

International Energy Agency

Owners and Residents Acceptance of Major Energy Renovations of Buildings (Annex 56)

Energy in Buildings and Communities Programme

March 2017



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Literature Review and Interviews

Energy in Buildings and Communities Programme

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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international co-operation among the 28 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates research and development in a number of areas related to energy. The mission of the Energy in Buildings and Communities (EBC) Programme is to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities, through innovation and research. (Until March 2013, the IEA-EBC Programme was known as the Energy in Buildings and Community Systems Programme, ECBCS.)

The research and development strategies of the IEA-EBC Programme are derived from research drivers, national programmes within IEA countries, and the IEA Future Buildings Forum Think Tank Workshops. The research and development (R&D) strategies of IEA-EBC aim to exploit technological opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy efficient technologies. The R&D strategies apply to residential, commercial, office buildings and community systems, and will impact the building industry in five focus areas for R&D activities:

- Integrated planning and building design
- Building energy systems
- Building envelope
- Community scale methods
- Real building energy use

The Executive Committee

Overall control of the IEA-EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA-EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA-EBC Executive Committee, with completed projects identified by (*):

- Annex 1: Load Energy Determination of Buildings (*)
- Annex 2: Ekistics and Advanced Community Energy Systems (*)
- Annex 3: Energy Conservation in Residential Buildings (*)
- Annex 4: Glasgow Commercial Building Monitoring (*)
- Annex 5: Air Infiltration and Ventilation Centre
- Annex 6: Energy Systems and Design of Communities (*)
- Annex 7: Local Government Energy Planning (*)
- Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
- Annex 9: Minimum Ventilation Rates (*)
- Annex 10: Building HVAC System Simulation (*)
- Annex 11: Energy Auditing (*)
- Annex 12: Windows and Fenestration (*)
- Annex 13: Energy Management in Hospitals (*)
- Annex 14: Condensation and Energy (*)
- Annex 15: Energy Efficiency in Schools (*)
- Annex 16: BEMS 1- User Interfaces and System Integration (*)

Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)

Annex 18: Demand Controlled Ventilation Systems (*)

Annex 19: Low Slope Roof Systems (*)

Annex 20: Air Flow Patterns within Buildings (*)

Annex 21: Thermal Modelling (*)

Annex 22: Energy Efficient Communities (*)

Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)

Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)

Annex 25: Real time HVAC Simulation (*)

Annex 26: Energy Efficient Ventilation of Large Enclosures (*)

Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)

Annex 28: Low Energy Cooling Systems (*)

Annex 29: Daylight in Buildings (*)

Annex 30: Bringing Simulation to Application (*)

Annex 31: Energy-Related Environmental Impact of Buildings (*)

Annex 32: Integral Building Envelope Performance Assessment (*)

Annex 33: Advanced Local Energy Planning (*)

Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)

Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)

Annex 36: Retrofitting of Educational Buildings (*)

Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)

Annex 38: Solar Sustainable Housing (*)

Annex 39: High Performance Insulation Systems (*)

Annex 40: Building Commissioning to Improve Energy Performance (*)

Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)

Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)

Annex 43: Testing and Validation of Building Energy Simulation Tools (*)

Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)

Annex 45: Energy Efficient Electric Lighting for Buildings (*)

Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)

Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)

Annex 48: Heat Pumping and Reversible Air Conditioning (*)

Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)

Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)

Annex 51: Energy Efficient Communities (*)

Annex 52: Towards Net Zero Energy Solar Buildings

Annex 53: Total Energy Use in Buildings: Analysis & Evaluation Methods (*)

Annex 54: Integration of Micro-Generation & Related Energy Technologies in Buildings

Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost (RAP-RETRO)

Annex 56: Cost Effective Energy & CO₂ Emissions Optimization in Building Renovation

Annex 57: Evaluation of Embodied Energy & CO₂ Emissions for Building Construction

Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements

Annex 59: High Temperature Cooling & Low Temperature Heating in Buildings

Annex 60: New Generation Computational Tools for Building & Community Energy Systems

Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings

Annex 62: Ventilative Cooling

Annex 63: Implementation of Energy Strategies in Communities

Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Energy Principles

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Annex 68: Design and Operational strategies for High IAQ in Low Energy Buildings

Annex 69: Strategy and Practice of Adaptive Thermal Comfort in low Energy Buildings

Annex 70: Building Energy Epidemiology

Annex 71 Building energy performance assessment based on in-situ measurements
Annex 72: Assessing Life Cycle related Environmental Impacts Caused by Buildings
Annex 73: Towards Net Zero Energy Public Communities
Annex 74: Energy Endeavour
Annex 75 Cost-effective building renovation at district level combining energy efficiency and renewables

Working Group - Energy Efficiency in Educational Buildings (*)
Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group - Annex 36 Extension: The Energy Concept Adviser (*)
Working Group - Survey on HVAC Energy Calculation Methodologies for Non-residential Buildings

Management summary

The fulfilment of the energy and climate objectives for the year 2020 and the year 2050 requires major initiatives from the building sector. Energy and climate renovations to improve energy efficiency, reduce carbon emissions and increase renewable energy use of the existing building stock are necessary, but are not currently realized to the extent needed. Therefore it is of great importance to study owner and resident acceptance of major renovations of buildings and their result. The acceptance, motivation, needs, obstacles and drivers of residents and decision-makers such as investors, owners, planners and contractors with respect to the renovation process need to be characterized and understood. With this knowledge the acceptance, motivation and needs can be further strengthened.

In order to evaluate the reasons for acceptance or non-acceptance of renovations including measures with the purpose to largely increase energy efficiency in multi-family buildings a literature review and a case study comprising group interviews with tenants were carried out. The literature on perception of energy renovation was found to be limited.

Insights in the stakeholders' different views of energy renovations gained in the studies should be taken into account in planning of future energy renovations. Most of the difficulties identified are identified by property owners, which might lead to not considering building energy renovation.

Crucial for the acceptance of a major renovation, the process and the result, is the relationship between the renovation stakeholders, in particular the housing company and the residents. Involvements from all sides are important. To begin with, stakeholder roles should be clear and visible in order to increase the understanding of the needs of those involved from all parties, including the residents. Residents' needs must be highlighted, but tenants should also be given the opportunity to understand the housing company's interests and subcontractors' situation in a renovation. However, residents are likely to have dissimilar interests regarding a major renovation and it is not possible to get full acceptance from everyone, the aim should be to satisfy the majority. Non-acceptance might result in moving out of the building.

Residents' acceptance of renovations with or without energy saving measures is influenced by improvements that are directly experienced and visible to the residents, such as improved security and safety, improved thermal comfort, and improved indoor air quality.

Important for an energy renovation can also be whether the residents pay for their own heating and how the energy saving measures is paid for. If e.g. the owner of a building pays for the energy saving measures and the residents save money, then the owner is not very motivated to do anything.

A good social environment is essential for the energy renovation to become accepted among the residents. Direct engagement and dialogue rather than one-way information e.g. a one-way

communication from the housing company to the residents of a building to be renovated, can be a way to create good relationships. This should be an ongoing process from the start and through all stages of the renovation.

Renovations with or without energy saving measures should include parts that will strengthen, or at least preserve, residents' possibility to perceive their building as a home. Increased security, higher aesthetic values and improved thermal comfort are examples of measures which can increase the home feeling. Renovation measures perceived as deterioration is difficult to gain acceptance for such as reduced thermal comfort and draught. Long-term environmental benefits or financial gains are arguments that might not be sufficient in these cases. An energy and climate renovation should not be perceived as unnecessarily costly by the residents and should ideally not mean an increase in the costs for the residents.

The many barriers to acceptance by users such as investors, planners, contractors and mainly owners of building energy renovation are related to the building context, regulations, economics, externalities, information/knowledge and socio-economics. The power and importance of the different barriers differ from project to project and user to user. Many owners need to be motivated by gaining more information and knowledge on all the benefits and additional benefits of an energy renovation.

Collaboration between all stakeholders including residents is beneficial for the renovation process and its outcome. The minimum level of participation of residents in a major renovation with or without energy saving measures is that the residents are informed by owners, planners and contractors from the start of the renovation process. The information should explain the renovation measures, the reasons and the expected results. The involvement of the residents in the approval, planning and decision making should always be considered and can avoid renovation mistakes.

The following recommendations are suggested for professional building owners:

- All the benefits of energy renovations must be understood and taken into account by building owners.
- Collaboration must be ensured between all stakeholders.
- Residents must be involved in the renovation process and their needs must be taken into account.
- Continuous information must be ensured during the entire renovation process and be two-way information/communication.
- Residents' acceptance of a renovation increases if some measures are directly experienced and visible.
- Long-term environmental benefits are not sufficient for full acceptance of a renovation.
- The need of residents to feel at home is important.
- Energy renovation should not increase the costs for the residents.
- Full acceptance of a renovation from all residents is not possible.

The following recommendations are suggested for planners and contractors:

- Continuous information must be ensured during the entire renovation process and be two-way information/communication.
- The residents must be involved in the renovation process.

The following recommendations are suggested for residents:

- The residents must learn to understand housing companies and contractors.
- The residents must understand the long-term environmental benefits of energy renovations.

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1. Introduction

To fulfil the EU energy and climate objectives for the year 2020 and the year 2050 require major initiatives from the building sector. The objectives will never be met if only new construction is considered, as it is likely that it can take 100 years to replace all buildings with new energy efficient ones. Major energy and climate renovations to improve energy efficiency, reduce carbon emissions and increase renewable energy use of the existing building stock must be realized. User acceptance of the renovation process and its outcome is then of great relevance for all major renovations of buildings. It is important to characterize and understand acceptance, motivation, needs, obstacles, and drivers of decision-makers such as investors, owners, planners and contractors with respect to the renovation process. With this knowledge acceptance, motivation and needs can be further strengthened. Solutions to overcome the obstacles and drivers can be developed. An initial literature study with the objective to gain more knowledge on the subject was therefore carried out within this project. Literature was in this first stage provided by the Annex 56 group.

A target group, which tends to be more or less neglected in many cases, are the people living in multi-family buildings. The residents of multi-family buildings are tenants that rent their dwellings, have access to a dwelling by being members in a cooperative housing association (partly tenants and partly owners), or have full ownership of their dwelling. The different modes of ownership lead to different rights and obligations in terms of energy efficiency and renovations. Tenants are dependent on the management of the housing company. Owners of a cooperative flat are responsible for the renovation needed inside their flat, but not the technical systems important to the energy use. Full owners have extended responsibilities, but depend on the intentions of other owners of the building. Despite mode of ownership, these three groups are the end-users of energy renovations, and have to live with the results, possibly for a long time. They are furthermore those who are most exposed to the hassles that arise during the renovation process.

The aim of the next part of the study was therefore to assess how users of multi-family housing perceive and are influenced by renovations where an important objective is to increase energy efficiency. The study does not directly include how users perceive installation of systems for renewable energy.

There are three different kinds of renovations:

- “anyway renovation” which only aims at restoring full functionality of the building
- standard raising renovation
- energy efficiency renovation with or without installation of systems for renewable energy

In this report a renovation typically includes one or both of the two first kinds of renovations together with an energy efficiency renovation with or without installation of systems for renewable energy.

The residents' acceptance of the renovation measures, and the outcome of these measures, is essential for a successful renovation process, but also in order to ensure that the residents do not move out of their building (Straub & Vijverberg, 2004; Hiller, 2013). Some of the multi-family buildings are worn down and most of the older multi-family buildings need at least some renovation due to wear and tear. The renovations will possibly increase the comfort for the residents and hence also their quality of life. However, more knowledge about how the renovation is perceived and contributes to residents' quality of life is necessary to secure that the renovation is sustainable, not only from an environmental and economic view, but also from a social view (Engberg & Hougboelle, 2005). The results from the initial literature study showed that there was no or little information about how residents experience far-reaching energy renovations in the reports provided by the Annex 56 group. These reports were therefore in the second part supplemented by scientific articles and conference proceedings retrieved from well-known databases. This literature review focused on tenants' perception of renovations which include as a main purpose to largely increase energy efficiency i.e. far-reaching energy renovations.

An additional study was carried out in order to supplement the literature review on issues related to acceptance, especially factors that could influence the perception of the energy renovation as beneficial or adverse. This study was a qualitative interview study in which tenants' own thoughts and feelings were asked for. The objective of the study was to get a picture of how energy renovations could be appraised by tenants, and which experiences had an impact on this appraisal.

2. Methods

2.1. Literature review

2.1.1. Barriers and drivers for decision-makers

For a correct understanding of the issues associated with user acceptance towards energy renovation of buildings, it was necessary to carry out a literature review of documents that focused specifically on barriers and drivers to building renovation mostly identified by owners, investors, planners and contractors, who can be called decision-makers.

The documents had to be categorized to allow to understand, for the different aspects that are brought to discussion, if they can be considered as a barrier or a driver, and also important, who is the “actor” or player involved.

All participating countries in IEA Annex 56 helped in identifying common constraints, needs and motivations of stakeholders, by supplying relevant literature where these issues are addressed. In addition, the partners were asked to categorize the documents they provide, according to the defined template – template available in Appendix 1 Literature review support record, and examples of filled information in Appendix 2 Literature review examples.

All these contributions were later aggregated and analysed together, to have a clearer view of the most common constraints or drivers identified, in the received literature.

2.1.2. Residents perception

In order to determine tenants' perception of renovations of residential buildings, the process and its outcome, with the purpose to largely increase energy efficiency, i.e. far-reaching energy renovations a thorough literature search was carried out. First a terminology describing those who rent flats in buildings (subject), the buildings being studied (object), the renovation (action) and its purpose (aim), and the results of the refurbishment as tenants' experience (outcome) was found in a preliminary review of literature (Table 1). The terminology was then used for a more thorough literature search with Boolean operators (simple words used as conjunctions to combine or exclude keywords in a search) OR, between terms in the same column, and AND, between columns.

Table 1 Terminology used in search algorithms. * means any letters.

Subject	Object	Action	Aim	Outcome
Tenant*	Rental building*	Refurbish*	Energy efficien*	Acceptance
Resident*	Multi-family hous*	Renovate*	Energy sav*	Satisfaction
	Housing block*	Retrofit*		Perception
	Rented apartment*			Apprais*
	Rented flat*			Comfort*

Nine databases were searched (Table 2). No papers were found that totally agreed with the research question i.e. how residents in multi-family housing perceive and are influenced by renovations where an important objective is to increase energy efficiency. One or more terms were therefore excluded so that relevant literature would not be missed. This gave however an excess of literature that dealt mainly with technical issues, not taking tenants' view into account. A first screening based on the titles of the articles was therefore necessary. The selected papers were then read. Only few papers were found to actually be within the interest of this report, and of those only a hand full reported empirical data. The results presented here are therefore a mixture of actually research findings and indications of factors of interest in studies of tenant's view on large renovations as described in the 38 articles finally used.

Table 2 Databases searched.

Database	Selected papers by title	Articles used in this review
AVERY	11	3
ENGINEERING VILLAGE	12	7
ICONDA	9	2
PSYCHINFO	2	1
PUBMED	2	1
SCOPUS	46	5
SOCINDEX	19	3
URBAN STUDIES	2	2
WEB OF SCIENCE	9	3
OTHER SOURCES	16	11
Total number	128	38

This literature review does not claim to be complete. Also, no evaluations of the cited articles were undertaken.

Results from studies on perception of other types of renovations and nearby issues were included when there was a lack of literature concerning the specific topic. Studies on individual energy behaviour were excluded.

The Human-Environment-Interaction model (The HEI-model; Küller, 1991) was used as a theoretical framework in the study of how large energy renovations in multi-family buildings (action) are perceived by the tenants and influence their quality of life (Figure 1). Following the model, the tenant's appraisal of the renovation could be predicted to not only depend on how the renovated building and its surroundings are perceived after the renovation (physical environment). Relationships with the landlord and the constructors, as well as experiences of participation in the pre-renovation decisions and the further process will additionally rule the outcome (social climate). People are also diverse and are in dissimilar stages of life that can be more or less demanding. Their resources and needs therefore vary (individual resources).

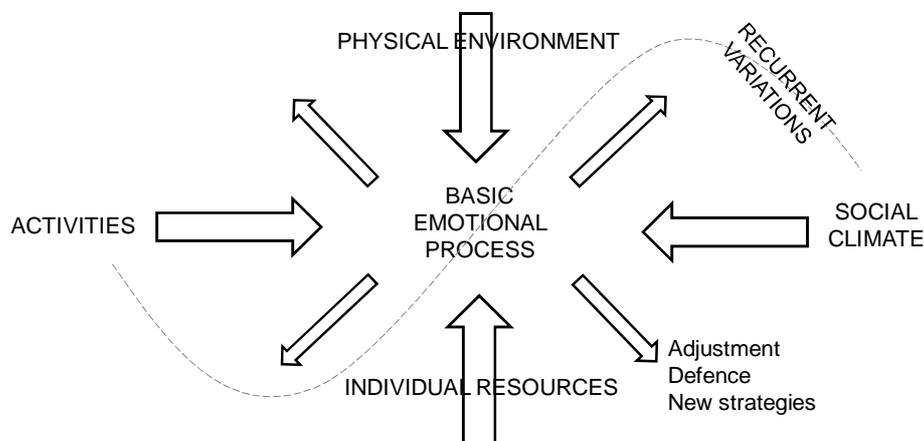


Figure 1. Human-Environment-Interaction model (Küller, 1991).

2.2. Interview study – case study of tenants' perception

The study was conducted in a residential area in Halmstad, a city in southern Sweden with 92,000 inhabitants. The area is owned and managed by the municipal housing company. The area was built from 1963 to 1965 and includes 579 flats (see figure 2 and 3). Tenants pay a monthly rent in which heating and domestic hot water are included, but not household electricity. According to the housing company, the population is socio-economic stable with most tenants paying for themselves. Two kind of tenants dominate the population: those who live in the same flat for a long time (even since the area was built), and those who stay only a year or two as they are studying in Halmstad or in-between other forms of living.



Figure 2 Residential area of case study before renovation (photo by housing company).



Figure 3 Residential area of case study after renovation (photo by housing company).

Extensive renovations were made successively between 2010 and 2013; the buildings were renovated one at a time. Most of the tenants lived in their flats during the renovation.

The following energy renovation measures were carried out:

- New common laundry rooms with new common energy efficient washing machines connected to district heating.
- Adding thermal insulation to the roof and the infill walls behind the balconies
- Raising the roof from being a flat roof to a ridged roof in order to accommodate the additional insulation and the new ventilation ducts.
- Replacing the windows with low energy windows.
- Installation of new thermostatic radiator valves and adjustment of the heating system.
- New substations for district heating.
- The original passive stack ventilation system was replaced by mechanical ventilation system with heat recovery (in most of the flats mechanical exhaust ventilation with supply of outdoor air from vents in the façade).
- Installation of low energy lighting for fixed lighting in the staircases.

The following renovation measures, i.e. an “anyway” renovation which only aims at restoring full functionality of the building and not at improving energy efficiency, but also includes standard raising measures, were carried out:

- The old entrance doors to the flats were replaced with new safety entrance doors.
- New surface finish of staircases.
- New burglar proof storerooms.
- Glazing of balconies.
- Improved outdoor environment.

The bathrooms had been renovated before the above described renovations.

Residents of the area were invited to participate in the study through a written invitation in their mail boxes with a prepaid return envelope included. Interested parties were contacted by phone to confirm participation and find appropriate times. In the end, a total of 17 tenants, divided into six groups of two to four participants in each group, participated. The participants were compensated for their involvement with lottery tickets or cinema tickets (corresponding to a value of 10 €).

The participants' ages varied from 23 to 80 years old (mean: 51 years, standard deviation: 22 years). Eighty per cent of the participants were women and 20% men. Some participants had lived long in their current flats or in other flats in the area, while others (mainly young persons) were newcomers.

An interview guide based on the previous literature review was developed. The interview study in groups started with an introductory question (“What did you initially think when you became aware about the upcoming renovation?”) and after that comprised five themes of questions:

- (i) recalled feelings and thoughts before the renovation started, (main answers in 4.2.2)
- (ii) the impact of the renovation during the time it took place, (main answers in 4.2.2)
- (iii) the results of the renovation and its impact on quality of life, (main answers in 4.1.2, 4.2.6, 4.3.2)
- (iv) thoughts about the impact of the renovation on energy consumption, (main answers in 4.3.4) and
- (v) recommendations for future renovations (main answers in 4.2.2).

The interviews took place in a one-room flat provided by the housing company and commonly used by local associations in the area. Coffee, tea, and sandwiches were served. The interviews lasted between 55 minutes and 75 minutes. The interview guide was only loosely followed; the participants were encouraged to talk freely. The interviews were taped and later transcribed by professional transcribers.

A one-page follow-up questionnaire was developed with the objective to give an understanding of the participants as a group.

Four questions were asked:

- (i) How important do you think the following aspects are when major renovations of block of flats are undertaken? (7 items), (main answers in 4.2.6)
- (ii) How do you perceive your flat now compared to how it was before the renovation? (6 items), (main answers in 4.1.2)
- (iii) What do you think generally about the major renovation of the block of flats you live in? (4 Items), (main answers in 4.2.6). and
- (iv) How do you think that the renovation has affected energy consumption compared to how it was before the renovation? (6 items), (main answers in 4.3.4).

All items had 5-point verbal rating scales. Age and gender was also asked for. The participants were asked to fill in the follow-up questionnaire right after the interview. Fifteen participants filled in the follow-up questionnaire satisfactorily. Note that the results of the follow-up questionnaire do not say anything about the total population in the area. Its purpose was, as stated above, to get a picture of the participants as a group. All data was treated confidentially and no names of the participants were kept after the interviews.

The analyses of the transcribed interviews were carried out in two steps. First, the participants' responses were organized in accordance with the interview themes, also including the results from the follow-up questionnaire. In a second phase, the text was analysed with a Grounded

Theory approach (Glaser & Strauss, 1967), i.e. more unconditionally. The participants' own expressions of what they thought and felt were coded and the codes brought together in concepts. The concepts were tested in the text again in a so-called constant comparison process.

The results are presented in separate subchapters (with key findings underlined) 4.1.2, 4.1.4, 4.2.2, 4.2.4, 4.2.6, 4.2.8, 4.3.2, and 4.3.4, in connection with the results from the literature review and in a separate subchapter, where the results of the Grounded Theory analysis are presented as categories (starting with the core category to which the other categories are connected) in subchapter 4.4. Examples of codes within in each category are in *italic*. The categories are illustrated by citations from the interviews.

3. Results and discussion – decision-makers

3.1. Aspects commonly addressed

The first analysis of the documents focusing on barriers and drivers related to building renovation allowed to understand that some aspects were more frequently addressed, and so, those particular aspects identified and addressed in the reference documents, were divided into six major subject fields:

- Building context
- Regulation
- Economics
- External factors
- Information and knowledge
- Socio-economics

With further reading of the documents, it was possible to add details of these subject fields, which led to a more precise categorization and perception of the issues related to building renovation. The following chapters refer in detail, which sub-topics were identified in the documents.

3.1.1. *Building context*

Physical or technical condition of the buildings – The degradation of the building or any of its elements (roof, facade, windows, heating system) is a natural opportunity for renovation. However, if degradation occurs unexpectedly and suddenly, the optimization of renovation may be compromised.

General renovation activity – The general nature of the renovation may be predominant. The extensions can easily lead to a need to meet regulatory requirements. A major renovation due to wear and tear is a good opportunity to realize energy saving measures.

Aesthetics and cultural heritage – Aesthetic aspects of a building can constitute a barrier if there is a wish to keep intact the original appearance, the historical value, or it can constitute a driver in case there is a willingness to change.

Technical difficulties – The actual condition of the building is often unknown or insufficiently known, creating difficulties in defining the best solution for rehabilitation. There may still be situations of incompatibility with existing techniques.

Project dimension – From a financial perspective, the size of energy-efficient projects compared to other investments and the eventual difficulty of replicability contribute to higher transaction costs for those projects, making investors tend to turn to other projects. In that way, the dimension of the projects and its reproducibility can have a relevant effect in the promotion of building renovation.

Type of dwelling – It refers to the type of building which has to undergo a renovation process, for example, detached house, townhouse, flat, etc.

3.1.2. Regulation

Planning and construction – The planning regulations can be a barrier when it comes to listed buildings, historical facades in city centres, or limitations on distances to neighbours. Some plans foresee an increase in the building capacity in expansion areas for those who renovate in historic areas.

Energy codes and standards – Minimal standard or energy certificate requirements in case of major renovations can be a barrier in the cases where they can prevent the renovation from being realized e.g. if there is only space for 100 mm extra insulation, and the regulation demands 200 mm extra.

Legal framework – Impact that building renovation has on compliance with other regulations.

3.1.3. Economics

Economic viability – Short-term perspectives, low energy prices and if compared to the base scenario (no renovation or anyway renovation), act as a barrier. In long-term considerations it can be a driver.

Financial need, access to capital, or others – Restricted access to capital acts as a barrier. Differentiated interest rates can be a driver as well as the requirement for profitability (of the owner) is also an issue. Other issues are loan approvals, or existing loans extension.

Tax incentives – Deduction in taxes for costs with energy efficiency renovations may act as a driver.

Payback time – From a financial perspective, energy-efficient projects tend to have a longer payback period than more traditional investments. They usually need longer payback periods which also increases investment risks.

Split incentives – The owner who decides about the investment does not necessarily benefit from it in the operational phase.

Energy price / energy price distortions – Subsidisation of energy prices and price-fixing not encouraging energy savings can distort the market, and prevent owners from receiving accurate

price signals that reflect the true cost of the energy use. The expectation for lower energy bills can act as a barrier for the implementation of building renovation projects.

Risk exposure to the return on investment – Commercial bankers typically pick investments which are safest and grant medium return on investments. Speculators or hedge fund managers on the other hand are more likely to take on risky investments and will be ready to spend more time analysing a specific situation, should the return be worth it. Some renovation projects present long payback periods, making them unattractive both for building owners and financing bodies, mostly in energy efficiency measures that present higher investments.

Discount rate, interest rate – It's usual to consider energy efficiency projects as risky investments, and as such to apply a high discount rate. The increase of the energy prices and risk associated to its evolution has also influenced investment analysis, depending also if it had been considered, or not.

Lack of financier awareness – Financiers who are not trained on energy efficiency issues do not naturally promote funding for such projects. This may result as an unexpected barrier to the implementation of building renovation projects, which must be analysed in order to evaluate its impact.

Value of property – The renovation process can increase the value of the property or the chances for renting, as well as contributing to valorise the neighbourhood in which they are located, representing in this way an external benefit.

Support programmes – Financial support programmes can contribute significantly to one of the following scenarios: a) implementation of energy renovation projects, that otherwise would not be implemented; b) implementation of more ambitious energy renovation projects than initially designed.

3.1.4. External factors

Environmental impact (air pollution, noise, climate) – Environmental damage and climate change.

Energy security – With high dependence on imports, energy security is an important policy objective.

Social policy – It refers to the prevention of “fuel poverty”. The renovation process can assure better indoor comfort and better living conditions, to those who cannot afford the energy costs for heating or cooling. Other policy programs can also have some impact on renovation processes.

Employment – Energy efficiency programmes can create employment opportunities or can contribute to stimulate economic development. In moments in which the construction sector may be somehow stagnated, building renovation can contribute to the economic growth and may reduce unemployment.

3.1.5. Information and knowledge

Information and know-how – Availability of information for different target groups adequate to their specific needs, at the technical and economical level. Information and knowledge are often insufficient for several players: owners/investor, consultant of owner/investor, planner / architect, and contractor / entrepreneur / professionals

Choice of company – Impact on renovation mode since companies tend to work as they are used to.

Awareness, attitude, strategy – It refers to behavioural determinants that are relevant to decision making.

Environmental consciousness – It refers to the wish to contribute to the conservation of resources and energy.

Distribution of responsibility between main actors – Refers to amount of actors involved in the renovation process, and the (possible) interactions between them, for instance, the energy consultant does not meet the buyer of the building personally, which complicates the communication between the consultant and the new owner, or the real estate agent is the one who has the main responsibility for the requisition for the energy label which may not be his prior interest.

Motivation of professionals – The motivation of the different professionals involved increases or reduces customer confidence in the renovation process. On this way the motivation of the professionals must be clearly addressed and evaluated in order to understand their impact.

Uncertainty associated with energy savings (related to the risk issue) – There are still challenges in the methods used to quantify energy savings, what contributes to create a fear of hidden risks in energy-efficiency projects.

Standardised measurement & verification protocol putting into service / commissioning by the contractors – The absence of reliable and accepted standardised measurements and verification protocols to analyse energy-efficiency projects leads to the need for financiers to spend more time on the evaluation of every single energy-efficient project, compared to the average time they will spend on other investments. Moreover, both investors and customers still get no certainty on the level of energy savings to be achieved; as such they tend to shy away from energy efficiency investments.

Trained personnel, technical or managerial expertise – The technicians can play a key role for orienting towards comprehensive energy-retrofitting.

3.1.6. Socio-economic

Education – Refers to the education level of the promoter/owner and its influence in the decision making process of building renovation.

Age – Refers to the age of the promoter/owner and its influence in the decision making process of building renovation.

Income – Refers to the income and/or financial resources of the promoter/owner.

Life changes – Changes in the family situations, such like a new dwelling, a birth, phase of retirement are often the starting point for the renovation process, especially when talking about single family houses.

Identity – Appearance, status, visibility, self-determination.

Social comparison – Residents are most likely to realize energy savings if these are both visible and contribute positively to his/her symbolical communication with others.

Time restrictions – The lifestyle may condition the willingness to promote the intervention.

Convenience – The ideal time for intervention can be conditioned by financial convenience, time, or other.

Social norms and values – It is normal the maintenance of behaviours that are common in the social environment in which each one acts.

User's disturbance – It refers to the amount of work and mess energy efficiency improvement might cause in the daily routines of the building users, considering some specific scenarios in own or rented buildings.

Social contacts – People's social surroundings, such as friends, family, colleagues, neighbours, or other peer groups, can strongly influence people's perceptions, opinions and behaviours.

Comfort – The aim for thermal, acoustic, visual comfort can be an important driver.

Longer/shorter housing perspective – The perspectives of occupation of the dwelling for a short or long period of time may condition the desire to promote the renovation.

Two additional variables are necessary to a correct understanding of the problems and/or advantages of building renovation; on a first level, if a certain aspect can be considered a barrier or a driver, and on a second level, who is the actor involved on that definition – contractors, investors, owners, or planners.

The literature review had to be registered on a specific document (Appendix 1), so that information could be easily accessed and classified. The template was designed having in mind a segmentation of topics that were addressed in the analysed document or article, as well as the possibility to indicate which of those topics are barriers or drivers, and who are the actors involved.

3.2. Discussion

Talking about building renovation, and how that can be an issue for the owner/tenant, needs to be supported by documents or studies. A total of 13 documents (papers, articles, reports, and

similar) were received and the results are based on the analysis of those – the list of documents can be found in the reference chapter. From the analysis of the collected information, it was possible to understand the main concerns regarding building renovation. The different sources of those documents helped to have a wider overview of building renovation throughout Europe.

After the reading and categorization of the documents it was possible to understand that major concerns and issues were similarly addressed. The main advantage on knowing if some aspect can be considered a driver or a barrier, is the possibility to remove or reduce significantly those barriers and to enhance and promote the drivers.

For this report, the approach was to perform a brief analysis of the received information, in order to understand how the topics can be organized. The goal is to have a structured format in which it is possible to draw some conclusions.

To begin this analysis, it was necessary to identify how many specific aspects are referred in each document, and compare them with the remaining literature, in order to see what aspects are mentioned more often.

In addition to the identification of each aspects, it was also necessary to label those aspects, according to what they can be considered – either constraints or drivers to building renovation. It is crucial to classify the aspects, in order to clearly identify which aspects are the ones that in fact are a “barrier” for the cost-effective building renovation.

All of the topics and aspects previously identified, are summarized in Appendix 3 Literature review diagrams – decision-makers.

Regarding **building context**, it can clearly be seen which barriers can prevent building renovations from being realized. The type of dwelling (single family house vs multi-family building) is often considered a constraint due to the implications and difficulties of building energy renovation, in particular the necessary consensus between the owners. This indicates, in theory, a more likely approach towards building renovation, if the building is a single family house, mostly due to the fact it has only one owner. Similar feeling might be seen if the multi-family building has only one owner. Another important constraint is regarding aesthetics and cultural heritage of buildings or neighbourhoods. When looking at the literature received, and from the categorization made of those documents, the building context constraints are mainly perceived by owners.

One theme that had most of the documents referring to as a barrier to mostly owners (but also planners), is the one regarding **regulation**, in particular the legal framework. It is common to regard the legal framework, and for that matter also the buildings codes and some municipal or regional regulations, as one of the constraints to building renovation. This particular approach, as opposed to new buildings, (probably) need to have a specific regulatory framework, in order to promote the effective energy building renovation.

One mixed theme is the theme of **economics**. Even though it considers most of the aspects as barriers, mainly the ones targeted towards economic viability, incentives, discount or interest rates, energy prices, or issues regarding the return of investment; some drivers are also identified,

in this case tax incentives, support programmes, and the increase of the property's value. The economic constraints are mainly perceived by owners, but also investors and planners.

The topic **external factors** have a bigger consensus as it has most of the aspect considered as drivers, and it is fairly easy to understand why. When looking at the environmental impact of building renovation, in particular its direct advantages – air pollution, noise, and climate –, it is common for people to perceive it has a driver. Most of the owners identified in the literature review are aware of these issues, and whenever they can they will try to mitigate them, in this particular case, by reducing their energy consumptions. This leads to another aspect addressed as driver, which is energy security, and the perception of that advantage for the country as a whole.

When looking at the topic **information and knowledge**, it can be easily divided in aspects that deal with expertise, information, know-how, experience, motivation of technicians that are considered as drivers, and those touching on choosing the contractor or company, the strategy for renovation, and the responsibility of the company, that are in fact understood as constraints.

From a **socio-economic** perspective, some aspects are clearly the drivers for the building renovation, in particular education and social stratum of the owner. Nevertheless, there are some issues that are considered a barrier, such as income (financial resources), lack of availability (in terms of time), social norms and values, the disturbance it may cause on the user, or even a longer or shorter housing perspective.

As said, identification of the aspects considered as barriers, can be the first step to overcome them, and from there, be able to bridge the gap of building renovation and setting the foundation for a wider range of renovations in our cities.

Another conclusion that is possible to obtain from the literature review, is the fact that, the most often identified actor of the cost-effective building renovation is the home owner. Other actors are of course addressed in the 13 documents, however they are not as frequently identified as the home owner.

4. Results and discussion – residents

A successful renovation should be sustainable not only in the view of local authorities or the landlord/owner, but also as perceived by the residents. It was suggested already in the 1990s that redevelopment success should be measured by seven criteria, of which several are directly linked to the perception of residents, for example (Vale, 1996):

- resident satisfaction,
- recognized design qualities,
- improved security, and
- improved resident involvement.

Residents are the actual end consumers of a refurbishment of multi-family building (Holm, 2000) and the results of a refurbishment have a direct impact on their daily living and quality of life. They are also influenced by the actual renovation work, which could be unpleasant for people who remain in the building while work goes on around them (Derbyshire, 1992). Residents are however often not in the position to decide what measures that will be taken, when the renovation will take place or who will carry out the work, i.e. they do not control the situation. The perception of which measures that should be taken can differ between landlords and residents. It has been suggested that residents place higher values to visible features (e.g. double glazing) that also give ancillary benefits (e.g. noise control), rather than those which will have the greatest effect on energy efficiency (Phillips, 2012). Improvements in flats, relatively those of the building, are stressed as most important (Vale, 1996). Hence, some energy efficiency measures will be perceived more beneficially than others, just by being visible and close to the residents' daily life.

4.1. The physical environment

4.1.1. Indoor environmental quality – literature review

Acceptable indoor comfort is sometimes difficult to achieve in old multi-family buildings of low quality. Refurbishments could hence substantially increase the quality of life for the residents. However, measures taken in energy renovations are sometimes based on energy models, engineering judgements and cost-benefit analysis, rather than focusing on indoor environmental qualities (Noris et al., 2013). Improved indoor environments are in these situations more of a bonus than deliberate measures. In other renovation cases a double objective to both increase energy efficiency and to improve indoor climate is set up. For both circumstances, features of indoor environmental qualities that may be affected by retrofits are for example thermal comfort, indoor air pollutant concentrations, acoustic conditions, and lighting conditions.

A small survey in London after refurbishment of three tower blocks built in the 1960s showed that the residents perceived that physical problems such as inadequate heating system, poor windows/doors, old bathrooms and unreliable lifts had decreased after the refurbishment in comparison to before (Khatib et al., 2011; Chileshe et al., 2013). Improvement of the flats was the residents' main concerns and a majority were satisfied with the renovations that were made in their flats. However, 31% pointed out partly new problems, e.g. poor quality materials, poor workmanship and uncompleted minor works left by subcontractors. Residents interviewed after renovations in a cross-nations study in Germany, Switzerland, Spain, Italy, and France also expressed their satisfaction with outcome of the measures, despite inconveniences during the realization phase (Huber et al., 2011). The general comfort and quality of living after the renovation were expressed as convenient, and specific advantages were more even temperatures at summer and winter time, as well as good light and air quality. On the negative side, some residents experienced a feeling of confinement in their dwellings, possibly due to unsuccessful ventilation. Indication of lowered air quality after energy renovations was also found in a study of sixteen flats in California (Noris et al., 2013). Thorough measurements showed general improvements in comfort conditions, bathroom humidity, and concentrations of carbon dioxide, volatile organic compounds and particles; results confirmed by a resident survey. However, formaldehyde and nitrogen dioxide levels increased in flats with initially low levels. In a small Swedish study (Liu & Thoresson, 2013), the perception of the indoor climate among residents in refurbished multi-family buildings (n = 31) was compared with those of residents in similar non-refurbished buildings (n = 11). Residents in the refurbished buildings were clearly more satisfied with the indoor air quality than those in the non-refurbished building, even though there were still problems with too dry air. An interesting side effect was that the noise problems were noticeably less in the renovated buildings despite that this had not been the purpose of the renovation. Similar results was obtained in a small Danish study (n = 25) with regard to perceived indoor temperature, draught and indoor air quality (Knudsen, 2014).

4.1.2. Indoor environmental quality – interview study

Non energy benefits are appreciated

The interview study touched upon similar indoor environmental aspects and some new ones e.g. increased security and safety, when expressing the perceptions related to the renovation outcome. The common view of the renovation outcome was that a lot of the measures were to the better, while some were strongly criticized. Most appreciated was the increased security and safety in the flats and the stairwell. Security doors were installed and a new system for access to the buildings and laundry was introduced, protecting the residents against burglary and unwanted use of the shared spaces. The new low energy windows were also prized by most participants as they were easy to clean and not because their energy efficiency. Both the doors and the windows kept out external noise better than the old ones, which were viewed as an extra bonus (though some experience external noise via vents to outdoor air). Improvements in the stairwells (with new postboxes) and laundry rooms were also mentioned as beneficial. However, some of the

participants were dissatisfied with the new design of the laundry rooms, for example that they now lacked mangle, a larger drying room and a sink to wash rugs in. The security system for the outdoor doors with tags and access only for designated persons were by some described as complicated and that it was no longer possible to invite friends over.

Many participants perceive the indoor temperature as too low

Most questioned were the lowered temperatures in the flats and the new ventilation system. Most participants, but not all, experienced that the flats were too cold for activities such as reading or watching television. It was also no longer possible to regulate the thermostats on the radiators. New thermostatic radiator valves were installed and the heating system was adjusted, which should have meant improvements, unless the valves were maximised at too low a level. It is also very difficult to satisfy everyone's preferred indoor temperature and it is also difficult to have very different indoor temperatures in different flats with traditional central heating systems.

New ventilation caused draught

The ventilation was perceived as too draughty, also contributing to experience of cold. This is likely to be due to the fact that in many flats the passive stack ventilation system was upgraded to mechanical exhaust ventilation with supply of outdoor air from vents in the façade, which can cause draught. Kitchen ventilators were discussed as problematic, perceived as not efficient enough and requiring special measures in form of keeping the kitchen window tilted when cooking. New traditional cooker hoods were installed, which commonly do not extract all cooking fumes.

The indoor temperature and the ventilation seem to be the main causes to that some participants perceived that the energy renovation had lowered their quality of life, but on the other hand according to the follow-up questionnaire the overall comfort in the flats became better, though opinion varied between participants; some thought it had been lowered.

4.1.3. Health symptoms related to indoor climate – literature review

In buildings with poor indoor climate, for example insufficient heating in the winter, refurbishments with energy efficiency objective expectantly lead to a better indoor climate for the residents and therewith better health. In a Danish intervention study, 106 residents living in flats in which the windows were changed filled in health questionnaires at one time before the window change and three times afterwards (Iversen et al., 1986). Their results were compared to 535 residents in flats that were not renovated. The intervention had an immediate effect on symptoms related to temperature, and complaints about outdoor noise almost disappeared. Other effects, for example a decrease of rheumatic symptoms, seem to have a latency period and were seen after 5 months. In a New Zealand study involving 1,350 households, dwellings were randomly selected to be insulated or not (Howden-Chapman et al., 2007). After insulation, energy consumption was 81% of that in the un-insulated buildings and the indoor temperature in the bedrooms at wintertime

increased with 0.5°C. The main gain were though that self-reported bad health, wheezing, and need for visits to a general practitioner were less likely among residents in the insulated dwellings than among those in dwellings in which no measures were taken. New health problems can though arise. In a large cross-sectional study in Sweden (n = 3,241), about half of the participants lived in buildings that had gone through at least one type of reconstruction or energy efficiency remedies during the latest 10 years, including exchange of heating or ventilation system, and sealing measure, i.e. exchange of windows, sealing of window frames, roof/attic insulation, or facade insulation (Engvall et al., 2003). Symptoms related to the respiratory system, skin and eyes were reported in a questionnaire. Electric radiators are associated with an array of symptoms (static electricity, high surface temperatures and variations in indoor temperatures related mostly to old electric radiators), which can occur and replacing them can hence be beneficial for the residents. However, residents in buildings with more than one sealing measure had an increase of ocular and nasal symptoms, headache and tiredness, associated with new building materials and lack of mechanical ventilation. A health impact assessment, carried out before a refurbishment, helps identify the measures that have the most influence on the self-reported health of the residents (Mesa-Frias, 2013).

Could energy renovations be considered as medical treatment? The Cochrane data base approves reviews that are scientific sound and that provide knowledge for what is called evidence based medicine. A Cochrane report based on 39 studies conclude that housing investments which improves the thermal comfort in the home can lead to health improvements if targeted at those with inadequate warmth and those with chronic respiratory disease (Thomson et al., 2013). Housing that is an appropriate size for the householders and is affordable to heat is linked to improved health. Hence, for some groups and some situations, energy renovations function as medical treatment.

4.1.4. Outdoor environment – literature review

The physical outdoor environment is seldom part of an energy renovation, but could be a visible change important for the acceptance of the renovation. Even though improvements of the flat were stressed as most important by residents in an interview study in Boston, outdoor improvements as landscaping, improved parking and children's play areas were mentioned (Vale, 1996). The main concern for the residents is though often to feel safe within the proximate surroundings of their home. Re-designing pathways and local traffic streets (Clayden et al., 2006) or regenerating yards and play-grounds (LaGrange, 1992) could provide incitements for perceiving the outdoor environment as safe. Physical features in the outdoor environment related to safety were in interviews with residents in a large renovation project in Birmingham stressed as important, for example incorporating 'unadopted' open space and installing traffic lights (Turkington & Wheelaghan, 1995). It is however central to maintain the sense of place and identity among the residents, and the outdoor environments should therefore be refreshed without changing the original typology in the area (Friesen et al., 2012). The above described measures are not within the scope of energy efficiency. However, retrofitting of outdoor lighting could with

new technology such as LED-lighting substantially decrease energy consumption without increasing the perception of danger (Kuhn et al., 2013).

4.2. The social climate

The social climate has often been found to be the most significant factor affecting residential satisfaction (Dinç, Özbilen & Bilir, 2013) and is important for well-being. Energy renovations typically do not affect the social climate, but could provide an opportunity for improvements. In a South Korean study among residents in four public housing estates classified as comprising low income families (n = 351), the impact of the physical environment (and how it was used) on social cohesiveness was investigated (Seo & Chiu, 2013). Social cohesiveness was here measured as shared norms and trust, attachment to housing estate and social networking. Estates with better conditions of the physical environment also had more residents with high social coherence. People who perceived the physical environment positively and used the facilities frequently showed higher community cohesiveness than others.

4.2.1. Participation – literature review

A sustainable refurbishment requires the involvement of residents. Participation could be classified on an ascending scale from information (e.g. receiving a leaflet in the mailbox that a renovation will take place), through anchoring (e.g. being invited to give their opinion about the suggested changes or offered to choose colours on the walls), onto participating in the planning and further being involved in the decision-making and management process (Hiller et al., 2013). Lack of involvement could lead to low acceptance of the time that the refurbishment takes (Chileshe et al., 2013) and of inconveniences that the residents have to put up with, such as noise (Holm, 2000). However, interest in participating varies greatly between individuals, and it can therefore be difficult for a property owner who has the intention to involve residents to actually launch collaboration (Gerdin & Hammarberg, 2010). Three main reasons why people participate are resources (because they can), mobilization (because they were asked), and motivations (because they want to); reasons that were empirically studied among 350 residents in UK who were engaged or not engaged in tenants' associations or tenant management organisations (Simmons & Birchall, 2007). Skills (educational qualifications, previous experience and training) and confidence were resources associated with participation, while money and time were not. Mobilisation was important, i.e. being personally asked to participate, but it mattered by whom; being asked by one in the own social network increased the likeliness to get involved. For motivations, collectivistic incentives (sense of community, shared values, shared goals) were stronger among participants than non-participants, while individual incentives did not seem to be of importance.

It is also important for the housing company to think through how to deal with residents' proposals. It could be experienced as unfair to raise people's expectations by asking them about options that

cannot be realised for financial or technical reasons (Derbyshire, 1992). Enabling groups of lay people to take part in meaningful decision-making requires careful forethought. If residents are truly empowered and in control of the process, that means that the landlord must also take into account, for example, different requirements in different parts of a residential area (Slavid, 1996; Engberg & Houghbølle, 2005). Diverse groups of residents might have dissimilar interests. In six high rise housing estates in Birmingham, a known division between those residents that had been in residence for up to 40 years and those who were less settled indicated that involving residents in a forthcoming renovation would require a flexible approach (Turkington & Wheelaghan, 1995). The resident participation was therefore practised differently in the six estates, which turned out well.

The housing company could gain valuable knowledge and avoid mistakes by engaging residents. An example of how the housing company learned from tenants and therewith increased the potential for long-term renting is Brogården in Alingsås, Sweden. Brogården, comprising 16 buildings with in total 300 flats, was built 1970-72 and it was decided in 2005 that a large renovation was needed (Friesen et al., 2012). The objective was to renovate to passive house standard, but also to increase the physical accessibility for seniors and people with reduced mobility. From the beginning this meant to install a continuous vapour/air barrier, install extra insulation on the building envelope, build in the balconies, replace the windows, and put on new facade material, and for the accessibility, to update the washrooms for wheelchair access. However, a tenant survey showed that there also was a need for additional flat types, so that tenants could remain in the area throughout different periods in life. The renovation project therefore grew. Flat plans were changed for a larger variation (2-, 3- and 4-room), elevators installed and other accessibility measures taken. Other studies have shown that improvements of accessibility are often overlooked by landlords (Straub & Vijverberg, 2004). The Brogården renovation became more extensive than planned, but hopefully with high sustainability values, not only for the environmental dimension, but also the social and economic.

Residents that are faithful to a residential area are possible good 'costumers'. Lessons from the Brogården refurbishment as well as renovations in Paris and Delft, all within the BEEM-UP project, have resulted in recommendations of what aspects to consider in the planning of successful tenant participation (Hiller et al., 2013). Another example of large tenant involvement is from Denmark where, according to the law, large-scale renovations proposals from the housing association have to be approved by a majority of the tenants (Engberg & Houghbølle, 2005). A case study of the Taastrupgaard project shows that proposals from the housing association sometimes actually are turned down by the tenants, whereby the planning processes has to back off and redo the plan. This will prolong the renovation, but hopefully lead to a better solution in the end. Both Brogården and Taastrupgaard can be seen as good examples of tenant participation. However, it can be questioned if there is a culture of tenant participation beyond these examples. Formal structures to empower tenants are needed but not enough, as shown by the Housing Action Trust experiment in UK (Hull, 2006). Decision-making rights and dedicated support staff are examples of supplementary requirements. It is also uttermost important to not rise too high expectations among the residents and to avoid mistakes during the renovation

process. In the interview study in Boston, residents frequently mentioned ways that their raised expectations were frustrated by the elimination of favoured amenities and by shoddy construction, still feeling bitter almost ten years after the renovation (Vale, 1996).

4.2.2. Participation before and during the renovation – interview study

The level of participation was determined indirectly in the interview study by raising the issues of:

- The thoughts before the renovation took place
- The experience during the actual renovation construction work

The interview study confirmed the need for involving the tenants during the planning and implementation of large renovations, and especially the importance of correct information at the right time to the tenants during the renovation process.

Before the renovation took place most participants who lived in the area realized that the renovation was needed. They recalled that they were generally positive about the renovation, but objected to part of it. Maintenance was seen as neglected and some participants felt that it would have been better to take care of the buildings continuously than to do such major renovations at one occasion.

Several of the participants worried already initially about how much the renovation would increase the rent. How much the rent would rise was due to what was considered standard raise (and thus eligible for the rent increase) and what was maintenance (which was not entitled to rent increase).

There was also some confusion about what exactly would be done and what it meant for the buildings and themselves. At an early stage, a futuristic vision in which some of the buildings would be demolished and skyscrapers erected was presented by the building company at a meeting for the tenants. This idea was later abandoned. From the participants' perspective, it was difficult after that to get an overview of the plans. There seem to have been different options for different parts of the area, for example to make personal choices such as glazed balconies or not.

During the actual renovation work in the buildings many participants realized that before the renovation it was difficult to picture how the renovation would impact daily life. For most participants, the renovation meant much greater intrusion while it lasted than they had imagined. Storage rooms and balconies must be emptied and the contents kept in the flats, as some participants remembered it, for up to six months. This confined the living space. Some participants living alone thought it was difficult to move their belongings up to their flats (the buildings do not have elevators) and would have liked help from the housing company.

The renovation also meant that craftsmen from various subcontracts needed to come into the flat or work on scaffolding just outside the windows. This limited privacy. It was also sometimes unclear at what day or time the craftsmen would be there.

Several activities during the renovation generated noise that penetrated the flats. It was perceived as very annoying while it lasted.

A common comment from participants was that the renovation took far too long time. They also would have liked some compensation for being without a storage room and balcony for so long, which they should have access to in accordance with their contracts, and for the general extra load with noise and dust.

The participants had clear thoughts on how the renovations process could be improved for the tenants. The building company should involve the tenants and make them into partners in decisions of which renovations that are needed and the planning of the process. Continuous information about the overall intention and planning, as well as daily activities is essential. Craftsmen's activities should be announced well in advance and with as precise time schedule as possible. All craftsmen should be professionals. The rent should be reduced during the renovation phase.

4.2.3. Control – literature review

Due to lack of involvement in the renovation process or lack of possibility to get involved residents are often not in the position to decide what measures that will be taken, when the renovation will take place or who will carry out the work, i.e. they do not control the situation (Derbyshire, 1992).

Measures that are taken to improve the energy efficiency sometimes give the residents less control, for example over the indoor temperature. There could be an understanding among property owners and constructors that comfort for the residents is simplicity, leading to installed technical systems that are not adjustable to the needs of the individual resident (Liu & Thoresson, 2013).

4.2.4. Control – interview study

The result from the interview study was similar. Most participants claimed that it was no longer possible to regulate the thermostats on the radiators (see also 4.1.2 Indoor environmental quality – interview study). New thermostatic radiator valves were installed in the flats and the heating system was adjusted, which should have meant improvements, unless the valves were maximised at too low a level. It is not only very difficult to satisfy everyone's preferred indoor temperature, but it is also difficult to have very different indoor temperatures in different flats in a building with a traditional central heating system. The residents are also likely to have different preferences with respect to thermal comfort and it is not possible to get full acceptance from everyone, the aim should be to satisfy the majority.

Control can also be more general e.g. the feeling of not having control over the situation, both during the renovation and afterwards (see also 4.4.5 Control).

4.2.5. Safety and security – literature review

A basic requirement for a residential area is that residents can feel safe in his/her flat, in the stairwell and in the immediate surroundings of the building. Safety can refer to protection against intrusion from outsiders, protection against assault, and protection against burglary. Improved security is also one of the most important aspects, from the residents' perspective, when a residential area is renovated (Vale, 1996; Chilese et al., 2013; Gerdin & Hammarberg, 2010). The social environment e.g. the number of friends within the area has been found to correlate with the sense of security (Becker, 1975). The physical environment was in this study of less importance, with one exception: the outdoor lighting (see also 4.1.4 Outdoor environment – literature review).

4.2.6. Safety and security - interview study

The importance of increased safety and security as a result of a renovation was highlighted and confirmed. Most appreciated outcome of the renovation according to the participants in the interview study was the increased security and safety in the flats and the stairwell. As mentioned before, the new security doors and new system for access protect against burglary, but it also has drawbacks. The system was by some of the participants described as complicated and that it was no longer possible to invite friends over.

According to the follow-up questionnaire most important aspects for the participants in connection with major renovations were that the renovation should not be too costly (69% 'very important') and that it should increase the flat's safety (69% very important). Most highly valued outcome of the renovation was the increased safety (50% 'better' and 38% 'much better'). As regards the extent of the renovation, according to the follow-up questionnaire all participants agreed that it was good that the buildings were redecorated and that it was good to make measures for increased safety.

4.2.7. Shared space – literature review

Challenging during a renovation phase is that residents and workers share a restricted space, i.e. the dwelling and stairwell. The number of involved people in construction projects is high but probably even higher in refurbishments that usually require an array of specialized subcontractors, and with residents already living in the buildings (Holm 2000). Residents' most private spaces, their homes, become workplaces for the contractors. In a UK case study were the construction phase of an energy efficiency renovation took 9 weeks, the main inconveniences described by the residents were lack of private space for the family and high noise levels, disturbing the children (Sunnika-Blank, 2012). The residents would in this case have preferred to be moved somewhere else during the most intensive work; the authors remark that this would also have provided more space for workers and accelerated the construction process.

4.2.8. Shared space – interview study

According to the interview study, for most participants, the renovation meant much greater intrusion while it lasted than they had thought. The renovation also meant that craftsmen from various subcontracts needed to come into the flat and they were sometimes working on scaffolding just outside the windows which limited privacy. It was also sometimes unclear when the craftsmen would be there.

4.3. Individual resources

Individuals are different; for one thing in how they perceive changes in their residential area. Data from three parallel surveys, comprising in total 1,826 respondents, the same environmental change could be perceived as for the better by some and for the worse by others (Pedersen & Johansson, 2014). Residents' appraisal was in these studies affected by their perceptions of the physical environment and the social climate, but also by their individual resources such as coping strategies i.e. strategies for handling changes. However, according to the literature, the residents' economic potential is their most important resource in this context.

4.3.1. Rent and cost sensitivity – literature review

Refurbishment costs are typically partly transferred to rents, if the buildings comprise rented or cooperative flats (Engberg & Houghbølle, 2005). Residents not accepting renovations can do so with the motive that they are sensitive to increased costs. It is in the building owners' interests to retain their tenants regardless of this is a justified or unjustified concern. Some renovations being done solely to increase the energy efficiency may be particularly sensitive (e.g. installation of a heat pump) because they do not directly contribute to increasing the quality of the dwellings or the surrounding environment. This especially true if the summed up costs for rent and energy are increased. Investments that are visible may be accepted, but non-visual measures are rejected as unnecessary costs (Gerdin & Hammarberg, 2010). Energy efficiency renovations could on the contrary be seen by the landlords as a way to increase the value of their property; energy efficiency is likely to become a quality criterion in the future real estate market (Huber et al., 2011). Lower energy bills are in cases where energy costs are not paid directly by the tenants, an incitement for low rents and they therefore improve the landlords' chances for renting, at the same time as large renovations might need necessary rent raises.

Residents with concern about a cost increase might move (Friesen et al., 2012). However, a UK study on the potential housing choices of tenants in public housing showed that people prefer to stay in their current dwelling if possible (Walker et al, 2002). Relocation decisions were comparatively insensitive to cost changes. Higher levels of security, condition of the property, and a somewhat larger dwelling were more important aspects when considering a move. Also, communicating to the tenants that the energy efficiency will lead to less likeliness that the costs for the tenants will increase in the future possibly gives an incitement to stay (Friesen et al., 2012).

New more flexible solution with individual agreements between landlord and tenant allowing tenants to undertake home improvements themselves, also in social housing, has been put forward (Straub & Vijverberg, 2004). Different systems with renovations funds for each flat are also in operation. Such contracts may prevent large rent increases and provide tenants with a certain possibility to choose between a higher standard or low rent. Inevitable rent increases as a result of energy renovation can also be smoothed out over time.

4.3.2. Rent sensitivity – interview study

The participants were definitely concerned about what would happen with the rent as a result of the renovation. Before the renovation took place several of the participants worried already initially about how much the renovation would increase the rent. How much the rent would rise was due to what was considered standard increase (and thus eligible for the rent increase) and what was maintenance (which was not entitled to rent increase).

Almost all of the participants thought that the rental costs had become worse (69%) or much worse (13%) than before the renovation. The household electricity costs were, as expected as there was little change in household equipment, perceived as being the same as before the renovation; 75% report that they were the same.

The rent (including heating but excluding household electricity costs) was in the study area increased by 15% in comparison to before the renovation. This could be compared with more extensive renovations in Sweden where the rent was increased by 35% excluding heating and household electricity costs (IEA 2014). The rent increases were mostly motivated by raising the standard of the buildings, which does not necessarily include energy saving measures. Participants in the interview study had all remained in the study area, most of them in the same flat as before the renovation, despite major concerns for rent increase. Tenants that had moved from the area, possibly due to the rent increase, were not captured in the invitation to participate in the study.

4.3.3. Energy use – literature study

The overall energy consumption might not always decrease, even though the refurbishment could be classified as successful. Four 24-storey blocks of flats in Glasgow were subject to extensive renovations; over cladding, re-roofing, window replacement, balcony enclosure and installation of a new heating system (Barbour et al., 2000). Environmental monitoring showed that the indoor comfort had increased substantially, and as expected the heating energy use decreased by 60%. Residents paid the heating individually in the studied buildings; the new heating was more costly per kWh than the old, but that was compensated by the higher efficiency so that the costs were approximately the same for the residents. The residents perceived this as reasonable, considering the improvement of the internal environment. However, a secondary finding in the study was that the domestic energy use had surprisingly increased with 20%. This could be

explained by differences in life style before and after refurbishment. If this life style change was due to the improvements or external factors is not known.

Residents paying for the heat could also lead to low incitements for the landlord to overtake energy renovations or replace old energy consuming appliances. A Canadian study identified efficiency problems when the landlord selects the equipment and the resident pays the energy bill (Maruejols & Young, 2011). On the other hand, if the energy is included in the rent, the effect of the energy renovation might not be as large as expected in line with what is described above. Tenants in the Canadian study not paying directly for the heat tended to select about 1 °C higher indoor temperature than those who paid directly. They were also less likely to turn down the temperature when they were away. There are several assessment tools that can be used to assure that a refurbishment is carried out in accordance with the sustainability requirements (ecological, economic and social). Included in these are obviously energy consumption and environmental impacts. More direct effects on residents included in the assessments are for example 'health and well-being' (BREEAM) and 'indoor environmental quality' (LEED), but the point systems used in such assessments are somewhat problematic (Alchimoviene & Raslanas, 2011) and will not reveal improvements of residents' quality of life.

A small Danish questionnaire study in a multi-family building showed that after being subject to a major energy renovation many of the tenants claimed that next time they look for a flat they would take into account energy efficiency (Knudsen 2014). The tenants were given information continuously during the whole renovation process and their costs for rent and energy was raised with 8 %.

4.3.4. Energy use – interview study

Measured data from one of the buildings in the interview study area in which mechanical ventilation with heat recovery was installed showed that energy use was reduced by 35 % (see figure 4). The reduction in energy use for the other buildings, where exhaust air heat pumps were installed, is likely to be of the same order magnitude.

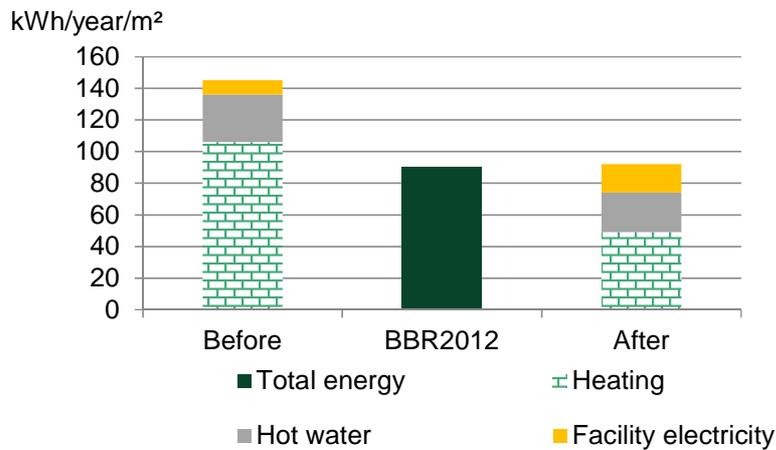


Figure 4 Energy use before and after renovation for the one of the buildings. BBR2012 is the energy requirement according to the Swedish building code for new construction.

Few participants of the interview study mentioned energy savings if not directly asked about it. The awareness of energy savings as one of the objectives of the renovation seemed low. The perceived low temperatures in the flats were perceived as a way for the housing company to save money, rather than an environmental friendly action. Some participants recalled having read something about the energy saving measures and some could list part of them, but they did not seem to have any meaning. As describe above, the rent includes the cost of space heating and domestic hot water heating.

In a follow-up questionnaire the participants were asked how they thought the energy consumption of the buildings had changed. Most participants thought that the energy use for heating of the flats had decreased: 50% answered 'lower' and 13% 'much lower', which is close to the actual energy reduction. It is not known how much information the tenants have received from the housing company. The actual energy use for heating (space + hot water) was reduced by approximately 50%, but the use of property electricity was doubled. Energy use for lighting in shared areas was perceived as higher by some (19% 'higher' and 6% 'much higher') and lower by others (25% 'lower'), and so was outdoor lighting (31% 'higher' vs. 19% 'lower' and 19% 'much lower'). The use of electricity is not likely to have increased. The lighting was improved giving better light, but this was done by installing low energy lighting for fixed lighting i.e. compact fluorescent tubes. Also energy use for shared washing machines was rated both as higher (31% higher) and lower (13% 'lower' and 13% 'much lower'). No changes in energy use for hot water or for electricity use in the flats were the most commonly reported answer. This is likely to be true as the equipment was not changed and there was no energy efficiency campaign among the tenants. There was no monitoring domestic hot water use and no access to metering of household electricity.

Four of the fifteen participants that answered the questionnaire did not agree on that it was good to install energy-saving equipment.

4.4. To accept or oppose – factors related to the perception of an energy renovation – interview study

Based on the interview study factors related to the perception of an energy renovation are presented in this chapter. The invitation to take part in the interviews attracted tenants that wanted to tell their story about the renovation; many of them described in detail how they reacted and how they felt. Several factors, other than the appraisal of the factual renovation and its outcome were revealed, possibly influencing the likeliness of acceptance of the renovation measures. Fundamental was the relationship to the flat and its immediate surroundings as a home. Therefore the results of the interview study are presented from this perspective, categorising the results according to:

- Living at home (core category)
- Distance
- Fairness
- Control
- Loss
- Coping

4.4.1. Living in a home

Living in a home is considered to be the central categorisation. The renovated buildings do not, in the view of the participants, only comprise flats, but the tenants' homes. Physically the home could be the same as the flat, but was often extended to include the adjacent stairwell, storerooms, laundry room and the outdoor environment, especially for those who had lived long in the area. The home also had partly other connotations than the built environment. The renovation was then not just a technical matter, but a change in the circumstances to be able to feel at *home*. An essential quality of a home is *safety*; a home is a place in which a person should be able to feel secure. *Comfort* and *aesthetics* mentioned by the participants are other qualities that constitute a home.

Quotations from the participants (note: the balconies were glazed-in during the renovation):

- P8: I think it's really good what they've done in the stairwell. It's perfect when it's been painted in grey and blue. It fits in perfectly. It's nicer. I think it's nice.
- P10: This in particular I think feels good. That we got it glassed-in. It feels... I think it's cosy. It became like a little conservatory, plus that it's a bit safer too.

The perception of the renovation as concerning the home was manifested in *great care* for the flats and the buildings. Several of the participants expressed worries about the *quality* of the renovation and how it had been carried out. They were concerned about that the building company should get the best value for the money spent on the renovation. The quality also had

an impact on their future daily life as they had to live with outcome of the renovation. Furthermore the great care also meant *taking responsibility* for that the buildings were kept neat and looking after other tenants.

Quotations from the participants:

- P1: They should have someone, in the same building they could have one, what could you say, a host for the tenants who live in the building. They could ask... It needn't be [so costly]. It could be a symbolic sum or something like that, they could have. And I'd have been happy to do it voluntarily.

Getting the home changed at the initiative of someone else was in itself problematic. Especially having strangers inside and outside the flat during the renovation process assaulted *integrity* and was perceived as an *intrusion* of privacy.

Quotations from the participants:

- P10: Yes, I think it felt long [the renovation period]. I was very frustrated for a while. Oh, I was so tired of it. You had no private life. You were going in to shower and everything had to be closed properly, and so get dressed and then you could start to move.
- P15: That's what was a pain, that you knew they [the workmen] were coming, but not when they would come. And you didn't know if they'd been there when you came home and sometimes you came home and there was a man in the living room doing something with a window. So it was a bit... You never knew if there would be someone in the flat or not when you came home.

The acceptance of the renovation process and especially the results of the renovation could be viewed in the perspective of the tenants being able to maintain the feeling of home in their flats, or even increasing it. The possibility for acceptance was associated with the relationship to the social environment in terms of distance, fairness and trust. The tenant's perception of being in control, feelings of loss, and handling the situation with the help of coping strategies were other factors shown to be of importance.

4.4.2. Distance

Many of the participants referred to the housing company with the term 'them'. "They" had no name or face, but was an abstract concept revealing a *distance* between me and them. This distance seem to have been established when the first vision of the renovation was presented. As the participants saw it, this vision was unrealistic from the beginning, and they were not surprised that it was not carried through.

Other people involved in the renovation and in the daily management of the site were mentioned by name. Some of these people were considered more viable than others. Personal contacts between the manager and the tenant led to a *sense of belonging*. They become part of, if not the home (typically the flat and its immediate surroundings), the social environment. Direct

information from this person and a belief that she would take care of the problems created *confidence*.

During the renovation, several of the participants also developed *relationships* with the craftsmen who carried out the work.

Quotations from the participants:

- P15: We were really lucky, we had very pleasant...
- P16: Yes, exactly...
- P15: ... construction workers who were there. It was, it meant a great deal too that they were so very pleasant and they showed respect too.

If the work performed by the craftsmen were not perceived as being well done, it was not seen as it was the craftsman's or subcontractors' fault. The problems were referred instead to the housing company that had hired the wrong people or had chosen the cheapest option for the procurement. In one of the groups, the new outdoor environment was discussed and considered dangerous because the construction workers had been careless and left loose stones that was easy to stumble upon.

Quotations from the participants:

- P11: Yes, but then you can't blame the workmen because... We can't blame them. Not anyone.
- P10: No, I don't think so [either]. They've done as well as they could.
- P11: [...] Instead it's what the housing company, what they themselves see as the whole and what security they want. What work they want done. [...] They get what they pay for.

The sense of distance between the housing company and the tenants that many of the participants spoke about was by some participants who had lived a long time in the area explained as that hired firms now handles much of the daily operations. They were thought of as not getting the same sense of what needed to be done and to not do it with the care that older time's caretaker had.

4.4.3. Fairness

Accepting the renovation or not was also associated with perception of the process and the outcome as fair. *Fairness* included several relationships: fairness between tenants, fairness between different residential areas that the housing company is responsible for, fairness between tenants and the housing company.

Unclear rules and rules that changed underway were perceived as annoying. Tenants who had chosen previous offered options and therewith had extra costs felt unfairly treated when the large renovation meant that they no longer had any advantage of this installation. To experience it as

if you are forced to agree on a change which was first perceived as optional created a sense of *powerlessness*. What occurred was on someone else's terms and conditions.

Quotations from the participants:

- P8: We got the note about whether we approve this decision or not, and then got the note that even if you don't approve then you must accept... Because they've made the decision that it would be like that anyway. [...] If I got the information, I know that someone is coming and will do [something]. But I never thought about how they'll do it, they'll just do their things like they decided. [...] They just said, move the furniture, they must have room to move, space that they need, so you always had to move...

Equal treatment of the tenants and not feeling disadvantaged was important. Some measures that could be observed by the participants were interpreted, rightly or wrongly, as unjustified benefits for tenants in neighbouring buildings.

Quotations from the participants:

- P2: Why have they invested in wash stacks, washing machines, such nice things downstairs. Is it for those in the opposite building? And afterwards when I think you almost get mad, as they got big extended balconies, glazed in balconies. My building, where I live, it was a so called listed building.

The strong demand for fairness also influenced the view on the rental increase in several ways. It was easier to accept a rental increase for a change that you thought of as beneficial for yourself, for example increased security, than one that was perceived as of no value or even negative.

Quotations from the participants:

- P6: Security is something I'd gladly pay a hundred crowns or so a month for. So that I get to keep my bike or my car or whatever. Because it's... it's my things. [...] But to buy the energy saving thing up on the roof...

Financial *compensation* for inconveniences during the renovation time was called for. The request was put forward in relation to the actual situation such as decreased access to rented area.

Quotations from the participants:

- P4: Much of the inconvenience you could have been compensated for some way or another by them lowering the rent. So even if it was just symbolic they would nevertheless show that they took into consideration that we didn't have any basement or any storage rooms for six months.

The parts of the renovation outcome that was perceived to contribute to *orderliness* were, in line with the high demands for fairness, praised. Examples were the new booking system of the laundry room and the mail boxes in the entrance halls. For these cases, the demand for fairness was met on a more long-term basis.

4.4.4. Trust

There was, from the participants view, sometimes a gap between what they were told and what they could see with their own eyes. This is especially obvious when it comes to measures taken with an energy-saving objective. To get the information that the change increased energy efficiency, but then observe the changes and perceive them as if nothing was gained, created a *distrust* of the housing company. Participants that discussed the energy efficiency of the new windows had their own thoughts of how good they were, based on what they observed. Information of the window standard seems to either not have been sufficient enough, or framed in a way that made it difficult to understand.

Quotations from the participants:

- P1: Some of the windows were rotten. It was those types you could open in two parts. Now they're those that they put in, they're called triple glazing, but there's no more than two panes of glass in them anyway. So you can ask what U-value there really is in those windows.
- P2: But they're really nice. You don't think there's any value in them, you mean?
- P1: Yes, they can have value... But they're equivalent to the windows that were there already.

Not being believed or and *not treated as an equal partner* also led to suspicion towards the housing company. One of the participants talked about an incident when she realized it was missing caulking around the windows in her flat after window replacement and therefore contacted the housing company. She expresses feelings of not being listened to or not being believed.

Quotations from the participants:

- P6: But what's stupid about this is that the housing company then... almost contradict you when you come and say that it's not sealed. So it feels really stupid.

Participants who had contacted the housing company after energy renovation and pointed out that they felt that it was too cold after the renovation experienced that they were *neglected*. This led in some cases to *despair* and *resignation*.

Quotations from the participants:

- P14: Hmm... I don't think they'll change their minds. They've been twice and adjusted the heat in our place. It hasn't got any warmer. [...]
- P15: Feels mostly like they're doing it to save money. They don't care much if you're freezing or not. It's their 21 degrees that apply. That's the way it is then. I don't know. That's what I think anyway.

The frustration at not being listened to when your home are subject to changes was by some participants expressed in relation to the existence of a buy-sell relationship between tenants and the housing company.

Quotations from the participants:

- P12: For after all it is the tenants who will live there, and pay.

4.4.5. Control

The feeling of not having *control* over the situation evoked frustration, both during the renovation and afterwards. Situations that took place in the flat could be a threat to the need to keep the flat homely and in good care.

Quotations from the participants:

- P2: You haven't covered the floor, I said. Then they were standing over there, just inside the corner. 'No, but it's not necessary. This is nothing that causes damage.' Nothing that causes damage? It's four layers of wallpaper and there's plasterboard and everything. And you stand there with your big boots and trample on it, on my linoleum floor.

Some of the changes made to increase energy efficiency meant that the individual no longer could control the indoor climate in their flats (see also 4.1.2 Indoor environmental quality – interview study). This was by some of the participants perceived as not being able to meet *individual needs*.

Quotations from the participants:

- P8: You can't decide yourself what heat you want in the flat. They've locked it in some way so you can't turn it. [...] They've changed in some way. They've blocked them in some way [the radiators], so you can't change, not decide yourself. [...] Some like it a bit warmer, others a bit colder.

4.4.6. Loss

The outcome of the renovation *matched the life style* of some participants with for example more modern equipment in the laundry room, while others perceived it as their needs were not met. They thought of the changes as *to the worse* and expressed feelings of *loss*.

Quotations from the participants:

- P11: Because before, you could put mats on the floor too, scrub them. But that's gone. Now you can't because it's not possible.
- P10: Yes, I miss that. [...] We can't scrub our mats. It's so lovely to hang out and that.

Some participants also expressed a general feeling of loss. This loss was to a part associated with the larger movement nowadays; tenants moved in and out more frequently. The loss of a gone social environment was possibly independent from the energy renovation, but the renovation was perceived as enhancing the likeliness for people to move out as it led to increased rents.

4.4.7. Coping

The participants described several modes of coping with the inconveniences during the renovation and also afterwards with, from their view, negative outcome of the renovation. One participant, who worried very much for the building to be renovated mainly because that would mean that the rent would increase, describes how she did not believe that the balconies would be changed; a *denial* strategy.

Quotations from the participants:

- P9: Yes, I lived a bit like so that I thought, it won't happen, because there are many people who say that they only do it [use the balcony] when they go out to smoke, so it won't happen.

One coping strategy that the participants had used was to take matters into their own hands and act constructively. Such *actions* were successful if it had the desired outcome.

Quotations from the participants:

- P2: I couldn't live in my flat, because I didn't know where I would go. I've got a cat. So I've got a kind friend so I got to use her cottage. Otherwise I'd have ended up in a lunatic asylum, both the cat and me. Because we couldn't be at home and live in this mess.
- P12: I'm happy with the flat and that, but it's this with the draught and that it's cold, because I mean... But I've invested in one of these heating mattresses.

Another way to take action was to *contact the housing company*. This was at several occasions successful as they would send out someone to deal with the problem. However, if this coping strategy was not successful, i.e. the matter was not solved properly in the tenants' view, it led to helplessness and resignation. One of the participants had several problems in her flat one of them being that the hot-cold water mixing control valve did not keep a stable temperature. She tried to think that this was a small matter in comparison to other problems that people have, and therewith *make it trivial*. But she did not totally succeed.

Quotations from the participants:

- P7: In view of how other people have it with their... I mean life situations, so I think, okay, you can live with it. [...] But no, it's so that every time you're going to shower or wash up you feel, oh, now there'll be problems. Now it'll be problems again and like this. So it'll take a bit of time and you don't feel like doing such things any more.

5. Conclusions

5.1. Decision-makers

It was expected to be able to have a more precise idea of the acceptance of energy building renovation, if they considered it as a difficulty or a positive matter. However, if building renovation is considered as a barrier, what can be done to overcome the difficulties and ease up the process? If, on the other hand, it is considered a driver, why is building renovation not happening at a larger scale?

Having taken into account the number of topics and aspect commonly identified in the literature review, it is clear that a higher number of barriers were addressed, compared with fewer drivers. Considering whom is referred to in the documents, as the driver that triggers (or not) building renovation, it was found that, from all decision-makers identified – owners, investors, planners, and contractors – building owners are the ones most often referred to.

In other words, decision-makers involved in the renovation process, more specifically property owners, often perceive energy building renovation as a difficulty, which leads to an inclination to refrain from renovation.

Most of the difficulties identified by the owner, from the 6 subjects and subtopics referred in Chapter 3.1, are related to building context and legal difficulties, financial and economic issues, or even lack of awareness or information on certain aspects. The fact that these aspects and topics are identified, in a wide range of documents, confirm that these are really the barriers of building renovations, throughout the countries, and most likely, a common (or at least similar) approach to overcome these issues should be possible to develop.

Even if some of these topics appear as no surprise, like financial or economic issues, the same cannot be said about other subjects. When building owners identify legal difficulties, they name roughly two aspects – the first dealing with the overlapping of different regulations (safety regulations, thermal requirements, and structural compliance for example) and the difficulties that derive from that, but also the requirement the building has to achieve when it is being renovated at an energy level.

This could indicate that energy related renovation has to have a deeper analysis and “effort” while compared with a more simple approach to building renovation, such as “anyway renovation”, so additional information has to be brought to the table, for property owners to choose between these approaches.

Lack of awareness or information was sometimes referred to as a barrier. Because other aspects are necessary to understand and they differ from “business as usual”, such as embodied energy or carbon emissions, information must be passed to building owners so that all aspects can be considered, when decision for energy related renovation is made.

On the other hand, some aspects are considered as drivers that motivate and allow for energy related renovation to occur. Taking into account the list defined in Chapter 3.1, some topics were considered as drivers, in particular the ones related to economic aspects and regarding information and knowledge.

As for economic aspects, it is clear to understand why it is considered a motivation, in particular the direct benefits that arise from building renovation, such as the possible increase of the property value. The existence of support programmes, or even tax incentives for example, also act as drivers towards building renovation, because they allow to “ease the burden” of the initial investment costs.

Information and knowledge can be considered as one of the most important topics, when considering drivers for energy related building renovation. The motivation of professionals regarding the (energy) subject, the expertise and knowledge of the technicians involved, all help to set the tone towards an environmental consciousness by the property owner, giving him a wider perspective of the renovation process.

Additional benefits that arise from energy-related renovation, like comfort, monetary savings, and sense of belonging for example, are sometimes more perceived as benefits and drivers, than energy saving itself.

Defining a strategy for communicating and disseminating the topics and subjects considered as drivers, can help to enhance and promote the advantages of energy related building renovation, and provide additional inputs and points of view, rather than just focusing exclusively on energy.

5.2. Residents

The acceptance or non-acceptance by the residents of a major renovation, especially an energy renovation, was here first studied in a thorough literature review and then in a case study with group interviews. A limited amount of information concerning acceptance or non-acceptance of energy renovations as such was found, but some conclusions have been possible to draw. Most of the findings from previous research apply to major general renovations in general, but also these results provide insights useful for understanding of response to energy renovations. In many cases the starting point for a renovation is the need for renovation due to wear and tear, and energy saving measures are included as part of the overall renovation.

The energy use and the energy cost do not always decrease as expected after an energy renovation. According to the literature review the residents paying for their own energy use for heating can prefer to improve the thermal comfort in their flats, especially if it was poor before. On the other hand, residents paying for their own heating give the building owner little incitement to invest in an energy renovation. If the cost for heating is included in the rent the energy savings might not be as high as expected, as there is no incitement for the residents.

In our case study of an area of multi-family buildings the interviewed tenants showed little awareness of and interest in the energy savings of their buildings. The cost for space and domestic hot water heating was included in the rent, but not for household electricity, which is paid separately. The motivation to contribute to the energy savings is lacking as they do not save any costs. The owner of the buildings has the benefit of the savings. Many residents do not see and value the energy savings as an environmentally friendly action. Although the resident acceptance of installation of systems for renewable energy was not studied, it can be assumed that there is not likely to be any global acceptance by residents of the installation of systems for renewable energy, especially if the costs for the residents are increased.

To motivate residents individual metering and invoicing of space heating can make sense in a multi-family building, especially if the metering is fair. However, there is always the problem that if someone turns off the heat, the flat in question will be heated by neighbouring flats and will save space heating costs on the expense of the neighbours. Individual metering has to take into account the indoor temperature. Individual metering and invoicing of domestic hot water heating does not have any problems of fairness in metering.

The group interviews provided substantial data and the discussions were rather similar in the six groups. However, it has to be pointed out that the invitation possibly attracted tenants that had been active during and after the renovation including energy saving features. Also, the number of participants was small compared with the total number of inhabitants in the case study area. The result of the study should therefore not be seen as a summary of all tenants' view. The strength of the study is instead that the robust descriptions the participants offered gave an insight of the complexity of intervening into some one's homes, even when it is for a good cause such as increasing energy efficiency. In many respects the results apply to residents in general, subject to major renovations with or without energy saving measures. As known from the previous literature study, the residents' perspectives could differ from that of the housing company. The disagreement can be less painful if the different perspectives are made visible and the understanding of the other party's view increased.

The residents often have differing views of a major renovation with or without energy saving measures and its outcome, which is not surprising as most residents have different backgrounds, different situations in life, and different perspectives in general. Usually there will be no general acceptance or non-acceptance of a major renovation, unless the renovation is unusually successful or very poorly executed. The residents' acceptance of the renovation measures, and their outcome, is essential for a successful renovation process, and might even influence whether the residents remain in the building or move out.

Residents already when faced with a renovation have different and sometimes strong feelings in favour or against a renovation. They can be generally positive about the fact that the building will be renovated, but strongly object to part of the renovation. They can be worried about what exactly will be done and what it means for them, e.g. what will happen with the costs for their flat.

It is important to take into account that residents live in their flats, which means it is their homes. One crucial aspect is if the flat still feels like a home after the renovation. This seems to be important especially for long-term residents. After all, a major renovation with or without energy savings measures can change the aesthetical expression of the building and the conditions for comfort and safety in the outer and inner environment. Physically the home is the flat, but often the attachment to the building expressed as feeling at home includes the adjacent stairwell, storerooms, laundry room and the outdoor environment, especially for those who have lived long in the area. The complexity of intervening in someone's home must not be underestimated. Measures, which has an impact on the home should be explained to and have the support of the residents.

Residents possible acceptance or non-acceptance of major renovations with or without energy saving measures depend on the social environment in terms of

- distance e.g. between residents and housing company, between residents and contractor management, between residents and craftsmen
- fairness e.g. between residents, between residents and housing company, equal treatment
- trust e.g. if there is a gap between what was told would be done and what could be seen was done, not being believed when pointing out mistakes, as a resident not being treated as an equal partner.

Other factors of importance for the acceptance are the residents' perception of

- being in control e.g. having or not having control of what will happen and why
- feelings of loss e.g. not being able to continue one's life style
- coping, which can mean denying what is happening, leaving the flat, contacting the housing company.

Residents' possible acceptance of renovations includes improvements that are directly experienced and visible to the residents. Appreciated by residents is if a renovation includes measures for improving security and safety, as the main concern for the residents is often to feel safe in the home and within the close surroundings of their home. Energy renovation measures with the potential to increase acceptance are also those who are directly sensed, e.g. improved thermal comfort as a result of additional insulation, or improved indoor air quality as a result of a new ventilation system with heat recovery, especially if the building was poorly insulated and poorly ventilated before the renovation. Alternatively, energy saving measures could be combined with measures improving e.g. security and safety. Some of these could concern the outdoor environment. Besides that the outdoor environment is seldom in focus when energy renovations are planned, though retrofit of outdoor lighting or installations of dynamic lighting controls could contribute to lowered energy use.

It is difficult to gain acceptance for cost increases that are not directly beneficial for residents (although it is possible to argue that increased energy efficiency and use of renewable energy is

good for the environment and keeps costs for the residents down in the long run). Long-term environmental benefits or financial gains are arguments that might not be sufficient in these cases. Some groups are sensitive to the rent and costs for their flat, though the majority prefer to stay if they have the possibilities.

Regarding the importance of trust during the renovation process, creating a social climate with true communication (rather than one-way information e.g. a one-way communication from the housing company to the residents of a building to be renovated) between the stakeholders would possibly be an initiative that would pay off in the long run. Creating a social environment with close links between stakeholders, a process that is perceived as fair, and conditions that promotes trust between partners possibly increases the potential for the residents to feel that their flat and its surroundings meet the requirements of a home.

It is likely that previous experiences influence the residents' perceived distance, fairness and trust in relation to stakeholders involved in a major renovation (with or without energy saving measures) such as the housing company, consultants and local managers.

However, the appreciation of a renovation is likely to improve if the residents are given opportunity for participation. The minimum level of participation is to be informed. Next level is that the renovation measures have the support of the residents. A still higher level of involvement is to participate in meetings with the housing company and other stakeholders, but not having a say in the decisions. The highest level is being actively involved in the decision making. Valuable knowledge can be gained and mistakes can be avoided by actively engaging the residents. However, one should be aware of that the interest in participating varies greatly between individuals.

However, information to residents about why the energy renovation is carried out and its implications locally, and also globally (when it comes to environmental concerns), is difficult to design to fit every resident and to deliver to every resident. Resident participation is usually beneficial, but need to be carefully planned and adapted to the situation.

Major renovations with or without energy saving features are complex processes that involve many stakeholders, both among those who are involved and those who study these processes. The latter is clearly shown in the publication of studies that reaches from straight forward descriptions of a selected case to more design research studies. There seem to be a lack of more complex empirical studies, with some exceptions, and especially studies based on theories of human perception and acceptance of uncontrollable changes in the home environment.

Some issues are more seldom studied. The impact of energy renovations on residents' general quality of life, and on a long-term bases their well-being and mental health, is very little known. Feelings of being in control of the dwelling (and the renovation) and safe in the residential area were mentioned in the literature and revealed in the case study with group interviews. These factors are possibly part of a psychological process in which the individual appraise the renovation as beneficial or a threat. Depending of the individual's resources, tangible or psychological, renovations and energy renovations would lead to increase or decrease of well-being and quality

of life. The outcome is possibly largely depending on the involvement of the residents and the quality of the renovation. Such a more process orientated research view most likely leads to a larger understanding of residents' response to renovations and energy renovations as beneficial or harmful, and hence to their acceptance or rejection.

5.3. Recommendations for energy renovations

Most of the difficulties identified by decision-makers are identified by property owners, which might lead to not considering building energy renovation, are related to building context and legal difficulties, financial and economic issues, or even lack of awareness or information. To begin with the owners need to be motivated by gaining more information and knowledge on all the benefits and additional benefits of an energy renovation.

Once the need for a major renovation has been surfaced, a good starting point for a major renovation with and without energy saving measures and/or installation of systems for renewable energy is good collaboration between all stakeholders including the residents. This collaboration is beneficial for the entire renovation process and its outcome. The collaboration has to last during the entire renovation process and continue through commissioning and for some time after that.

Insights in the decision-makers' and residents' view of energy and non-energy renovations gained in the studies presented here should be taken into account in planning of future energy and non-energy renovations. The expectations, needs and purposes of all stakeholders have to be considered.

Stakeholder roles should be made visible to increase understanding of the needs of those involved. Residents' need to feel that they live in a home must be highlighted, preferably improved and not impaired, but residents also need to have greater understanding of the housing company's interests and contractors' and subcontractors' situation. This task is possibly not best solved with traditional ways of information, but rather with collaboration between stakeholders, also including residents.

A good social environment is essential for the renovation and the energy renovation to become accepted among the residents. Direct engagement and dialogue rather than one-way information/communication can be a way to create good relationships. This engagement and dialogue should be prioritized and continuous before, during and after a major renovation. If there is an understanding of residents' need for control of their homes, there are prerequisites for the design of contacts during the renovation process that works for all parties. There should e.g. be an agreement on the desired indoor climate after the renovation, if the renovation will have an impact on the indoor climate.

Renovation and energy renovation should include parts that are directly experienced and visible to the residents, and should strengthen residents' possibility to perceive the building as a home. Increased security, higher aesthetic values and improved indoor climate are examples of such measures. Actions perceived as deterioration (e.g. degraded indoor climate) are difficult to gain

acceptance for; it is probably not possible to increase acceptance by describing their advantages as good for the environment or good in the long run.

Economic means for energy renovation should if possible be set aside in advance or the energy renovation costs should be covered by the savings in energy costs so that the renovation does not have to be borne by a rent or cost increase for the resident. Energy renovation should not be perceived as unnecessarily costly but as offering good value for the money invested. Some financial compensation or other type of compensation during the renovation should be considered.

During the construction work in the building all craftsmen should be well organized (e.g. showing up at promised times of work affecting flats) professionals with social competence.

The minimum level of participation of residents in a major renovation is that the residents are informed by owners, planners and contractors from the start of the renovation process. The information should describe the renovation measures and explain the reasons and the expected results. If the rent or costs for the flats have to be increased, the information should give the size of the increase and what it pays for. The involvement of the residents in the approval, planning and decision making should always be considered.

5.3.1. Recommendations for professional building owners

The above-mentioned recommendations can be summarized for professional building owners as follows:

- Acquire information and knowledge on all the benefits and additional benefits of an energy renovation and consider them.
- Ensure collaboration between all stakeholders including the residents during the entire renovation process.
- Involve the residents in the renovation process (planning and building).
- Highlight residents' needs and taken them into account during the entire renovation process.
- Inform on the renovation continuously during the entire renovation process and ensure two-way information/communication i.e. a dialogue between residents and representatives of the housing company.
- Increase residents' acceptance of a renovation by including measures, which are directly experienced and visible.
- Long-term environmental benefits are often not sufficient for resident acceptance of a renovation.
- Crucial for the acceptance of a renovation is a good relationship between housing company and residents.
- Highlight the need of the residents to feel at home and preferably strengthen by the energy renovation.

- Energy renovation should not increase the costs for the residents and they should be compensated during a renovation.
- Full acceptance from all residents is not possible, but should be ensured from the majority.

5.3.2. Recommendations for planners and contractors

The above-mentioned recommendations can be summarized for planners and contractors as follows:

- Involve the residents in the renovation process (planning and building).
- Inform on the renovation continuously during the entire renovation process and ensure two-way information/communication.

5.3.3. Recommendations for residents

The above-mentioned recommendations can be summarized for residents as follows:

- Must learn to understand the role and conditions of housing companies and contractors.
- Must learn to understand the long-term environmental benefits of energy renovations.

5.4. Future research

As stated above insight gained into residents' view of major renovations including energy saving measures should be taken into account in planning of future renovations. However, energy renovations are complex processes and the understanding of how residents are influenced by the measures taken and the interactions between stakeholders are not fully understood. This is not only the case for energy saving measures, but also for installation of systems for renewable energy. There seem to be a lack of more comprehensive empirical studies, with some exceptions, and especially of studies based on theories of human perception and acceptance of uncontrollable changes in the home.

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7. Appendix 1 Literature review support record – decision-makers

Annex 56 - Cost-effective energy and carbon emission optimization in building renovation
STD_D1-1_Literature Review support record

Literature Review Survey Review

Bibliographic reference

Document type	Escolha um item.	Language	Clique aqui para introduzir texto.
Author(s)	Clique aqui para introduzir texto.	Year	Clique aqui para introduzir texto.
Title	Clique aqui para introduzir texto.	Organisation(s)	Clique aqui para introduzir texto.
Link (URL)	Clique aqui para introduzir texto.		

Constraints and/or drivers to cost-effective energy and carbon emission optimized building renovations

	Aspects	C	D	Actor
Building context	Physical or technical condition of the building			
	General renovation activity			
	Aesthetics and cultural heritage			
	Technical difficulties			
	Project dimension			
	Type of dwelling			
regulation	Planning and construction			
	Energy codes and standards			
	Legal framework			
Economic, financial, fiscal	Economic viability			
	Financial need, access to capital, or others			
	Tax incentives			
	Payback time			
	Split incentives			
	Energy prices / energy prices distortion			
	Risk exposure to the return on investment			
	Discount rate, interest rate			
	Lack of financier awareness			
	Value of property			
	Support programmes			
Externalities	Environmental impact (air pollution, noise, climate)			
	Energy security			
	Social policy			
	Employment			

	Aspects	C	D	Actor
Information and knowledge	Information and know-how			
	Choice of company:			
	Awareness, attitude, strategy			
	Environmental consciousness			
	Distribution of responsibility between main actors			
	Motivation of professionals			
	Uncertainty associated with energy savings (related to the risk issue)			
	Standardised measurement & verification protocol putting into service/commissioning by the contractors			
	Trained personnel, technical or managerial expertise			
Socio-economic	Education			
	Age			
	Income			
	Life changes			
	Identity			
	Social comparison			
	Time restrictions			
	Convenience			
	Social norms and values.			
	User's disturbance			
	Social contacts			
	Comfort			
	Longer/shorter housing perspective			

**Annex 56 - Cost-effective energy and carbon emission optimization in
building renovation
STD_D1-1_Literature Review support record**

Brief resume

Click aqui para introducir texto.

Contribute information

Name	Click aqui para introducir texto.	Date	Click aqui para introducir una data.
Organisation	Click aqui para introducir texto.	Country	Click aqui para introducir texto.

Legend: In the field actor refer:

C – Contractors;

I – Investors;

O – Owners

P - Planners

8. Appendix 2 Literature review examples – decision-makers

Set of examples of gathered information and completed template

Annex 56 - Cost-effective energy and carbon emission optimization in [building renovation](#)
STD_D1-1_Literature Review support record

Literature Review Survey Review

Bibliographic reference

Document type	(Project) Report	Language	English
Author(s)	Françoise Bartheus	Year	2011
Title	A Qualitative study of home energy-related renovation in five countries: homeowner's practices and opinions		
Organisation(s)	Intelligent Energy Europe		
Link (URL)	Clique aqui para introduzir texto.		

Constraints and/or drivers to cost-effective energy and carbon emission optimized building renovations

	Aspects		Actor	
	C	D	C	D
Building context	Physical or technical condition of the building	X	O	
	General renovation activity	X	O	
	Aesthetics and cultural heritage	X	O	
	Technical difficulties			
Information and knowledge	Information and know-how	X	O	
	Choice of company:	X	O	
regulation	Awareness, attitude, strategy	X	C	
	Environmental consciousness			
	Distribution of responsibility between main actors			
	Motivation of professionals	X	P	
	Uncertainty associated with energy savings (related to the risk issue)			
	Standardised measurement & verification protocol putting into service/commissioning by the contractors			
	Trained personnel, technical or managerial expertise	X	C	
	Economic viability	X	O	
	Financial need, access to capital, or others	X	O	
	Tax incentives	X	O	
Economic, financial, fiscal	Payback time	X	O	
	Split incentives			
	Energy prices / energy prices distortion	X	O	
	Risk exposure to the return on investment			
	Discount rate, interest rate	X	O	
	Lack of financier awareness	X	P	
Socio-economic	Value of property			
	Support programmes	X	O	
	Environmental impact (air pollution, noise, climate)	X	O	
	Energy security (dependence on other countries)			
Externalities	Social policy	X	O	
	Employment			

Annex 56 - Cost-effective energy and carbon emission optimization in [building renovation](#)
STD_D1-1_Literature Review support record

Brief resume

Qualitative survey realised in Belgium, Bulgaria, the Czech Republic, Latvia and Portugal with 117 interviewed homeowners who are undertaking energy-related renovations. Despite different historical and geographical context, there are many similarities in these five countries when it comes to energy-related renovations done. The document also contains indication of energy-related subsidies and programmes, factors that interfere in the energy renovation process and other policy areas to strengthen the implementation of the EPBD. This survey shows that doing energy-related renovations is not only a technical issue but also a social issue, as a matter of trust and friendship, as a giving or exchange of advice or services, and with interest, as a new source of information namely on contractors' reputation. Social support from friends and relatives is a major condition before and during energy-related renovation. The 117 informants appear to be inserted in social networks that are quite significant in helping them make energy-related renovations and that are often connected to the labour force in the construction or energy sectors. When contradictory advice arises, friendship appears to be more valued than technical criteria on energy savings. Feelings of coldness or thermal discomfort, often related to old building stocks, as well as need or wish to reduce energy bills are, among other factors such as a concern for global warming, efficient means for triggering energy-related renovations, but these factors are never isolated, always acting in combination. Also the factors hampering energy-related renovations are interrelated and may act in both directions, favouring or not energy-related renovations. Some of the pointed factors impeding informants to make some or further energy-related renovations were: lack of necessity, lack of money and lack of support, although these obstacles may have different meanings and are also related to aesthetical criteria, lack of know-how and lack of interest. The necessity to comply with regulations protecting historic centres and other town-planning rules can hamper façade insulation and change of frames and windows, and in multi-apartment buildings the necessity to reach an agreement between a high *quorum* of co-owners is also a factor impeding buildings renovation.

Contribute information

Name	Ana Rodrigues / Marco Ferreira	Date	20-08-2012
Organisation	Universidade do Minho	Country	Portugal

Legend: in the field actor refer:

C – Contractors;
I – Investors;
O – Owners
P – Planners

Example 1

Annex 56 - Cost-effective energy and carbon emission optimization in building renovation
 STD_D1-1_Literature Review support record

Bibliographic reference

Document type	Working Paper	Language	English
Author(s)	Martin Jakob	Year	2007
Title	The drivers of and barriers to energy efficiency in renovation decisions of single-family home-owners	Organisation(s)	CEPE – Centre for Energy Policy and Economics – Swiss Federal Institutes of Technology
Link (URL)	Clique aqui para introduzir texto.		

Constraints and/or drivers to cost-effective energy and carbon emission optimized building renovations

Aspects	C	D	Actor
Physical or technical condition of the building	x		o
General renovation activity	x		o
Aesthetics and cultural heritage	x		o
Technical difficulties			
Project dimension			
Type of dwelling	x		o
Planning and construction			
Energy codes and standards	x		o
Legal framework	x		o
Economic viability	x		o
Financial need, access to capital, or others	x		o
Tax incentives		x	o
Payback time			
Split incentives			
Energy prices / energy prices distortion	x		o
Risk exposure to the return on investment			
Discount rate, interest rate			
Lack of financier awareness			
Value of property			
Support programmes			
Environmental impact (air pollution, noise, climate)			
Energy security (dependence on other countries)			
Social policy			
Employment			

Annex 56 - Cost-effective energy and carbon emission optimization in building renovation
 STD_D1-1_Literature Review support record

Brief resume

Paper about Switzerland, where barriers and drivers of energy efficiency in the case of single-family house (SFH) renovations were addressed by three approaches, namely by an analysis of the technical, legal and economic framework conditions, by a survey that gathered the subjective perceptions of these framework conditions as well as the motivations of the SFH-owners, and by the econometric modelling of the revealed renovation choices. Consistency between the three approaches was observed in terms of some, but not all barriers and drivers. The analyses consistently revealed that building envelope renovation is triggered by general renovation activity such as building extensions or alterations, by the end of the lifetime of the element and by energy saving and environmental concerns. It is only the latter that leads to significantly more energy-efficient renovations. Consistency was also observed in terms of regulations, which are unanimously not identified as relevant barriers, and in terms of information, during the period considered technical information in terms of brochures, websites and public consulting was available (especially in the 1990s) and owners did not criticise a lack of information. Overall, the variety of obstacles and motivations stated by the owners is quite broad, including environmental/energy saving, technical and economic reasons. Opportunities and occasions such as building and space extensions and internal motivations are relevant drivers of EE renovations rather than information, education or high income which do not show a significant impact on the renovation choice. To summarise concisely: It is conviction rather than economics that have driven building insulation so far, and it is a lack of consciousness and partly economics that have hindered building insulation in the past.

Contribute information

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Example 2

9. Appendix 3 Literature review diagrams – decision-makers

From all the 13 documents received, taking into account the structure of subjects detailed in chapter 3.1, it was possible to compile all data for a better understanding of the theme.

The following graphs show, for each subject field and subtopics, which were the subtopics more often referred to as well as if it was considered a barrier or a driver.

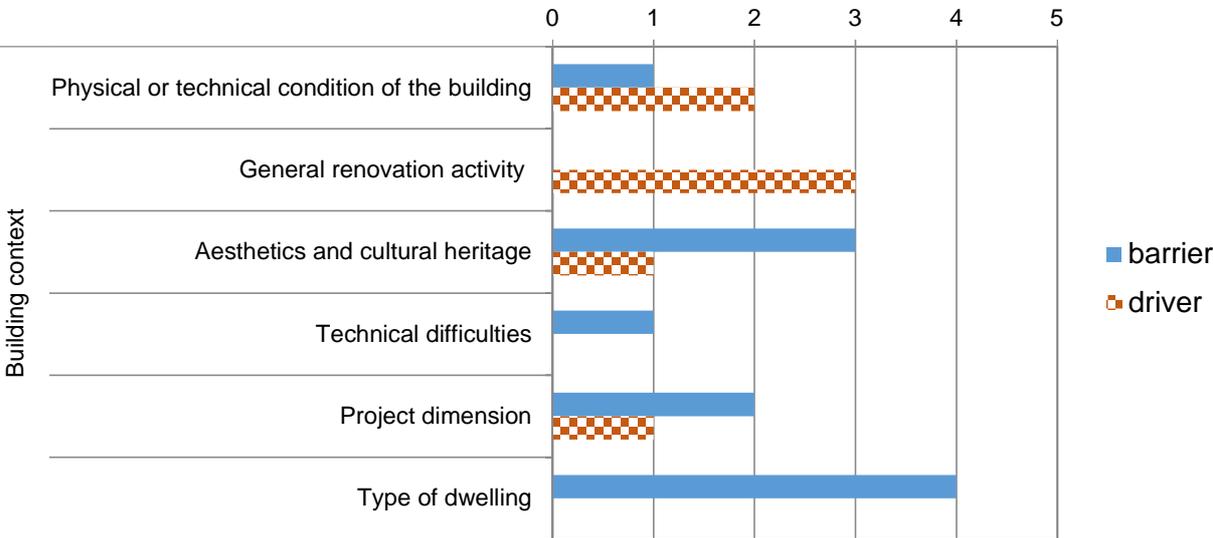


Figure 1 - Building context (18 answers in total)

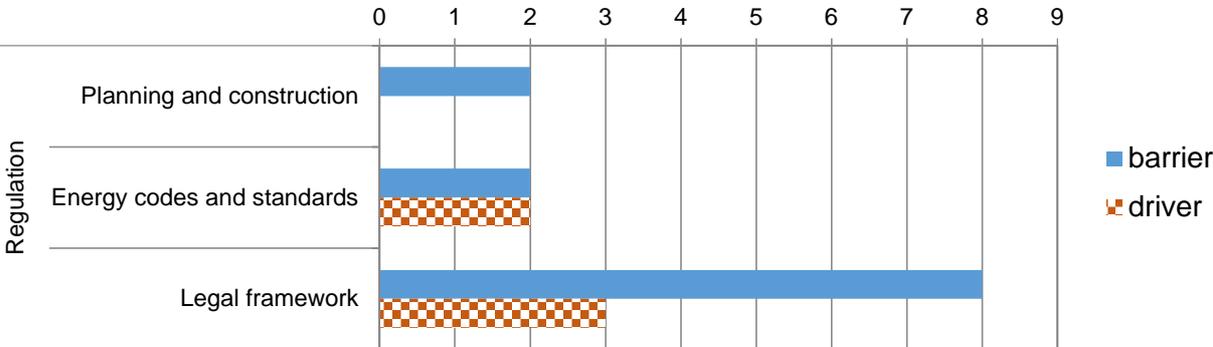


Figure 2 - Regulation (17 answers in total)

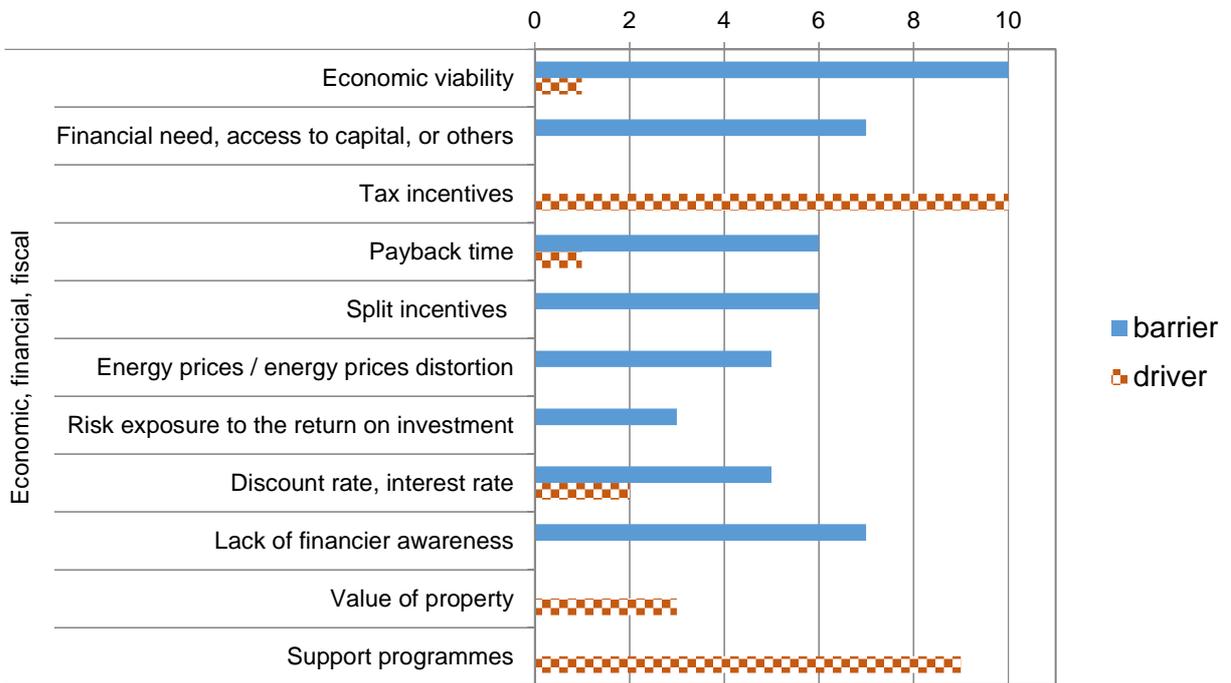


Figure 3 - Economic, financial, fiscal (75 answers in total)

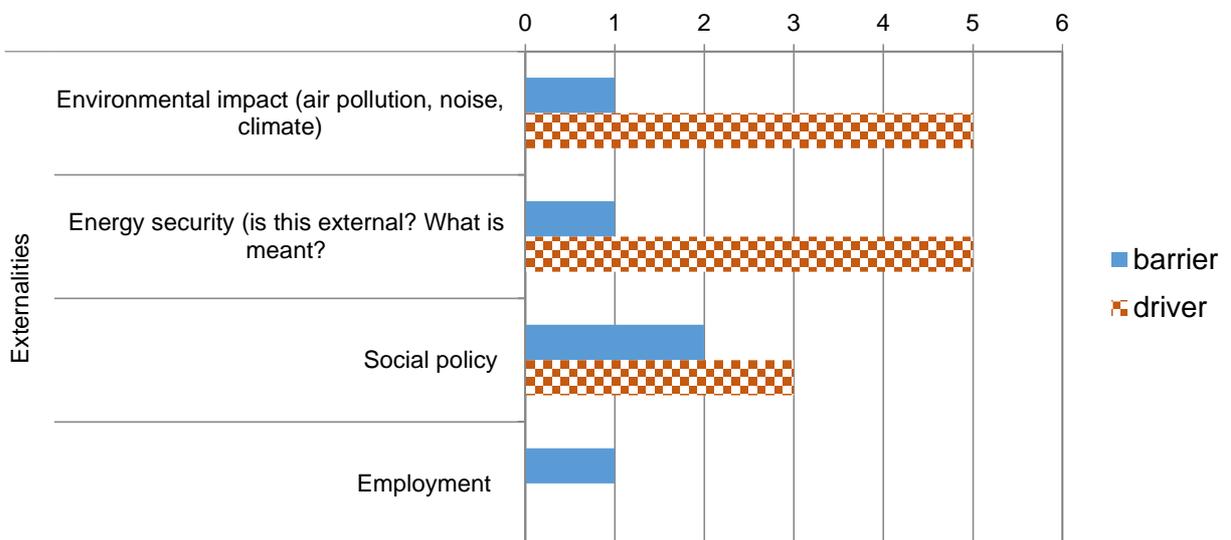


Figure 4 - Externalities (18 answers in total)

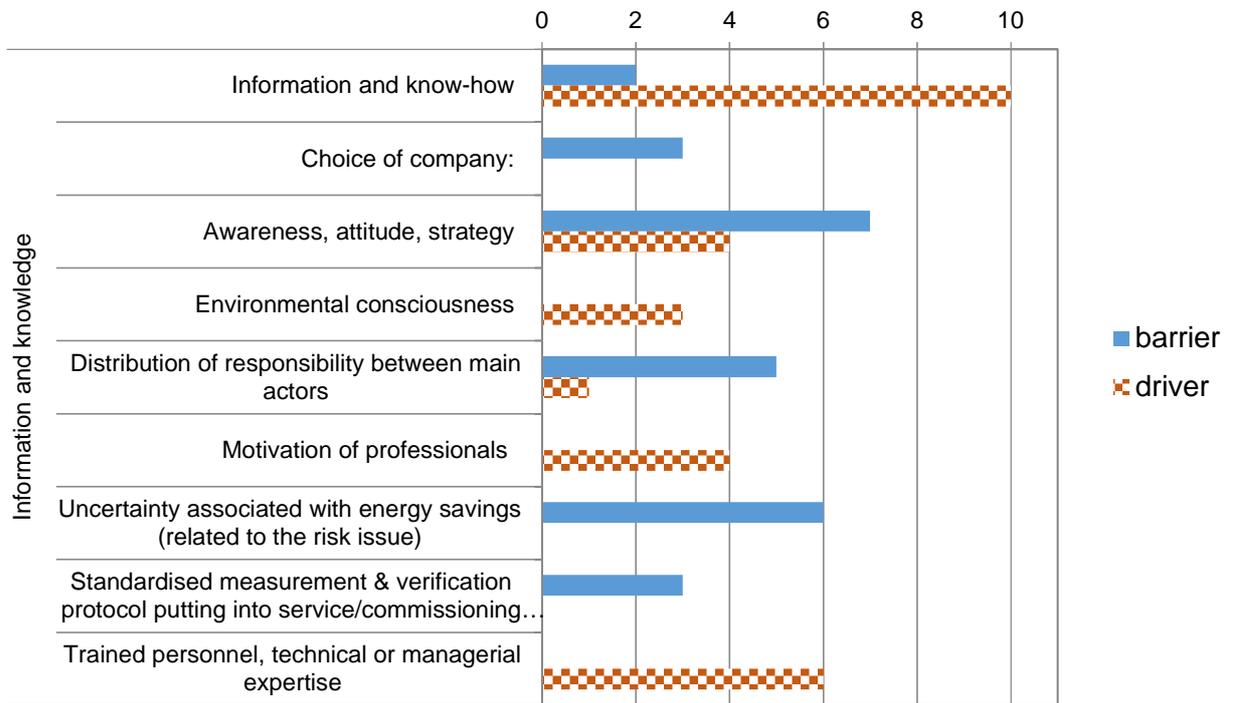


Figure 5 - Information and knowledge (44 answers in total)

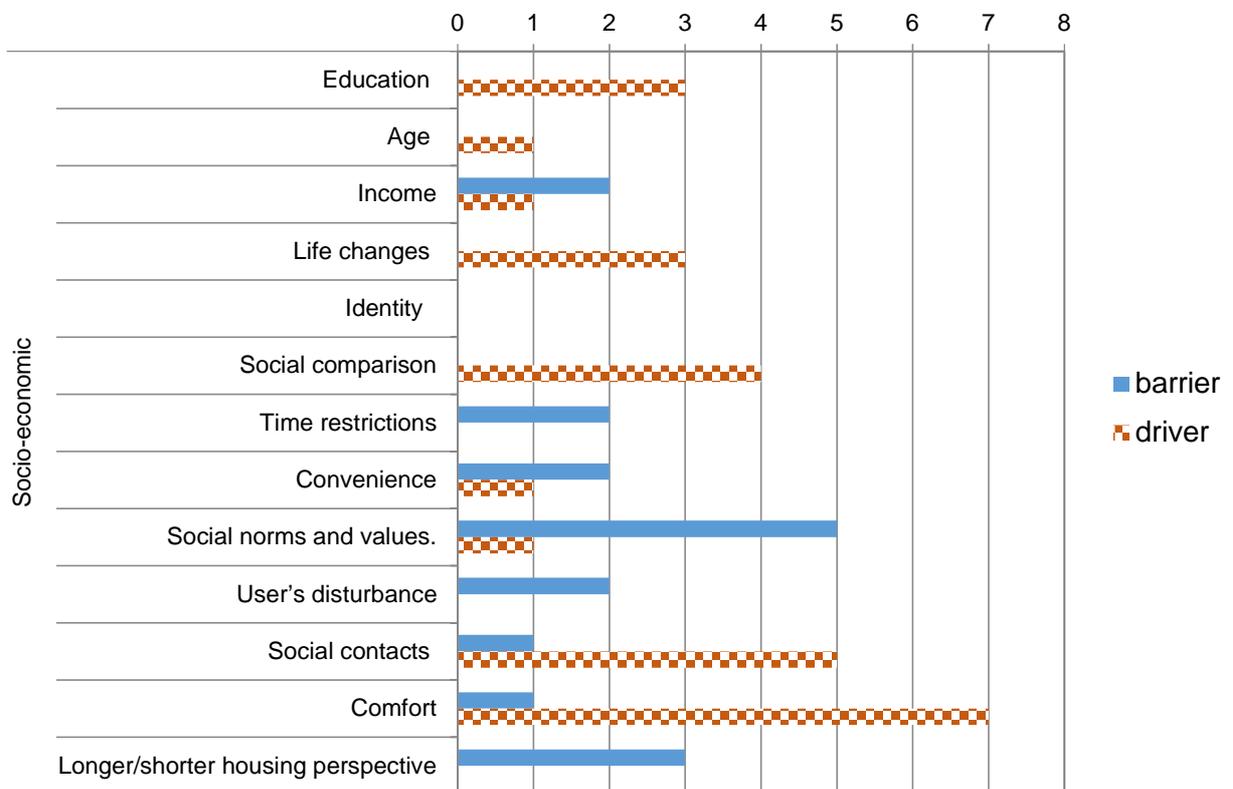


Figure 6 - Socio-economic (44 answers in total)



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