey appreciated receiving a letter for each intervention. However with short notice: often the day before work started.

The majority of tenants were disappointed with the level of involvement of ICF-Novedis and would have preferred greater on-site presence to monitor contractor progress. Nearly half of the tenants (49%) would have preferred that ICF-Novedis followed up contract work to a greater extent. More than a third of those surveyed (38%) would have liked ICF-Novedis to provide its tenants with a better level of information during the work, by letter, Internet or poster in the lobbies and regular information meetings to report on progress and problems encountered, for example.

Tenants expressed some expectations concerning ICF-Novedis:

- a manual or workshop on how to use the thermostat and videophone.
- more transparency on charges after the changes
- a few would welcome some financial compensation for the disturbances caused.
- a dozen tenants would like an event to be organised to close the work: a house-warming party or a welcome meeting by ICF-Novedis agent and the architect or a Brézillon representative.

2.2.3 Conclusions of Cotentin-Falguière

In conclusion, many of the households interviewed said that they are already aware of saving energy. A majority have already adopted certain eco-habits and have installed low-energy bulbs, adapters, etc. They expect that they will be able to better use the equipment installed in their apartment, including the videophone, which is considered useful for monitoring their consumption.

The interest of the BEEM-UP energy efficiency restoration and improvement project has been acknowledged by the tenants, in association with a forecasted decrease in energy consumption and therefore its economic benefits. The work, which lasted for a long time, occasionally making life difficult on a daily basis, is now finished, so tenants would like to enjoy the benefits it will bring. Also, a **convivial closure event for the work** organised by ICF Novedis, inviting all tenants to give their opinion on these months of work, would be the occasion to discuss dissatisfaction, appease animosity and encourage the relationship and communication between landlord and tenants.

In order to better evaluate the benefits of the work in the long term, with a greater amount of technical and financial data, it would be worthwhile organising a **new survey in six months' time** to discuss energy savings made in the apartments with the tenants as a result of the new equipment, in particular.

In addition to organising an event to mark the end of the work, we feel there are two actions which need to be taken before seeing the tenants again as part of a survey:

- provide **information on the equipment** (videophone and thermostat) via paper media and possibly workshops (several dates and times)
- communicate on **how heating and hot water charges operate** to reassure and enable tenants, generally willing to make energy savings, to be increasingly autonomous.

Chapter 3 Evaluation of Van der Lelijstraat in Delft

3.1 Information about the project

The project at the Van der Lelijstraat in Delft has 108 dwellings, one third semi-detached and two thirds in the form of maisonettes. The homes were built in 1958. They are rented in the social housing sector, meaning that the income level of the tenants is relatively low.



Figures 21-23: View of the project

The types and floor areas are presented in Table 3.

Type	#	m ² /dwelling
Floor apartments	40	79
Top apartments	20	88
Top apartments (semi att.)	20	76
One family house (semi att.)	14	96
One family house (att.)	14	96
Total	108	9.128

Table 3. Types of dwellings

The average dwelling size in the Netherlands is 75 m², meaning that with an average surface area of 84.5 m² in the project the dwellings are relatively large.

A survey on the demands and perceptions was conducted before the design process started. In the pre-renovation evaluation, correlations were found:

- Higher electricity use and more persons in the households.
- Higher natural gas use and more children in the households.
- Higher age and lower temperature set points while away.
- The older the household members, the fewer showers per week.
- More showers per week in larger households.
- Number of laundry washing cycles and number of persons in households.

- Level of gas consumption and:
 - temperature set points in living rooms.
 - level of temperature reduction during night
 - evidence of energy conscious behaviour.

A committee of neighbourhood representatives was formed and was consulted during all steps of the design and execution phases of the renovation. Dissatisfaction with the poor thermal quality of the envelope brought tenants together in an effort to increase the owner's priority for renovation. The cold winters of 2009 and 2010 caused a strong conviction that improvements were needed. When the initiative for the renovation project was taken and an active group was consulted about the plans, they demanded new insulating windows before the next winter, or they would not cooperate in other proposals of the owner. This priority resulted in the homeowner's promise that new windows would



be installed before Christmas 2011. The deal changed the process in many ways: disconnection of the envelope from installations inside the building and even disconnecting the replacement of windows from insulation of the roof and further measures on the façade. Another effect was that scaffolding had to be erected twice to execute the works.

Figure 24. Old window frame

The goals of the renovation included improvement of the energy standard from label E and F to label B and C. Some dwellings reached label A. The tenants stayed in their dwellings during the renovation.

The moment of execution of different measures covers quite a long period of time, see Figure 25. This has an impact on the interpretation of energy consumption data in the reference situation and after the renovation.

The windows and glazing have been replaced in the period November and December 2011, the roofs were insulated in the first months of 2012, while extra's, such as the home energy management system, modern central heater and solar domestic hot water systems have been installed in 2012 and up to May 2013. The renovation was executed in a collective exercise first, followed by individual measures that the tenants could choose: the so-called free selectives. The collective part included new window frames, roof insulation and the clean-up and repair of the masonry facades. The improvement of the envelope is without rent increase for the present tenants. The free selectives were individual central heating, or a new combined hot water/heater if central heating is already available, a solar domestic hot water system, floor insulation above crawlspaces, a smart electricity meter and a home energy management system (HEMS). Figure 30 provides a timeline for the renovation. Subfloor insulation was cancelled after a few cases, because of the technical complexity including discovery of asbestos containing sewer pipes in the crawlspaces. The prevention of emission risk of asbestos fibres had too much impact on the execution of this measure. For the free selectives a rent increase must be accepted.

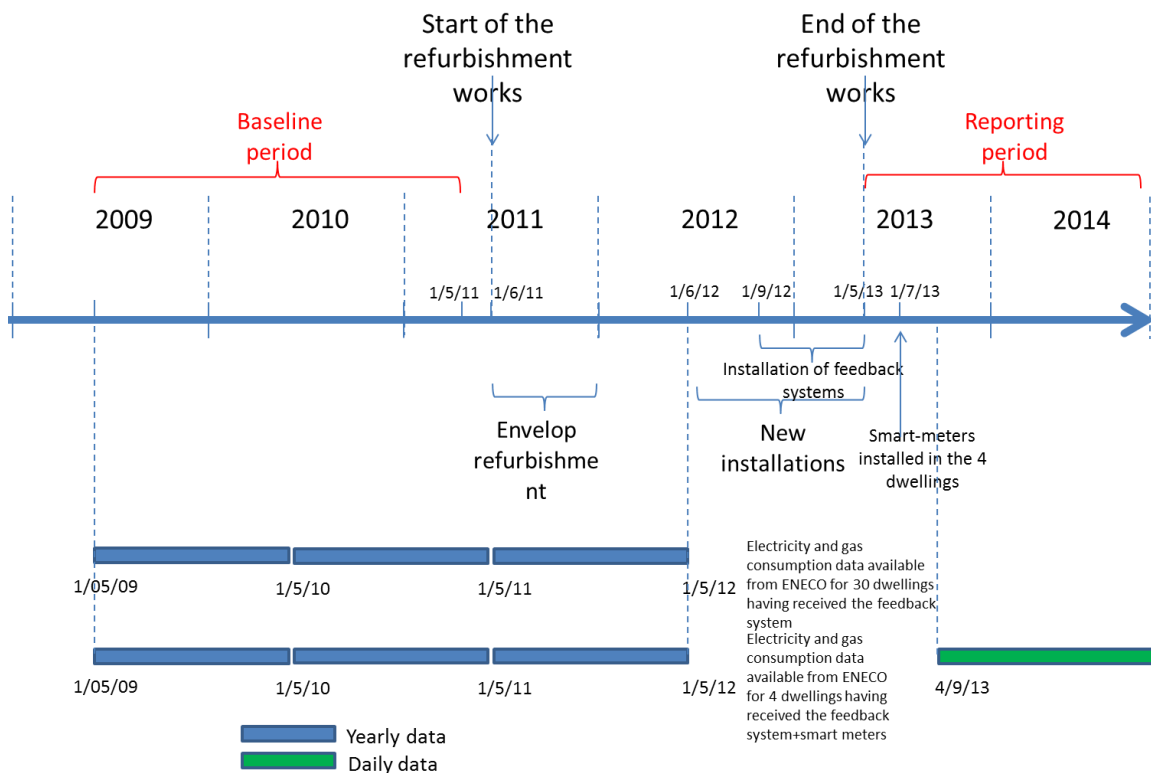


Figure 25. Planning of renovation activities



Figure 26. Woonbron arranged open house meetings for tenants in the pilot apartment (March 2011)

The home energy management system for feedback (HEMS) was free of charge during the first years. Many tenants have ENECO as energy provider, but since the market is open for competitors, other companies have an increasing number of customers in the neighbourhood. The HEMS was provided for ENECO customers only. About one third took the selective measures, but the package differed per occupant, depending on preferences and the dwelling characteristics.

A pilot apartment was renovated first. This apartment was used for meetings of professionals and tenants during the execution and a period of some months after the renovation project.

Activities to promote participation in energy saving measures were:

- Tenants were offered a promotional energy-saving box (light bulbs, thermometer etc).
- Social activities included energy saving instructions, idea generation that resulted in proposals to improve outdoor lighting in the area and a neighbourhood-party around Christmas 2011. These activities have built trustful relations with the tenants as there had been some mistrust previously due to for example postponement of window replacement.
- There was a “consultation hour” every morning about practical issues.
- Individual inspections of the dwellings including “warm” interviews (explained below) that gave an opportunity to “get to know the tenants”. A questionnaire to monitor the reference situation concerning energy related behaviour was handed over during these home visits. The response was 40%, however, only 15 households presented their requested energy data.
- A newsletter and other information were sent out regularly to all tenants.
- Regular meetings were held with the tenant feedback group.
- In information sessions the solar boiler and energy feedback system were demonstrated.



Figure 26. Façade drawings of main housing types in the Delft project

Not all tenants were interested or receptive to the information at the moment it was supplied. The individual approach towards tenants gradually took over the position of large meetings that were used previously. The personal approach is called “warm inspection” and was much appreciated by tenants.

The post occupancy interviews were held in May 2014 and this is almost two and a half years after insulation of the envelope and at least one year after the renewal of heating systems. The report includes energy data analysis of almost all dwellings until June 2014. The Technical University of Delft has analysed the relationship between household

characteristics, indicators on behaviour and energy consumption on the basis of 31 interviews. The energy data analysis is presented in report of Deliverable 3.8. of the BEEM-UP Project. The focus here is on energy data analysis of interviewed households, while some tables about the overall energy consumption for the project are presented, to indicate how the interview results relate to the overall result.

3.1.1 Data collection and analysis

Results of energy data analysis of all dwellings

Detailed information on the analysis of energy data is presented in BEEM-UP report D3.8. This deliverable also includes the motivation of correction factors for Degree Days and for non-heating energy use (showers, cleaning, cooking). In this post occupancy evaluation study the focus is on the interviewed households. However, it is important to stipulate the overall impact of energy saving measures.

The overall energy savings for heating are 35% over two years after the renovation (Figure 33). Expressed in kWh/m²,yr this leads to the following change in heating energy use: from 140 kWh/m²,yr to 88 kWh/m²a. The electricity consumption is 30.8 kWh/m²a before and 29.6 kWh/m²a after the renovation. The electricity consumption is reduced some 4%.

The average electricity use for households in the Netherlands is 3500 kWh. The average natural gas consumption is 1600 m³. Actual energy use in the project in Delft is much lower: 30% lower than average for electricity and 32% lower for gas. After the renovation, the monthly cost for gas is €60 and for electricity €50. Tenants are more aware of the gas cost than the electricity cost and consider the temperature control and minimizing the ventilation volume effective means of energy savings.

The non-heating energy consumption includes hot water for bathing and cleaning and is approximately 250 m³ with the geyser and 350 m³ gas per year with the combined heater.

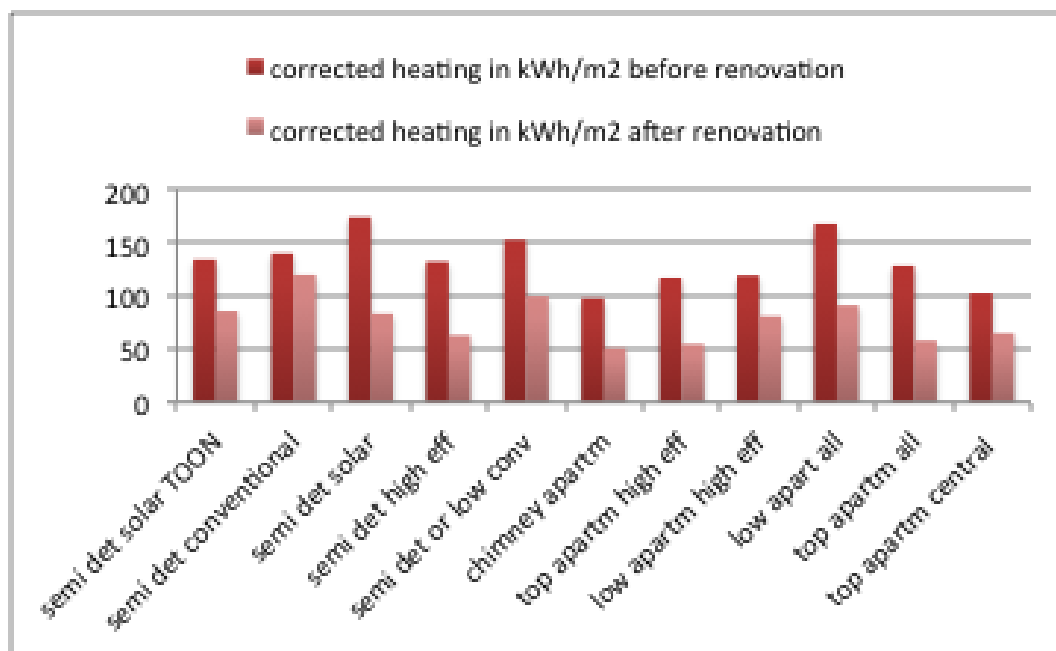


Figure 27. Corrected heating energy in kWh/m²yr before and after the renovation for different packages and dwelling clusters

The effect of insulation depends on the dwelling type and ranges from about 17-37%. The best results are obtained in top apartments, where roof insulation borders heated rooms: the effect of insulation is 37% in these under the roof situated maisonnettes. Where the heating system is changed into high efficient central heating, the savings sum up to 35% to 50%. The next large effect comes from solar domestic hot water. 12 top apartments have a solar system resulting in energy savings of 55%

The effect of singular measures are based on low numbers per set of variables, making statistical output quite unreliable. Instead a table with effects per measure is produced with most likely contributions (see Table 4). This table can be compared to the perception of the interviewed tenants about the energy savings.

Heating in kWh/m ² yr	semi detached	apartment low levels	apartment high levels
reference	145	145	120
insulated envelope	120	100	75
+ high efficient heater	90	90	60
+ high efficient heater + solar domestic hot water	90	90	60
+ high efficient heater + solar domestic + TOON	85	85	55
saving complete package	41%	41%	54%

Table 4. Most likely effect of measures per dwelling type with energy saving percentage

3.2 Post-occupancy evaluation of Van der Lelijstraat

3.2.1 Information about occupants and occupants' behaviour

The interviews have been carried out face-to-face in the occupant's homes, allowing for a closer look at people and their living conditions. Appendix B presents the topics that were used in the questionnaire. The interviews were held in May 2014, almost two years after the renovation and including one year of energy meter readings after completion of the works. The interviews of 31 households supply information on the household type, temperature settings, ventilation habits, the number of showers, cooking habits, use of lights and household appliances etc. This detailed information was used for precise calculation of the heating energy consumption, first by calculating the energy for cooking and bathing, then correcting the resulting consumption for degree days per year. In total 26 of these 31 households provided meter readings. The insight into these 26 households has led to more reliable conclusions about the effect of the renovation on energy savings.

Average period living in the house

Semi-detached:	20.3 years
Maisonette levels on lower floors:	11.5 years
Maisonette levels on top floors:	12 years

The difference is large and indicates that people appreciate living in the semi-detached dwellings. Also, long periods implicate that the age of occupants in these dwellings is relatively higher, with more often old couples and single old ladies who have a sparse lifestyle.

Number of occupants

The average number of occupants per dwelling is 2.5 persons, which is higher than the average in the Netherlands, which is: 2.3. In semi-detached dwellings the average occupation is 2.3 persons and with relatively more couples or singles without children at home. In maisonettes on levels 1 and 2 the average occupation is 2.6 persons; often larger households with children at home. In maisonette levels 3 and 4 the average occupation is 2.5 persons.

Use of electrical appliances

About half of the households have an electrical laundry dryer: one quarter a condensing dryer and one quarter an exhaust duct connected to outside. The laundry dryer is used for 2.4 cycles per week on average. The average frequency of using the laundry machine is 3.5 times per week. The large majority washes on low temperatures: 30-50 °C.

Of the 31 interviewed households, 9 still use incandescent light bulbs as permanent lighting (when dark), 4 have halogen lights, the 2/3 majority use energy saving lights for permanent lighting, including a number of LED lights. Lighting that is used for short periods of time, such as in restrooms, hall etc. were not discussed.

Domestic hot water system

Half of the interviewed households still use the small geyser for kitchen use including showering, the other half use the combined heater/hot water system and one household

still uses an electric boiler. Everybody is happy with the hot water service, even the people who still use the geyser (with only 2.5 instead of 6 dm³/min of hot water).

3.2.2 Satisfaction with the renovation

Tenants were confronted with minor visible effects of measures, for instance heating water pipes on the wall and other effects of installations. The need of interior re-decoration was minimal. New curtains were not needed. The pipes connecting the radiators were not painted and are considered ugly. Due to some extreme weather conditions during the insulation of the roof occasional leakage occurred and some people had to change flooring material. Insurance (of the contractor) covered most of the damage.

Tenants were asked about not yet solved complaint situations. Most remarks were: a. We hear more noise from outdoors and neighbours and b. Some delivery issues still need attention.

Overheating is hardly a problem and only exists during extreme hot summer conditions. The tenants of the maisonettes experience overheating in the bedrooms and some also in the living room. No problems about overheating were expressed in the semi-detached dwellings.

Some draught problems come mainly from the ground floor-maisonettes, not from other housing types. Tenants who complain about winter comfort, tend to complain about many other performance topics as well, for instance about control of the temperature and about the renovation process and the overall results of the renovation. These tenants mainly live in the semi-detached dwellings and in the maisonettes on the top floors.

Almost 60% of the interviewed tenants still have some complaints relating to malfunctioning of installations or poorly finished jobs. These complaints have been expressed shortly after the end of the renovation process and with positive hope that it would help. Often, nothing or not enough has been done to solve the complaints and now some tenants express frustration and tend to complain about other performance issues as well. Poor maintenance of the outdoor environment (by the city of Delft) has been mentioned in this respect also.

Satisfaction about what is offered for the rent is highest in the top maisonettes, then on the bottom floor and in the semi-detached dwellings. The overall ranking is 7.5 on a scale of 10, which reflects the overall positive appreciation of the renovation.

3.2.3 Specific measures

Ventilation

Ventilation characteristics changed and are different per dwelling: 80% has trickle vents always/mostly open, 10% mostly closed while 45% of windows in bedrooms are mostly to always open in winter. The bedroom door stays open, depending on the privacy: 54% are open, 46% stay mostly closed. The impression is that the trickle vents are better used than the old sliding windows, because the inlet is higher up on the wall and causing less draught

than the vertical ventilation opening in the cold and draughty window frames. The effect could be somewhat better ventilation, which causes higher energy consumption but a healthier indoor environment. Interviewed persons express that the renovation did not cause changes in the use of the dwellings, nor in the number of occupants including pets, nor in the user behaviour relating to heating bedrooms, frequency of airing or ventilation. The majority of the households does not heat up bedrooms, or only do so for a short period of time during cold periods.

Information about the heating systems before the renovation is not very detailed. Most households have had chimney tied heaters combined with radiators. Information about the heating system after the renovation is more accurate.

Heater type	Before renovation number of dwellings	After renovation number of dwellings	Explanation
chimney tied heater without radiators	probably 16	16	only living room can be heated, combination with small geyser
chimney tied heater combined with radiators	probably 81	5	single heater in living room connected to circuit with radiators, combination with small geyser
traditional efficiency central heating	11	11	installed by tenants, varying efficiency, often with hot water
high efficiency central heating + domestic hot water		76	modern and efficient system with relatively high efficiency for domestic hot water
total		108	dwellings in the project
high efficiency central heating + solar system		46	solar system always combined with modern heater, saves 50% of energy for domestic hot water (av.
home energy management "TOON"		34	always together with modern heater

Table 5. Change of the heating systems in the project

Solar domestic hot water

Of all households 43% have a solar system; of the interviewed households this figure was almost 50%.

Home energy management system TOON

The smart display called TOON is a programmable thermostat that can present real time and historical energy data and information about outdoor and indoor temperatures, heat and power consumption as well as information on the weather forecast (see Figure 34). Comparisons can be made with averages of the neighbourhood. The service comes from the

energy company and is free of charge for the tenants during the first two years of use. In total 34 systems were installed. During the interviews, that were carried out one year after the installations of the displays, some tenants indicated that the insight in the power consumption had an impact on the purchase of energy efficient lamps, on more selective use of the electric laundry dryer (and coffee maker even) and early replacement of a freezer. The majority of interviewed households with the smart system use it as stand-alone display, while one third is Internet connected through WiFi. Few dwellings had clock-controlled thermostats. About half of the stock in the project is equipped with programmable room thermostats now, including the modern management system.



Figure 28. TOON monitor with remote sensors, wireless connection and Internet interface

Interviews with users indicate that the “real-time” information on energy consumption gives new insights and affects behaviour. The learning curve is steep and will last a few weeks, but energy minded or cost minded people stay interested in feedback on the household’s energy consumption. When being faced with replacement decisions, they are more likely to replace an old refrigerator for A++ type, an old TV set for a LED television, while taking long showers by teenagers may be discouraged on the basis of the visible energy feedback. Quite many households use the four pre-set set points of TOON (away/at home/sleeping/comfort) similar to the manual thermostat: lower temperature by selecting “away”, higher temperature with “comfort”. This feedback is pretty similar to the manual thermostat and is effective as energy saving measure. In the first weeks after installation the tenants checked the historical energy data and also the power consumption quite often and expressed a high learning curve. Then the activity dropped, depending on the level of interest in energy issues. The interviews indicated different reasons causing the fading interest. Some reached the end of a positive learning period, some were disappointed in the effect of their efforts to save energy and some had played enough with the new gadget and lost interest. An average positive effect on energy consumption has been reached, however.

Further lessons learnt regarding the system were that the more reliable, transparent and understandable the feedback was, the more the user would take notice of the information. Because these new systems were not (yet) robust enough and frequent breakdowns occurred, tenants lost interest. Poor repair or no repair at all occurred frequently, because the installation operators were not familiar with the system, while the radio transmitter was not strong enough to cover the distance between meter and display in the higher situated maisonettes. Some tenants became disappointed in the service and did not even bother to reset the system and stopped using the feedback system completely.

3.2.4 Evaluation of energy use of interviewed households

Of the 31 households only 26 provided gas consumption data, the other 5 were based on calculations and therefore not used in this analysis.

For each of the interviewed households individual corrections were used, different before and after the renovation and based on changes in household size, technical installations, number of showers taken, cooking frequency and so on. This is relevant for the interpretation of energy effects of the renovation. For instance: the effect of a solar thermal system depends on actual number of showers taken. With only 1 or 2 showers per week the solar domestic hot water system does not contribute much to energy savings, but with for instance 14 or 20 showers per week the savings are about 50%. The total natural gas use is for space heating, domestic hot water, cooking and kitchen use (cleaning, washing dishes by hand).

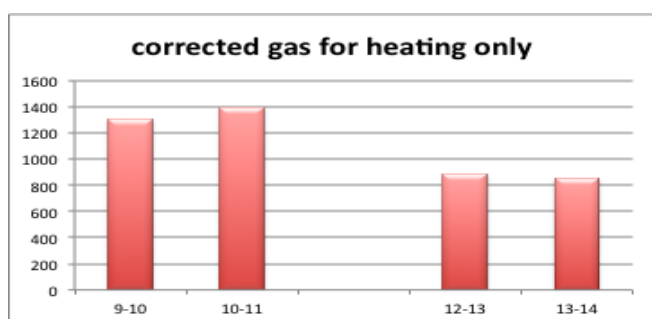


Figure 29. Degree day and balance point corrected gas use per year (Y-axis) for space heating of 26 interviewed households, resulting in 35% savings after the renovation

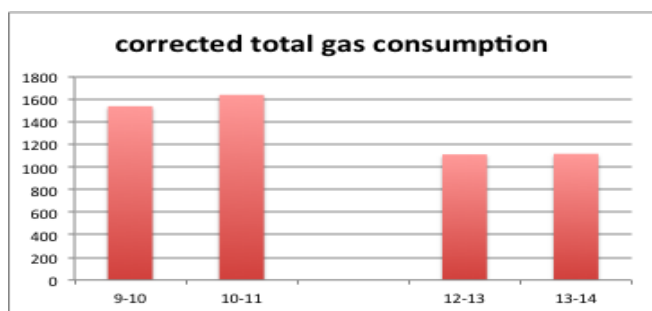


Figure 30. Average corrected total gas consumption per year (Y-axis) of interviewed households, resulting in 30% energy savings after the renovation

Figure 31 shows that the electricity consumption trend is stable. More electrical appliances, such as battery chargers, tablets and other computers, coffee machines and larger refrigerators are used, but the efficiency improves. Higher efficiency may also compensate longer periods of use. Further electricity savings come from LED lighting. Many households only use a few lights for permanent lighting and most often with energy efficient fixtures. The lights in the toilet, the hall and bedrooms are used for short moments. It means that lighting has little impact on the total electricity consumption.

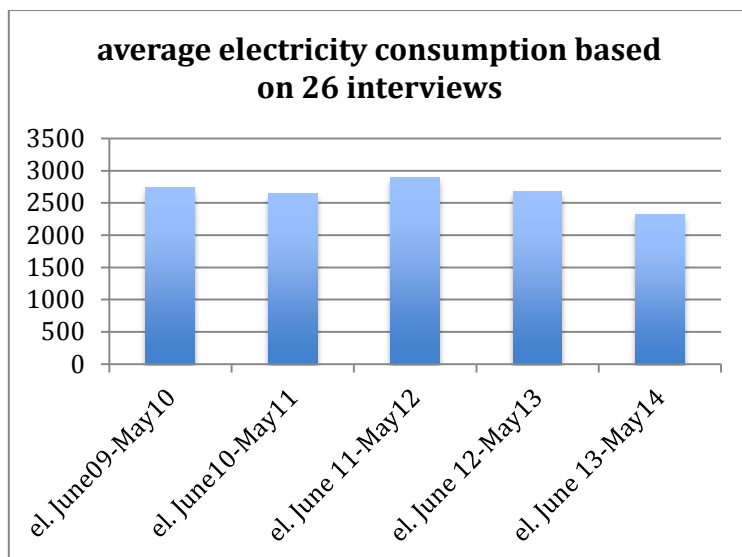


Figure 31. Average electricity consumption in kWh over five years of 26 interviewed households

Household types

Household types that represent higher or lower energy consumption in combination with differentiation in dwelling types can point at priority fields of attention, both in information/motivation of behaviour and in technical measures. During the interviews we discovered a rather simple household typology: warm, cool and average, referring to heating energy demand. The number of showers is of great influence. Hence, the typology should include number of showers. From the pre-renovation interviews it has been known that the number of children in the household is an indicator of gas use, while the total number of persons is a good indicator of electricity use.

Semi-detached dwellings are well appreciated and show a long average period of use. The effect is that these dwellings are more than average occupied by single elderly woman. Despite lower metabolism and related need for higher temperature levels, these occupants have learned how to save on energy cost, do not heat the bedroom, have few electrical appliances and tend to take fewer showers.

The interviews show that the occupation period in maisonettes is shorter than in the semi-detached dwellings, and the impression is that younger and more often singles and single women with children occupy these apartments. Many single persons tend to work and are not at home during weekdays. The houses with only 2 and 3 bedrooms tend to have a higher occupancy rate than the 3-bedroom lower level dwellings and much higher than the semi-detached dwellings.

The interviews have given better insight into the behaviour of tenants that have a tight and non-flexible financial situation: the monthly budget must be kept in control and there is no room for extras or for financial risks. Many households in this situation seem very aware of the energy cost. It does not mean that these people lack thermal comfort or do not take showers, but they have fewer electrical appliances and use the heating and hot water

service as sparsely as possible. These poor households have low energy consumption but the energy costs take a large portion of their budget. The feedback about the yearly energy bill is important to them: they do not want to pay unforeseen extra cost. When the users rely enough upon the effect of energy savings because of the renovation, first more comfort is welcomed and second some reduction of monthly cost is welcomed. TOON and other measures where cost come before savings are not trusted and for that reason poorly accepted. The interviews did not include income details, but the accounts of strict energy budgets and risk reductions were clear. Doubt about the energy saving effect will prolong for some years even, until the monthly energy fee stabilizes on a lower level and the users have more to spend on other needs.

On the other hand: not all households in social housing are financially constrained. They might have applied for the dwelling many years ago and their financial situation may have improved considerably. Some changed their home into a comfortable place, while appreciating the simple traditional heater and geyser. They are more likely to oppose the renovation when it affects the indoor decorations. Relatively many of these households can be found in the semi-detached dwellings.

3.3 Conclusions of Van der Lelijstraat

3.3.1 The process

Omitting the rent increase for the basic package and for the existing tenants has eased the process. It is difficult to evaluate what would have happened with higher ambitions including a rent increase, but it could have worked out, if more time would be available for the process.

Giving users the freedom to select extra measures highlights the user aspects of these measures. This “free choice” gives users real influence.

Getting to know the tenants in how they use the dwellings and how they perceive the comfort was very important. The renovation has been quite successful seen from the perspective of the tenants. Comfort has improved, maintenance problems and some major complaints have been solved and there is energy cost reduction from the selective package of measures. The empowerment effect of the process seemed promising as long as the process was stimulated by the home-owner, but did not continue although there were some social active people in the neighbourhood. The involvement of the tenants had a positive impact on accepting the disturbances of the renovation.

Some complaints were not solved quickly or completely, for example the malfunctioning of the home energy management system. The partly restored trust between the homeowner and tenants was put to the test again because of these unsolved issues.

Before the start of the planning process a real estate expert claimed that the investments in energy performance would not increase the sales value. At that moment the homeowners wanted to put the dwellings for sale to the tenants. This opinion together with the financial problems of the housing association had a large impact on the

investment level and the future outlook. The housing market was very slow during the renovation process and selling the dwellings to the tenants was no issue any more.

3.3.2 Energy savings

The contribution of different measures to energy savings is different from theoretical models. In specific dwelling types with many measures two-thirds of the calculated energy savings have been reached. On average for the project half of the ambitions have been reached.

The contribution of insulation measures is very modest for low level apartments that miss the effect of the roof. The effect on semi-detached dwellings is also rather disappointing. The reason is that in these dwellings the roof covers attics that already function as an important temperature buffer and that most bedrooms are unheated.

The effect of solar domestic hot water systems and heaters with high efficiency is positive. The number of showers is on average 14 per week and the solar thermal system can save 50% of the energy use for hot water: which correspond to 145 m³ gas per year on average. When changing from small geysers with 2.5 dm³/minute hot water flow to 6 dm³/min with the new installations, the solar system compensates for this higher comfort level and even more, meaning that the solar system covers more than the rebound effect.

The effect of highly efficient heaters is positive, especially when replacing traditional central heating. The theoretical (and per system in laboratories tested) nominal efficiency increased from 84% to 107%. However, not this theoretical factor counts much, rather the effects of the closed combustion system and the missing pilot flame of high efficiency heaters. The temperature control of central heating in a situation where the heat source is hidden in a closet is less robust than with the chimney tied heater in the middle of the living room.

Better insulation plus central heating facilitates heating of bedrooms better than before and these rooms may gradually be used for other functions besides sleeping that require heating.

The energy saving effect of the home energy management system was about 7% in a thorough study by Sonja van Dam (PhD) and this range is expected in the Beem-Up project as well, but many variables make it hard to claim a specific percentage. However, the cost is minimal and the comfort and energy effects are positive and more than the cost, meaning that installing this smart thermostat is a good measure.

3.3.3 Recommendations

- For higher energy saving results the insulation value must be improved. The cool bedrooms can be welcomed, but need a separate thermal zone.

- The natural ventilation is energy efficient, considering avoiding electricity use for fans and the embedded energy of installation and maintenance, but for real low-energy dwellings heat recovery ventilation seems a must during the few winter months.
- A solar thermal system is welcomed in any renovation package. PV systems are effective energy savers as well.
- Beginning with the energy consumption in practice and making plans based on actual consumption and user behaviour is becoming accepted as a major innovation in renovation now, at least among the BEEM-UP partners.
- The energy issue could play a more prominent role in any renovation process. The promotion of energy saving behaviour provides a good opportunity if integrated in the tenant involvement during the design process.
- Multiple communication activities could well include the active role of ambassadors in the community. These need support in their role.
- Understanding tenant needs had much attention in the process in Delft. However, information about the technical aspects was limited. A recommendation is to combine technical inspections with the pre-renovation interviews and data collection.

Chapter 4 Evaluation of Brogården in Alingsås

4.1 Information about the project



Fig32-35. The pilot project at Brogården in Alingsås, Sweden - before and after the renovation The pictures showing some green area (left) and part of a court yard (right)

The housing area Brogården includes 300 apartments built in the 1970s. The area is owned by the public housing company Alingsåshem. A thorough renovation using passive house techniques has improved the energy performance drastically.

The renovation

The houses were stripped down to the frame and rebuilt using passive house techniques. While doing this the layout of the flats have been slightly changed to assure a better accessibility and provide an increased number of large flats that suits the modern way of living better than the old layout. This means that all tenants have been evacuated during the renovation of their house, and it also means that no part of the residential area have stayed unaffected by the refurbishment.

Energy consumption and billing

Before the renovation, domestic hot water and household electricity were collectively paid for through the rent. Since everything was collective and the bills paid by the housing owner Alingsåshem, it was impossible to see how much energy the individual household was consuming. After the refurbishment both hot water and household electricity are individually metered and billed. The tenants are themselves able to influence their costs by their behaviour. Alingsåshem has helped them by providing an energy efficient climate envelope, water efficient fittings and low energy fittings in the common areas. (It is also possible for the housing owner to see the hot water consumption of the house as a whole, which might be relevant in the houses that have a laundry room that can be used by all the tenants.)

Passive houses require a minimum of heating, only a few cold days a year when a pre-heating of the incoming air is necessary. Because of the minimal heating requirement, it is not cost effective to bill the tenants for the heating.

Dialogue and communication

Procured partnership

Procured partnership has been a key to success at Brogården. Thanks to this cooperation model everyone involved have been important cogs in the development process: designers, contractors, property managers and residents.

The partnership is a structured and modern form of collaboration where partners form the project together. The expected benefits are production and cost efficiency and continuous improvement of products and service. The partnership is characterized by trust, transparency, shared goals and dedicated partners. In a procured partnership all skills are seen as valuable. Continuous feedback-loops and evaluations from everyone involved have ensured that the working conditions and technical solutions have evolved during the project's running time

Each stage of the project has started with an experience recuperation meeting involving every team member on the project. On this arena, different teams get to share and understand each others' perspective and are given the chance to raise key aspects or needs for improvement. Many solutions and process turning points of the project rise from these meetings.

A kick-off meeting, including all contractors, subcontractors and representatives from the building owner, was held at the very start of the retrofitting process. This kick-off ensured that everyone worked towards the same goal, and established good communications from the very outset.

Showroom apartment

A showroom apartment was renovated first. This apartment was used for meetings for both professionals and tenants all through the project.

The tenants

Brogården represents an important part of Alingsåshem's housing stock and the project has involved a great number of tenants for a prolonged period of time. Because of the long project period, and also because of the necessary relocation of tenants, much work has been put into helping tenants and giving assistance to fulfil individual needs.

In order to create security, dismiss rumours and get feedback a continuous dialogue was established with the tenants. It is also much easier to create an understanding for changes made if the recipient has been involved in the early stages of the process.

In addition to one-to-one meetings, all tenants have been invited to frequent open houses in a showroom apartment; a newsletter have been published regularly and all three companies have been available for all sorts of questions. All these actions have been made in collaboration between the housing owner Alingsåshem, the entrepreneur Skanska and the Swedish Union of Tenants.

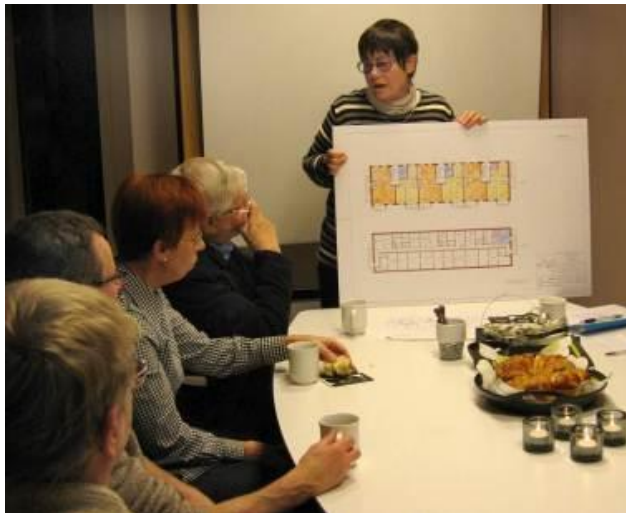


Figure 36. Architect Kerstin Nilsson shows the change in spatial dispositions for some tenants at an Open House in the show apartment.

However, some problems have arisen along the way: the people that first established the dialogue with the tenants changed jobs; the Swedish Union of Tenants, which was a very important partner, lost members; and the real enthusiast in the area had to go on sick leave. This event is very much a widespread phenomenon, indicating that permanent representation is not of this time. Instead, more open coalitions and actions that involve people represent the present situation.



Figure 37. The Swedish passive house expert Hans Eek answers questions about passive houses at an open house in the show apartment.

4.2 Post occupancy evaluation in Alingsås

Alingsåshem executed a post-occupancy evaluation in November 2014. Appendix B presents the topics that were used in the questionnaire. The study has been performed in House H at Brogården in Sweden. There are 18 flats/apartments in House H.

The interviews

The study was performed as telephone interviews. The interviewer had sent out a letter to all the households in the house, one week prior to the study, warning them that they would get a call from the interviewer. The letter stated how important it was to participate in the study, since this was the tenants' chance to leave their views on how the house actually performs. It was also pointed out that all participation was voluntary. The interviewer called the households in the evening, between 5 pm and 8 pm. The first question was always if it was convenient for the respondent to talk right now, or if they would prefer to be called at any other time. The interview followed a set of fixed questions, with ample time for the respondent to leave other comments or to elaborate on their answers. Each interview took about 40 mins. All interviews were anonymous, marked in the answer sheets with a number only.

4.2.1 Respondents

Out of 18 households, 10 participated in the post-occupancy study.

- In 1 household the tenant had only lived in the house for a week, so he declined.
- 3 households made themselves unavailable.
- 4 households did not answer their phones despite attempts to contact them.

The respondents show a wide range in household size, age and habits. Most of them have lived in the house since it was habitable again after the retrofit, which equals to 2.5 years. One respondent had lived in the house for 1 year.

4.2.2 The retrofitting process

Out of the 10 respondents 6 stated that they lived in Brogården pre-retrofit. We know for a fact that a seventh respondent lived in the area before the retrofit and are unsure why she stated that she did not. Most respondents said that they were okay, content or very content with how the management process of the renovation had turned out. The same applied for the level of information during the renovation; the attention for their needs and the results of the renovation.

Two of the respondents were not content, or indeed very dissatisfied. When asked why they were dissatisfied they left differing answers. Tenant 2 was discontent because the renovation took too long: she had spent years on a building site, she thought, and building sites are dusty. She was also very angry because someone at an early state in the proceedings had given her an estimation of her rent after refurbishment, and that estimation was wide off the mark. Despite the estimations of the coming rents being

adjusted just months after the initial information, she was still very upset some 6 years later that she had been misinformed the first time. Tenant 7 was discontent due to the new layout of his flat. He used to live in the smallest type of flat, a one-room apartment with a cooking cupboard. Alingsåshem deemed those apartments as too small for modern needs, and rearranged the space so that all small apartments now have a small kitchenette and a sleeping alcove. According to the tenant the layout was better before the renovation, and no one has listened to his views during the retrofitting process, which also made him upset with the management.

Lessons learnt

What we can learn from this is that it is not wise to give estimations of costs before all plans and calculations are confirmed. It does not matter if the estimations are marked as “temporary” or “estimated” - for the recipient who has nothing else to go on, they will be important facts. When those “facts” are changed the sender has lost some credibility in the eyes of the receiver. It is also clear that what the tenant and the housing company regard as a good living might not always coincide. It is always useful to ask the real experts - the tenants - if an apartment is comfortable or not.

4.2.3 Use of the flat before and after retrofit

Some of the respondents that lived in Brogården pre-retrofit have stated that they use their space differently before and after retrofit, but when asked why it turns out that this has less to do with the house itself and more to do with changing personal circumstances. No one has stated that they use their rooms differently because of the retrofit, or that the renovation has changed how much time they spend at home. The balcony was the one feature that seems to be used in another manner from before the retrofit. The old indented balconies were considerably smaller than the new balconies that are in line with the façade and have shields on the sides. Since there is now a possibility to make the balcony completely glazed, a few of the tenants treated the balcony as a new extra room, and spent more time on it now than before. One tenant had even furnished it like a small living room. Tenant 5, who was very pleased with the results of the renovation, stated that he now longs for home every day. He felt content as soon as he entered the area and saw the houses. He cannot remember doing this before the retrofit. He did, however, hesitate in giving the mark “very satisfied” in the questionnaire, as he usually never did that in any survey.

4.2.4 The rent level in relation to performance

One respondent declined to answer how she felt that the new rent level was in relation to performance of the house. Out of the other 9 respondents the result was

- 3 households were very satisfied
- 4 households were content
- 1 household was “okay” with the performance in relation to rent
- 1 household was not content

The discontent household was tenant 7, who lived in Brogården pre-retrofit and felt that his flat was not as convenient after rearrangement as it had been before. He was not happy about having to pay more for something he thought was less practical. The respondent that stated that she was “okay” with the rent level in relation to performance came to this mark as a compromise: she was actually content or very content with the performance as a whole, but she had considerable problems with cooking fumes (see below) in her apartment and that influenced her to set a lower grade on the average performance.

4.2.5 Comfort

Temperature before and after the retrofit

The 6 tenants that lived in Brogården before the retrofit have differing answers when asked about the temperature in the living room and bedrooms before and after the renovation.

- 3 households think that the temperature is worse now than before.
- 2 households think it is better now than before.
- 1 household thinks the temperature now is the same as before.

The differing answers might be due to number of people in the household, and personal preferences when it comes to comfort temperature levels. Indeed, some thought that the bedrooms were too cold now, while others thought that they were too warm. Tenant 8 deemed the temperature as worse than before. When asked what his preferred temperature would be, he stated that he would like 25°C or more (up to 28°C during the winter). This is a temperature that no public housing company in Sweden can guarantee, and it was never supplied in Brogården before retrofit as it would have been extremely costly to do so. Most households answered spontaneously that the bathroom was too cold. Since Brogården is retrofitted using passive house techniques, there is no radiator in the bathroom. The incoming air is pre-heated but, as the study shows, it might not be enough in single-person households or households where the bathroom is used for less than one hour each day.

Preferred temperatures

In Brogården, Alingsåshem guarantee a lowest temperature of 20°C. This is in compliance with Swedish norms, rules and praxis. It is also a temperature that the houses should be able to maintain without much added energy. Swedish norms state that a rental flat should keep between 20 and 23°C. The temperature should never be lower than 18°C, and never higher than 26°C for a longer period of time (that is, more than 2 days, allowing for quick shifts in outdoor temperature and natural technical lag in adjusting temperatures). The average Swedish comfort indoor temperature varies between 20°C and 24°C depending on age and activity. We know that elderly people usually have a comfort temperature that is a few degrees (2-4°C) higher than teenagers.

In the post-occupancy study at Brogården the tenants showed clear tendencies when it came to preferred indoor temperatures: most tenants answered that they preferred 18°C in the bedroom, 21°C in the living room and 22°C in the bathroom. The two older men in the study did not comply with this general trend: they both preferred 23°C in the

bedroom, and 23-28°C in the living room and bathroom. As a whole, this implies that the tenants in the survey follow the Swedish average for preferred temperatures.

The thermostat and the control of temperatures

Most tenants are content or very satisfied with the new thermostat that has been implemented in the living room after the retrofit. The thermostat is marked from 1-5, and regulates the temperature of the incoming air. Each flat has one thermostat, and it is always located in the living room. The tenants found the thermostat easy to use, and appreciated the possibility of regulating the temperature individually. At least half of the respondents stated that they thought that the thermostat was “slow”. When they felt that the flat was too cold, they wanted to turn up the thermostat and feel the results at once. In a passive house the process is much slower than that, since the incoming air regulates the temperature. The tenants complained that they often could not feel the result of the changed thermostat until the next morning. All respondents stated that during the winter, they always kept the thermostat at 5 and never changed it.

Overheating

In passive houses there is a risk of overheating, especially on the south facing side of the house, due to strong sunlight. House H has a long south facing facade with nothing substantial to shield it from the sun. The risk of overheating is higher if there are large windows that are not shielded from the sun. In all Alingsåshem’s houses it is the tenant’s responsibility to install blinds. The blinds can be used both to ward off the sun and to ensure privacy. In the survey 4 respondents claimed not to have installed blinds, but they had all put up curtains instead.

The summer of 2014 was extremely long and hot in Sweden. The country experienced temperatures that far exceeded normal for several weeks in a row. In the post-occupancy study the tenants at Brogården were asked about overheating this summer. No household claimed to have experienced overheating in the bathrooms. Most households had had hardly no, or no problems at all with overheating in the bedroom, living room or kitchen. The one flat that often had problems with overheating in the kitchen and bedroom is the smallest flat, where the kitchenette and the sleeping alcove is connected to the living room, all facing the south side. The temperature quickly transfers from one space to the other. Three tenants claimed that they often had problems with overheating in the bedroom. This seems not to be due to sun exposure, but due to them preferring lower temperatures in the bedroom and when sleeping there with closed doors and windows the room gets warmer than comfortable simply due to the expelled body heat.

Winter comfort

One of the biggest problems with the indoor comfort at Brogården before retrofit was the cold draughts from the indented balcony, the windows and even the ventilation. The post-occupancy study shows that no tenants have problems with cold draughts after the retrofit. All the respondents perceived the indoor temperature during the winter as acceptable, good or very nice. Some tenants gave a lower grade because they thought that the bedroom got too warm during the winter, and due to the cold air outside they did not want to open a window, as they would normally have done during any other season. The bathroom was the one room that often was perceived as too cold by the respondents. As stated before, this room has no radiator and the temperature is dependent on the usage.

Ventilation

It is somewhat surprising that many tenants let their windows open during the summer. The interviews confirm this observation. Most of the tenants in the study claim that they let the window or the balcony door open “most of the day” during spring and summer, despite the recommendation for passive houses to ventilate during a short but intensive period of time (airing). This is both to avoid loss of heat, but also to keep the right humidity in the air. The study shows that the tenants are more than happy with the temperature and the air quality with constant open windows. A few of the respondents pointed out that the indoor air gets very dry in winter. The tenants use windows and doors for ventilation much less frequently during the winter. They avoid open windows due to the heat loss.

No one has said that they use the thermostat as a tool for air exchange in particular. No one has said that they use the door to the staircase as a means for ventilation. This is encouraging as open doors to the staircase often lead to complaints about noise and/or cooking fumes.

Cooking fumes

We know for a fact that a few of the flats in Brogården have problems with a strong smell of cooking fumes coming through the air intake. The problem gets worse if the tenants do not use the kitchen fan, allowing the cooking fumes to mix with the air in other rooms in the flat. The fumes from the kitchen are then expelled through the same exhaust on the roof as the air from the bedrooms, when it is actually supposed to go out through the exhaust of the kitchens and bathrooms. The wheel-heat exchanger involves the risk that outgoing air mixes with the fresh incoming air.

In the post-occupancy study all the tenants claim that they use their kitchen fan when cooking, and that they always open a window. We have reason to believe that they are more convinced of this in theory than in practice.

In the study 4 tenants claimed that they have had problems with the smell of other tenants' cooking fumes, 1 had a serious problem, 1 talked to her cooking neighbour whenever it happened, 1 smelled fumes in the staircase but not in the flat.

Three tenants claim that sometimes water is dripping from their kitchen fan and onto the stove. One tenant said that she always used the fan when cooking, since it always started dripping if she did not.

Acoustic quality

The soundproofing was poor at Brogården before the retrofit. After the retrofit the thick outer walls, and acoustic insulating of the staircase ought to have changed the acoustics in the house. The study shows that most of the tenants are very pleased with the soundproofing. They are pleased with the soundproofing both concerning sounds between outside and inside; between flats; and between flat and staircase. The complaints raised in the study have more to do with the behaviour of selected neighbours, than the actual performance of the house. No one has complained about disturbing sounds from the ventilation appliances.

Light

The overall verdict from the tenants is that the lighting conditions in the flats are good. Some complain that the hallway is too dark, as that is the only room in the flat that lacks

natural light. All seem content with the amount of daylight that the windows provide, and none has problems with overwhelming brightness.

The artificial lights in the staircase and the shared laundry rooms are deemed acceptable to very nice. A few tenants think that the lighting in the laundry room is too bright. The artificial lights in the yards are acceptable along the edges of the paths, but most tenants would have preferred more light in the middle of the yard. They still feel safe, but more light during dark winter evenings would mean that children could play at the central playgrounds even after dusk (around 4 pm).

4.2.6 Energy use

The tenants' own comments

When asked to comment upon their own energy consumption it quickly turned out that the tenants had very different views on energy use. Some of them had not contemplated the question at all before the survey. Tenant 1 kindly pointed out that more questions in the survey ought to have been about computers, and time spent using the computer. He thought that while everything else in the apartment could be used less in order to save energy, he would not easily cut down on the time he spent in front of the computer. Tenant 5 had a general idea that everyone should try to save energy, and she herself feels the obligation to do so. That is her main reason for her own low consumption. Tenant 6, on the other hand, thought that energy issues are important, but she herself does never think about them specifically. Tenant 7 and 8 are not interested in energy or environmental issues and consider that as "a normal level of involvement". Tenant 10 was the only respondent in the survey who had developed smart solutions in order to minimize the family's energy consumption. Her family consists of two adults and three children, and the children like her to cook and bake often. She has now dedicated a few days a month to baking, making more cakes all in one go, and using the after heat in the oven - making the process as effective as possible from an energy point of view. As she herself said: "it's easy to be clever".

The energy bill

Before the retrofit both hot water and electricity were included in the rent for the tenants at Brogården. After the refurbishment the hot water is billed on the rent invoice, and the household electricity is billed separately from Alingsås Energy.

In the survey the tenants were asked if they study the electricity and hot water bills. Four households said that they study the electricity bill sometimes or always and five households said that they study the warm water bill sometimes or always. Only 3 households said that the bills influenced their behaviour: one said that she thinks more about her consumption now, the other that he had stopped doing the dishes with the water running. One household that did not study the bill still turned off a few lamps if he thought that the bill was too high. The tenants that answered that they never study the bill all explained this with the same answer: the bills were still moderate and they saw no reason to change their behaviour for the sake of saving money. It is interesting to note that tenant 10, who was the most active energy saver, did not study the bills. She thought that the bills were still "cheap", so she saw no reason to "worry about them". Tenant 6, who saw a moral

obligation in saving energy, did not study her bills either. Her reason for this was that she knew that her consumption was low.

Light bulbs

According to the survey the tenants in House H have few light fittings that are turned on permanently (that is, even when unnecessary). The tenants are also very aware of how many lamps that are turned on when it is dark outside. Few people use “unnecessary” lamps in the flats. Most lamps used are either LED or energy saving lamps (including fluorescent lamps). The few traditional light bulbs that are in use are old and will be replaced when they cease to work. It is interesting to note that the general response to the issue of saving energy seems to be to turn off unnecessary light bulbs. Indeed, tenant 8, who complains about the low temperature in his flat, frequently turns on the stove and oven in order to heat up the rooms. He lets the oven door stand ajar for up to 16 hours each day, with the thermostat turned up to 200°C in the hope that the flat will be warmer. When his energy bill is too expensive, his preferred method of saving energy is to turn off the lamps on the balcony. To buy a radiator or a heat fan would be enormously more effective and much less dangerous but that is not something he plans to do.

Laundry washing and drying

In Brogården, like in most Swedish public housing areas, there are shared laundry rooms for the tenants to use. This was the case before the retrofit, and the laundry rooms are still there in the same form after the renovation. Changes of the laundry service are new surfaces, a new booking system, new locks and more energy efficient goods and fittings.

After the retrofit the bathrooms in each flat have become large enough to accommodate a laundry machine and tumble drier. It is up to the tenants if they want to install an individual laundry machine and tumble drier on their own cost. All but one of the ten respondents claim that they use the shared laundry room. Four of the respondents have installed a laundry machine; no one has installed a tumble drier. Even though the four respondents that have their own washing machines are free to wash as many loads as they wish every week, the actual usage differs between 1 and 5 loads per week. Indeed, household 5, with 1 adult and 2 children, claim to wash only 1 load per week despite having a washing machine of their own. The households using the shared laundry room wash between 2 and 8 loads per week. The household that washes 8 loads per week (1 at 40°C and 7 at 60°C) comprises of 2 adults and 1 toddler. The child is the reason for their heavy wash load. The households that use the shared laundry room despite having a washing machine of their own, use the machines for different purposes: the machines in the shared laundry rooms are suitable for heavier loads and can therefore be used for the washing of blankets, jackets etc.

The bathroom

After the retrofit there is enough room in most bathrooms to fit a bathtub if the tenant wishes to do so. The standard equipment in the bathroom is a shower with foldable shower doors. Only 2 of the flats in the survey had bathtubs. In 1 case the tub had been there when the tenant moved in, but she prefers a shower and had never used the tub at all. The other flat had used the tub twice in a year. The respondents were asked to estimate the number of showers that the household took per week. The number differed between 1 shower per week, to 25. The household taking 25 showers per week was also the biggest household, with 2 adults and 3 children who all showered daily. Everyone in the household

was engaged in different sports, so some of the showers were taken at their respective clubs. In general, households with younger tenants showered more frequently than those with older tenants. In the households taking frequent showers, they were well aware of the water consumption and tried to keep it down.

The kitchen use

All kitchens in Brogården are fully furnished with white goods when the tenants move in. Standard equipment is stove with oven and fan, refrigerator and freezer. It is Alingsåshem's responsibility to service the goods and to replace them when they have reached end of life. This makes it possible for the home-owner to ensure that all fittings are as energy efficient as possible. In this study, the use of the kitchen is the issue with the biggest differences between households - probably due to the different family types and their respective occupation during the day. When asked how many cooked meals the household do per week, the answers differed between 4 and 21. Cooked breakfast was not that common, but since porridge is a popular breakfast dish in Sweden it was not rare either.

The use of the oven varied between "sometimes" and 180 minutes per week. Average time was 90 minutes per week. The oven seems to be used for cooking meals, not for keeping already made meals hot. 1 respondent did never use the oven for cooking, but had it turned on for up to 16 hours each day in order to heat the flat. As this behaviour causes danger to the tenant himself and to other tenants in the house the home-owner plans to discourage him doing this. Eight out of the 10 respondents had a microwave oven. Most households used it for around 10 minutes each day (mainly for heating water to tea or coffee). The households with toddlers used it "all the time" for heating food for the children.

After the refurbishment most flats have the space and the equipment necessary to install a dishwasher if the tenant chooses to do so. The dishwasher is the tenant's own responsibility. Four out of the 10 respondents had installed a dishwasher. Two of the households used the dishwasher 1-2 times per week. Household 4 used it up to 10 times a week. This is not the biggest family in the survey, and they claimed to cook meals only 7 times per week so why their use of the dishwasher is higher than once per day is unclear.

Most of the respondents in the survey had a freezer that was full or quite full, yet they only defrost once a year. All of them tried to do the defrosting during a cold day in winter, so that they could put the frozen goods on the balcony while the freezer was being worked with. It is unclear whether the respondents thought that defrosting is for sanitary reasons or energy efficiency. However, they all seemed to realize that they ought to defrost more frequently than they do.

4.3 Conclusions for Brogården

4.3.1 Energy consumption

As far as it is possible to tell from the answers in the survey, the tenants in House H do not generally think about energy efficiency when going about their normal lives. They try to

keep their water consumption down and they seem modest consumers, making it hard for some of them to be more efficient (except for the person heating the flat with the oven).

4.3.2 Indoor climate

Overall the tenants seem pleased with the indoor climate after the renovation but there are still issues that affect the level of satisfaction. Individual needs and preferences make it hard to provide a temperature that is optimal to all - more so in a passive house. The bedroom temperature during the night is too high for some respondents while it is not enough for others. It is, however, quite clear that the house has withstood both winters and an extremely hot summer and managed to keep most of the tenants content or very content with the indoor climate. Overall that must be considered a success.

4.3.3 Cooking fumes

A few of the flats in Brogården have problems with a strong smell of cooking fumes coming through the air intake. Several surveys, tests, and technical amendments have been done during the last two years and although the problem has somewhat lessened it is not yet solved. By end of 2014 neither Alingsåshem nor Skanska know why the problem occurs, nor why it occurs in a few flats that seem randomly distributed through the area.

To avoid “contamination” of fresh air the tenants have been asked several times to always use the kitchen fan when cooking, and to always open the kitchen window just a fraction when using the fan. If the window is not open, the fan creates under-pressure in the flat that disturbs the air balance. Most people perceive a conflict when opening the window while using the fan. This is a learning issue for the next period.

Chapter 5 General conclusion

5.1 Defects and ambitions

Two of the projects are constructed in the 1950's, meaning that the technical and functional problems have some similarities. The Swedish project was built in the early 1970's. The project in Sweden follows a long process, which promotes a high level of attention to communication and process management, relating to both social aspects as well as technical innovations. The projects in Paris and Delft are rather small and short in attention span and this may create fewer bases for social and technical innovation.

The project in Alingsås and Paris include small dwellings (one - three room apartments), which require enlargement. The Delft project has large dwellings with many bedrooms and this gives future oriented quality and a high level of flexibility in renting the dwellings out to diverse target groups.

Defects

Major defects are similar in the three projects: outdated installations, the need to modernise and repair visual appearance of the building and the need to improve thermal comfort through better insulation. Mould and moisture problems that tend to occur in this type of dwellings due to poor thermal properties and ventilation have not been mentioned as problems.

The energy performance in the pre-renovation period is poor, based on the indicators for energy performance: low insulation level, poor efficiency of technical appliances, in some cases missing individual metering and cost control. The Paris and Alingsås projects describe high energy consumption as defects of their buildings (total energy consumptions of 280kWh/m² for Paris and 216kWh/m² for Alingsås). In the Delft project the reference energy consumption is relatively low (120-145 kWh/m²yr) - due to individual control and billing, low average indoor temperature and households that economise on heating costs. Many of the small dwellings are occupied by two persons working and not being at home for many hours a day, thus reducing the time period that heat is actually demanded from the system. In Alingsås the collective installations and all-inclusive billing of energy cost are responsible for high energy consumption. In Paris the electrical domestic hot water systems uses much electricity.

Ambition

The energy ambition of the three projects meets the requirements of the BEEM-UP project to save 75% of the initial energy consumption through advanced energetic refurbishment. However, the conditions are different. In Alingsås, the near passive house performance level has been chosen and is successfully being applied. The ambition level in the Delft project depends on the willingness of the tenants to support the plans and to pay for the associated rent increase. The basic plan with new window frames plus insulated glazing and roof insulation was welcomed by the tenants without rent increase. For the higher ambitions individual support is required. The position of the tenants in Paris seem less

crucial for reaching the ambition level, as it depends more on the financial possibilities of the homeowner.

The reference situation on the relationship tenant-owner differs per project, but the BEEM-UP partnership has harmonised the tenant input in the renovation process. In Alingsås, efforts to have good communication and get support for different issues from the residents has been tremendous, and a major factor is the temporary relocation and the big changes in the living conditions. In Delft the tenants did not move out, but 70% legally required support for the collective measures was needed. This triggered focused communication and even community development. In Paris, the tenants traditionally live in the estate for a short number of years and the social cohesion is little, which the owner regards as acceptable. However, good communication has been set up during the renovation process.

In Alingsås, the change from collective into individual systems had a great impact on individual energy use, awareness and the cost level for households. The Paris project had collective changes with high impact as well. This type of change did not occur in Delft.

In Alingsås the energy use is minimised through technical means. The behaviour related savings focus on domestic hot water and electricity use of individual appliances. In Delft almost all energy use is subject to individual behaviour. Paris has an efficient collective heating system with individual metering and billing which makes individual awareness and control important as well. After all, the home energy management system is dedicated as the tool to promote savings through behaviour both in the Delft and Paris project. In Paris all households have the feedback tool, in Delft only those who are willing to pay € 3.50 per month for it. However, in both projects the active use depends on the choice of the users.

Communication process

Tenant involvement policies and social interaction has a positive and long history in Alingsås, leading to many recommendations for Delft and Paris. The activities range from neighbourhood meetings to formation of special committees, individual approaches etc. The communication process in Delft started with interaction by a small group of five active participants and after the first renovation measures a new group of social active persons was formed, creating a positive social environment. Individual approaches towards tenants have been dominant, however. The social interaction on group level in Paris was rather low. Some individual interviews have taken place to get informed and give information.

Behaviour change is induced by feedback systems in the first place, then by written information and quite important as well, by personal contact with tenants who file complaints.

The housekeepers in Paris can play an important role in helping the tenants with many different energy aspects, e.g. to use the systems in a proper way, to select energy efficient new appliances when returning to their house and also to prevent overheating in the summer. An initiative was launched in Paris to give the housekeepers training on the effects of energy focussed behaviour.

5.2 Major changes

The planning process and the approach during the construction phase differs per project and depends on the following parameters:

- Relocation in Alingsås is very comprehensive.
- The owner in Delft puts emphasis on the value added effect of measures, meaning that without increased selling prices part of the investment in extra quality will have no return (and is therefore not economically feasible).
- The change from collective to individual control is a big change for the tenants. Where collective control is mixed with individual control, conflict may arise, for instance in the collective balanced flow ventilation system in Alingsås.
- An individual billing system and energy feedback system are crucial for learning and self-adaptation to energy saving behaviour. The feedback systems vary in the projects, from indirect to direct, with individual billing to real time information on consumption on displays.
-

5.3 Planning process

In Alingsås and Paris an architect was involved in the project. The external energy expert in Alingsås, who was a tenant in the project, supported the passive house approach. It had impact on the design, the performance control and on the process innovation aspects. In Delft the energy expert focussed on the improvement of the energy label. In Paris expertise was involved in designing energy efficient installations and innovative insulation of the envelope on the courtyard side of the building.

The contractor in Alingsås was a partner in solving many design issues. The contractors in Delft and Paris were selected on the basis of bidding after detailed design work and had no (positive) influence on the innovative part. In Delft the energy company acted as provider of energy systems that represents an innovative approach.

5.4 Energy savings

Electricity consumption

The heating energy consumption has received great attention, but domestic hot water is now level with heating energy use and needs more attention for instance by applying solar systems.

The power use for appliances is stable and reaches 30 kWh/m²year, making electricity control the challenge for the future.

5.5 Discrepancy in theory and practice of building performance

Climate control in the summer differs from the winter; daytime differs from night-time conditions, being at home differ from being away from home, stormy and rainy weather conditions differ from calm hot weather etc. Most ventilation and heat control systems in low energy buildings are designed for winter conditions, while with increasing insulation levels the heating season and also the heating period per day becomes shorter. A new control issue function is lowering the temperature in the house, or in the bedrooms. Designers tend to focus on standards and meet the minimum required levels, while the occupants have other preferences and needs. User involvement in design and maintenance leads to more knowledge about the house, greater ability to use complex technologies and better acceptance of discrepancies of needs and what is delivered.

Temperature and ventilation compartments

Many occupants prefer a cool bedroom, a very warm bathroom and temperatures in the living room that can be adjusted to the activity level, temporal comfort needs etc. A small surface area with increased radiant temperature is welcomed as comfort increases. Meeting these preferences through design is an important stepping stone towards energy efficient housing. This quality is sometimes missed: despite living in very well insulated dwellings with an even distribution of indoor temperatures higher than 23⁰C the occupants still complain about the cold.

Many occupants make selective use of heating. This behaviour leads to low average temperatures without suffering from the cold: when heat is demand controlled and the temperature level serves individual needs in individual rooms, the rest of the dwelling can be cooler. This insight from post occupancy studies explains why the energy consumption of poorly insulated dwellings is surprisingly low. Also, how this effect can get lost when individual control is limited.

Further reading

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Appendices

A. Questionnaire used in Post Occupancy Evaluation in Paris

FRENCH	ENGLISH
1)	
Satisfaction liée à la participation au projet BEEM-UP	Satisfaction with participation in the BEEM-UP project
Oui	Yes
Neutre	Neutral
Non	No
Je ne connais pas ce nom	I don't know this name
Globalement, vous-êtes vous senti impliqué dans le processus de travaux de réhabilitation ?	
Oui, suffisamment, autant que je le souhaitais	Yes, sufficiently, as much as I wanted
Non, cela ne m'intéressait pas	No, I wasn't interested
Oui, mais finalement assez peu	Yes, but not much in the end
Non, pas suffisamment	No, not sufficiently
2)	
Satisfaction globale concernant des travaux pour l'installation des nouveaux équipements du logement	Overall satisfaction with work for installing new equipment in apartments
Pas de tout satisfait	Not satisfied at all
Peu satisfait	Not very satisfied
Plutôt satisfait	Quite satisfied
Tout à fait satisfait	Completely satisfied
A quoi attribuez-vous votre insatisfaction ou faible satisfaction ?	
Choix des équipements	Choice of equipment
Matériaux utilisés	Materials used
Finitions	Finishing
Choix et qualité du travail des entreprises	Choice and quality of work by contractors
Durée	Duration
Autre : nuisances, problèmes non résolus, manque de considération...	Other: disturbances, unresolved problems, lack of consideration...
Nombre de réponses	Number of responses
Satisfaction en fonction de l'équipement	
Vidéophone pour le report des consommations	Videophone for the consumption report
VMC	CMV
Nouveaux radiateurs	New radiators
Biofluides et suppression du ballon d'eau chaude	Biofluids and removal of hot water tank
Thermostat d'ambiance et chauffage	General thermostat and heating
Fenêtres	Windows
Pas de tout satisfait	Not satisfied at all
Peu satisfait	Not very satisfied
Plutôt satisfait	Quite satisfied
Tout à fait satisfait	Completely satisfied
Ne l'utilise pas, n'y touche jamais / NSP	Don't use it, never touch it/DNR
Estimez-vous que les nouveaux équipements installés dans votre logement favorisent les économies d'énergie ?	
Oui, totalement	Yes, completely
Oui, je pense, en partie	Yes, I think so, partially
Non, pas spécialement	No, not really
Je ne sais pas encore (pas de facture, pas assez de recul,...)	I don't know yet (no invoice, too early to say etc.)

Utilisez-vous le vidéophone pour suivre vos consommations ?	Do you use the video phone to monitor your consumption?
Non	No
J'aimerais bien mais je ne sais pas m'en servir (pas de mode d'emploi...)	I'd like to but I don't know how to use it (no instructions...)
Non, je ne le souhaite pas / Pas besoin	No, I don't want to/No need
Oui, parfois	Yes, sometimes
Oui, souvent	Yes, often
Utilisez-vous le thermostat d'ambiance ?	
Non, je ne vois pas son utilité / Pas besoin	No, I don't see the point/No need
Non, je ne sais pas l'utiliser, je n'y touche pas	No, I don't know how to use it, I don't touch it
Oui, je le manipule parfois mais manque d'info sur fonctionnement	Yes, I use it sometimes but not enough information on how it works
Oui, juste comme thermomètre	Yes, simply as a thermometer
Oui	Yes
3)	
Estimez-vous avoir changé vos pratiques de consommations d'énergie dans votre logement depuis les travaux ?	Do you think you have changed how you consume energy in your apartment since the work was completed?
Pas spécialement, j'étais déjà sensible aux économies d'énergie avant	Not really, I was already aware of energy savings before
je me suis équipé de nouveaux matériel dans mon logement pour faire des économies d'énergie (lave-vaisselle, ampoules basse-conso...)	I bought new equipment in my apartment to save energy (dishwasher, low-energy bulbs etc.)
Je pense faire plus attention à mes consommations d'électricité	I think I'm more careful with electricity consumption
Je pense faire plus attention à l'eau et à mes consommations	I think I'm more careful with water and consumption
Autre	Other
Estimez-vous avoir gagné en confort cet été grâce aux nouveaux équipements ?	
Do you think the new equipment has brought greater levels of comfort?	
Estimez-vous avoir gagné en confort l'hiver dernier grâce aux nouveaux équipements ?	
Do you think you had greater levels of comfort last winter thanks to the new equipment?	
Oui	Yes
Non	No
Sans opinion / Ne le mesurent pas	No opinion/Do not measure it
Quelle température cherchez-vous à avoir chez vous... ?	
Which temperature do you prefer at home... ?	
22°C ou plus	22°C or higher
16°C ou moins	16°C or lower
J'éteins le chauffage	I turn the heating off
Ne sais pas	Don't know
La journée quand vous êtes chez vous	During the day when you're at home
La nuit	At night
La journée quand il n'y a personne	During the day when no one is there
Avez-vous installé des multiprises dans votre logement ?	
Have you installed adapter sockets in your apartment?	
Avez-vous installé des ampoules basse-consommation ou LED dans votre logement ?	
Have you installed low-energy or LED bulbs in your apartment?	
Oui, partout	Yes, everywhere
Oui, dans certaines pièces	Yes, in some rooms
Non, pas encore	No, not yet
Non, je n'en vois pas l'utilité	No, I don't see the point
4)	
Satisfaction concernant les travaux dans les parties communes en fonction de l'adresse	Satisfaction about work done in shared areas on an address basis
Pas de tout satisfait	Not satisfied at all
Peu satisfait	Not very satisfied

Plutôt satisfait	Quite satisfied
Tout à fait satisfait	Completely satisfied
La satisfaction des équipements des parties communes	
Porte d'entrée	Entrance door
Interphone	Interphone
Neutralisation des vide-ordure	Not using the rubbish chute
Local poussettes	Pushchair area
Sol et revêtement couloirs	Floor and surface colours
Escaliers et paliers	Stairs and landing areas
Espace verte extérieur	Outdoor grass area
Local Poubelle	Bin room
Pas de tout satisfait	Not satisfied at all
Peu satisfait	Not very satisfied
Plutôt satisfait	Quite satisfied
Tout à fait satisfait	Completely satisfied
Sans opinion / NSP / pas concerné	No opinion/DNR/not concerned
Appréciation de la propreté des ouvriers	
Appréciation de la qualité des travaux et des finitions	Opinion of workmen cleanliness
Très insatisfaisant	Very unsatisfactory
Peu satisfaisant	Quite unsatisfactory
Satisfaisant	Satisfactory
Très satisfaisant	Very satisfactory
Comment jugez-vous les réponses à vos questions apportées par vos interlocuteurs Novedis pendant les travaux ?	
Très insatisfaisant	Very unsatisfactory
Peu satisfaisant	Quite unsatisfactory
Satisfaisant	Satisfactory
Très satisfaisant	Very satisfactory
Non-réponse	Non-response

B. Topics of post-occupancy evaluation in Delft and adapted for the pilot project Brogården in Alingsås

1. General satisfaction with the apartment

- **Compare before-after perception of quality**
 - Best improvements
 - What not to do again
- **Floor plan**
 - Size
 - Number of rooms
 - Layout
 - Service level of kitchen
 - Service level of bathroom
- **User friendliness of temperature control**
- **Heating comfort/temperature levels when heating is needed**
- **Periods that temperatures exceed comfort levels (25 / 28 C)**
- **Quality of ventilation**
 - Exhaust in kitchen and bathroom and other places
 - Inlet of fresh air
 - Ease of control
 - Overall quality of indoor air
- **Acoustic comfort between apartments**
 - Acoustic comfort between rooms
 - Acoustic comfort with outdoors
- **Other health issues**
 - Safety, security
 - Accessibility
 - Social interaction

2. Satisfaction with the collective areas

- **Outdoor spaces**
 - Parking
 - Storage
 - Collective entrances
 - Collective services, for example washroom

3. Satisfaction with total cost of living

- **Housing related costs**
 - Rent level
 - Service cost

4. Energy use

- **Insight in energy consumption**
 - Heating cost
 - Electricity cost
- **Insight in how to influence energy consumption**

5. Satisfaction with the renovation process

5a. Satisfaction with the design process

- Taking care of needs
- Become informed about plans
- Have influence: comments, advice, cooperation

Level of participation

Information and communication

- Amount and usefulness of information
- Perception of personal care when having individual questions during planning, during execution, using the apartment again

5b. Satisfaction with the execution

- Help with relocation of goods/furniture
- Effect and reliability of planning and agreements on dates
- Period of noise, dust and other nuisance
- Care when inside the apartment
- Quality of result

6. Other

For instance:

- What do you expect from the owner/housekeeper after renovation?
- What ideas for your own involvement or ideas of improvement?
- Are there reasons why you would like to move out?
- How would you promote your apartment to new candidates?