MASTER

Investigating possible mismatches in deep retrofitting projects
an analysis of mismatches occurring the design-, construction- and in-use phase in
Dutch deep retrofitting projects

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Investigating Possible Mismatches in Deep Retrofitting Projects
An Analysis of Mismatches Occurring the Design-, Construction- and In-Use Phase in Dutch Deep Retrofitting Projects.

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Supervisors:
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Investigating possible mismatches in deep retrofitting projects

An Analysis of Mismatches Occurring the Design-, Construction- and In-Use Phase in Dutch Deep Retrofitting Projects.

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Preface

This Master thesis is the result of the study during my graduation at Eindhoven University of Technology, conducted at DuneWorks BV in Eindhoven. My internship at DuneWorks BV gave me the opportunity to cooperate in a research project commissioned by Platform 31, which gave me access to very interesting deep retrofitting projects of the innovation program Energiesprong.

This Master thesis is the final assessment of the educational program Innovation Sciences, faculty of Industrial Engineering & Innovation Sciences. I experienced the Master thesis project as a very interesting, enjoyable but also as a time consuming process. It required a lot of motivation and effort to process the large amounts of data and to write this thesis. The realisation of this Master thesis would not have been possible without the help of some very motivated and committed people, who I would like to thank.

I would like to start with a word of thanks to respectively my first- and second supervisor Rob Raven and Johanna Höffken. I would like to thank them for introducing me to DuneWorks BV, their valuable input, the provision of clear feedback and their valuable guidance and support during the Master thesis project.

And last but not least, I express my deep gratitude to Sylvia Breukers for her constructive comments to the thesis, inspiring collaboration, guidance and assistance during my Master thesis project. My thanks are extended to Ruth Maurik and Tomas Mathijsen, my colleagues at DuneWorks BV during my internship.

Luc van Summeren
April 28, 2014
Abstract
Currently many houses are deeply retrofitted to lower energy consumption which is needed to meet energy saving ambitions, to lower energy poverty and to boost employment in the building sector. However, evaluations of existing low-energy houses have indicated a big performance gap between the in-use energy performance and the design intent of these houses. This research aimed to indicate, explain and provide solutions for mismatches occurring in Dutch deep retrofitting projects in the design-, construction-, and in-use phase.

First a literature study was conducted in which the historical context of low-energy houses, user involvement in the design process, and factors that influence the behaviour of residents in low-energy houses were investigated. In this study a multiple case embedded design was used to investigate three projects drawn from the innovation program Energiesprong. Data was gathered by means of semi-structured interviews with both residents and project leaders of the selected projects.

The literature study showed that in efforts to lower the energy use of buildings the focus is mainly on building-related energy use while little attention is paid to domestic-energy use, the way how residents use their houses and how this influences the total energy consumption. Furthermore, three main categories of factors that influence how residents use low-energy houses are indicated: user characteristics, building characteristics and builder-resident interactions.

The empirical data shows that many mismatches occur in the design-, construction-, and in-use phase. Designers often do not make sufficient use of information about- and provided by residents. This led to designs that often did not match residents’ needs and goals. Mismatches occurring in the construction phase mainly consist of power issues and lacking communication. Furthermore, the renovation may have big impacts on residents, especially when delay and damages occur or when they have to stay in their houses under harsh living conditions. In the in-use phase it is found that lacking maintenance and aftercare can lead to distrust in the technologies which may eventually lead to inefficient usage. Indicated mismatches in the in-use phase show that even informed and highly motivated residents do not always use the low-energy houses as prescribed. The completion of the renovation should not be the end of the project, additional guidance and support should help residents to make sense of the new technologies.

It is clear that in the investigated phases of deep retrofitting projects more attention should be paid to the residents of low-energy houses in the design-, construction and in-use phase. This is necessary to meet the energy saving ambitions and to make sure that residents enjoy living in the deeply retrofitted houses.
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1. Introduction

In the Netherlands the build environment uses around 35% of the total Dutch energy consumption, almost half of this is consumed in households (Agentschap NL, 2012). The high energy consumption gives rise to environmental impacts. Furthermore, in the last fifteen years the prices for energy increased three times as fast as the average prices of other products. In the future an increasing number of people will be suffering from energy poverty. Someone who suffers from energy poverty does not have enough financial recourses to pay the energy bill after paying for the costs of housing and living. (Rijkswaterstaat, 2013) In addition, because of the financial crisis many construction companies went bankrupt. To boost employment in the construction sector and to lower the energy consumption of households, the construction of houses with a low energy use are promoted (Energiessprong, De Stroomversnelling, 2013).

Dutch and EU policies demand that from 2020 all buildings have to be nearly zero-energy buildings (Agentschap NL, 2012). Zero-energy houses have improved insulation, improved efficiencies in building services (heating, hot water systems, lights and better controls), and the addition of efficient and/or renewable energy generation which makes it theoretically possible that a home does not need any external energy from the power- or gas grid (Gupta, Gregg, & Cherian, 2013).

However evaluations of existing low-energy houses have indicated that there is a big performance gap between the in-use performance and the design intent of these houses. In low-energy houses the energy reductions include both domestic- (heating, cooling, domestic hot water, etc.) and building-related energy use (lighting, using domestic appliances, etc.), more information about various definitions of energy efficient houses can be found in appendix A. Because energy use in houses strongly depends on how people use their houses, installations and other devices; this may have major consequences for the performances of low-energy houses (Willems, et al., 2012). However, due to a lack of monitoring in-use behaviour and evaluation with residents, there is a lack of useful information about how people use the new technologies in their houses and which interventions are effective (Heaslip, 2012). This research aims for expanding the knowledge base surrounding mismatches that give rise to these performance gaps, so that in the future they may be anticipated and improved. This will help low-energy housing projects to realize their energy saving ambitions.

Different types of mismatches can be distinguished in different phases of the realization of low-energy houses that may cause performance gaps. These mismatches consist of two types: resident – builder (housing corporation/construction company) and resident – low-energy house. The different phases consist of the design-, construction- and in-use phase. In the design phase mismatches may occur between the design(er) and residents, and between the housing corporation and residents. During the construction-phase mismatches may occur between construction company and residents, and for projects which consist of social housing also between the housing corporation and residents. Furthermore, in the in-use phase mismatches may occur between the deeply retrofitted houses and the residents, for projects which consist of social housing between the housing corporation and the residents, and for projects in which the houses are privately owned between the construction company/workers and residents. These mismatches in the three phases will be investigated by analysing the expectations of residents and project leaders (and comparing them with each other), the behaviour and the experiences of residents in the low-energy houses, how residents are incorporated in the design process, and the support and guidance of the residents. Investigating these mismatches will help to understand and solve them, which will eventually lead higher energy performances of low-energy houses.
To investigate these mismatches, first a literature study (chapter 2) is conducted in which the historical context of low-energy houses, user involvement in the design process of these houses, and factors that influence the behaviour of residents in low-energy houses are researched. The development of low-energy houses in the Netherlands is important to embed this research in the historical context. Furthermore, the way residents are involved in the design process and how this influences the way low-energy houses are used is discussed. Further, numerous factors influencing the behaviour of residents in low-energy houses are identified. Finally, the information resulting from analysing academic literature is used to develop a conceptual framework which helps to explain how design, construction and use processes surrounding low-energy houses affect each other.

The possible mismatches will be empirically investigated by conducting a multiple case study. The cases are drawn from an innovation program that involves deep retrofitting with high energy-saving ambitions. This innovative program is called ‘Energiesprong’ (Energiesprong, Website, 2013). This research is done in co-operation with DuneWorks BV and their research project BoB (Bouwers ontmooten Bewoners; builders meet residents). Aim of the BoB project is to improve understanding about the possibilities to use energy performance contracts for deeply retrofitted or new low-energy houses between residents and housing providers (housing corporation, builder, consortium). More comprehensive explanations of the Energiesprong program and the BoB project can be found in respectively appendix B and C. In very innovative projects like the cases of Energiesprong, mismatches are present and they may have major consequences for whether or not the energy saving ambitions will be realized. These projects can, in addition to the techno-economical knowledge that can be derived from these projects, provide knowledge about social aspects which often are very important in these highly innovative projects. These social aspects may concern participation processes, social acceptance and other social issues.

The aim of this thesis is to identify, explain and provide possible improvements for mismatches occurring in Dutch deep retrofitting projects. This leads to the following main research question which will be answered in this Master thesis:

- Which mismatches can be identified in Dutch deep retrofitting projects (renovation processes that include very ambitious energy-saving measures)?

This question can be split up into four sub questions, that are answered by means of a literature study (question 1) and a case study (questions 2, 3 and 4). First, it is important to explore existing literature about low-energy houses and occurring mismatches. Secondly, mismatches will be identified in the design-, construction, and in-use phase. Thirdly, these mismatches will be explained. Fourthly, possible solutions or improvements for these mismatches will be identified.

1. What has already been published on low-energy houses and possible mismatches that may occur?
2. Which mismatches can be identified in Dutch deep retrofitting projects in the design-, construction-, and in-use phase?
3. How can these mismatches be explained?
4. How can the identified mismatches be anticipated and improved?

In this research attention is given to three phases in the realization of low-energy houses. The design- and the in-use phases are chosen because the literature study revealed evidence that mismatches may occur in these phases. The construction phase is included because there are indications that mismatches may also
occur in these phases which may affect the performances of low-energy houses. However, this phase has not yet been extensively studied, therefore for this phase the research will have a more explorative nature.

In the next chapter the research methods will be discussed. Secondly, the findings of the literature study will be discussed and how this will be used to form a theoretical framework. Thirdly, findings resulting from the analysis are discussed. Finally, the main results and conclusions derived from this study will be discussed.
2. Methodology

This chapter starts with an overview of the methods used in the literature study. Secondly, the design of the case studies is explained. Thirdly, the method used for selecting the cases is described. Fourthly, the interview method used for data collection in the interviews with project leaders is discussed. Fifthly, the interview method used for data collection about the residents is discussed. Finally, the analytical methods are discussed.

2.1 Literature study

In advance of this thesis a literature study was conducted in which the historical context of low-energy houses, user involvement in the design process of these houses, and factors that influence the behaviour of residents in low-energy houses will be researched. Below the different research methods used to research each topic are briefly presented.

2.1.1 Trends and developments in the low energy housing sector

First, the historical developments and trends of low-energy houses in the last few years with an emphasis on the Netherlands will be investigated. The focus of this research was on important policies, trends, previous trends and whether the residents were considered important for the success of low-energy houses. A content analysis is conducted concerning literature describing the developments in the low-energy housing sector. For this historical overview, a research by W/E adviseurs (2010) was used that investigated the historical development of sustainable building in the Netherlands between 1995 and 2010. This research was commissioned by the ministry of VROM (ministry of housing, spatial planning and the environment). In addition, information was added from papers of Opstelten, Weterings, & Versteeg (2011), Spies (Nationaal plan, 2012) and SER (2013) which respectively described the energy transition of the building sector in the Netherlands, recent policies aimed for increasing energy efficiency and savings in the housing sector, and the Energy Agreement which was formulated recently. The Energy Agreement was completed on the sixth of September 2013; over forty different parties are involved in formulating four goals in the field of energy-saving and –generation (SER, 2013). Secondly, this chapter provides an overview of renovation- and new construction projects in the Netherlands. This is based on information from the the Energiesprong website that reviews inspiring and innovative low-energy building projects with very high energy saving ambitions in the Netherlands. Since the focus is on the housing sector, projects from other sectors (e.g. offices) are left out.

2.1.2 User involvement in the design of low energy houses

The second part of the literature study focuses on literature about user involvement in design and innovation processes. The conceptual framework developed is based on STS theory with a focus on user involvement in the design of energy efficient houses. The focus was on STS literature because they integrate social and technical knowledge. This integration is very important in investigating the mismatches between low-energy houses (technical) – residents (social). The book of Rohracher (2005) is used as a start and subsequently started a search for articles related to this subject. These articles were found with search engines Scopus, Web of Science and Focus. Keywords which were used in different combinations in the search for articles are: ‘user involvement’, ‘design’, ‘innovation’, ‘houses’, ‘script’, ‘energy efficient’ and ‘low energy house’.

The literature was analysed with a focus on STS concepts such as end-users, the interaction between users and technologies, expectations of users and designers, and mismatches between (the expectations of)
users and designers. But when other subjects were found to be important which fit with the STS conceptual framework, they were also derived from the literature.

### 2.1.3 Factors influencing the interactions between the residents, technologies and the builders of zero/low energy houses

The third part of the literature study uses empirical findings of previous studies which analysed the behavioural aspect in low energy houses, segmentation of energy consumers, and evaluations of previous projects. Most papers are peer-reviewed papers presented at the summer study 2013 of the ECEEE, which is a platform for the exchange of state-of-the-art empirical and theoretical work on energy efficient housing and userss (ECEEE, 2013). These and other papers were suggested by colleagues at DuneWorks BV (social scientists) and by the first supervisor of this Master thesis project, and found with the search engines Scopus, Web of Science and Focus. Keywords which were used in different combinations in the search for articles are: ‘expectations’, ‘behavio(u)r’, ‘houses’, ‘energy consumers’, ‘households’, ‘energy saving’, ‘energy efficient houses’, ‘energy efficiency’.

The literature was analysed with a focus on factors that influence residents’ behaviour in low-energy houses. These factors were divided in three categories: user characteristics, technology and house characteristics which may be important in the interaction with residents, and builder-resident interactions which may influence residents’ behaviour and acceptance, and therefore also the performances of low-energy houses.

### 2.2 Case Study Design

The research design used is a multiple case embedded design. This design is used because in order to collect relevant data about the (mis)matches that may occur in deep retrofitting projects, it is important to involve all relevant units of analysis. So within the cases attention is given to subunits such as project documents, project leaders and residents. The main focus is on how residents use their low-energy houses and how they evaluate the design-, construction-, and in-use phase. Furthermore, the analysis of multiple cases instead of one single case is often considered more compelling and the overall study is therefore seen as more robust (Yin, 2009).

A case study design is used because of the nature of the phenomenon; in order to investigate the mismatches between builders – residents and low-energy houses – residents, it is important to gather data about things like experiences with- and behaviour of residents in low-energy houses, and interactions between the housing provider/builder and residents. An advantage of using a case study design is that it allows to investigate these real-life events which are embedded in specific contexts. It is not possible to capture all relevant data, including these contexts, with experiments or surveys. Furthermore, multiple cases are investigated because this may lead to substantial analytic benefits because it creates the possibility of direct replication. When analytical conclusions arise independently from different cases, this will lead to more powerful conclusions (Yin, 2009).

Data collection is done by studying project documents and websites and by conducting semi-structured interviews with both project leaders and residents. Semi-structured interviews are used for data collection because this allows respondents to come up with new subjects that were not considered important beforehand (Boeije, 2005). This opens the possibility of finding new relevant things surrounding mismatches in deep retrofitting projects. For example, the main reason for including the construction phase in the scope of analysis is that many respondents brought up this subject during the interviews.
Another reason why semi-structured interviews were used is that they can be used to gather information about opinions, different perspectives, facts and observations.

## 2.3 Selection of cases

The investigated cases are drawn from an innovation program called “Energiesprong”, this program involves deep retrofitting with high energy-saving ambitions (Energiesprong, Website, 2013). The fact that all cases are drawn from the same innovation program makes them more comparable, this is because they are situated in the same institutional context. Especially in very innovative projects like the cases of Energiesprong, mismatches are present and they may have major consequences for realizing the energy saving ambitions.

These three projects were drawn from Energiesprong after reviewing the available cases and consultation with Energiesprong, other parties responsible for monitoring activities and parties responsible for the renovation projects:

- Amsterdamse Buurt; Haarlem
- Bestaande Wijk van Morgen; Kerkrade
- Wel de lusten, niet de lasten; Utrecht

These projects are chosen because they have an ambition for energy reductions of at least 60%. In addition, for these projects the construction/renovation of the low-energy houses was completed and the houses are inhabited at the time of the study. This is important because this made it possible to interview residents who already live in renovated houses, in this way it is possible to derive information about their expectations about the renovated houses but also about how they experience and use their renovated house and the new installations.

In advance of the interviews, templates were made which contain all collected information about the selected projects. This information was derived from the subsidy application, the website of Energiesprong, the websites of the parties involved in the project, the website of the project, news websites and other project documents. Table 2.1, 2.2 and 2.3 show brief overviews of the cases studied in this research. In chapter 4 more comprehensive descriptions of these cases are given. In two out of three cases the housing is provided by housing corporations. Housing corporations are an important actor in deep retrofitting projects and therefore the derived information can be useful for many future projects.

<table>
<thead>
<tr>
<th>Amsterdamse Buurt, Haarlem (phase 1)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of housing</td>
<td>Social housing</td>
</tr>
<tr>
<td>Number of houses</td>
<td>37</td>
</tr>
<tr>
<td>Energy performance</td>
<td>Energy reduction of 60%</td>
</tr>
<tr>
<td>Housing provider</td>
<td>Elan Wonen</td>
</tr>
<tr>
<td>Executor</td>
<td>Van Wijnen</td>
</tr>
<tr>
<td>Most important energy measures</td>
<td>Wall, floor and roof insulation. HR+++ windows, ventilation system (air extraction)</td>
</tr>
<tr>
<td>Particularities</td>
<td>The renovation led to much inconvenience and therefore residents later got the possibility to stay in a temporarily, alternative house.</td>
</tr>
</tbody>
</table>

Table 2.1: Overview project: Amsterdamse Buurt; Haarlem
### Bestaande Wijk van Morgen, Kerkrade

<table>
<thead>
<tr>
<th>Type of housing</th>
<th>Social housing (and 5 private houses which are not renovated (yet))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of houses</td>
<td>153</td>
</tr>
<tr>
<td>Energy performance</td>
<td>Energy label DD → A++ (passive)</td>
</tr>
<tr>
<td>Housing provider</td>
<td>HEEMwonen</td>
</tr>
<tr>
<td>Executor</td>
<td>BAM Woningbouw</td>
</tr>
<tr>
<td>Most important energy measures</td>
<td>New prefabricated insulated facades, new prefabricated insulated roof with integrated PV-panels and solar water heaters and a heat recovery ventilation system.</td>
</tr>
<tr>
<td>Particularities</td>
<td>Residents stayed in their houses during the renovation.</td>
</tr>
</tbody>
</table>

Table 2.2: Overview project: Bestaande wijk van Morgen; Kerkrade

### Wel de Lusten niet de lasten, Utrecht

<table>
<thead>
<tr>
<th>Type of housing</th>
<th>Private house owners (18) and social housing (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of houses</td>
<td>30</td>
</tr>
<tr>
<td>Energy performance</td>
<td>Energy reduction of 80%</td>
</tr>
<tr>
<td>Housing provider</td>
<td>Gronnmij, Seinen, housing corporation Lopik</td>
</tr>
<tr>
<td>Executor</td>
<td>Varies between different houses</td>
</tr>
<tr>
<td>Duration</td>
<td>Varies between different houses</td>
</tr>
<tr>
<td>Most important energy measures</td>
<td>Varies between different houses. Some examples of energy measures taken are: low temperature heating system (variokomp heating, lowH2O radiators), heat pump, improved insulation, PV-panels, new energy efficient domestic appliances.</td>
</tr>
<tr>
<td>Particularities</td>
<td>All private houses differ from each other, therefore not standard measures could be taken.</td>
</tr>
</tbody>
</table>

Table 2.3: Overview project: Wel de lusten, niet de lasten; Utrecht

### 2.4 Interviews with project leaders

As said templates were made which contain information about the projects, these templates were used to gather knowledge about the cases which was used to highlight important aspects for the interviews with project leaders. In chapter 4 descriptions of the cases based upon these templates can be found.

After this, the project leaders of the selected projects were interviewed. These interviews were semi-structured. The interview started with a detailed description of the project by the project leader to obtain more relevant information about the projects. During and after the presentation the project leaders were asked to answer some questions about the project. These questions were about notable things said by the interviewee, remarkable findings in the templates and subjects resulting from the literature study and the BoB project of DuneWorks BV. In these interviews more recent information was derived about the project, expectations about residents and their behaviour, the renovation process and the renovated houses. The list of prepared questions asked in the interviews can be found in appendix D.

The interviews with the project leaders were conducted by two persons of which one was intensively making notes to make sure that all relevant information was captured. After the interviews the derived information was discussed to make sure that nothing was missing in the notes.


2.5 Interviews with Residents

Next to the project leaders also residents were interviewed. Here these interviews will be discussed starting with the sample. Secondly the way the interviews were conducted is explained.

2.5.1 Sample

The target population consists of residents of low-energy houses. Lists of addresses provided by project leaders were used as a sampling frame. For the projects in Haarlem and Kerkrade letters (appendix E) were sent out to the residents to inform them about the research. Project leaders of the projects in Haarlem and Kerkrade provided a list of phone numbers of residents of whom they thought they were willing to cooperate or were likely to have interesting information. Next to this list, also other residents who were not on this list were called for the Haarlem project. Multiple methods were used for approaching potential participants to increase the sample size and to create a sample which is more representative for all residents. All residents in Kerkrade and Haarlem received the letter so that all residents had the opportunity to participate. In the period from November 18th and January 15th data was gathered by interviewing 22 households (in total 30 residents). In table 2.4 an overview is shown about how the participants were selected for each case.

<table>
<thead>
<tr>
<th>Project (number of interviewees / number of renovated houses)</th>
<th>Participants who called after receiving the letter</th>
<th>Participants who were called after receiving the letter (list project leader)</th>
<th>Participants who were called after receiving the letter (not on list project leader)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdamse Buurt, Haarlem (10/37)</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Bestaande Wijk van Morgen, Kerkrade (9/153)</td>
<td>6 (of which one was on the list provided by the project leader)</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Wel de lusten niet de lasten, Utrecht (3/30)</td>
<td>0</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2.4: Overview of the selection procedures of the participants.

For the Kerkrade case one of the participants who called was also on the list of the housing corporation, so in total four people of the list provided by the housing corporation were interviewed. No residents next to the list of the housing corporation were called because already a sufficient number of participants was available. The Utrecht case is a project in which both houses of private house owners and a housing corporation were renovated. However, only a few private owned houses and no corporation houses were completed at the moment of this research. The project leader provided phone numbers of three residents of whom the houses were completed. Only these residents were called and they all participated.

2.5.2 The interviews

The interviews were semi-structured and started with a brief explanation of the research. The aim of the interviews was to identify mismatches between builders-residents and between low-energy houses-residents. The interviews consisted of open questions about (positive/negative) changes in their houses, the house before the renovation, how they control their indoor climate (ventilation and heating system), how the new installations are used and if they understand the way they work, energy saving behaviour and the motivations for this behaviour, the support and guidance provided by the housing corporation,
maintenance of the installations, the renovation process, their insights in their energy use, etc. The checklists of all subjects covered in the interviews is located in appendix F.

Besides this checklist there was room for the participants to talk about things they think is important and for questions popping up during the interview. If indications were found pointing at a possible mismatch more specific questions were asked to figure out how they were caused and how residents think they could be solved or prevented. The interviews were conducted by two persons since the data is also used for the BoB project of DuneWorks BV. Due to practical considerations (location, time) part of the interviews are conducted by one person, an overview of the interviews is shown below in table 2.5.

All interviews were recorded using a sound recorder and were transcribed afterwards. This method has some major advantages. First, it leads to high quality data because the interviewer only has to focus on the interview itself and the data is not affected by how and what is written down. Secondly, they increase insights in the subject of research since both the questions and answers are recorded and therefore can be cited for the analysis. Finally, they increase the quality of the research since the literal conversations can be subject for discussion between researchers. (Boeije, 2005)

<table>
<thead>
<tr>
<th>Project</th>
<th>Number of interviews</th>
<th>Conducted by two persons</th>
<th>Conducted by one person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amsterdamse Buurt, Haarlem</td>
<td>10 (12 residents)</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Bestaande Wijk van Morgen, Kerkrade</td>
<td>9 (13 residents)</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Wel de lusten niet de lasten, Utrecht</td>
<td>3 (5 residents)</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2.5: Overview of the interviews and the interviewers.

### 2.6 Analysis

Between and after interviews the interviews were discussed with a colleague during the coffee break (face-to-face), over the phone (when the interview was conducted by one person) or the day after at the office. This was done to capture and discuss important first findings and information about the context. In this way the data gathering and –analysing activities are partially carried out simultaneously, it is an iterative process. This is an important aspect of qualitative research methods; these interim analysis activities make clear what information needs to be collected in the remaining interviews (Boeije, 2005). In this way gathered data may reveal interesting subjects which can be used to guide the other interviews and data analysis. The derived information in this stage of the research was used to identify themes which were later used for the analysis. These themes were later supplemented during the analysis activities described below.

As said the interviews with residents were recorded and transcribed. First all cases were analyzed separately. The main activity in the single case analysis is the coding process, in this process main categories in the data are distinguished (Boeije, 2005). This process consists of three steps: open encoding, axial coding and selective coding (Boeije, 2005). This means that first the written interviews are read after which important parts are marked and labeled. Secondly, the labeled parts of the interviews are subdivided in themes and first interpretations are made. Finally, the themes were structured, linked,
and interpreted after which the core themes were selected. The themes that were used in the coding process were divided in the three phases: design (differences between houses, goals of residents, preliminary activities), construction (duration, inconvenience and living conditions, damages, compensation, communication, the extent to which residents are able to influence measures, completion of the renovation, aftercare, impact of the renovation on the relationship between the housing corporation and residents) and use (differences between residents, knowledge and understanding about the low-energy house and installations, ventilation system, heating system, feedback, controllability, maintenance, guidance and support, maintenance carried out by the housing corporation, energy savings, other changes in the houses, impacts on health, sound insulation and overall assessment of the results).

After the single case analysis all cases were compared. This comparing analysis can be found in chapter 5. This is done because when similar mismatches are found in the different cases and contexts, it creates the possibility of direct replication. So when analytical conclusions arise independently from different cases, this will lead to more powerful conclusions. Especially when these mismatches are also present in the literature the findings are more likely to be generalizable to other contexts. In contrast, differences between the identified mismatches in the different cases may provide indications for possible solutions or improvements for these mismatches.
3. Theory

Before the research questions could be answered by analysing multiple cases, a literature study was conducted in which the historical context of low-energy houses, user involvement in the design process of these houses, and factors that influence the behaviour of residents in low-energy houses are researched. In this chapter most important findings of the literature study are summarized.

In the original literature study attention is given to other matters such as definitions of energy efficient houses, the innovation program Energiesprong and the BoB research project performed by DuneWorks BV. This can be found in respectively appendix A, B and C. Here the research questions of this literature study will be answered each in a different paragraph, starting with historical trends and developments in the low-energy housing sector. Secondly the way residents are involved in the design process of low-energy houses is discussed. Finally, factors that influence the interactions between residents and low-energy houses are discussed.

3.1 Trends and developments in the low-energy housing sector

In this chapter, trends and developments in the low-energy housing sector will be discussed. This will help to embed this research in the historical context of low-energy houses. In the original literature study first important developments (such as policies, standards and trends) in the low-energy housing sector were discussed. Secondly, an overview of some previous and current projects was given. Here the first two parts are summarized and discussed.

In the literature study many ambitious goals and an increasing number of policies aimed at energy efficiency in the housing sector were discussed (appendix G). The Dutch government aims at lowering energy consumption and increasing the renewable energy generation as stipulated in the 2020 goals of the EU and the energy-agreement of the Netherlands. Since 1995 new buildings have to conform to the Energy Performance Coefficient (EPC), this EPC is used in many policies to form the goals. The EPC is tightened over time so that new buildings will become more energy efficient and in 2020 all new buildings have to be energy neutral (EPC = 0). However behaviour strongly influences the actual energy use, the EPC only assess building-related energy use under standard circumstances and standard user behaviour. According to Opstelten, Weterings & Versteeg (2011) since 2006 the platform for energy transition of the built environment includes the energy use of domestic appliances in calculations about the energy efficiency of houses. In this way they put more emphasis on the behavioural influence on energy consumption of houses. However, in 2007 the policy program ‘Clean and economical: new energy for the climate’ excluded the domestic energy use in their goals. This was done because market parties did not think they could effectively affect the domestic energy use. In 2011 the innovation program Energiesprong started, one of their main priorities was adding user aspects and usability in the design process of low-energy houses. So in many projects and initiatives supported by Energiesprong, the resident became more important. In 2011 the ‘Blok-voor-Blok’ approach started in which also attention is paid to residents and behavioural change. The deal the ‘Stroomversnelling’, signed in 2013, plans were made for renovating 111,000 houses to zero-energy houses. For zero-energy houses also the domestic energy use is included in the calculations of the energy efficiency of the houses. Also the Energy agreement was signed in 2013, this agreement aims at lowering the energy consumption and increasing the proportion of renewable energy generation. The starting point is that energy saving must lead to benefits for citizens and companies, and that they will take responsibility to save energy. The measures
will consist of a combination of the provision of information, awareness creation, unburdening and funding support (SER, 2013). So also in the energy agreement attention is paid to residents.

Despite the fact that since 2006 more attention is paid to residents and domestic energy use, the EPC (which excludes domestic energy use) still remains the dominant factor in energy efficiency ambitions in recent projects. A list of these recent and current projects can be found in appendix H. This list shows that many renovation and new construction projects aim for increasing energy efficiency and lower energy use. The overview of the projects also show that housing corporations are often an important actor in these projects.

It will be interesting to see whether the increased attention for residents in policies will actually lead to projects that build low-energy houses which better match with the residents and therefore have better energy performances.

3.2 User involvement in the design of low energy houses

Designers often do not make sufficient use of the knowledge and information about the end-users (residents). The user representations are usually not sufficient to come to a design which fit with the residents. One important reason for this is that there is no ‘standard user’ of the technologies. Instead there are various types of users/residents with different social backgrounds, perspectives, ideas, wants and needs (Rohracher, 2005).

Using more realistic user representations and/or increasing the involvement of residents in the design process may result in the design of low-energy houses which better match with residents (higher usefulness, higher acceptance), and therefore perform better in terms of energy efficiency. The cause for not using realistic information about residents and their behaviour in the design originates in the existence of two different approaches: the behavioural and the engineering approach (Jelsma, 2005). These approaches are often used for reducing energy consumption in households. They often overemphasises the importance of respectively behavioural aspects and technology characteristics while undervaluing the importance of the other approach. Science and technology studies provide a conceptual framework in which the engineering- and the behavioural approach are linked. This framework (figure 1) can help to find solutions which include more reliable user representations in designs so that good functional low-energy houses can be developed. Below figure 3.1, these concepts are shortly explained.
Figure 3.1: Design and use processes explained by concepts derived from STS studies (Jelsma, 2005, p. 96).

- **Scripts**: Properties based on specific structural features of an artefact that encourage (inscribed features) or force (prescriptive features) certain behaviour while counteracting other behaviours.
- **Design logic**: This covers the ideas, views, beliefs, values, intentions, estimations, etc. that are inscribed into a specific artefact or building during the process of its design. The question is whether or not user representations are adequately included in the design logic.
- **Use logic**: This covers the processes and forms of use of an artefact which are being shaped and driven by the characteristics of the social and cultural context and by all other kinds of stimuli and constraints communicated by scripts which are integral parts of the user environment. In most cases residents will be able to explain their way of using an artefact, even if it is a routine form of usage.
- **De-inscription or domestication**: For using the technology, the resident has to de-code the inscriptions of the artefacts inscribed by the designers. But for residents there are multiple options for embedding an artefact into their behaviour next to the intentions incorporated in the scripts of the designers. User logic and the context of use can lead to forms of use that never were intended by the designers of the technology.
- **Delegation**: Delegation explains the division of labour between human and non-human actors in carrying out tasks. So in other words, to what extent is the resident and to what extent is the technology responsible for carrying out tasks. It can be used to empower or disarm the resident. Designers often tend to minimise resident influence on the performance of technologies because they expect that residents ‘irrational’ behaviour will cause low performances.

Active user involvement can be used to get access to this more realistic and reliable information about residents. Using this information in the design process may help to create scripts of technologies which can support and guide residents’ behaviour and routines more effectively towards more energy efficient behaviour. User representations will be more realistic and useful if they include more information about factors that influence the resident – low-energy houses and resident – builder interactions. In the next paragraph these factors that influence how residents use low-energy houses will be discussed.
3.3 Factors influencing the interactions between the residents and zero/low-energy houses

In this part, important factors are indicated and explained which are important for improving the low-energy houses themselves and the support, guidance and consultation in the preliminary- and handover processes so that they better match with residents. However, due to a lack of sufficient monitoring and evaluation of previous projects, not enough reliable scientific information is available about these factors so that they can be effectively incorporated in new projects.

But still it was possible to indicate factors that influence the behaviour of residents in low-energy houses. These factors are divided in three categories. First the important user characteristics are discussed. Secondly technology and house characteristics are discussed which may be important in the interaction with residents. Thirdly, important characteristics of interactions between residents and builders in the preliminary-, implementation- and handover process are discussed.

3.3.1 User characteristics

Values, attitudes, needs, goals and social norms influence the behaviour of residents, but they may differ for different residents. People may be interested in things like convenience, reliability, status, comfort, price, appearance, the technology itself and environmental effects (Heaslip, 2012) (De Vries, 2012). Residents may consist of individuals who are elderly, man or woman, from ethnic minorities, or individuals that have learning difficulties; these different groups will have different goals and specific needs which need to be considered in designing interventions and support (Swan et al., 2013). All this leads to the fact that different residents will use their low-energy house and the installations in various ways. This is why the use of standards in systems is often not sufficient (Heaslip, 2012).

One important goal of residents is comfort. Often energy savings are only considered acceptable if they do not conflict with any utility derived from consumption, such as comfort (Sütterlin, Brunner, & Siegrist, 2011). Designers often aim for a perfect average comfort level while in reality residents have a great diversity in requirements across time and contexts (Swan et al., 2013). For example, thermal comfort is an important type of comfort and people experience different temperatures as comfortable. Thermal comfort is complex; it is affected by room air temperature, mean radiant temperature, relative air humidity and relative air velocity (Karjalainen, 2013). But thermal comfort is not only determined by physical factors, also personal factors such as clothing, activity level and one’s psychological state influences thermal comfort (Karjalainen, 2013). So thermal comfort can only be achieved when the resident is involved in the control loop, they are the only reliable source of information about the extent in which the thermal environment satisfies the resident. Important aspects for the control of thermal comfort are that it should be easily adjustable and that it will act rapidly (Karjalainen, 2013). Also for other systems that affect indoor environmental comfort it is important that it provides residents with possibilities to control the system (Karjalainen, 2013). The perceived controllability and individual preferences have an effect on whether or not someone finds a certain temperature comfortable (Heaslip, 2012). The importance of controllability will be discussed in more detail below since the level of controllability depends on building characteristics.

The behaviour of residents affect the effectiveness of low-energy houses, one important type of behaviour is called a routine. These routines underlie many everyday life practices which are important determinants of energy consumption in households. Routines are guided by cues, which refer to materialistic
characteristics of human practice. These cues activate mental schemes on a subconscious level which guide the resident in an automated way through a trajectory of actions towards their goal (Jelsma, 2005). For a new technology to become functional, it must be incorporated in the routines of the residents (Behar & Chiu, 2013). But people often take their existing routines to new situations; however, these routines can be broken or shifted to more sustainable ones with the use of good technical designs (Jelsma, 2005). But if it is still possible to use existing routines in combination with their new technologies, it may be very hard for people to effectively incorporate the new technologies in their daily routines (Behar & Chiu, 2013).

Energy consumers require personal capabilities to perform particular energy-saving behaviour. These capabilities consist of things like knowledge, skills, availability of time, and general capabilities and resources such as money, literacy, social status and power. (Sütterlin et al., 2011) One capability that is considered as very important is knowledge about the working of the technologies. Even the most advanced and efficient technologies and installations will not perform optimal if poorly informed residents do not use them in the right way (Swan et al., 2013) (Behar & Chiu, 2013). However, installations in houses are getting more complex while residents are often still expected to operate their houses with limited support or training (Heaslip, 2012). Barriers to individuals about their understanding of knowledge can arise because of multiple reasons like the lack of understanding the available information, lack of available knowledge, lack of understanding the nature of improvements and information about which technologies are installed in their house, conflicting information, conflicts between information and values, lacking ability to find information, confusion about the links between environmental issues and their respective solutions, information overload and whether or not information is perceived as trustworthy (Swan et al., 2013). People do not only need technical knowledge about how the technologies work, often it is more important how residents make sense of a particular technology when they use it for the first time and how they try to control and adapt to it (Behar & Chiu, 2013). Next to knowledge and understanding about the working of the technologies, also knowledge is needed how, by whom and when to perform maintenance for the installations so that their performance will not be reduced (Behar & Chiu, 2013). Another factor that negatively influences the effective use of the systems is that consumers lack experience with new type of housing such as low-energy housing. Unless individuals have the opportunity to interact with these new types of houses it is unlikely that they will develop preferences for- and knowledge about them. This is especially the case for low-energy housing technologies such as thermal wall insulation or heat-recovery ventilation systems which are not visibly present in the houses. People will not know what to ask for because they lack knowledge and they have no experience with the technologies. (Palm, 2013)

Behar & Chiu (2013) have found that some people lack the abilities to effectively use the new installations, however because of the access of support they may still be able to properly use the new situations. People may experience problems with finding information and support (Swan et al., 2013). Support may be provided by the builders but it may also be accessible through someone’s social network. This social network may include people like neighbours, family or friends (Behar & Chiu, 2013). Behar & Chiu (2013) have found that some people may have the abilities to effectively use the new installations because of the help from other people, while other more knowledgeable people who do not have this help may fail.
3.3.2 Building characteristics

Technology and the design of low-energy houses can exert a guiding and translating force on the behaviour of residents (Jelsma, 2005). Here building characteristics that are important in the interactions of low-energy houses and residents are discussed.

Installations in houses can work automatically, with manual operation or with intermediate levels of automation (Karjalainen, 2013). Even though most residents have limited knowledge about a system and only a minority has the capabilities and motivation that is necessary to operate the complex energy systems efficiently, residents still want some level of control (Karjalainen, 2013). People want to be in control over their own indoor environment, they are dissatisfied in a climate system if they cannot control and adjust it to their own preferences (De Vries, 2012). For example, thermostats are considered important even if they were only used rarely; the possibility of adjusting the room temperature is very important for residents (Karjalainen, 2013). Residents also want to have the possibility to control the systems in different rooms separately since they have different preferences for different room such as the bed- and the living room (De Vries, 2012). An important reason for the desirability of control is that residents often do not trust the systems with high levels of automation (Karjalainen, 2013). Karjalainen (2013) has found several system characteristics that may potentially improve the level of trust in domestic automation such as a carefully chosen level of automation, predictability, transparency and feedback, simplicity and usability, and suitability for everyday life. The level of automation is important for the performance of control systems and whether or not residents accept the automation system (Karjalainen, 2013). The study of Karjalainen (2013) shows that different residents have different goals and needs and therefore they want different levels of automation for different systems. Domestic systems should be suitable for these different kinds of residents and their preferences. This can be done by choosing more robust systems that have adaptable automation, which means that residents can choose a point on the spectrum for their interaction with automation. A disadvantage is that these extra options will add more complexity to the system. (Karjalainen, 2013) (Huis vol Energie, 2011) Evaluations of residents living in low carbon houses have shown that they often have a poor understanding of the technologies and control systems, which may be due to the increased complexity of the systems (Heaslip, 2012). This results in a lack of effective control which has negative effects on energy efficiency and resident satisfaction (Heaslip, 2012) (Behar & Chiu, 2013). An advantage of giving the resident some level of control over the system is that the resident may develop a closer relation with the system, which may lead to more interest in energy efficiency and therefore also to more energy savings (Karjalainen, 2013). More perceived controllability leads to more satisfaction and therefore there is a need for usable and intuitive controls with clear user displays and simple ways to control the installations (Heaslip, 2012). In this way the residents will have some control over the system without adding to much complexity. Another advantage of controllability is that if people perceive a greater degree of control they often forgive other negative effects of an installation, such as noises (Behar & Chiu, 2013).

Besides the personal control over the installations, people normally want some level of control in choosing the installations. However, often residents did not have the chance to choose the specific technologies used in the low-energy house. When they buy or rent a low-energy house the installations and systems were already installed, unless they are added in a restoration. This lack of choice separates the resident from the purchase and installation decision which may hinder residents acceptance and satisfaction (Behar & Chiu, 2013). As discussed in paragraph 3.2, designers often see residents as a factor that may negatively influence the performances of the system, while the main reason for choosing
particular systems should be in order to satisfy the needs of the residents (De Vries, 2012). To satisfy the residents it is important that buildings are designed in such a way that there will be a good indoor environment, which is also adjustable to the specific needs of that moment and that the installations require minimum maintenance (De Vries, 2012) (Behar & Chiu, 2013).

As seen in the previous paragraph, the behaviour of residents may influence the efficiency of the installations. However, the new systems can also influence the behaviour of residents. Two different types of energy-saving behaviours are distinguished: energy-saving behaviour based on curtailment and based on the adoption of energy efficient technologies. Energy-saving behaviour based on curtailment refers to actions that have to be done repeatedly and they are associated with a change of habits and routines in everyday life. Energy-saving behaviour based on efficiency improvements require just one single action and therefore does not demand a change of routines in everyday life. The technology will do the same job while using less energy, therefore this type of behaviour does not need a big effort or sacrifices besides the financial investments. Often energy efficiency savings are offset by greater consumptions, this is why efficiency improvement are not always effective for energy savings (Swan et al., 2013). Curtailment behaviour on the other hand requires sacrifices because consumers have to decrease or change their use of existing energy systems to reduce their energy consumption. (Sütterlin, Brunner, & Siegrist, 2011) Technologies which need energy saving measures based on curtailment can force a resident out of their old routine behaviour towards making a conscious decision (Jelsma, 2005). Residents have to get used to new heating systems which often more slowly adjust comparing with old heating systems (Huis vol Energie, 2011). Also the way of controlling and maintaining the ventilation systems will change (Huis vol Energie, 2011). New designs can incorporate scripts (properties of a technology that encourage or force certain resident actions while counteracting others) that facilitates force on the actions of residents, in this way it can break old routines which may lead to new more sustainable routines (Jelsma, 2005).

One way to influence the behaviour of residents is to provide feedback about the working and effectiveness of systems. In this way residents will better understand the working of the technologies (Behar & Chiu, 2013). If no feedback is provided, residents will use visual or aural cues to gain understanding about the technologies (Behar & Chiu, 2013). For example, some residents use the noise of the ventilation system as a cue that it is working properly, while the noise may be due to lack of maintenance or malfunctioning (Behar & Chiu, 2013).

3.3.3 Builder – resident interactions

Traditional selling or renting a house is seen as a complete handover, residents receive very little support before, during and after the renovation or building processes. But for the success of zero energy houses it is important to consider energy efficiency into the long-term by supporting residents before and after moving into the house (Swan et al., 2013). For good support, guidance and consultation in the preliminary- and handover processes the builders (or housing corporation) needs certain resources and capabilities to perform different types of interventions (Swan et al., 2013). But having these resources and capabilities is not enough for a succesfull process, there is also a need for effective management to balance resources and outcomes. Often it is not clear what the costs may be if people not successfully engage while it would require considerable resources if all the possible interventions will be applied (Swan et al., 2013). Here important factors that are important in the interactions between the provider of the houses (which can be a construction company or housing corporation) and the residents are discussed.
There is a need for a good handover procedure and after sale support in order to ensure that people will make sense of the new technologies in their home (Behar & Chiu, 2013)(Swan et al., 2013). For efficient support communication between residents and builders is important because this influences how the technology will be adapted, especially when residents did not make the choice for a particular system (Behar & Chiu, 2013). This communication has to start before the handover process to create initial awareness prior to higher levels of engagement, this may build relationships between residents and builders and it will also introduce the idea of low-energy houses (Swan et al., 2013). Residents often have different goals than the builders of these houses, they often consider costs, comfort and health as more important than longer-term environmental issues; this is important for the message that will be used to sell low-energy houses and to realize successful engagement. (Swan et al., 2013) Another important issue of communication is trust, it is important that people trust the actor which gives them information (Swan et al., 2013). An effective way of informing and supporting residents is with the use of community champions; these champions are trained residents who were designed for communicating with their own community about energy efficiency (Swan et al., 2013). Behar and Chiu (2013) stated that good communication between the suppliers of ventilation systems and residents is critical to facilitate the successful incorporation of the new systems into homes. This communication should prevent mismatches between the way technologies are handled by suppliers and how they are adapted to the preferences of specific resident groups. This is needed to prevent low performances and low rates of resident acceptance and satisfaction (Behar & Chiu, 2013).

An important part of the after sale process is to provide reliable feedback about the energy savings, working and effectiveness of systems which influences the perceived response efficacy which tells whether or not someone believes that their actions can produce a certain outcome (Sütterlin, Brunner, & Siegrist, 2011). Good feedback systems can also be used as a basis for neighbourhood benchmarking which provides a basis for the formation of social norms around energy use.

Next to this feedback, additional support may be helpful, especially when people lack understanding about the technologies (Behar & Chiu, 2013)(Swan et al., 2013). In this way they use the systems by following the instructions without the need for understanding the exact working of the technology (Behar & Chiu, 2013). However, it is more effective to incorporate simple and robust systems in the design so that a high level of support in the form of guidance is not necessary (Huis vol Energie, 2011).

For a good working of the new installations maintenance is needed, which can be performed by the suppliers, housing corporations, residents or landlords (Behar & Chiu, 2013). Behar & Chiu (2013) have found that it is not always clear who is responsible for the maintenance. If it is done by contractors, it is important that they are trained well; they have to treat residents courteously, communicate clearly and they have to leave sites clean after performing maintenance to ensure that early engagement efforts are not lost (Behar & Chiu, 2013). If residents are supposed to perform the maintenance it is important that they know how to do it and how often, evaluations have shown that this information is often not available for residents (Behar & Chiu, 2013). Residents should receive a maintenance manual which contains information such as a design statement, manufacturer’s contact details, information about the location and setting of automatic controls and the location and use of important features of the system, details of important parts of the system, and instructions for cleaning and maintenance for the different parts of the system (Behar & Chiu, 2013).
For the interventions explained above to be effective, more information is needed about the in-use behaviour of residents. Little is known about the specific residents and their goals, and how they behave in different contexts (Heaslip, 2012). Therefore low-energy housing designers often cannot work from a specific evidence base because there is not enough published evidence; instead they do whatever they feel that might work (Swan et al., 2013) (Heaslip, 2012).

### 3.3.4 Conclusion

The indicated factors are important for improving the low-energy houses themselves and the support, guidance and consultation in the preliminary- and handover processes so that they better match with residents. However, due to a lack of sufficient monitoring and evaluation of previous projects, not enough reliable scientific information is available about these factors so that they can be incorporated in new projects.

However existing scientific literature that there is a large variety of residents. The behaviour of residents and the design of the house should not be separated. Many building characteristics influence the behaviour of residents while different people will use technologies differently because they have different goals, needs, attitudes, values, routines and personal capabilities. Because of this variety in residents and the differences between low-energy houses residents will need different forms of support. For a good match between residents and low-energy houses user characteristics, building characteristics and builder-resident interactions have to be considered.

### 3.4 Conclusion

Since 2006 more attention is paid to end-users/residents and domestic energy use instead of only focussing on lowering building-related energy use. However, as the overview of the projects shows, the EPC (which only assess building-related energy use under standard circumstances and standard user behaviour) still remains the most important factor in most projects for formulating energy efficiency ambitions. So in lowering the energy use of buildings the focus remains mainly on building-related energy use while little attention is paid to domestic-energy use, the way how residents use their houses and how this influences the total energy consumption. Similar trends were found in the design process (paragraph 3.2), designers often focus on technology while not making sufficient use of the knowledge and information about users of that technology.

In the third paragraph, important factors that influence how residents use the low-energy houses were discussed. However, there is a lack of sufficient monitoring and evaluation of previous projects, not enough reliable scientific information is available about these factors so that they can be incorporated in new projects. But existing literature already indicated many factors that are important to incorporate in the design and accompaniment processes (during the preliminary, renovation, handover, and in-use phases) so that the mismatches could be improved. Three categories of factors that influence the way residents use their low-energy house are discussed: user characteristics, building characteristics and builder-resident interactions. Several user characteristics that influence the way residents use their low-energy house are found, they consist of expectations of residents about the new technologies, existing routines, personal capabilities, knowledge, whether or not someone has access to support and values, social norms and attitudes of residents. Furthermore, the literature study also indicated several building characteristics that influence how residents use their low-energy house such as the controllability of the new systems and the indoor climate, feedback and designs that may change routines. Also the interactions between residents
and builders (housing corporation or construction company) may influence how residents use their low-energy house. Factors important for these interactions are the handover procedure, communication, feedback, additional support, guidance, maintenance, monitoring and evaluation.

The information derived from the literature study is combined to develop a conceptual framework (figure 3.2). As said the design-, construction- and in-use phase are investigated in this thesis. The design- and the in-use phase are investigated because the literature study (respectively paragraph 3.2 and 3.3) revealed evidence that mismatches often occur in these phases. Jelsma (2005) showed how the design phase may affect the way residents use the low-energy houses (figure 3.1), however this figure is based upon newly build houses since the design(ers)- and use(rs) world are separated. While in deep retrofitting projects the residents already lived in the houses prior to the renovation and therefore they cannot be excluded in the design phase. Furthermore, the construction phase is excluded, while in deep retrofitting projects this phase also seem to be important. In the conceptual framework below (figure 3.2), the construction phase, the process between the design- and the in-use phase in which the design is realized, is included because the empirical data shows indications that mismatches may also occur in this phase which may have impacts on how residents use their houses and therefore also on the overall performances of the low-energy houses. However, this phase has not yet been extensively studied.

Both the literature study and the empirical data indicated multiple factors and core themes that may be of importance in the design-, construction-, and in-use phase. Below an overview of these themes is given (table 4.1). These themes are used in the coding process which was one of the main activities in the analysis, which was already discussed in more detail in the methods section.
<table>
<thead>
<tr>
<th>Design</th>
<th>Construction</th>
<th>In-use</th>
</tr>
</thead>
<tbody>
<tr>
<td>User involvement</td>
<td>Duration</td>
<td>Differences between residents</td>
</tr>
<tr>
<td>Possibility of residents for choosing the systems</td>
<td>Inconvenience and living conditions</td>
<td>Knowledge and understanding</td>
</tr>
<tr>
<td>Differences between houses</td>
<td>Damages</td>
<td>Use of the ventilation system</td>
</tr>
<tr>
<td>Goals of residents</td>
<td>Financial compensation</td>
<td>Use of the heating system</td>
</tr>
<tr>
<td>Preliminary activities</td>
<td>Communication</td>
<td>Usability</td>
</tr>
<tr>
<td>Organization of the project</td>
<td>The extent to which residents are able to influence measures</td>
<td>Feedback</td>
</tr>
<tr>
<td></td>
<td>Completion of the renovation</td>
<td>Controllability</td>
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<td></td>
<td>Aftercare</td>
<td>Maintenance</td>
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<td>Impact of the renovation on the relationship between the housing corporation and residents</td>
<td>Maintenance carried out by the housing corporation</td>
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<td>Guidance and support</td>
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<td>Overall assessment of the results</td>
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Table 4.1: Themes derived from the literature study and the empirical data that were used for in the coding process which was part of the analysis.
4. Case studies

Here the selected cases are described. The case descriptions below are based upon project documents, websites of parties from the consortium and the interviews with the project leaders. No information derived from interviews with residents is used in this section, these interviews are analyzed in chapter 5.

4.1 Amsterdamse Buurt; Haarlem

The Amsterdamse Buurt is a neighbourhood in Haarlem. The renovation project consists of two phases. Phase 1 and 2 have energy reduction ambitions of respectively 60% and 80% and consist of respectively 37 and 71 houses. At the moment of research, only phase 1 was completed and therefore only phase 1 was subject of research. The houses were built in 1908 and are all single-family homes. The houses owned by Elan Wonen are all categorized as social housing, this means that only people with income below average can rent these houses. The residents living in the Amsterdamse Buurt consist mostly of elderly and of people on benefits (Fennema, 2013). The project is led by housing corporation Elan Wonen, van Wijnen is hired as the construction company. Other actors involved in the project are Merosch (consultancy), Schouten Techniek (installer), municipality Haarlem, residents committee, and Seinen Projectontwikkeling BV. (Elan Wonen et al., 2012)

Originally the residents were going to stay in the houses during the renovation. This influenced the design to lower the nuisance for residents during the renovation. For this reason the roofs were insulated instead of replaced. Furthermore, the walls were insulated from the inside and insulation was placed under the ground floor. The windows, dormers and most of the frames were replaced. It is not possible to open windows anymore on the ground floor, instead air vents can be opened which are placed in the frames. Next to this also a ventilation system is installed which extract the air from the kitchen and bathroom. This installation has 3 levels which can be manually controlled on a control panels placed in the kitchen or the bathroom, or in both rooms (residents have to pay extra each month for two control panels). For more efficient heating most efficient combination boilers available were installed. Next to the energy measures it was also possible for residents to refurbish their kitchen and bathroom. In exchange for these extra measures the rent will increase. Residents also got the option to choose the colour of their new front door and the colour of the new tiling in the kitchen and bathroom. (Fennema, 2013) (Elan Wonen et al., 2012)
In the beginning the renovation was seen as major maintenance. However, due to considerable nuisance and harsh living conditions in the houses it was changed to a renovation. Because of this residents were given the possibility to make use of exchange houses during the renovation and they received a higher expense allowance. Residents also got the possibility to store their furniture in containers so that they would not be damaged during the renovation (Fennema, 2013).

To finance this deep retrofitting project the rent for the houses is increased. However, the increased energy efficiency leads to energy savings for residents which should outweigh the rent increase due to the energy measures so that residents overall will financially benefit. The residents were represented in a residents committee. All residents were informed about the plans with newsletters, meetings and home visits. One model house was finished before the renovation started, in this way residents could already see the desired outcome of the renovation. During the handover process residents received a brief explanation about how they should use their low-energy house. This contained information about how to ventilate the house using the ventilation system and new air vents (Fennema, 2013).

4.2 Bestaande Wijk van Morgen; Kerkrade

In the project in Kerkrade, 153 modular houses built in the sixties and seventies with energy label D were deeply retrofitted so that they will become passive houses with energy label A++. These houses consist of four different types: family houses with sloping roofs, family houses with flat roofs, ground floor- and upstairs apartments. Of these houses 148 are owned by housing corporation Heemwonen, the other 5 are privately owned. The houses owned by Heemwonen are all categorized as social housing, this means that only people with income below average can rent these houses. Heemwonen leads the project, BAM is hired as the construction company. Other actors involved in the project are Teeken Beckers Architecten, the municipality Kerkrade, Hogeschool Zuyd and the residents were organized in a council for tenants and in working groups. (Energiesprong, 2013) (Heemwonen, 2013) A lot of the residents living in this neighbourhood consist of elderly and unemployed people. According to the project leader 30% is poorly literate, they have troubles with reading and writing. Many residents are dealing with social problems (Vincken, Costongs, & Bovendorp, 2013).

To improve the energy efficiency of the houses, many energy measures were carried out. The starting point for the design was that it should be possible to carry out the renovation in ten working days. Most important measures were the added insulation for the ground floor and the replacement of the facades and the roof with new prefabricated insulated facades and a roof. This totally changed the view of the houses, as can be seen in images 2 and 3. PV panels and solar water heaters are integrated in the prefabricated roof to provide the house with electricity and warm water. The deep retrofitted houses are passive, to provide the residents with sufficient fresh air a heat recovery ventilation system is placed. This ventilation system can be controlled with displays located in the kitchen and the bathroom. It has three different levels: 1 for normal circumstances, 2 for extra ventilation and 3 for maximum ventilation (cooking, taking a shower). It also has a fourth button which sets a timer after which the ventilation system will automatically be turned back to level 1. For a proper working of the ventilation system residents have to clean the filters and air vents regularly. Next to this also a warm water collection vessel to store the warm water from the solar boiler, a new combination boiler, and a device for the PV panels are placed. Next to these large measures the houses also received new radiators, a smart meter and an outdoor mailbox. For an adequate air supply all internal doors were shortened or equipped with a vent (Vincken et al., 2013) (Heemwonen, 2013) (Energiesprong, 2013).
Because of the modular nature of the houses, a systematic approach could be used. This approach made the renovation more cost efficient and less time consuming. It was possible to renovate a house in 10 working days to minimize nuisance for the residents, who continued to live in their houses during the renovation. The construction process is described as a ‘rolling factory’ in which the houses were being renovated sequentially. A disadvantage of this construction method is that when something goes wrong leading to delay, this will also affect the timing and duration of the renovation for the following houses.

In total the renovation of a single house costs 100,000 Euros (Vincken et al., 2013). To finance this deep retrofitting project the rent for the houses is increased. However, the increased energy efficiency leads to energy savings for residents which should outweigh the rent increase so that residents overall will financially benefit. Residents were informed about the renovation plans with meetings, newsletters and home visits. Of each type of house a model house was finished before the renovation started, in this way residents could already see the desired outcome of the renovation. All residents received an information map with detailed information of the renovation process, about the new installations and how to use the low-energy house together with tips about how residents can easily save more energy. Next to this map also a dvd was provided which contained short videos with instructions. During the handover process the residents also received face-to-face guidance about how to use the new installations (Heemwonen, 2013) (Vincken et al., 2013).

4.3 Wel de lusten, niet de lasten; Utrecht

The project in Utrecht differs much from the cases in Haarlem and Kerkrade described above. In this project 18 houses owned by private house owners are renovated together with 12 houses of housing corporation Lopik. These houses of the housing corporation are included to meet the requirement of the subsidy to renovate 30 houses. The aimed energy reduction is 80% for all houses. Only three private house owners are interviewed in this research because at the moment of the research other houses were not yet renovated. Other parties involved in the project next to the housing corporation and the private house owners are Grontmij (project leader), Energy-U, Natuur en Milieufederatie Utrecht, Seinen Energy Solutions and AE finance solutions (Klaassen, Seinen, & van Erp, 2012).

The private houses are spread in and surround Utrecht. All houses are different and therefore it was not possible to use standard energy measures in the renovation. For each house other energy measurements
and installations were used to match with the specific situation. For many houses the renovation was not only for realizing the energy reduction, also (overdue) maintenance was part of the renovation (Lukkes, 2013). All participating households receive 4,000 euro subsidy, they have to pay the remaining costs themselves.
5. Analysis

The aim of the analysis is to find and explain mismatches that occur between ‘builders’ and residents, and between low-energy houses and residents. The analysis is mainly focused on the interviews with residents but also information derived from the interviews with project leaders are included. Findings in the analysis are supported by quotes from the interviews with residents, these quotes are translated to English. The original quotes (in Dutch) extracted from the transcribed interviews can be found in appendix I, in this chapter the translated quotes are shown so that also non-Dutch speaking people will be able to read this thesis. Quotes used in the analysis are anonymized and linked to residents and project leaders with respectively numbers and letters (table 5.1).

<table>
<thead>
<tr>
<th>Interviewee</th>
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<tr>
<td>Residents Haarlem</td>
<td>(1 – 10)</td>
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<tr>
<td>Residents Kerkrade</td>
<td>(11 – 20)</td>
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<tr>
<td>Residents Utrecht</td>
<td>(21 – 23)</td>
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<tr>
<td>Project leaders of Haarlem, Kerkrade and Utrecht</td>
<td>Respectively (H), (K) and (U)</td>
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<tr>
<td>Quote number</td>
<td>[1], [2], etc.</td>
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Table 5.1: Codes used to link empirical data (quotes) with interviewees (anonymized) and the original quotes in Dutch.

Distinction is made between the design-, construction- and use-phase. If possible theory from the literature study is used to underpin or explain findings, in this way it may be possible so that these findings will be better generalizable. In this chapter relevant findings of- and differences and similarities between the studied cases are discussed.

First identified mismatches in the design phase will be discussed. Secondly, mismatches occurring in the construction phase will be discussed. Finally, mismatches in the in-use phase are discussed.

5.1 The design phase

Here all findings concerning the design phase are discussed. The focus is mainly on how residents were involved in the design and how this could have resulted in mismatches. Also other relevant issues during this phase are discussed which may not be directly linked with the user involvement in the design phase.

Involvement of residents in the design process

As discussed in the literature study, high user involvement or the use of more realistic user representations in the design process may result in low-energy houses which better match with the end users (higher usefulness, higher end-user acceptance) (Jelsma, 2005). Therefore these low-energy houses may perform better in terms of energy efficiency. Furthermore, if users are not involved in the design process they have a lack of choice that separates the user from the purchase and installation decision, which may hinder satisfaction and users acceptance of the new technologies too (Behar & Chiu, 2013).

In both Kerkrade and Haarlem the residents were represented by a residents committee in the whole process. However, this committee was not actively involved in the design process. In both projects most of the design was already developed before residents were involved (H, K). All energy measurements were non-optional. Because 70% of the residents agreed with the renovation plans in both Kerkrade and Haarlem all residents had to take part in the renovation. So residents were separated from the purchase
and installation decision which may lower satisfaction and users acceptance of the new technologies. In Kerkrade the residents only got a few options from which they could choose, concerning the colour of the front door, whether or not they wanted new fences and whether or not they wanted a new gateway. As explained in the previous chapter; in Haarlem residents had more options, they could choose a new front door and they could also choose some indoor house improvements like a new kitchen or bathroom in combination with additional rent increases. However, several respondents in both Kerkrade and Haarlem felt that they were compelled to agree with the renovation plans so that the requirement of 70% could be achieved: “We had no choice, we were forced. If we did not agree with the renovation then all four houses would not be renovated (...) so we had to agree, because I did not want to quarrel with the neighbours. Because then we would be the reason why the renovation would not be realized.” (18A) [1]. Furthermore, (elder) residents felt they had no power during the design process. This respondent in Haarlem referred to some elder residents living in their neighbourhood who did not want their houses to be renovated: “There were some older people who did not want anything at all, but they had to cooperate anyway. That is actually sad, those people thought they finally had some rest at home. And then, all of a sudden, they had to clear out their entire house.” (10) [2].

In contrast, in the Utrecht project residents (private house owners) were actively involved in the design process. They opted to renovate their houses and they paid for the renovation themselves. Respondents stated they got a say in the design and which installations were chosen, as is reflected in the following quote about a new floor heating system: “That is a brand new system, they proposed it to us, I thought: well, let’s do it. It was a bit more expensive, am few hundred Euros more, but it has its advantages and it is energetic too.” (20) [3]. However, one respondent argues that it is difficult for construction companies to cooperate with residents: “With the existing houses that will be renovated, you have to work in a completely different way. They have to communicate with a customer who does not know anything about it, business-to-consumer, and now they are realizing that the customer, who already lives in the house, has questions too.” (20) [4].

**One size does not fit all**

In both Kerkrade and Haarlem several respondents stated that the differences between the houses were not always sufficiently taken into account in the design. There seem to be conflicting priorities between residents and the housing corporation, the residents respectively want the best possible houses while the housing corporation wants to do it as cheap as possible, so that many houses can be renovated in a cost efficient way. The approach in this project led to standard measurements which did not fit all houses, because over the years most houses had been customized by the residents. More customized designs could possibly lead to increased energy efficiency and satisfaction among residents. This is clearly reflected in the following quote: “I warned Van Wijnen at that moment. I said: ‘boy, all those houses are different. Everybody customized their own house during the last 80, 90 or 100 years’. Even the houses across the street are different than these houses.” (10) [5]. Several respondents believe the housing corporation used these standard solutions to make the renovation as cheap as possible. They think this negatively influenced the proceedings and results (2, 3, 8): “Look, they wanted to make these houses environmental friendly, as they say so. Well, then they should do it in the right way, without trying to save money on every little thing.” (2) [6].
Residents want to be taken seriously when it comes down to their homes

For residents it is important that they are taken seriously when it comes down to the state of their houses. Many residents have been living in their houses for a long period of time and therefore feel like they know a lot about their own house and often feel like experts on the situation. Residents may provide valuable information about defects in their houses but the builders do not make sufficient use of this information most of the time. For example, one respondent (retired construction worker) stressed that a lot of trouble could have been prevented if only the housing corporation and the construction company had listened to him. He told them the ground floor needed to be replaced, however the construction workers only noticed the poor condition of the ground floor when the residents were about to return to their house: “He: that was not possible because they still had to install the floor. She: yes, and we already told them, 8 weeks before the renovation started. (...) He: that the floor was in a bad shape. I have 40-50 years of experience in construction, I know exactly what is right and what is wrong... And when I told them, they did not listen at all. (...) Well, in the end they removed the floor, they found out for themselves. Normally you would expect, when I tell them the floor is in a bad shape, they would start with the floor.” (2) [7]. A similar thing also happened to another respondent who told the housing corporation that her roof was leaking for a long time, but this problem was not solved during the renovation: “Eventually, after a few years, the problem was solved, but this would not have been necessary if they just repaired right at the start, if they just had listened.” (8) [8].

Goals of residents

As already pointed out in the literature study, users may have different goals than energy saving (Heaslip, 2012) (De Vries, 2012). Most respondents in Haarlem and Kerkrade did not show much interest in energy saving. They often attach more value to the comfort and indoor improvements (new kitchen, new bathroom, etc.) which involves renewals and beautification. Damages occurring during the renovation often caused deterioration of the perceived indoor quality. Several respondents see the improvements inside and outside the house and the increased comfort as the most important advantages. Focusing more on these alternative goals in the design and also in the communication towards residents may help to increase user acceptance and satisfaction. One respondent said the following about it: “And now, besides the improved luxury, the rent increased with 36 or 38 euro because of the insulation. I will still be satisfied, even when the energy use and the energy bill will not decrease... I am living more comfortable now, I am already noticing. Before the renovation I had a couch over here and during the winter... well you just felt the cold in your neck. Single glazing... the cold just went through.” (3) [9].

The project leaders in both Kerkrade and Haarlem were aware of the fact that residents often attach more value to non-energy measures, but they still mainly focused on energy savings in the communication towards residents prior to the renovation (H, K). However in Haarlem extra options were available (in combination with a rent increase) such as a new kitchen, an enlarged bathroom, etc. These options made it possible for residents to choose what they think is important, besides the energy savings. In contrast, in Kerkrade all measures were mandatory and mainly focused on energy improvements while the indoor quality often deteriorated because of damages inside the houses. This is reflected in this quote: “Well, I do think it is a disadvantage that they did not do anything on the inside. If you spend over a 100.000 Euros on each residence, I wonder why you cannot spend another 5 grand to put in new doors in every house. Or new bathrooms.. most people still have the same bathroom they had 40 years ago. But then they say, if the tiles are in place, then everything is fine. I just think they should work on the inside as well.” (12) [10]. Another respondent (11) even stated the whole renovation project is a fiasco because of
the damages inside his house during the renovation: “It is a fiasco, that whole project is a disaster. It is just superficial, if you drive by you probably think: ‘wow, those houses turned out really nice’. Yes they turned out nice, but only on the outside. On the inside nothing has changed.. They destroyed everything inside the houses, everything people have ever worked for.” (11) [11]. However, several respondents do appreciate the improved facades of the houses, they do think that, since the renovation, the houses look better on the outside: “If you enter our neighbourhood, you see it looks really good.” (15) [12].

In Utrecht the private house owners have different goals than the residents in Haarlem and Kerkrade, they are mainly motivated by environmental values and comfort considerations, the financial considerations are considered less important. The private house owners can be seen as early adopters who are mainly driven by environmental values and ideals: “We participated in a special route for sustainable houses (Duurzame Huizenroute), when we got a call from the municipal council. They thought our house was a perfect example of how you should sustainable renovate an old house (1896) and our aldermen came over. I was really excited. Even though most of the houses in Utrecht signed up to participate in the route, our house was chosen to be the starting point of the route.” (20) [13]. A different respondent stated the following about their motivation to deeply retrofit their house: “I just think you should do everything in your power to support the environment.” (22) [14]. Two respondents stated that they agreed to install experimental energy measurements (a new floor heating system and a heat pump) so that these installations could be tested in an renovated house. The respondents who agreed with the installing of a heat pump in their house said the following about it: “Her: our house was used as a model house for the heat pump. Him: yes, we chose to do it because we like it. (…) The installer really wanted to install a unit in an existing house... make a hole in the roof and it is done (laughs), it proved to be the first instalment in the Netherlands. He installed it for a lower price because he really wanted to do it and he is convinced it will work, he just wanted to test it in an existing house. And that’s how it works. We had a connection, we both consider sustainability as important, even though we may have a different approach, you still go ahead and do it.” (21) [15]. In addition, respondents also consider comfort as an important goal, so the design should not only serve to save energy: “It is just magnificent. Now I can walk on the floor with my bare feet.” (20) [16]. Another respondent stated the following about the expected payback period: “No we are at the point where we can recalculate all the costs and the payback period is just a few years... well, I do not consider that as very important. It almost has an idealistic motivation... and you need to have that because it will not directly lead to profits, I am aware of that.” (22) [17].

Residents also consider the situation before the renovation in their overall assessment
Residents do not only care about the outcome of the renovation, they also consider the situation before the renovation took place as important. According to several respondents in both Haarlem and Kerkrade the houses were in a very bad shape prior to the renovation. Many respondents see the major improvements in indoor comfort but they also think this should have been done a long time ago. Several respondents see the renovation as overdue maintenance. This is a quote of a respondent from Kerkrade who stated the houses desperately needed a renovation: “They did not maintain these houses anymore, overdue maintenance... (…) I told the housing corporation I did not need my keys anymore, I could easily enter the house, the door was rotting. I have been living here for 36 years, they never put effort into maintaining these houses besides new radiators and a little bit of painting. And that is it. (…) That window. Everything made of wood was rotting. The renovation was desperately needed.” (16) [18]. Also in Haarlem some respondents see the renovation as overdue maintenance: “When it is considered as overdue
maintenance they would not receive subsidy, because then it is their own fault. But they waited, twisted and bended until it would be seen as a renovation... so that they could receive a subsidy.” (2) [19].

The organization of the project and the communication towards residents

In Utrecht all respondents stated the organization of the project was lacking, it is not even clear whether the project will be carried out or not: “You don’t create good expectations among the residents like that. The residents are definitely up for the project and they understand that everybody has a different situation. (...) The residents really want to cooperate and put effort in sustainability. And when the organization does not react at all at that point... I do not think that is clever.” (21) [20]. The same respondent also said the following about the organization: “The first meeting was pretty clear and they came up with many declarations of intent. But at the second meeting there were many questions... we have to save 80% with 30 persons within the next three years, logically people began to wonder and asked questions like: what is going to happen when 2 participants will not make the 80%? What will happen with the subsidy? Are we responsible as a group? The organization just did not think about that kind of stuff at all!” (21) [21]. The respondents felt that they should be informed about the progress and possible disturbances in the project: “In four months we will be a year further, and still nothing has happened and we did not hear a thing. I find that really weak, even if there are many things that do not go as planned or fail unexpectedly, you still have to inform such a big group because they signed up for it with good intentions.” (21) [22].

The potential advantages for participating private house owners

In Utrecht, according to the respondents and the project leader, possible advantages of the projects are sharing knowledge, joint purchasing benefits and subsidy (U). However, because of disturbances in the organization these benefits seem absent: “Normally you would have the advantages of sharing all the knowledge, the joint purchases and the added value of all the individuals.. that is completely lacking right now.” (21) [23]. However, all respondents stressed that the most important advantage of the project is that a lot of knowledge, knowhow and expertise is available, which is necessary for such an integrated approach: “That requires professionals. To get professionals you need money and a coherent approach when it comes down to insulation, technical installations, power generation and behaviour too. You do not just get a contractor who lives around the corner and who knows some plumbers or electricians from the past. You have to do it together in an coherent approach, it is important that you get this kind of expertise and knowhow.” (20) [24]. The same respondent also stated that he started early with the renovation to make sure the expertise was still available: “The subsidy is nice... 4000 Euros... but it is more like... it is really nice if you receive it, but if you do not receive it will not kill you either. So I just thought, lets start as soon as possible, because I want to use the professionalism before the project may be cancelled.” (20) [25]. But some respondents feel that they could have benefitted more from the project if everything worked out just as planned: “We just said, well, lets do a little bit more than we actually had planned because we viewed it as an advantage to join this project... even though the project probably will not proceed we are happy with the knowledge and Seinen’s contacts we took advantage of... and actually... we do not have any expectations of the project anymore, that is actually sad because it could have been so much better.” (21) [26]. Besides personal benefits, one respondent also showed interested in advantages for future projects: “But we would definitely like to see the project paying off for... we are not idealists... but we would like to see the project paying off anyway, so that it could be replicated for other projects and similar things...” (21) [27].

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5.2 The construction phase

Here all findings concerning the construction phase are discussed. This phase has not been extensively studied yet, therefore the research will have a more explorative nature in this phase.

Delay and the duration of the renovation

In both Kerkrade and Haarlem the proceedings were delayed for many houses, this caused extra inconvenience for the residents. In Haarlem the proceedings in a house were supposed to take three or four weeks, but in some cases it took about two months to get everything finished: “It almost took two months. They said it was going to take about three weeks, but everything got delayed.” (5) [28].

In Kerkrade the proceedings should take about ten working days, however in some houses it took much longer: “Ten working days, that is what they told me, but they were here for two months, because a wooden lath did not come in yet, the carpenter and painter both could not make it and even asbestos... It took two whole months before most of it was finished. (...) However it is still not fully finished, my front door still has to be painted...” (18) [29].

Furthermore, in both Kerkrade and Haarlem it took a long time before all problems were solved after the renovation. During this time residents continued to experience inconvenience: “We went to the meeting where they said that the inconvenience caused by the renovation would take approximately eight to ten working days. But it was going to take a lot longer anyway, it took them 3 weeks and after that, many other things still had to be built and had to be constructed, so it took them a couple of months after all.” (16) [30].

Several respondents also see the preparations and aftercare as part of the renovation, which in total took much longer than ten working days. Several respondents in Kerkrade explicitly stated that residents and the housing corporation had conflicting views about which activities could be seen as part of the renovation. Residents believe the renovation is completed when everything in and around their house is finished and when they do not experience inconvenience anymore: “When they actually start demolishing and that kind of stuff, that is what they call ‘the start’. But prior to what they call starting, they carry out many preparations like digging out the facade, putting up scaffoldings and all that kind of stuff. And that is inconvenience as well! So if you tell me the renovation will take eight working days, I assume it will take eight working days from the moment they start digging to the end of the renovation.” (12) [31].

Inconvenience and harsh living conditions during the renovation

In both Kerkrade and Haarlem residents experienced much inconvenience during the renovation. The timing (and weather conditions), duration (and delay), specific situations of residents (health, mobility) and the type and state of the house (Kerkrade: single family house vs. apartment) influenced the levels of experienced inconvenience. Respondents whose house was renovated in the winter experienced harsh living conditions because their house was ‘open’ and they had no working heating system. A respondent in Haarlem said they had to flee to houses of relatives because of the inhabitable situation: “They told us we were going to be able to live in our house, but that was not possible at all (...) we had to flee. It was cold as ice over here, with no heating, shower, toilet or anything.” (4) [32]. However, in reaction to these harsh living conditions all residents got the possibility to stay in a temporary alternative home during the renovation, this will be discussed in more detail below. One respondent in Kerkrade compared the living conditions in their house with the TV show Utopia in which participants have to live under harsh


circumstances: “It feels as if we are going to Utopia. (...) I have lived without heating and hot water for two weeks. We had to put a kettle on the fire, like we were living in 1815.” (18A) [33].

Delay may too cause an increasing amount of inconvenience because of the fact that residents have to live longer with a lot of mess. For example, in some houses the preparations were done long before the actual work started, causing a lot of inconvenience: heaters were removed, dust screens and scaffolding placed and the warm water supply was cut off. “I stood outside in the cold for three weeks while nothing was happening inside my house. You just stand here, you can't wash yourself, the only thing you got was a heating stove... (...) I even had to put my dog somewhere else...” (16) [34]. In addition, it appeared that due to the delays, the construction workers were trying to catch up with the planning which resulted in things being forgotten or done very hastily and chaotic which caused even more inconvenience. One respondent said the following about this: “A supervisor from Van Wijnen already quitted, he could not deal with it anymore. A new supervisor came and they send us from pillar to post. (...) I think that is really bad. You may know that. (...) It was really chaotic. (...) They did not work at one house at a time but they went from one house to another. They started working across the street while our house was not even finished... it was just badly organized. (...) Even the construction workers were tired of it.” (7) [35].

Furthermore in Kerkrade many construction workers were simultaneously working in the houses, causing confusion and distrust among residents. In addition, many construction workers worked alternately in the houses. Residents do want to know who is working in their house so decreasing the number of construction workers working in a single house during the renovation and the provision of nametags with the name of the firm, can contribute to solve this problem: “They did not even have nametags. Only when a resident complained about it, who are you and who are you, the construction workers got nametags. There were so many people walking in and out all the time. Some older people just sat in their house and be like, uh who are you sir? They just could not keep up with so many different construction workers.” (18A) [36].

Several respondents feel that it is important that during the renovation alternative facilities are provided so that they can take a shower, wash their clothes, etc. The absence of these facilities, which were supposed to be made available by the housing corporation, caused much dissatisfaction among these respondents. In both Kerkrade and Haarlem residents could not take a shower in their own house during the renovation, they could take a shower in the model house instead. However, in Kerkrade it appeared that the model home was hardly ever available or opened, making it almost impossible to take a shower at all: “You have to live in a mess without heating, hot water and showering. That was one of the worst things if you ask me. We got a letter that they arranged a model house where you could take a shower. I do not have a husband or children, so I went to the model house... I went to the executor with my clothes and towels, I said: ‘Executor, I am going to take a shower’. He did not know what I was talking about. So I called the housing corporation, they said: 'Take a shower? No, you cannot take a shower.’ Then I had to go to unfamiliar people to take a shower, that bothered me a lot... ” (16) [37].

**Temporary alternative homes and financial compensation**

In both Kerkrade and Haarlem several respondents stated the need for temporary alternative homes during the renovation because of the harsh living conditions (11, 14, 18). In Kerkrade no temporary alternative homes were available for residents. In Haarlem there were also no alternative houses available at first. Originally, the renovation in Haarlem was labelled “major maintenance”, not renovation, and therefore
residents received a compensation between 500 and 1100 euro to compensate for the inconvenience and possible damages in their houses. In Haarlem, the difficulties experienced with the first homes that were renovated led to much resistance among residents. Several residents undertook action against the housing corporation in order to receive a higher financial compensation and to get the option of an alternative residence during renovation. Eventually the project was labelled as a renovation and the residents received a financial compensation of 5630 euro, they were offered alternative housing and they could rent a container to store their belongings so that they would not be damaged during the renovation. Many respondents were pleased about the fact that the housing corporation had been willing to make these changes to improve the conditions and compensation to satisfy the residents. This shows that if the housing corporation is flexible when unforeseen problems occur, often residents seem to forgive ‘faults’ when they see that the housing corporation is willing to solve them. One respondent stated the following about this: “Yes we pointed it out many times and I think it actually worked, in the end we got 5400 or 5500 Euros or something, instead of 800 or 1100 Euros. (...) So then they finally realised. But many people had to undertake actions for it though.” (4) [38]. One respondent told that she sent a letter to the housing corporation, signed by twenty other residents, in which she demanded (threatening to take legal steps) that the label ‘renovation’ should apply instead of ‘major maintenance’ and that a higher compensation should be provided together with the option to stay in an alternative home during the renovation. A different respondent, who was a member of the residents committee, discussed the same things directly with the project leaders: “We would get a financial compensation of 550 Euros, the housing corporation then raised it to 1100 Euros and we would get a container to store our stuff. I did not agree with that. (...) The ‘major maintenance’ would take up to 20 days. Well, that did not happen. It was just not liveable anymore. So I demanded that they would turn it into a ‘renovation’, so we got 5630 Euros instead of 1100 Euros, partly because of me. Many people thanked me for it.” (3) [39].

In Kerkrade residents received financial compensation for damages in their houses and the inconvenience during the renovation. However, many respondents stated this was not sufficient to cover all the costs resulting from damages and for replacing things like curtains, which was necessary because the dimensions of the windows changed. The height of the financial compensation did not dependent on the delay or damages occurred in a house, which led to much dissatisfaction among multiple respondents in Kerkrade: “We got a financial compensation of 360 Euros and even if they would add 2000 Euros, it still would not be sufficient. If you see what they break down... (...) garden furniture, the pavement and the grass, they destroy everything and you have to replace all of it. You get 50 Euros in total for it.” (11) [40]. Several respondents also complained about the fact that when things in their houses got damaged, they were told the original financial compensation would be able to cover all costs caused by the renovation. In this way the financial compensation was used as an excuse to not give extra compensation for damages or inconvenience: “No. I was not able to use anything after the renovation, I had to replace everything. Because of the asbestos, they threw away everything from the bathroom, lights, switches, you name it. (...) I told the housing corporation about it and they just told me that I had to use the compensation... they broke two of my vases, and even then they say, ‘oh well, you get compensation so...’.” (16) [41]

Special needs of residents during the renovation

As explained in the literature study, residents differ from each other in terms of needs, goals, specific circumstances and values (Swan et al., 2013). These specific needs and circumstances (mobility, health issues) for residents were not always taken into account sufficiently by the housing corporation and the
construction company, which often led to extra inconvenience for this vulnerable group of people. For example, in Kerkrade two respondents were not able to leave their houses with their mobility scooter because unfinished work (17) or building materials (14) were blocking the pathway: “And even with my mobility scooter... usually I drive around the back to go outside, but they did not even take people with mobility scooters into account, so they just put all the materials on the pavement. (...) And the contractor, he knew that I have a mobility scooter and he said that they would leave my pavement empty. (...) But in the end the contractor clearly did not pass that message on to the construction workers.” (14) [42].

However, the interviews with both the project leader and some respondents pointed out that some residents moved to another house so that they did not have to live in a house which was being renovated. This was mainly done by residents dealing with health problems. In Haarlem residents who were dealing with health issues could live in a temporary, alternative home during the renovation too. However, these alternative homes did not always match the specific needs of the residents. For example, an older couple, of which the man has major health issues, stayed in an alternative home from the beginning of the renovation. However, this house had no stair lift which was needed because the man was not able to go upstairs using the stairs, therefore he had to live and sleep downstairs during the renovation: “Yes and then they get him a house in which he cannot even go upstairs. I had to wash him in the kitchen for eight weeks. That is ridiculous right? His bed stood in the middle of our living room because he was not able to go up the stairs.” (2) [43].

The way the housing corporation and construction company dealt with damages done during the renovation

In Haarlem residents could rent a container to store their furniture and belongings so that they would not be damaged during the renovation. But the house itself still got damaged during the renovation process. For example, in two houses the construction workers sawed a hole in the laminate floor without first discussing this with the residents. Especially the fact that it was not communicated in advance led to dissatisfaction (2, 9): “I was going to keep my laminate but one day I came back home to see how the renovation was going and I saw that they had sawed a hole in our laminate floor. I just think it is perfectly normal to discuss such things with the residents. Of course, if the ground beneath is rotten, they have to solve it, that is fine, but just discuss it with the residents.. that just did not happen at all.” (9) [44].

Residents want to be informed when damages occur or when radical procedures are going to be carried out inside their houses. Several respondents believe this was not done sufficiently which led to dissatisfaction. This indicates that informing residents may increase understanding about interventions and damages which may lead to higher satisfaction. One respondent stated that residents should be notified in advance when radical interventions were going to be performed inside their houses: “I think they should let the residents know what they are doing. In my opinion they have to inform the residents, even if they are going to put a nail in the wall. If they just would say: ‘We want to do this and that, is that okay with you?’” (10) [45].

In Kerkrade several residents stated some furniture got damaged during the renovation. As said earlier, residents often attach more value to the comfort and indoor improvements (new kitchen, new bathroom, etc.) than they value energy improvements. In Kerkrade, houses were not improved on the inside, quite the contrary: the damages inside resulting from the renovation caused a deterioration of the perceived indoor quality and dissatisfaction among some respondents. Damages in the house and the fixings
between existing walls and the new facades were hidden underneath wooden strips, which was not appreciated by all respondents (11, 18): “Every piece of wall they removed, they covered up with a wooden strip. (...) those people only have wooden strips, that is the only thing they got. First they destroy everything, (...) there was a big hole in this wall and they did not even repair it. I just got a wooden strip for it. They put wooden strips everywhere.” (18A) [46].

In Utrecht, one respondent stated that the construction company paid for repairing the faults that occurred during the renovation. For example some construction workers wrongly installed the new floor heating system: “So they made some mistakes and everything had to be removed, the whole thing had to come out again... that cost the contractor a few thousands extra. But he was like, well, lets get everything out, at our expense.” (20) [47]. The construction company also paid the extra rent for the temporally, alternative home caused by the delay of the renovation: “We had a delay of 14 days. We wanted to be in our house just before the summer holidays, but that was not possible (laughs)... the delay was caused by the fact that they were using new technologies. I think they learned a lot from it. And how they dealt with the delay: ‘no problem, it was definitely our fault, we will pay for it’.” (20) [48].

**Communication towards residents during the renovation**

In both Haarlem and Kerkrade many residents are dissatisfied with how the housing corporation and construction company deal with their questions and complaints. It appears that there is ample room for improving communication between on the one hand the housing corporation and the construction company and on the other hand the residents. Good communication is important especially when residents stay in their houses during the renovation, when they have questions or complaints, when the proceedings are delayed and when damages occur. When residents stay in the houses they can be seen as active spectators assessing all proceedings in and around their houses, they are aware of faults during the proceedings and things that went wrong between construction workers and the housing corporation. Respondents believe it is important that they are informed about these disturbances or faults during the renovation.

The projects in both Haarlem and Kerkrade show that problems occurring during the renovation often lead to dissatisfaction among residents. This dissatisfaction may be reduced by taking residents’ complaints and concerns seriously. In Kerkrade several respondents explicitly stated that they missed an easily accessible contact person to turn to and who actually represents and defends the interests of the residents during the renovation: “You need a committee, one or two or three persons, who defends the interests of the residents. (...) We did not have a partner, in this type of projects you need someone, someone that will help you and evaluates the proceedings in the houses.” (11) [49].

In both Kerkrade and Haarlem several respondents stated it was necessary to undertake further actions because they felt that the housing corporation and construction company did not take their concerns and complaints about damages, inconveniences and harsh living conditions seriously. Their actions included (threatening with) pressing charges, hiring a lawyer, informing the media, helping vulnerable neighbours, discussing the proceedings and measurements with the housing corporation and construction workers, and sending or 'throwing' the construction workers out of their houses. According to this dissatisfied respondent many residents are pressing charges: “95% of the people that live here, one after the other, are going to court, one by one. The people are being screwed with, are being fooled with and no one listens to their complaints. We received a financial compensation of 360 euro, if they would add 2000
euro, it would still not be enough. If you see all the things they damaged…” (11) [50]. Another respondent stated that they hired a lawyer so the housing corporation would keep their promises regarding a new canopy: “Him: The lawyer wrote one letter, one single letter, and two days later they called back. Her: ‘Sure we will make a new canopy the way you want it’. Why was it not possible the first time, why is it necessary to do it like this?” (18A) [51].

In Kerkrade and Haarlem several respondents stated that they demanded the construction workers to stop working and/or leave their house, because they were not satisfied with the proceedings (8, 10, 16, 18B): “No, we sent them away, we sent them away. (…) It was worthless, but earlier we already had a fight. I kicked everyone out of my house. I was just so sick of it.” (18B) [52]. Respondents also stated that the housing corporation and the construction company were not acting as one party when problems came up: “And the contractor, van Wijnen, of course they say: ‘the housing corporation does not allow that’, and in this way they blame each other…” (2) [53].

In Utrecht, the communication was lacking during the renovation in some cases. Clear communication between construction workers and residents showed to be very important in such an integrated approach: “Maybe they should have made a list for every individual space, based upon the action plan, about everything that has to be done… this was clearly lacking. He had the whole plan inside his head. We had an assignment, and a budget… however we should have been more clear about it, so that we, as the executing party, would have had an overview of all things that had to be done.” (20) [54]. Different energy measures influence each other’s effectiveness and therefore construction workers have to know what needs to be done. This respondent also argued that the communication between construction workers should be improved: “The team of construction workers should document everything with each other. So that the executor will be better able to… it is a construction professional with experience as an carpenter… A skilled man… but he could have known better how E (electricity) and W (heat) work, and how they affect each other. We deliberated a lot, he told me how he thought it should be done and he definitely knew what had to be done. However the other construction workers who were working in the house were not aware of these plans. For example, the plan was to install a heat recovery system for the water used by the shower… however, they already finished the ceiling in the kitchen. Nice plaster, new lights… I was not willing to remove it again, one week before everything had to be anhydrous and dust-free because of the new floor which was going to be constructed. These things happen, also little other things.” (20) [55].

Power of residents and their ability to influence the proceedings and measurements during the renovation

As stated before, residents were not actively involved in the design process. But during the renovation some residents were able to influence the proceedings and measures taken in their houses, while other respondents felt they had no power. Several respondents believe that the degree of assertiveness towards the housing corporation and construction workers influences the extent to which they listen and act towards their complaints, questions and wishes. This is not fair towards the more vulnerable residents who were not able to have much influence which in some cases seemed to result in worse outcomes. One respondent said the following about this: “Take care of things yourself. If you did not do anything yourself, nothing would happen, that is just the way it was.” (2) [56]. Another more assertive respondent stated that she also was able to influence the proceedings: “Yeah, and at a certain point that is what you get with working men, that is what I did, they would say ‘oh there she is again, with those puppy-eyes’.
Because I know them all by name and... but it just depends on how you do it and if it is realistic of course (...) But they also did a lot of extra things for me. Only props for those guys.” (3) [57].

Besides assertiveness, knowledge about and experience in construction showed to be useful assets in influencing the proceedings: “Because someone who lives here, one of my neighbours, has working experience in construction, he knows how stuff like that works. He is not shy, and they put his pavement in wrong. (...) He said it was not done properly and that they had to do it again, and they did it! (...) Yeah, if you had the urge to speak up (...) He came to our house one day to take those construction workers back to his work, that man was crazy. And when you say something about it, he just says he made it. Yeah, while we were living in a mess. If you needed somebody you had to go to him, he knew all the people. (...) Yeah, that man was retired, he was home all day and knew how he had to deal with that... and he got everything done, and we were still living in a mess. Because we were still working, we did not know how stuff like that worked.” (16) [58]. One respondent also believes that being a member of a working group could lead to useful contacts among the construction company and housing corporation which turned out to be useful during the renovation: “Because I am in a working group, then it all moves a bit faster.” (13) [59]. Another respondent was able to influence the proceedings by hiring a lawyer to force the housing corporation to fulfil their commitments. In cases the more assertive residents stood up for vulnerable neighbours. So next to knowledge and being assertive, social contacts (friends, family, neighbours) can help influence the proceedings during the renovation.

**Aftercare activities**

In both Haarlem and Kerkrade several respondents pointed out the aftercare was lacking, while some of the remaining problems were causing discomfort and direct energy losses (draft, heat leakages caused by warped doors, malfunctioning heating system, etc.). Many residents believe this could be solved when the housing corporation would come over shortly after the renovation, to check the installations for malfunctioning, examine the house to check if nothing is wrong and to ask the residents if everything is fine in the low-energy houses: “That they do not put effort into service (...) Why did they not come to us after a week or fourteen days to ask if everything was all right? Just like they did with the doors you know (...) They should come over to see what works and what does not work and why that might be.” (2) [60].

In Kerkrade different parties responsible for the renovation and installations were blaming each other for malfunctioning or defects, causing delay for some aftercare activities. Respondents stated that they do not care who is responsible for the malfunctions, they just want everything solved as soon as possible: “Yeah, and they put blame on Heemwonen, they say Heemwonen are slow in making decisions, Heemwonen says you have to go to the executer, from BAM. And that is how it is, you are being pulled from left to right en nothing happens.” (11) [61]. However, this is also caused by the fact that external parties are responsible for warranties for the installations. Only the supplier is authorized to fix or adjust the installations without losing the warranty: “Yeah, normally if something is wrong with the equipment, Heemwonen, firma Verploegen comes to fix it. But because it is a warranties question it should be taken up by the supplier and so it goes on and on. And when it is almost ready, Heemwonen passes it on to BAM who placed this, and BAM says, yeah we should search for that by the supplier. And so it goes on and on, and as a resident you are not being helped.” (12) [62].

In one striking example of malfunctioning where aftercare was lacking, multiple adjacent houses experienced similar problems with the heating installations: “In the beginning it was very cold in here.
But every residence was, we were all complaining about the cold. But according to the executor that wasn’t the case, it could not be. (...) And at a certain point I was like, I am not saying anything anymore.” (16) [63]. Different parties were blaming each other for the malfunctioning heating system: “And they all put the blame on each other, who placed the heating. They say like, no it is not us, that problem is not caused by the heating we put in. That is because of the panels. Well, then you go to the executor, who is in contact with the people who placed the panels. And those people say, these people are fools, where do they get this information? But really I do not care anymore, the resident should be helped.” (11) [64]. It took several months before the problems were solved: “No gas for seven months (...) Yeah, I called and called and called about that, they would only talk to me on the phone (...) Not one time they came over. Then some guy says to me that I do not get it, then he is just going to turn it on for me, well he put it on 26 degrees and then they got a little hot. And after that, nothing. I think it should not be that way, if you put it on normally, on 20 degrees, it should go on (...) Well it works now, after eight months.” (17) [65]. Apparently, the warm water distribution was incorrectly adjusted, the warm tap water was too hot while the heating system was not able to sufficiently heat the house: “And at a certain point someone was here, he adjusted something with the water and suddenly it was warm. But now I have cold water, very cold. Because I had the water temperature at 87 degrees, that guy came in here, he said, miss, your water is way too hot, you will burn yourself, and so he adjusted it, the warm water is a lot colder now and my heating works properly.” (16) [66].

In contrast, in Utrecht one respondent stated that his properly functioning heating system will be adjusted so that it will match his needs. This respondent stated that originally the heating system was not adjustable in every room, but this will be adjusted so that the heating system will with the needs of this respondent: “The funny thing is.. I never understood that system... everything is on the thermostat downstairs. And if he reaches it is top downstairs, it does not work here anymore either, while I have a different need of warmth. (...) Now something is going to be installed so they can function separately, it will be separate things working on the same warmth pump.” (20) [68].

Impact of the renovation on the relationship between the housing corporation and residents

As said in the literature study, guidance and support may be important to influence the way residents will use their house. A good relationship with- and trust in the housing corporation is needed for support and guidance to be effective (Swan et al., 2013). The impacts of the renovation and how the housing corporation deals with problems during the renovation may have an impact on the relationship between the housing corporation and residents. When the housing corporation deals with the problems of residents seriously and helps to find a solution the satisfaction will increase and the possible negative impact on the relationship between the housing corporation and the residents will lower. After the renovation the relationship between the housing corporation and residents does not stop, the residents keep living in the houses owned by the housing corporation.

In Kerkrade several respondents showed strong negative emotions towards the housing corporation and construction company because, in their opinion, the communication towards the residents was lacking and they do not think the financial compensation covers all damages and inconvenience caused by the renovation. Some respondents also believe the housing corporation did not comply with all promises. A few interviews showed negative impacts on the relationship with- and trust in the housing corporation: “But Heemwonen, I say it again, is a corrupt group of people, and I mean that, I really do mean that.”
Furthermore, there is much interest in the project from external parties (schools, housing corporations, construction companies, etc.). Several respondents do not appreciate this attention and the fact that this project is seen as a success (11, 18A, 18B): “But they do pat themselves on their back, they got the medals and everything is pretty. Everything shines (...) Look at what we have done, and then we are being looked at as monkeys. Photographers take photos of how I live here, while they are touching my stuff. (...) He even asked if I would put those flowers straight... No I do not feel like it, get out... (...) Whole groups of people, schools with children, come over here. Students, you name it. It does not matter, you do not feel comfortable (...) And that bothers us.” (18) [69]. This respondent felt that they did not recognize their suffering during the renovation: “Heemwonen gets the medals while we are suffering (...) On our back, those of 153 houses” (18A) [70].

In Haarlem several respondents also believe that the communication was lacking and there was much resistance and dissatisfaction because the compensation was not sufficient to cover all the costs and experienced inconvenience during the renovation. However, most respondents were satisfied about the fact that the housing corporation recognized the problems during the renovation process and increased the financial compensation and gave the residents the possibility to stay in an alternative home during the renovation. One elderly respondent in Haarlem said the following about this: “I appreciate that, I really do. I was very pleased with that, because you get high expenses with the floor and all those circumstances.” (6) [71].

5.3 The in-use phase

Here all findings concerning the in-use phase are discussed. The focus is mainly on how residents use their low-energy houses and how this is influenced by the house, interactions with the builders and by differences between users. Also other important and or relevant issues during this phase are discussed which may not be directly linked with the actual usage of the low-energy house and the installations.

Ventilation routines

In Haarlem, Kerkrade and Utrecht a large part of the respondents still ventilate like they used to do in their old house. Many respondents tend to find their own way in creating a comfortable indoor climate, mostly by continuing their window-opening routines.

In Haarlem the windows located downstairs cannot be opened anymore, instead the houses have air vents located above the windows. Some respondents now open their backdoor instead, to ventilate downstairs. In Haarlem several respondents stated that the ventilation system does not have enough capacity for ventilating the bathroom, so to get rid of the humidity they open the door to the hallway or they open a window. One respondent said the following about the humidity in the bathroom: “Our neighbour opens the door of his bathroom too, because otherwise everything becomes steamy. (...) In my opinion the ventilation system is not working sufficiently. The capacity is too low and everything becomes steamy in the bathroom.” (3)[72].

In Kerkrade residents are aware of the fact that the ventilation system should be able to take care of the provision of fresh air, but many of them still open their windows to ventilate their house. These routines conflict with the transcribed use of the retrofitted house because the heat recovery ventilation system (Kerkrade) is supposed to take care of providing the house with sufficient fresh air in a more energy efficient way. This shows that just informing residents about how they should use the new installations is often not sufficient to make them change their routines. One respondent stated she opens her window
because she want fresh air: “They told us that we could close our windows, you do not have to ventilate. However, I have to ventilate, it is just, I just want fresh air!”(18A) [73]. The heat recovery ventilation system is supposed to provide sufficient fresh air when it is on level 1. It should be switched to level 2 or 3 when it is warm, during cooking and when residents take a shower. Two respondents seem to use level 2 of the ventilation system as the normal level (13, 17), one of them never changes it to another level (17). The latter said she does not understand how the ventilation system works and she shows a lack of interest in understanding the working of the system, her daughter and her domestic help take care of the maintenance and she pointed out that she does not control the system herself, it just stays on level 2. Other respondents normally use level 1 and only use the higher levels when they are cooking or when they take a shower.

The empirical data of the Utrecht case shows that, also for residents who are highly motivated by environmental values, existing routines influences the way how they use their house to create a comfortable indoor climate: “Look, over here the window is open too (bedroom), we are not used to sleep with the windows closed.” (20) [74].

Usability issues

In Haarlem several respondents are dissatisfied by the usability of the ventilation system. Residents received one control display, often located in the kitchen, to control the ventilation system. It was an option to get an extra display in the bathroom, this led to the situation that not all residents have two displays and therefore sometimes forget to switch the system on or off. Especially for residents for whom it is time-consuming to go upstairs, because they have to use a stair lift for example, it is considered very user-unfriendly. Sometimes people also forget to switch off the ventilation system, because they can barely hear the system downstairs, were they have to control it: “The only thing that could really mess things up is the annoying air extractor. It already happened a couple of times, the ventilation system was running all day and we were not aware of it. You barely hear it over here.” (2) [75]. Another respondent who is quite short cannot reach the display to control the ventilation system, instead she often opens her door to ventilate the house when cooking (7). This respondent is also not able to control the air vents located above the windows since she also cannot reach to the sticks for opening or closing the air vents: “And yes, I am short, but there are more people in this neighbourhood who are short... I cannot reach that thing. I always have to ask my son or my neighbour if they can help....” (7) [76]. It is clear that the ventilation system in Haarlem does not match the needs of all residents. Furthermore, having just one display to control the ventilation system is not sufficient since it leads to ventilation behaviour which is easier to perform, but less energy efficient (opening of windows leading to heat losses and opening of doors leading to more humidity in the houses).

Besides the usability issues concerning the air vents and the ventilation systems, some usability issues were found which were not directly related with the energy measurements. For instance, in Haarlem the windows in the dormer now open to the outside, which makes it hard to clean them (2). In contrast, in Kerkrade one respondent (16) was very happy with the fact that the windows on the first floor now open to the inside so that she is able to clean them. An older respondent complained about the raised doorstep in the bathroom which may cause her to stumble (6).
**Changed heating routines**

In both Haarlem and Kerkrade respondents now lower their temperature settings of the heating system, they do this because of the increased temperatures inside the houses (due to the increased insulation). Often the temperature settings are set upon a low temperature so that the heating system is not switched on during the day: “So far I especially notice it upstairs, I have not put the heating system over 20 degrees at all. Normally I set the heating on 21, 22 degrees at this time of the year.” (3) [77]. According to this respondent in the old situation it was necessary to heat her house during the whole day to create a comfortable indoor climate: “That was definitely different prior to the renovation. Normally I switched it on during the day, otherwise it was just too cold over here. Around four o’clock I switched the heating system off because then the cold was gone. I do not think that is necessary anymore. Now the windows are open and it is not even cold over here.” (3) [78]. Several respondents stated that in the old situation they were also heating their bedroom, since the renovation this is not necessary anymore. So the heating routines of many residents seem to have changed as a result of the higher temperatures caused by the increased insulation.

**Residents differ in needs, knowledge and goals**

Both the literature study and the empirical data show that residents are diverse, they differ in needs, knowledge and goals resulting in different usage of the low-energy houses (Heaslip, 2012). This is why the use of standards in systems is often not sufficient. For instance the ventilation- and heating system both affect the indoor climate. However, people have different ways of using them. Some respondents pointed out that they lower the temperature on the thermostat when he opens a window: “When I open the door, I do not need the heating system. (...) That is just logic.” (15) [79]. While one respondent argued that she continually heat the bedroom because the window is open: “My daughter told me that I should leave the heating system turned on, because my window is open.” (17) [80]. For the latter, her ventilation behaviour is mainly influenced by distrust in the ventilation system and comfort considerations and not by energy saving. The examples above show differences between households, but there are also differences in the preferences and needs between members of a household: “Well, I have to open the windows every morning, because when he gets the chance, he closes all the windows again (laughs).” (2) [81].

**Understanding and feedback**

The literature study revealed that the provision of reliable feedback about the working and effectiveness of systems may positively influence the understanding about the installations. If no feedback is provided, people will use visual or aural cues to gain understanding about the technologies (Behar & Chiu, 2013).

In both Haarlem and Kerkraade the renovated houses have a display in the living room which can be used to control the heating system. It also gives information about the current temperature and whether or not the heating system is turned on. However, no clear and easy accessible feedback is available for the ventilation system. In Haarlem the ventilation system only extracts air from the house, new fresh air comes in through the air vents and windows. Respondents stated that they do not receive any clear feedback from the ventilation system, instead they use audio cues (noise) to check if the system is turned on. Also the humidity after taking a shower is used as a cue to check whether the system is functioning sufficiently, if not often residents ventilate by opening a door or a window. Several respondents believe the windows do not insulate well because sound comes through the windows: “I believe, when there is something wrong with the windows, like sound passing through, well then there is something wrong with the heat insulation too.” (2) [82].
In Kerkrade ventilation is carried out by a heat recovery ventilation system, which is more complex than the ventilation system used in Haarlem. Many respondents have a lack of knowledge about how this new installation actually works. Respondents gave wrong and conflicting explanations about the working of the heat recovery ventilation system which indicates that it is not totally clear for many respondents how the system works. Because of this lack of understanding and no clear and easily accessible feedback, respondents use aural and visual cues to make sense of- and to evaluate the working of the ventilation system. These cues consist of the amount of dust in their house (18A): “The dust circulates, it is extracted and then it circulates again. (...) But, because it also blows, it is a system, that extracts the warm air, it goes up, it is filtered, and it is supposed to blow clean air. (...) And the next time, when the sun is shining, I wonder where all this dust is coming from?! While the ventilation system is always switched on. On level 1. (...) There should be just a little bit of dust.” (18A) [83]; the amount of dust on the filters (19): “And the filter on this side, I think that this one... removes the large pieces (this filter is dirtier) (...). So it does work.” (19) [84]; the temperature of the incoming air (11, 12, 19): “The fresh air that comes in should be pre-heated with the warmth inside the house. But I do not think that is working properly, because the temperatures decrease regularly to 18 degrees during the night.” (12) [85]; and the screen of the heat recovery installation itself (19): “Here you can see that it is set at level 1. If it is set at level two, than this shows a two. If it is set at level three, than this shows a three. In this way you can always see that the system is working.” (19) [86].

However, this installation together with the other installations are located in the loft (in the single family houses) and therefore it requires some effort to check them regularly. One respondent does not think older people will check these installations regularly: “I can imagine when you are 70 or 75 years old, you will not check the installations for malfunctioning every two days. (...) Older people surely will not check whether those displays are giving error messages or not... you can use warm water anyway, even when the system is malfunctioning, because the heating boiler is still connected.” (12) [87]. However not all residents understand the interfaces of the installations. For example, one respondent tried to show some information on the display of the device for the PV-panels, however he was not able to successfully find and derive information from this interface (13). He also did not totally understand the information showed on the display: “22 cubic watt, in total 15... 5... 1558 cubic watt.” (13) [88].

Clearly, not all residents fully understand the installations and the provided feedback. As for the PV-panels, it is possible to obtain information about their effectiveness. However, for the heat recovery ventilation system no reliable information is available about the effectiveness. The only visible feedback about the effectiveness of this system is the amount of money they save as a result of the combination of the heat recovery ventilation system and other energy measurements. However, this feedback is delayed and not directly linked to the effectiveness of the heat recovery ventilation system. As pointed out above, some respondents experienced difficulties with obtaining information about whether or not the ventilation system is providing them with a sufficient amount of fresh air (which may result in the opening of windows) and also no direct information is available about the amount of energy saved by the system. While this new system led to reduced controllability over the indoor climate (which will be explained in more detail below), it requires effort to perform maintenance (which will also be explained in more detail below) which is necessary to ensure the system is functioning properly. The question is whether residents will be motivated to properly use this new ventilation system without reliable feedback about the effectiveness in both energy savings and ventilation capacity.
Trust in the installations

The literature study pointed out that even though most users have limited knowledge about a system and only a minority has the capabilities and motivation that is necessary to operate the complex energy systems efficiently, users still want some level of control (Karjalainen, 2013). An important reason for the desirability of control is that residents often do not trust the systems with high levels of automation (Karjalainen, 2013).

As explained above, as a result of the lack of reliable feedback, residents often use aural and visual cues to make sense of and to evaluate the working of the ventilation system. Some of these cues, such as large amounts of dust or cold incoming air, make people believe the system is not functioning properly. This may affect their trust in these technologies. The empirical data also shows that malfunctioning during and after the renovation can cause mistrust in the new installations, resulting in different usage than intended by the designer. For example, a respondent’s heating system was not working properly for eight months. The installation is repaired now, but the respondent does not trust the installation anymore. She is afraid the heating system will not turn on again once she switch it off. Therefore she never turns the heating system off and does not change the temperature at all: “Just one stable temperature is fine by me, I even leave the system on at night, I am not turning it off because I am afraid it won’t turn on again. But they are saying that I can just turn it off and on again, but I am not doing that...” (17) [89].

The level of control residents have over the installations

The literature study shows that installations in houses can work automatically, with manual operation or with intermediate levels of automation (Karjalainen, 2013). Even though most residents have limited knowledge about a system and only a minority has the capabilities and motivation that is necessary to operate the complex energy systems efficiently, residents still want some level of control (Karjalainen, 2013). Residents want to be in control for their own indoor environment and comfort, they are dissatisfied in a climate system if they cannot control and adjust it to their own preferences (De Vries, 2012). Residents also want to have the possibility to control the systems in different rooms separately since they have different preferences for different rooms, such as the bed- and the living room (De Vries, 2012). The level of automation is important for the performance of control systems and whether or not users accept systems with high levels of automation (Karjalainen, 2013).

In Kerkrade residents lost some control over the ventilation inside their house, it is always running at level 1. This unstoppable airflow from the vents causes some discomfort for several respondents (11, 12, 16). One respondent who was dissatisfied about the temperature in his house, said the following about it: “Right now, you do not have any other options anymore. And the heating had something to do with the ventilation system as well. The cold comes in from outside, because there are pipes. Those vents you have here, those two, you have outside as well. These vents attract cold air. If you sit here, you are getting cold (...) and you do not even have the possibility to turn that thing off.” (11) [90]. When it is cold inside the house because of the ventilation system, people were told by the housing corporation to use the heating system to reheat the room: “But then they say, if it is to cold, you just have to turn the heating system on.” (19) [91].

As already explained above, in Haarlem several residents did not chose to get an extra display in the bathroom to control the ventilation system, which they are now regretting. This leads to problems because of the fact that the only feedback they receive from the ventilation is the noise it makes, which is hard to
hear downstairs where they can control the system (for houses with only one display to control the ventilation system). One respondent stated that it would have been better if the ventilation could be controlled together with the light (one button for both), because they do not easily forget to switch the lights off. This lowered the perceived degree of control residents have over their indoor climate. Also the fact that they cannot open their windows downstairs anymore, but only the air vents, let to a lower degree of control. Several respondents stated they miss the possibility to open a window downstairs for the provision of fresh air (2, 6, 8, 9): “Those vents, okay. But in the summer you cannot even open a window... So they should have tried to invent another system. I just think you should be able to open a window when it is hot.” (6) [92]. Several residents stated that they now open their backdoor to ventilate their kitchen and living room.

**Guidance and support provided by the housing corporation or construction company**

The literature study revealed that people do not only need technical knowledge, but experience with technology too. Often it is even more important how residents make sense of a particular technology when they use it for the first time and how they try to control and adapt to it (Behar & Chiu, 2013). The housing corporation can support and guide users during this period to help them make sense of the new installations in the low-energy house.

In Haarlem residents only received a little bit of guidance and support during the handover process on how to use the technology and how to ventilate their renovated houses. Several respondents stated it was easy to use the new ways of ventilation, and therefore they do not need any support. However, many respondents still often ventilate differently than intended by the designer. Additional guidance and support (also after the renovation) could have helped users to make sense of the new technologies. And even when the used technologies are not complex, guidance can be used to help people change their routines so that these routines better match the low-energy house. This respondent believes he does not need any guidance to help him with the new ways of ventilating his house: “Of course we are not totally crazy. It is just a matter of putting the air vents up and down, that is all.” (5) [93]. However, another respondent experiences difficulties with the air vents: “I want to close it, but then... I do not know.... I do try, I put them up or down, but then I begin to doubt if they are open when they are in the upwards position or in the downwards position... I just do not know.” (9) [94].

In Kerkrade the heat recovery ventilation system is more complex and many respondents showed poor understanding about the exact working of the technology. Several respondents argued that they would have liked some additional guidance and support to increase their understanding: “We had that with our filter, it started flashing, those things are examples of... they do explain it, but only partly. (...) You have to figure it out on your own or you have to call them what needs to happen, things like that should be explained more detailed.” (19) [95]. All residents did receive a book and a DVD with information about the renovation, changes in their homes and instructions on how to use and maintain the new installations. Besides, some respondents received face-to-face guidance at the handover process, but they do not all regard this as sufficient. The project leader is also aware of the fact that some residents have problems using the heat recovery ventilation system, even though all residents did receive an information folder and guidance during the renovation and handover process. This indicates that providing written information and an instruction DVD about how to use the installations is not sufficient for everyone to ensure proper usage. Additional forms of guidance and support are needed not only during the renovation and handover process, but also a few weeks after the renovation, since residents often do not understand how the new
installations work and how they should use them. One respondent said he did not read the book: “Yes I have that book, it is in the attic, but I have not yet read it…” (13) [96]., but he did watch the DVD which was, according to him, sufficient for proper usage. However, his ventilation system is mostly set at level 2, while level 1 is supposed to be the standard level. Another respondent was not at home when the devices were installed, therefore she did not receive any guidance and support with the new installations during the handover process: “Yes you get some explaining and then yeah…. I was not at home, bad luck for me… I did not receive any explanation at all. You only get a book and then you may figure it out for yourself.” (16) [97]. Residents did not receive any guidance or support after the renovation and it is not clear to whom they can turn to when they have questions regarding the installations. Both things are desired by some respondents: “Especially for the older people. (...) They should explain to them the way the installations work and how to use that kind of equipment. Like this: ‘do you understand how you should use the installations? Do you want us to explain it to you again?’ In this neighbourhood there are a lot of older people. (...) They need someone to whom they can turn to if they have any questions. So that they can be helped immediately.” (18A) [98].

The Utrecht case shows that highly motivated residents may need or want guidance and support too, so that they are able to properly use the new installations and also because most of them are interested in the way these new technologies work. One respondent argued that he does not understand how to use the new heating system and he has no information folder to find the required information: “Especially if you are in the in-use phase, you have got that thing and you wonder what do I have to do with it? Back in the days you only had to watch the water pressure in the boiler and once a year someone from the maintenance came over. But now, I want to know more about it, because it is something totally different. Where can I find it? Well, nowhere actually. There is no explanation at all on how I should operate that thing.” (20) [99]. This respondent would have liked more guidance and support in using the new installations: “They put that system in place and they actually did it very well, but when it comes down to giving someone who does not know anything about it some explanation… Yesterday it was the same thing, I said: I would like to improve my comfort, that is all. And they had to translate this into systems, well they managed to do this… and now, when it comes down to explaining how I should use the systems… well… that is something they are not very good at.” (20) [100].

The provision of guidance and support by social contacts
As indicated in the literature study, residents may be very dependent on support in order to properly use the new technologies in the low-energy house (Swan et al., 2013). This support can be provided by the housing corporation, but users may also depend on people from their social network. In Kerkrade two respondents were highly dependent on support from people in their social network, varying from family to domestic help and neighbours (Behar & Chiu, 2013). These respondents do not know how to use and/or maintain the new installations and are fully depend on social contacts for this. An older respondent (90 years) receives help from his neighbour for many things concerning the new installations: “Those houses were finished at the same time, if something needs to be done, the neighbour comes over and he tells me what I have to do and what I should not forget. (...) He also knew that new filters had to be placed, so he ordered them for me as well.” (15) [101]. Another respondent with health problems (lungs) receives help for cleaning the installations and the maintenance of the installations, from her daughter and her domestic help: “Yes that ventilation system in here, I do not know how that works or anything, so I said to my daughter, you take care of that.” (17) [102].
When guidance and support by the housing corporation is lacking and residents do not have social contacts who can provide this support, it can be expected that these residents will not effectively use the new low-energy house. Therefore it is important that the housing corporation also guide and support residents after the renovation has finished. One respondent has no social contact or relative who can help her repair the defects resulted from the renovation or explain to her how the air vents work: “Well, when I am sitting on the couch at night and I am watching television, and I feel a wind squall, then I try to... I try to look if the air vents are open or closed... Well, I think I have to ask my neighbour some questions...” (9) [103].

**Maintenance responsibilities**

The low-energy houses in Haarlem and Kerkrade differ in the amount of maintenance residents have to perform. It seems that in Haarlem residents do not have to do anything extra when you compare the new situation to the old one. For some respondents it is not clear whether they have to conduct any kind of maintenance themselves on the new installations, or not: “They did not say anything about that to me, so I really do not know (...) We got a little book with it, I have to read to find out if I have to conduct any kind of maintenance... (...) There is probably something written about maintenance, I think.” (3) [104]. Several respondents argued that the housing corporation performs maintenance on a yearly basis on the installations.

However in Kerkrade residents have to clean the filters and air vents on a regular basis in order to ensure a proper working heat recovery ventilation system. It takes effort and motivation to perform this maintenance. Checking the other installations (solar boiler, PV-panels) for malfunctioning takes effort too, since they are located in the loft (in the single family houses). Most respondents know how to clean the filters of the ventilation system and do it regularly (12, 13, 14, 16, 18, 19). Some respondents also check the displays of the installations located in the loft regularly (12, 19), these displays show if there are errors and whether the filters have to be cleaned. Some of the respondents do not regularly check these displays, instead they check the filters themselves or they just seem to clean the filters regularly. As said before, two respondents are very dependent on social contacts and they also outsourced the maintenance and cleaning to these contacts (which may be family, domestic help or acquaintances) (15, 17).

Just like in Haarlem, the housing corporation should perform maintenance on the installations on a yearly basis. However, according to several respondents, the housing corporation shows neglectful in their maintenance duties. They are supposed to send a mechanic over, to check the installations for malfunctioning every year (according to both the respondents and the information folder): “And if Heemwonen expects from the residents that they are going to clean the filters once every three months or whatever, they have to stick to their promise and send a assembler once a year.” (12) [105]. No mechanics checked the installations since the renovation, which was more than one and a half year ago at the moment of the interviews. Furthermore, according to several respondents and the information in folder provided by the housing corporation, the housing corporations should give them new filters for the ventilation system twice a year. But the housing corporation did not provide those new filters since the renovation. However, there is also a sticker on the ventilation system with a code which can be used to order new filters on the internet for free. But not all respondents were aware of this. In addition, some argued that although it is possible to order new filters yourself, it remains the responsibility of the housing corporation to provide new filters: “Yeah, these filters, but we would get a new set of filters from Heemwonen every six months. And there was a sticker on it, with a code which you could fill in, and then
Some respondents pointed out that without new filters they do not think the ventilation system is able to work properly. This mistrust may eventually lead to different and less energy efficient usage as prescribed. The following respondent believes the ventilation system will not work properly if they do not receive new filters: “They say you should not open your windows because then the system is going to... but the system does not work properly. (...) Because it has to be filtered, but if we do not get any new filters... and I have washed them over six times in one year. (...) And the folder said we would get new filters twice a year.” (18A) [107].

Rent increase vs. house improvements and/or energy savings
In both Kerkrade and Haarlem the energy savings should outweigh the rent increase (apart from the rent increase resulting from extra options in Haarlem). However, in both projects, most respondents are sceptic about the promised energy reduction. They do not believe that the renovation will actually lead to the promised energy savings, which should outweigh the rent increase. This is also reflected in the following quote: “However, they say you are going to save 30 Euros a month, that seems a little bit exaggerated, if you ask me.” (8) [108]. However, in Haarlem some respondents think that the house improvements are worth the rent increase, even when the energy savings do not cover the full rent increase. Satisfaction and the acceptance of the new technologies can be increased when the renovation is not only aimed at energy improvements. As said earlier, often residents find indoor quality and comfort more important than things like energy savings and the positive environmental effects. This is reflected in the following quote: “Well I thought, apart from the normal rent increase which is approximately 35 Euros, it is actually not that bad with the whole renovation. Because you did get more comfort for it in return, right. (...) Yeah, and now you have double glazing, and when the costs for heating decrease as well, then it really does not matter anymore. (...) Because I do have a nicer place of course. (...) And it will last a lot longer too.” (5) [109].

While in Kerkrade several respondents are dissatisfied about the fact that there were no improvements inside their houses, and a few of them even believe that they are worse off than before, because of the damages and inconvenience during the renovation (11). In Kerkrade just two respondents were confident that the saved energy will outweigh the rent increase and they both check their meter regularly. These respondents (an older couple) said the following about the expected energy savings: “So we got a rent increase of 40 Euros, and 24 Euros extra for the panels on the roof. So that was the cause of the rent increase. And if you save 70 Euros each month, then you make 6. I think I probably will save even more than those 6 Euros.” (19) [110]. Another respondent was happily surprised with the money she received from the energy company because of the realized energy savings. She did not expect to save this amount of money: “My god... (...) I received more than 1000 Euros (...) I was shocked, I first thought I was supposed to pay that. But I got it back!” (16) [111].

Motivations of residents to save energy
Energy saving behaviour based on curtailment refers to actions that have to be done repeatedly, and they are associated with a change of habits and routines in everyday life (Sütterlin, Brunner, & Siegrist, 2011). This behaviour consists of turning off the lights, not using the tumble dryer regularly, lowering the temperature settings during the night, etc. Many respondents stated saving energy is not seen as an important goal, still many respondents told they regularly show these types of energy saving behaviour. Some of them also stated that the amount of energy they use is largely dependent upon certain habits (2, 3, 4, 5, 10, 12, 15, 19): “(...) So the gas bill has reduced, but my electricity bill has gotten a lot higher
than the bills of the people around here, yeah, they show that to us, what the average is in our
neighbourhood. And then I think, I just do what I always have done.” (10) [112]. Often this energy saving
behaviour is driven by financial considerations, habits and social norms: “It is just like, I was raised that
way, (...) I learned it that at home (...) I mean, it is my money right?” (15) [113]. Another respondent
stated: “Mainly because I am used to it, but it is more about the money for me. (...) I used to be in debt
restructuring, well, then you learn how to deal with your money”. (12) [114]. One respondent explicitly
mentioned that he became more motivated to save energy now that he sees how much money can be
saved (19). However, he already was motivated before the renovation to reduce his energy use. Several
interviews indicate that there is a social norm not to waste energy. Environmental considerations are not
that important for most respondents: “That bunch of crap about the environment, I am not falling for that.
It is just self-interest, that is it. (...) Look, if you only have an old-age pension, than you would like to
save, trust me ... you can be happy if you are not in depth at the end of the month.” (2) [115]. Only a few
respondents mention that they are slightly driven by environmental values, as long as this behaviour does
not lead to lower comfort.

In contrast, in Utrecht all respondents were highly motivated to save energy and they are mainly driven by
environmental values. In Utrecht the aim of the renovation is to lower the total energy use (both building-
and domestic related energy use) of the houses with 80% and all respondents are aware that they also
have to lower domestic energy use. However, no clear feedback is available about the amount of energy
saved. They would like to receive feedback about how much energy they save at the moment, so that they
know if they are achieving the goal to reduce their energy use with 80%: “There are no numbers yet, that
tell me if I am on the right track or not. You should be able to say that with a certain amount of certainty,
so I can take measures right now, if that would be needed. For instance hot fill on the laundry and
washing machine, or more with hot recovery or something like that... now I am only going to start with
those measures, when I receive a way to high energy bill.” (20) [116].

How residents think the retrofitted house will affect their health
In both Kerkrade and Haarlem several respondents have health issues (2, 4, 7, 17). In Haarlem, during one
interview the possible positive effects on their health had explicitly been mentioned: “Since we moved
back here, you did not had to go to the hospital as much as you had to go before the renovation. So it
does have an influence.” (2) [117]. Another respondent also stated that the lowered humidity may have
positive effects on their health. So in Haarlem a few residents believe the renovation may have positive
effects on their health. However, in Kerkrade several respondents believe the renovated house may have
some drawbacks on their health. The respondents blame several changes in their indoor environment for
these drawbacks. This data cannot be used to identify a causation between the changes in the houses and
positive- and negative effects on residents’ health, but it does show concerns of residents in Kerkrade
about possible negative effects on their health. One respondent stated that more people were getting the
flu because of the heat recovery ventilation system: “Yes, but with that heat recovering system you get a
different kind of air. Many people are bothered by it, more people have colds.” (12) [118]. This flu can
also be caused by residents changing their ventilation habits in the low-energy house: “Yes, but I did get
the flue from it a time ago, I was not used to it, I never slept with the window open. (...) Yeah, they have...
they said that you do not have to open your window because you will get air from the system. But yet, I
still open my window. Because I am stuffy anyways.” (16) [119]. Another respondent stated that the
increased amounts of dust in the house may cause problems for people suffering from lung disorders:
“But they cannot say that people with asthmatic problems can still live here. Since we got the filters, all
there is, is dust, dust and more dust.” (18) [120]. Also the increased temperatures are seen as a bad influence on their health: “After we got the heating, I noticed that I got a feeling of pressure on my chest from the heat.” (18B) [121]. A different respondent believes that the increased temperatures may have negative effects too: “That the hormones are coming in to play, in the menopause. (...) That you get hot flashes. And... that has gotten much worse.” while her husband said: “Nice and hot... I think it is nice (laughs).” (18A) [122].

Improved sound insulation?
In Haarlem several respondents do not think the improved insulation and the insulated windows improved the soundproofing. Some of the respondents even believe they hear more sound from outside than before the renovation took place. They have conflicting explanations about what caused this lowered sound insulation: “So in terms of... in terms of sound, if it is about the reduction of sound, in terms of insulation density, sound from inside to outside, I doubt that. I think that you can hear us better from the outside then before, so I have my doubts about that.” (8) [123]. This respondent believes this is caused by the air vents, she thinks these vents let sound pass through: “And indeed, I do hear more sound from the outside, but I think the main cause are those vents, because you can close those vents but obviously they do not isolate 100%.” (8) [124]. While another respondent believes the lowered sound insulation is caused by the windows, which he thinks are inserted reversed: “Look, the painter can put a window in the wrong way around by accident. (...) Because a neighbour had put in double glazing 20 years ago, and when you were inside, you didn’t hear anything from the outside. (...) I am not really bothered by the sound that passes through, but it is not supposed to be that way. Then I assume, if the glass is not good and the sound passes through, then the insulation is not good either.” (2) [125]. In Kerkrade several respondents think that they have less noise from outside, however some of them pointed out that they perceive more noise from their neighbours (12, 14, 16, 18B).

Privacy issues
All houses in both Haarlem and Kerkrade got a smart meter. Two respondents in Haarlem brought up privacy issues concerning data about their energy use. So not all residents want to share information about their energy use with the housing corporation or third parties. One respondent did not want other parties to remotely record the meter because of privacy considerations: “Well, we got a smart meter of course, but mine is not ... I do not want them to, from a distance ... I turned that off, that is private to me. (...) Actually, my daughter went with me, and she said mum, I do not think that something like that will happen ... yeah, it probably won’t happen but they are able to see from a distance when you have somebody over, or not. When the shower is used more, or something like that. That is all a part of my privacy, which I don’t want to give up.” (3) [126]. Another couple also did not want to receive tips on how they could save more energy, based upon the information derived from their smart meter: “But they are not going to interfere with what I turn on and off. They already interfere too much. (...) If I want to put on my dryer, then I am putting it on. I am not going to ask them how I could save energy, I know that myself. If my wallet doesn’t allow it anymore, than I am actually going to cut back. But as long as I can afford it...” (4) [127].

The empirical data showed many mismatches during the design-, construction-, and in-use phase. In the next chapter relevant mismatches are shortly explained and recommendations on how they could be improved are given.
6. Conclusion and recommendations

The aim of this thesis was to identify and explain mismatches in Dutch deep retrofitting projects. These mismatches consist of two types: resident – builder (housing corporation/construction company) and resident – low-energy house. The main focus is on how residents use their low-energy houses and how they evaluate the design-, construction-, and in-use phase. The data derived from the interviews with residents provides valuable insights about mismatches in the three phases and also how residents think they may be improved or solved. If possible also possible solutions or improvements for these mismatches are given. A large part of the findings is supported by scientific literature and is therefore to a greater extent generalizable. Findings that are not supported in the literature may contribute to the understanding of mismatches occurring in these projects. As said earlier, the construction phase was not yet been extensively studied, therefore for this phase the research will have a more explorative nature and will provides new insights about mismatches that may occur in deep retrofitting projects. These new insights will be discussed in more detail in the theoretical implications section (paragraph 6.3).

First, the identified mismatches in respectively the design-, construction-, and in-use phase in the studied projects are explained and recommendations for improvements are given. Secondly, the conclusions are drawn and discussed. Thirdly, implications resulting from this research are discussed. Fourthly, limitations of this research will be discussed. Finally, possible directions for future research are discussed.

6.1 Results

Here the identified mismatches and recommendations for directions for improvements/solutions are discussed. First, this is done for the design phase. Secondly, the mismatches found in the construction phase are discussed. Finally, identified mismatches in the in-use phase are discussed. The recommendations can be used to improve future deep retrofitting projects.

6.1.2 Design phase

Both scientific literature and the empirical data shows that often the design does not match with the needs and goals of residents. The empirical data shows that in Haarlem and Kerkrade residents were not actively involved in the design process. Several respondents showed dissatisfied about the fact that they had little say in which measures were implemented. Furthermore, the design and communication was mainly focused on energy saving while residents often have other goals and attach more value to comfort, perceived indoor improvements, renewals and beautification. In Haarlem residents could choose more options to improve their house, they could choose a new front door and they could also choose some indoor house improvements like a new kitchen or bathroom in combination with additional rent increases. These options made it possible for residents to choose what they think is important besides the energy savings. For some residents home improvements even outweighed the rent increase regardless of whether the projected energy savings are realized or not. In contrast, in Kerkrade all measures were mandatory and mainly focused on energy improvements while the indoor quality often deteriorated because of damages inside the houses.

Furthermore in Haarlem and Kerkrade often the condition of- and the differences between the houses were not sufficiently taken into account in the design. Often standard solutions do not fit with all houses because over the years all houses are customized by the residents. Residents may provide valuable information about defects in their houses and often the builders do not make sufficient use of this information. For residents it is important that they are taken seriously when it is about the state of their
house, many residents have been living in their houses for a long time and therefore feel like they are experts about the situation.

In contrast, the Utrecht case differs much from the two other cases because in this case the private house owners opted to renovate their houses and they paid for the renovation themselves. Furthermore, because of the differences between the houses, different energy measures were taken. These private house owners were highly involved in the design process, they can be seen as partners during this process. They had a final say in which energy measurements and installations are implemented. This resulted in low-energy houses that better match with the needs, preferences and goals of these residents. The participating private house owners in this project are early adopters, they are mainly driven by environmental values and comfort considerations. Some of the residents even agreed with implementing experimental energy measurements so that new installations could be tested in their houses.

However, the empirical data shows that also in Utrecht respondents felt that they were not sufficiently informed about the progress and possible disturbances in the project, it was not clear whether or not the project would be carried out. However, the available knowledge, knowhow and expertise are seen as the most important benefits for participants, and this was still available. This shows that there is a demand for parties who are able to implement integrated approaches which is needed for deeply retrofitting single houses.

**Recommendations:**

- Focus more on realizing the personal goals of residents. More actively involving residents in the design process may provide valuable information about the main goals of residents. It is important to ask residents before realizing the designs what they think should be improved during the renovation. This will improve the mismatch in goals because it will lead to designs that better reflect the needs and goals of the residents. Focusing more on these alternative goals (comfort, beautification, indoor improvements and renewals) of the residents in the design and also in the communication towards residents will increase residents’ acceptance and satisfaction, and therefore also the energy performance. This can be done by giving residents options for indoor improvements so that they can choose what they think is important. When the goals of residents are sufficiently taken into account it will be possible to evaluate whether these goals are realized in the renovation and whether residents think their house really is improved after the renovation.

- Make better use of valuable information which may be provided by residents about the state of their houses. Involving residents already in the design phase will allow them to provide useful information about their houses which can be used to better match the design and measures with the actual states of- and differences between the houses. The housing corporation should visit residents in their houses, not only to inform them about the design and the renovation but also to ask residents about the state of their house. This information can be used to better match the design with specific circumstances instead of using a standard design with standard solutions for different houses and different situations.

- Inform private house owners about innovative energy measurements which could be implemented. They can be seen as early adopters and therefore they may be willing to implement experimental energy measures so that the construction company can gain experience with these new installations.
- Inform private house owners about the progress of the project. They are also interested in possible advantages for future projects and are therefore interested in how the whole project works out.

6.1.2 Construction phase

The empirical data show that the renovation process may have a large impact on residents. Many residents experienced high levels of inconvenience. The level of inconvenience is influenced by duration (delay), timing (weather conditions), specific situations of residents (health conditions, mobility) and the type and state of the house.

The construction phase took for some houses much longer than expected, this caused extra inconvenience for the residents. The empirical data show that some residents and the housing corporation had conflicting ideas of which activities (such as preparation and aftercare) are part of the renovation. Residents believe the renovation is completed when everything in and around their house is finished and when they do not experience inconvenience anymore. However, often aftercare was lacking, it took a long time before everything was finished and all problems were solved after the renovation. While some of the remaining problems were causing discomfort and direct energy losses (draft, heat leakages caused by warped doors, malfunctioning heating system, etc.).

Furthermore, it appears that there is ample room for improving communication between on the one hand the housing corporation and the construction company and on the other hand the residents. Good communication is especially important when delays occur in the renovation process, when damages occur when radical interventions are going to be performed inside peoples’ homes, and when residents stay in their houses during the renovation. Especially when residents stay in the houses during the renovation they can be seen as active spectators assessing all proceedings in and around their houses. Residents are dissatisfied when they feel that the housing corporation is not taking their needs, questions and complaints seriously.

Furthermore, in Haarlem and Kerkrade residents felt they had little power in influencing the proceedings and measurements taken in their houses. However, the degree of assertiveness towards the housing corporation and construction workers seemed to influence the extent to which the housing corporation listens and acts towards their complaints, questions and wishes. This is not fair towards the more vulnerable residents who were not able to have much influence which in some cases resulted in worse outcomes. In contrast, in Utrecht residents were able to influence the measurements and they had the final say in which energy measures were implemented. They paid for the renovation themselves and are therefore treated as an important party in the whole process.

In Utrecht sometimes the communication between construction workers was lacking which led to faults in the construction process. Clear communication is very important in such an integrated approach, different energy measures influence each other’s effectiveness and therefore construction workers have to know everything that needs to be done.

Recommendations:

- Factors (delay, timing and weather conditions, specific needs of residents and the type and state of the house) that influence the level of inconvenience during the construction phase should be taken into account in the renovation plans. It is important to consider if it is possible for (all) residents to stay in their houses during the renovation or that it would be better if they could stay...
in a temporary, alternative house instead. A possible solution is to let residents choose whether they want to stay in their house or in a alternative house during the renovation.

- Especially when residents are supposed to stay in their houses during the renovation it is important that the housing corporation and construction company are flexible so that they are able to solve or compensate unexpected problems which may occur during the renovation. For example, in Haarlem in reaction to the high levels of inconvenience residents received a higher financial compensation, were offered alternative housing and they could rent a container to store their belongings so that they would not be damaged during the renovation.

- There is a need for an easily accessible contact who represents and defends the interests of the (more vulnerable) residents during and after the renovation. In this way residents will have more power during the renovation. Problems and malfunctioning occurring during and after the renovation often lead to dissatisfaction among residents, which can be reduced when this contact takes the concerns and complaints of residents seriously.

- The housing corporation should come over shortly after the renovation to check the installations for malfunctioning, examine the house and to ask the residents if everything is okay in the low-energy houses. In this way problems can be solved quickly and residents have the possibility to ask questions about how to use and maintain the new installations.

- Because of the integrated approach of numerous measures it is important to pay attention to the communication during the construction process so that all construction workers and the house owner are aware about what needs to be done in the house.

6.1.3 In-use phase

Both the literature and the empirical data show that many residents do not use the low-energy houses and installations as intended by the designer. For example, many residents keep ventilating by opening their windows and doors while their new ventilation system should be able to take care of that. Even if they are highly motivated to save energy (Utrecht) they stick to their existing window opening routines. There are numerous possible factors that influence how residents use their low-energy house such as a lack of trust in the installations to create a comfortable and healthy indoor climate, lack of understanding, no easily usable installations, lack of feedback, lack of guidance and support provided by the housing corporation or social contacts, complex installations/interfaces, low capacity of the installations and the fact that often residents have different goals than saving energy. Often just providing information (in the form of books and DVD’s) about how the low-energy house and installations should be used in the most energy efficient way is not enough to ensure proper usage. Furthermore, several new insights resulted from the empirical data about how mismatches in the construction phase may affect the way residents use their low-energy houses. The empirical data shows that when aftercare and maintenance activities are lacking this may lead to distrust in the low-energy house, which may eventually lead to ineffective use of the installations.

The literature study reveals that people do not only need technical knowledge but also experience with technology; often it is more important how residents make sense of a particular technology when they use it for the first time and how they try to control and adapt to it. The housing corporation can support and guide residents during this first period to help them make sense of the new installations in the low-energy house. However the empirical data shows that the guidance and support after the renovation is often lacking. In Kerkrade the heat recovery ventilation system is complex and many respondents showed poor understanding about the exact working of the technology. Several respondents argued that they would have liked some additional guidance and support to increase their understanding. And even when the used
technologies are not complex, such as in Haarlem, guidance could be used to help people change their routines so that they will be more energy efficient and better match with the new situation. However, the numerous mismatches in the construction phase can harm the relationship between the housing corporation and residents and a good relationship is needed for this guidance and support to be effective. Also residents who are highly motivated to save energy, such as in Utrecht, may need/want guidance and support because they are interested in the way the new technologies work and so that they are able to properly use the new installations. Furthermore, the highly motivated residents would like to receive feedback about how much energy they save at the moment, so that they know if they currently achieve the goal to reduce their energy use with 80%.

Recommendations

- It is important that the technologies used in the low-energy house are easily usable, also for residents with special needs. For example, small residents should be able to reach for the sticks to open the air vents. Another example is that (especially less mobile) residents may need an extra display to control the ventilation system so that they can control it in both the kitchen and the bathroom (where the air is extracted). Furthermore the new technologies should provide clear and easily accessible feedback so that the residents gain understanding about- and trust in the installations. For complex installations it is important to provide simple and easily usable interfaces so that residents are able to use and control the installations. Furthermore, these interfaces should be located at easily accessible locations (instead of in the loft) so that residents will be aware of malfunctioning installations.
- The provision of good aftercare is important so that problems are solved quickly. Malfunctioning installations may lead to dissatisfaction and to distrust in the low-energy house and installations.
- Perform maintenance. Lacking maintenance may lead dissatisfaction and to distrust in the low-energy house and installations.
- Besides explaining how to use the low-energy house and the installations during the renovation and the handover process, also guidance and support is needed shortly after the renovation is completed. This will help residents to make sense of the new technologies at the moment they start using them which will influence how they try to control and adapt to it. Also when the technologies/displays are not complex (Haarlem) or when residents are highly motivated to save energy (Utrecht) there is a need for additional guidance and support. This guidance and support should focus on how residents can reach their goals (realizing a comfortable and healthy indoor climate) instead of focusing merely on energy savings in order to motivate residents to properly use the installations. The guidance and support should also be used to help people change their routines so that they will be more energy efficient and better match with the new situation. The guidance and support can be combined with the aftercare and maintenance activities to optimally use the already existing contact moments.
- Contact moments for aftercare, maintenance, guidance and support could also be used to monitor in-use behaviour and evaluate the low-energy houses and installations with residents to increase understanding about the way residents use their low-energy houses. In addition, it is important to also involve producers of the installations in these monitoring and evaluation activities so that the usability of the installations and their interfaces could be improved.
6.2 Discussion

Here the results will be discussed and the sub questions will be answered. These answers result from the analysis and the results section above. The results are already explained in detail above, here only short answers are given which summarize most relevant findings of the results.

The first sub question in this thesis is answered by means of a literature study is: *What has already been published on low-energy houses and possible mismatches that may occur?* The theory section answered this question already in great detail, here most important findings are briefly discussed.

The literature study shows that since 2006 more attention is paid to end-users/residents and domestic energy use instead of only focusing on lowering building-related energy use. However, the EPC (which only assess building-related energy use under standard circumstances and standard user behaviour) still remains the most important factor in most projects for formulating energy efficiency ambitions. So in lowering the energy use of buildings the focus remains mainly on building-related energy use while little attention is paid to domestic-energy use, the way how residents use their houses and how this influences the total energy consumption. Similar trends were found in the design process, designers often focus on technology while not making sufficient use of the knowledge and information about users of that technology. However, there is a lack of sufficient monitoring and evaluation of previous projects, not enough reliable scientific information is available about these factors so that they can be incorporated in new projects. But existing literature already indicated many factors that are important to incorporate in the design and accompaniment processes (during the preliminary, renovation, handover, and in-use phases) so that the mismatches could be improved. These factors that influence the way residents use their low-energy house were divided in three categories: user characteristics (expectations, existing routines, personal capabilities, knowledge, access to support and values, social norms and attitudes of residents), building characteristics (the controllability of the new systems and the indoor climate, feedback and designs that may change routines) and builder-resident interactions (the handover procedure, communication, feedback, additional support, guidance, maintenance, monitoring and evaluation).

Other sub questions that are answered in this theses are: *Which mismatches can be identified in Dutch deep retrofitting projects in the design-, construction-, and in-use phase?*; *How can these mismatches be explained?*; and: *How can the identified mismatches be anticipated and improved?*. The results discussed above already explained the identified mismatches in detail. Also recommendations for solving or improving these mismatches are given. Here these results are interpreted for respectively the design-, construction-, and in-use phase.

In the projects which consisted of social housing (Haarlem and Kerkrade) residents were not actively involved in the design process. This resulted in designs with (energy) measures that did not always match with the goals, preferences and needs of residents. Furthermore the numerous mismatches in the in-use phase show that the resulting designs do not always fit with how residents (want to) use their low-energy houses. Therefore it is important to make more use of valuable information about the residents. Also in the project in Utrecht, in which the private house owners were actively involved in the design phase, the organization and communication towards residents was lacking. It seems that both housing corporations and construction companies have difficulties in cooperating with residents in the design phase.

The empirical data of the projects which consisted of social housing (Haarlem and Kerkrade) shows that the main cause for the mismatches during the construction phase was that residents felt they had no
power. During the renovation they were barely able to influence the proceedings and measures so that they would better match with the state of their houses, their goals, preferences and needs. Furthermore they felt they were not taken seriously when they had questions or complaints. Also the communication towards residents was lacking which led to dissatisfaction, while good communication may lower dissatisfaction when delay, damages or other problems occur. In contrast, in the project which consisted of houses owned by private house owners (Utrecht) no mismatches were indicated concerning these power issues. These residents opted to renovate their houses and they paid for the renovation themselves, therefore they had more power during the project. They were already actively involved in the design phase and they were also able to influence the proceedings during the renovation. This resulted in low-energy houses that better match with the needs, preferences and goals of the residents. However, also the communication towards these residents was sometimes lacking. Just like in the design-phase, it seems that also in the construction phase both housing corporations and construction companies have difficulties in cooperating with residents.

Furthermore, the mismatches identified in the in-use phase show that even informed and highly motivated residents do not always use the low-energy houses as prescribed. Just providing information about how the house and installations should be used is often not sufficient to ensure proper usage. Additional guidance and support is needed not only during the renovation and handover process but also a few weeks after the renovation. This guidance and support should also focus on changing the routines of residents which are not energy efficient to reduce the energy consumption. The mismatches in this phase show that the completion of the renovation should not be the end of the project, more attention should be paid to how residents use their low-energy houses and how they can be guided and supported during the period shortly after the renovation.

It is clear that in deep retrofitting projects more attention should be paid to the residents/users of low-energy houses. In the end, it is important that residents enjoy living in the renovated houses and that they use the low-energy house in the prescribed way so that the predicted energy savings will be realized.

6.3 Implications
In this paragraph the implications of this research are discussed. This research give rise to theoretical implications and implications for housing corporations and construction companies that take part in deep retrofitting projects. Here the theoretical implications are discussed. The implications for housing corporations and construction companies are already discussed, in the form of recommendations in the results section (paragraph 6.1).

This thesis shows besides the design- and in-use phase also the construction phase in deep retrofitting projects can influence the way low-energy houses are used. Furthermore, the empirical data reveals that the renovation process can have large impacts on residents. Residents do not only assess the final result but also the realization process (renovation) of the low-energy house. Mismatches during the renovation may lead to dissatisfaction among residents, which in turn may result in lower acceptation of the new technologies and therefore this will possibly result in lower energy performance. Therefore the construction phase is crucial in realizing high energy performances of the low-energy houses and satisfied residents who enjoy living in the deeply retrofitted houses. The mismatches that may occur during the renovation consist mainly of power issues (whether or not the residents have power to influence the proceedings), communication (whether residents will be informed when delay or damages occur) and
whether or not the housing corporation/ construction company takes the questions and complaints of residents seriously.

The mismatches in the construction phase can harm the relationship between the housing corporation and residents. Guidance and support may be important to influence the way residents will use their house and a good relationship is needed for this guidance and support to be effective. Mismatches occurring during the construction phase may also have a more direct influence on the way residents use their renovated houses. For instance, often aftercare and maintenance activities were lacking, leading to distrust in the low-energy house which may eventually lead to ineffective use of the installations. This shows that also the construction phase can have a decisive influence on the ways in which people eventually use their low-energy houses.

Jelsma (2005) already indicated (interconnected) mismatches in the design- and use-phase (figure 1). However, Jelsma (2005) separated the design(ers)- and the use(rs)-world which does not reflect deep retrofitting project since the residents already lived in the houses prior to the renovation. Residents could already customized their houses prior to the renovation or they may be able to influence the design (Utrecht). Furthermore, the construction phase is not included in this conceptual framework. However, when researchers investigate deep retrofitting projects it is important to also include the renovation process since this may have large impacts on residents and on how they use their low-energy houses. Therefore a new conceptual framework (figure 3) is created which shows how mismatches in the investigated phases may influence how residents use their low-energy houses.

Figure 6.1: Theoretical framework in which the bold arrows show the way mismatches in the design-, construction- and in-use phase affect each other and also how residents use their low-energy houses.

The mismatches which are consisting of power issues in deep retrofitting projects could be described or analyzed by the concept translation, which originates from the Actor Network Theory (Raven, Verbong, Schilpzand, & Witkamp, 2011). Raven et al. (2011) argued that ready-made solutions (the designs of low-energy houses) cannot be simply implemented into a context without negotiations and struggle. The concept translation describes four moments of the process through which actors realize their so called
Problematisation refers to framing of problems by an actor in the network so that their actor-worlds can be realized. This is done in such a way that this actor becomes an obligatory passage point, which means that this actor will become a central actor in the network (Raven et al., 2011). The mismatches described above show that residents lack power during the whole project. The problem (high energy consumption) should be reframed in such a way that it contains the needs and goals of residents (comfort, house improvements). Other actors have to realize that in order to realize the high energy saving ambitions residents should become a crucial actor in deep retrofitting projects. In this way the residents should become an obligatory passage point. The second moment is called interessement, which refers to the actions undertaken by the translator-spokesperson to interest other actors in their actor-world (Raven et al., 2011). In this case these other actors consists of residents and construction companies. As indicated in this research, residents often have other goals (such as comfort and house improvements) than the housing corporation (saving energy). To increase interest of residents in deep retrofitting projects the housing corporation should also focus on goals of residents in the negotiations. The third moment is enrolment, which is the outcome of successful interessement. Successful enrolment means that residents will accept their new roles and support it with positive actions (Raven et al., 2011). So interessement activities may lead to residents who are more motivated to cooperate during the renovation and during the in-use phase which could result in more energy efficient usage of the low-energy houses. The fourth and final moment is the mobilization of allies (Raven et al., 2011). Successful enrolment of actors is often the result of a reduction of networks (or visions) which they represent into a single element of the initial actor-world (vision). In the case of deep retrofitting projects successful enrolment of residents could lead to an increasing number of residents that share the initial actor-world or vision, which is in this case the realization of low-energy houses and reducing the energy consumption of households.

6.3 Limitations
Here several limitations of this research are briefly discussed.

To ensure the validity of the research, different measures were taken to increase the quality of research (literature study, recording and transcribing of the interviews, systematic analysis methods). Furthermore, as said in the methods section initial findings were discussed to increase inter-rater reliability. Many findings are supported by the literature, which makes them generalizable to other projects. However, it must be noted that original the construction phase was not the main focus of this research, therefore this phase was not investigated in much detail in the literature study. The research design used for this thesis made it possible to find information about what residents of low-energy houses think is important. These interviews showed that residents consider the construction phase, where many mismatches occur, as very important in assessing the overall results of the project. But due to the exploratory nature of this part of the research, these findings might be limited in generalizability.

Furthermore, during this research neutrality with respect to the data was very important. During the interviews many residents showed strong emotions (anger, disappointment, satisfaction, happiness) when the construction phase was discussed. It was important not to feel too much compassion with the
respondents because this could have influenced the objectivity of the researcher. However, it was hard to sympathize during the interviews so that respondents felt safe without reinforcing negative or positive thoughts and feelings about the renovation and the housing corporation.

Another limitation is that the sample of the interviews may not be representative for all people in the Netherlands for several reasons. First, a small sample is used which makes the findings not entirely generalizable. Secondly, the sample of the Haarlem en Kerkrade cases consist of many elderly and socially disadvantaged residents while the sample of the Utrecht case consists of early adopters who choose to invest a large amount of money in the renovation of their houses. These two groups do not represent the total population. Thirdly, the fact that many respondents in Kerkrade called after they received the letter indicated that it is possible that only the most outspoken residents did respond. In addition, it is plausible that the respondents are either very positive or negative about the renovation. For example, in the Kerkrade sample four out of nine respondents lived in the same row of houses which were renovated in the winter and have had experienced much delay and inconvenience. These negative experiences may have caused the high response for these residents. Therefore it can be stated that this sample is not representative for all households in Kerkrade. However, this sample does consist of people who did have experienced (mis)matches and is therefore still very useful for indicating possible mismatches that may occur in deep retrofitting projects. But it is clear that because of the fact that the respondents do not fully represent all residents in the projects and because of the limited sample the findings are not exhaustive and fully generalizable. But the mismatches indicated in this research can be used to guide future research to increase understanding about possible mismatches in- and also to indicate possible pitfalls for future deep retrofitting projects.

6.4 Possible directions for future research

Future research could complement findings of this research in multiple directions. Here several directions for future research are discussed.

It is argued that higher user involvement may solve several mismatches. Residents can be involved in many different ways. Future research could investigate whether these different ways of user involvement will actually lead to less mismatches and therefore higher satisfaction and better energy performances.

This study indicated several mismatches in the construction phase that can influence how residents assess the overall success of the project and how they use their low-energy houses. However, mismatches could possibly also influence residents’ behaviour in other ways than indicated in this research. Future research is needed to fully understand the impacts of mismatches that may occur in the construction phase.

Furthermore, future research could focus on the power issues that may occur between residents, the housing corporation and the construction company in deep retrofitting projects. In the theoretical implications section (paragraph 6.3.1) the concept translation is discussed. This concept could be a very useful tool in future research to analyse the relationships and translations between actors involved in deep retrofitting projects.

Future research could also focus on how residents actually use the low-energy houses and installations. Little is known about specific residents and their goals, and how different types of residents use the various installations in low-energy houses. The research should also focus on pilots in which residents
receive additional guidance and support during the in-use phase to see which interventions are successful in influencing the way residents use low-energy houses.

In this research many mismatches are indicated, however it is unclear whether all mismatches will actually influence (and to what extent) the energy performance of low-energy houses. Future research should also monitor the energy performances of the houses to gain understanding on how this is affected by the numerous mismatches occurring in deep retrofitting projects.
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Appendices

Appendix A: Definitions

At the moment different definitions of energy efficient houses exist. Four relevant and commonly used definitions and their characteristics are shown in table 1.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Includes building-related energy use</th>
<th>Includes energy use of domestic appliances</th>
<th>Energy performance coefficient (EPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy neutral house</td>
<td>Yes</td>
<td>No</td>
<td>EPC = 0</td>
</tr>
<tr>
<td>Zero-energy house</td>
<td>Yes</td>
<td>Yes</td>
<td>EPC &lt; 0</td>
</tr>
<tr>
<td>Low-energy house</td>
<td>Yes</td>
<td>Yes</td>
<td>EPC &lt; or = or &gt; 0</td>
</tr>
<tr>
<td>Passive house</td>
<td>Yes</td>
<td>No</td>
<td>EPC &gt; 0</td>
</tr>
</tbody>
</table>

Table 1: This table shows the main differences between the different definitions.

Building-related energy use covers energy use such as heating, cooling and domestic hot water. Energy use of domestic appliances covers energy use of things like lighting, the dishwasher and the television. The energy performance coefficient (EPC) is defined in the norm NEN 7120, some important characteristics of this norm will be briefly explained below:

- Energy use will be determined under standard use and normal climate conditions
- Only building-related energy use is included in the calculations
- Energy generation can take place in- or outside the building
- Renewable energy sources will be valued
- The net energy use will be calculated over a year

A house is energy neutral when the energy production equals the building-related energy usage (Agentschap NL, 2013).

The definition zero-energy house (or “zero on the meter”) includes all energy use in buildings which is visible on the energy meter, thus it includes both building related and domestic energy use. The sustainable energy production of the house thus equals the total energy use in the building over a year, under normal climate conditions and normal usage (Energiesprong, 2013). Since this definition includes energy use from both building-related and domestic appliances in the calculations, the EPC of these buildings will be lower than 0 (Agentschap NL, 2013).

Just like the definition of zero-energy houses, low-energy houses include both building-related and domestic appliances in the calculations (Duurzaam Thuis, -). The difference between zero- and low-energy houses is that for low-energy houses the incoming energy flow is bigger than the outgoing energy flow. So these low-energy houses still use energy from the gas- or power grid.

In passive houses the heat losses are minimized due to passive measures which use heat from the sun and the earth optimally, these measures could be things like: good insulation, draft proofing, efficient ventilation with heat recovery, passive solar energy, etc. (Agentschap NL, 2013) (Duurzaam Thuis, -). Because of these measures passive houses do not need a heating system (Duurzaam Thuis, -). The EPC of these passive houses are normally between 0.3 and 0.4 (Agentschap NL, 2013).
For the master thesis, the definition of low-energy houses is most important, because most of the cases involve projects aiming at realising low-energy houses with often 60% or 80% energy reduction. Important to keep in mind with this definition of low-energy houses is that the energy reductions include both domestic- and building-related energy use.
Appendix B: Energiesprong

Energiesprong is an innovation program carried out by Platform31, which is a knowledge- and network organization for regional and urban development, they support professionals and organizations which face social-, economic- and spatial issues. Together with partners, Platform31 produces and shares scientific knowledge, sets up experiments and creates networks. (Platform31, 2013) Energiesprong is commissioned by the Ministry of Internal Affairs and Kingdom Relations. It aims to create a demand for, and supply of, zero-energy buildings. Energiesprong intends to support the transition to a more sustainable building sector in which the starting point is that a change is needed in the processes and methods used in the building sector. According to Platform31 (2013) for an energy transition to occur in the building sector changes are needed, such as different ways of calling for tenders, increasing financial possibilities, and changes in laws and regulations. (Energiesprong, Website, 2013)

The innovation program Energiesprong has three main priorities (Spies, Nationaal plan, 2012):

1. Accelerating the development and implementation of energy saving measurements with high energy ambitions in renovation projects.
2. Accelerating the development of energy saving measurements with an integrated approach of design and implementation.
3. Adding user aspects and usability in the design process of low-energy houses.

Energiesprong selects projects that have high energy-saving ambitions, that are large (housing projects should include at least 30 houses to qualify for the subsidies of Energiesprong), that have the potential to be replicated elsewhere and that perform process innovation. They aim for all kinds of buildings such as houses, offices, shops and hospitals. (Energiesprong, Website, 2013) The selected projects receive different forms of support from Energiesprong, the two main activities of Energiesprong consist of financial support and of sharing knowledge and experiences of frontrunners in their projects (Energiesprong, Website, 2013). Energiesprong supports and implements many initiatives which aim to stimulate the development of zero- and low-energy buildings. Participating actors of these initiatives are housing corporations, associations of private house owners, construction companies, and mixes of these groups. Of these initiatives, the following two are particularly relevant in view of the multiple case study that will be performed:

- ‘Trajectaanpak Woningbouw’: Energiesprong made an appeal for ambitious renovation projects which aim to realize an energy reduction of 60% and 80%, both for at least 30 houses. Projects which conform to these requirements received financial support. (Energiesprong, Website, 2013)

- ‘Woningrenovatie 80%’: Energiesprong made an appeal for ambitious renovation projects which aim to realize an energy reduction of 80% for at least 30 houses. Projects which conform these requirements receive financial support. (Energiesprong, Website, 2013)
Appendix C: The BoB project

As said the research underlying this thesis is performed in collaboration with DuneWorks BV. The data used for this thesis is also used in the BoB project. The latter is briefly described below.

The BoB research (Bewoners ontmoeten Bouwers; Residents meet Builders) is commissioned by Platform 31 (see above). This research aims to improve understanding about the possibilities to use energy performance contracts for deeply retrofitted or new low-energy houses between residents and housing providers (housing corporation, builder, consortium). The main purpose of an energy performance contract is to guarantee the aimed energy reduction of a building to the owner or tenant. In this way the building owner gain more certainty about the benefits of an investment. Starting point of the study is to investigate the way residents use their deeply retrofitted houses and installations and how this could be incorporated in energy performance contracts.
**Appendix D: Interview questions for the interviews with project leaders**

<table>
<thead>
<tr>
<th></th>
<th><strong>Interview Penvoerder:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Datum:</strong></td>
</tr>
<tr>
<td>1</td>
<td><strong>Projectgerelateerde vragen</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Proces:</strong></td>
</tr>
<tr>
<td></td>
<td>- Hoe zijn de (toekomstige) bewoners betrokken geweest bij de ontwerpen/plannen voor de renovatie/nieuwbouw? (participatie, afstemming, informative, mee-ontwerpen)</td>
</tr>
<tr>
<td></td>
<td>- Hoe is dit proces tot nog toe verlopen?</td>
</tr>
<tr>
<td>3</td>
<td><strong>Verwachtingen:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Proces:</strong> Wat verwacht u van het verdere verloop?</td>
</tr>
<tr>
<td></td>
<td><strong>Gebouw:</strong> Wat verwacht u van de nieuwe woningen en installaties? Worden de beloofde prestaties mbt energiereductie gehaald? Wat verwacht u mbt onderhoud(svriendelijkheid)? Gaat u dat monitoren? Hoe? (mbt project energiemonitoring?)</td>
</tr>
<tr>
<td></td>
<td><strong>Bewoners:</strong></td>
</tr>
<tr>
<td></td>
<td>- Hoe verwacht u dat de prestaties van de nieuwe woningen beïnvloed worden door het gedrag van de bewoners?</td>
</tr>
<tr>
<td>4</td>
<td><strong>Bewoners en hun gedragingen</strong></td>
</tr>
<tr>
<td></td>
<td>- Wordt er van bewoners gevraagd dat ze hun gedrag/routines veranderen?</td>
</tr>
<tr>
<td></td>
<td>- Zoja, op wat voor manier/in welk opzicht?</td>
</tr>
<tr>
<td></td>
<td>- Worden ze daarin begeleid? Hoe, wanneer en hoe vaak, door wie? Verwacht u dat dat voldoende is?</td>
</tr>
<tr>
<td></td>
<td>- Wat denkt u dat bewoners belangrijk vinden als het gaat om: het process; de nieuwe/gerenoveerde woning; de begeleiding; wooncomfort en belevenis.</td>
</tr>
<tr>
<td></td>
<td>- Heeft u vragen over bewoners en hun gedragingen waar u graag meer inzicht in zou willen?</td>
</tr>
<tr>
<td>5</td>
<td><strong>Energieprestaties</strong></td>
</tr>
<tr>
<td></td>
<td>Wie is waarvoor verantwoordelijk:</td>
</tr>
<tr>
<td></td>
<td>- prestatie van de woning?</td>
</tr>
<tr>
<td></td>
<td>- Hoe wordt dat gemeten? Welke indicatoren?</td>
</tr>
<tr>
<td></td>
<td>- Hoe wordt onderscheid gemaakt tussen gedrag en gebouw als oorzaak?</td>
</tr>
<tr>
<td></td>
<td>- Wat vindt u van energieprestatiecontracten als middel om de afspraken en verantwoordelijkheden te verankeren? Waarom wel/niet?</td>
</tr>
<tr>
<td></td>
<td>- Voordelen en nadelen:</td>
</tr>
<tr>
<td></td>
<td>- Tussen welke partijen zouden deze afgesloten worden in uw geval?</td>
</tr>
<tr>
<td>6</td>
<td><strong>Praktisch, voor als we de bewoners gaan benaderen (<strong>een 10-tal interviews max</strong>)</strong></td>
</tr>
<tr>
<td></td>
<td>Hoe zijn de bewoners georganiseerd? Is er een bewonersvereniging, commissie, of iets dergelijks? Heeft u contactgegevens daarvan voor ons?</td>
</tr>
<tr>
<td></td>
<td>Zijn er bewoners waar u contact mee heeft en die we zouden kunnen benaderen?</td>
</tr>
<tr>
<td>7</td>
<td><strong>Overig:</strong></td>
</tr>
</tbody>
</table>
Appendix E: Letters to residents

Haarlem:

Geachte ..., 

Sinds enige maanden woont u in een gerenoveerde woning. De renovatie in uw buurt is ingrijpend geweest. Wellicht heeft u ideeën over wat goed is gegaan en wat beter had gekund. Wij, Sylvia Breukers, Ruth Mourik en Luc van Summeren van het bedrijf DuneWorks, onderzoeken wat bewoners zoals u van de renovatie en de woning vinden.

Graag zouden we binnenkort langskomen bij u thuis voor een gesprek hierover. Het gesprek duurt ongeveer een uur, met aandacht voor vragen als: Hoe ging het renovatieproces? Hoe bent u begeleid, waarover bent u tevreden en waarover minder of niet? Hoe bevalt de woning nu? Wat is er veranderd? Misschien kunnen we ook een rondje door het huis lopen?

Het gesprek maakt deel uit van onderzoek dat op verschillende momenten wordt gedaan bij de gerenoveerde woningen in de Amsterdamse buurt (zie ook bijlage 1). Opdrachtgever is Platform31, een organisatie die woningrenovaties met energiebesparende maatregelen stimuleert. Op basis van de gesprekken in de Amsterdamse Buurt en in buurten elders in Nederland waar vergelijkbare renovaties hebben plaatsgevonden stellen we aanbevelingen op om bij volgende projecten de wensen en behoeften van bewoners zo goed mogelijk mee te nemen. Wellicht kunt u hieraan bijdragen met uw suggesties. Dit onderzoek wordt NIET in opdracht van Elan Wonen uitgevoerd maar vanuit Platform31, en is daarmee onafhankelijk, we kunnen onze eigen conclusies trekken.

Wilt u meedoen of heeft u nog vragen? Neem dan alstublieft contact met ons op:

Mail sylvia.breukers@duneworks.nl of bel 06 520 171 39

Alvast hartelijk dank en hopelijk tot ziens!

Sylvia Breukers (tel 06 520 171 39)

DuneWorks B.V.

Eschweilerhof 57

5625 NN Eindhoven
Bijlage 1. Onderzoek en Monitoring Projecten Energiesprong

Omdat het renovatieproject in de Amsterdamse Buurt vernieuwend is (tot wel 60% energiereductie), wordt er onderzoek gedaan naar wat goed is gegaan en wat beter kan. Daarbij wordt aandacht besteed aan de volgende aspecten:

<table>
<thead>
<tr>
<th>Onderzoek gericht op:</th>
<th>Wat?</th>
<th>Wanneer?</th>
<th>Door wie?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bewoners</td>
<td>Gesprekken met bewoners</td>
<td>Binnenkort (november of december 2013)</td>
<td>DuneWorks B.V.</td>
</tr>
<tr>
<td></td>
<td>(zie de brief)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bewoners</td>
<td>Enquêtes onder bewoners</td>
<td>In 2014 als u al geruime tijd in de woning woont</td>
<td>RIGO</td>
</tr>
<tr>
<td>Het renovatieproces</td>
<td>Gesprekken met woningbouwcorporatie Elan, bouwers, installateurs</td>
<td>Doorlopend</td>
<td>TNO</td>
</tr>
<tr>
<td>Prestatie van de woningen</td>
<td>Metingen van energieverbruik van In 2014, als u al geruime tijd in de woning woont</td>
<td>Verbeek</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kijken of de apparatuur in de woning voldoet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

U ziet in de laatste kolom verschillende namen. RIGO, TNO en Verbeek doen samen onderzoek dat kijkt naar bewonerstevredenheid, het renovatieproces en de prestatie van de woningen. Dat onderzoek heet Monitoring Energiesprong en wordt gedaan in opdracht van Platform31 (www.platform31.nl).
De onderzoekers van DuneWorks komen de komende weken bij bewoners thuis langs voor een gesprek, daarover gaat de brief. In 2014 zal RIGO enquêtes houden dus daarvoor zult u in de in de loop van 2014 nog benaderd worden. Deze enquête is een vragenlijst die u kunt invullen.
Kerkrade:

Eindhoven, 3 december 2013

Geachte bewoner(s),

Sinds enige tijd woont u in een gerenoveerde woning. De renovatie in uw buurt is ingrijpend geweest. Wellicht heeft u ideeën over wat goed is gegaan en wat beter had gekund. Wij, Sylvia Breukers en Luc van Summeren van het bedrijf DuneWorks, onderzoeken wat bewoners zoals u van de renovatie en de woning vinden.

Graag zouden we binnenkort langskomen bij u thuis voor een gesprek hierover. Het gesprek duurt ongeveer een uur, met aandacht voor vragen als: Hoe ging het renovatieproces? Hoe bent u begeleid, waarover bent u tevreden en waarover minder of niet? Hoe bevalt de woning nu? Wat is er veranderd? Misschien kunnen we ook een rondje door het huis lopen?

Het gesprek maakt deel uit van onderzoek dat op verschillende momenten wordt gedaan bij de gerenoveerde woningen in Kerkrade. Opdrachtgever is Platform31, een organisatie die woningrenovaties met energiebesparende maatregelen stimuleert. Op basis van de gesprekken in Kerkrade en elders in Nederland waar vergelijkbare renovaties hebben plaatsgevonden stellen we aanbevelingen op om bij volgende projecten de wensen en behoeften van bewoners zo goed mogelijk mee te nemen. Wellicht kunt u hieraan bijdragen met uw suggesties. Dit onderzoek wordt NIET in opdracht van Heemwonen uitgevoerd maar vanuit Platform31, en is daarmee onafhankelijk, we kunnen onze eigen conclusies trekken.

Wilt u meedoen of heeft u nog vragen? Neem dan alstublieft contact met ons op:

Mail sylvia.breukers@duneworks.nl of bel 06 520 171 39

Alvast hartelijk dank en hopelijk tot ziens!

Sylvia Breukers (tel 06 520 171 39)

DuneWorks B.V.

Eschweilerhof 57

5625 NN Eindhoven
Appendix F: Checklist interviews with residents

<table>
<thead>
<tr>
<th>1</th>
<th>Mbt nieuwe woning algemeen:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wat verwacht u van deze (her)nieuwe woning? (denk aan verbetering comfort en woongenot?).</td>
<td></td>
</tr>
<tr>
<td>Hoe bevalt de nieuwe woning?</td>
<td></td>
</tr>
<tr>
<td>Wat bevalt beter dan verwacht?</td>
<td></td>
</tr>
<tr>
<td>Wat is minder/even wennen?</td>
<td></td>
</tr>
<tr>
<td>Voldoet de woning aan uw verwachtingen?</td>
<td></td>
</tr>
<tr>
<td>Hoe is dat voor andere gezinsleden?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Begeleiding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoe bent u begeleid in uw nieuwe woning?</td>
<td></td>
</tr>
<tr>
<td>Wie is verantwoordelijk voor onderhoud van de verschillende installaties?</td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>3</th>
<th>Comfort &amp; verwarming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoe werkt de verwarming en hoe verwarmt u? Welke ruimtes?</td>
<td></td>
</tr>
<tr>
<td>Wat is comfortabel en hoe wordt daar over gedacht door verschillenden leden vh huishouden?</td>
<td></td>
</tr>
<tr>
<td>Wat is anders/veranderd in vergelijking met de vorige woning?</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>4</th>
<th>Comfort &amp; douchen/baden: condens en schimmel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoe vaak wordt er gedoucht door elk van de gezinsleden? Enig idee hoe lang? Bad- idem. Spaar-douchekop?</td>
<td></td>
</tr>
<tr>
<td>Verschillen tussen leden huishouden? Wordt daarover gesproken? Vergelijkbaar met vorige woning of is het anders nu?</td>
<td></td>
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<table>
<thead>
<tr>
<th>5</th>
<th>Ventilatiesysteem en gebruik daarvan/interactie met ventilatiesysteem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gebruik van ramen en deuren</td>
<td></td>
</tr>
<tr>
<td>Hoe ventileren jullie? Hoe werkt de ventilatie? Doen jullie daar iets mee; zoja, wie? Zonee, waarom niet? Iets anders/veranderd ivm vorige woning?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6</th>
<th>Koken, eten, bewaren</th>
</tr>
</thead>
<tbody>
<tr>
<td>Let u op gasverbruik bij het koken? Zoja, hoe? Andere gezinsleden?</td>
<td></td>
</tr>
<tr>
<td>Wat voor koelkast heeft u? Welke stand staat ie meestal? En uw vriezer? Waar staat ie en staat ie altijd aan? (is ie meestal vol? Zelfde stand winter als zomer?)</td>
<td></td>
</tr>
<tr>
<td>Iets anders/veranderd in vergelijking met de vorige woning?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7</th>
<th>Overig: (af)wassen; PC, stereo, TV, Airco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afwasmachine, wasmachinegebruik en droger (temperatuur, helemaal vol?)</td>
<td></td>
</tr>
<tr>
<td>TV, stereo, computers (stand-by; staan apparaten aan als niemand ze gebruikt)</td>
<td></td>
</tr>
<tr>
<td>Overige apparatuur die veel energie verbruikt?</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>8</th>
<th>Energieverbruik en inzicht daarin (rekeningen); zelf opwekken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energiebewustzijn en interesse daarin algemeen; zelf en andere bewoners</td>
<td></td>
</tr>
<tr>
<td>Wekt u ook zelf energie op (PV?; warmtepomp,?)</td>
<td></td>
</tr>
<tr>
<td>Wie betaalt de energierekening?</td>
<td></td>
</tr>
<tr>
<td>Houdt u in de gaten of de rekening hoger of lager uitvalt door de tijd heen? (Zonee, hoe komt dat).</td>
<td></td>
</tr>
<tr>
<td>Is de energierekening wel eens onderwerp van gesprek tussen gezinsleden? Zoja, hoe gaat dat dan?</td>
<td></td>
</tr>
<tr>
<td>Wie heeft er het meeste verstand van energie-gerelateerde kwesties?</td>
<td></td>
</tr>
<tr>
<td>Is energie voor u aan milieu en/of duurzaamheid gekoppeld? Zoja, hoe?</td>
<td></td>
</tr>
<tr>
<td>Bent u energiebewust?</td>
<td></td>
</tr>
<tr>
<td>En de andere gezinsleden?</td>
<td></td>
</tr>
<tr>
<td>Wordt er over energie gesproken? Hoe gaat dat dan?</td>
<td></td>
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</tbody>
</table>

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<thead>
<tr>
<th>9</th>
<th>Binnenmilieu (geluid, temperatuur, licht, CO2/stof/geur, luchtkwaliteit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent u tevreden over het binnenklimaat mbt geluid, temperatuur, licht, CO2/stof/geur, luchtkwaliteit?</td>
<td></td>
</tr>
<tr>
<td>Hoe was het eerst?</td>
<td></td>
</tr>
<tr>
<td>Wat is veranderd?</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>10</th>
<th>Mbt nieuwe woning: ICT in huis; Privacy kwesties (in geval van monitoring en slimme meters); Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoe bent u wegwijs gemaakt mbt de nieuwe woning? En andere gezinsleden? Bent u goed geïnformeerd over hoe de verwarming werkt? En de ventilatie? Elektriciteitsvoorziening?</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Sociaal demografische aspecten</td>
</tr>
<tr>
<td>----</td>
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<table>
<thead>
<tr>
<th>12</th>
<th>Renovatieproces</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hoe is het renovatieproces verlopen?</td>
</tr>
<tr>
<td></td>
<td>Wat viel mee/tegen?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13</th>
<th>Huurverhoging vs. verbeteringen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weegt de huurverhoging op tegen de verbeteringen in de woning?</td>
</tr>
<tr>
<td></td>
<td>Wat is uw verwachting over de daling van het energieverbruik? Weegt dit op tegen de huurverhoging?</td>
</tr>
</tbody>
</table>
Appendix G: Historical context (1995 – 2013)

1995: Energy Performance Co-efficient: 1.4
Since 1995 all new buildings have to conform to a minimum energy performance indicated by the Energy Performance Co-efficient (EPC-value) (W/E adviseurs, 2010). This EPC-value addressed all building related energy use but no user-related energy use (Opstelten, Weterings, & Versteeg, 2011). Originally the EPC-value was set at 1.4 and it is tightened over the years so that it will be 0 in 2020, this means that yearly the overall building related energy use should equal the energy generation of the building (SER, 2013)(Spies, Nationaal plan, 2012) (Opstelten, Weterings, & Versteeg, 2011). A tightening of the EPC is always backed with feasibility studies which examine the cost effectiveness, effects on the quality of the indoor environment and the maturity of applied techniques (Spies, Nationaal plan, 2012).

1996: National sustainable building manuals
In 1996 the foundation Bouwresearch introduced digital manuals in which a collection of concepts and measures were described. They formed the basis for agreements between actors in the building sector about the concept sustainable building and how to realize this. After these manuals 33 housing- and 17 non-residential building demonstration projects were performed. (W/E adviseurs, 2010)

1996: The development of instruments for assessing the environmental quality of buildings
Around 1996, also some models for assessing the environmental quality of buildings were developed. The most important models developed were GPR Gebouw, EcoQuantum and Greencalc. Some of these models were updated over the years and are still being used. (W/E adviseurs, 2010)

1998: Energy Performance Co-efficient: 1.2
In 1998 for new houses the EPC was set at 1.2 (Spies, Nationaal plan, 2012).

2000: Energy Performance Co-efficient: 1.0
In 2000 for new houses the EPC was set at 1.2 (Spies, Nationaal plan, 2012).

2002: BANS climate agreement
The Bans climate agreement was in force between 2002 and 2007. The national government, provinces and municipalities agreed to provide subsidies for projects which aimed for lowering CO₂ emissions including sustainable building projects. The maximum amount of subsidies provided by this program is 37 million euro. (Pronk, 2002)

2004: Toolkit sustainable housing
To stimulate the realization of low energy housing a toolkit was developed. This toolkit consists of 28 realistic energy concepts for housing which can reduce CO₂ emissions with 50%. It gives information about building physics, installations, costs, processes and issues of implementation. (W/E adviseurs, 2010)

2006: Energy Performance Co-efficient: 0.8
In 2006 for new houses the EPC was set at 0.8 (Spies, Nationaal plan, 2012).

2006: Platform for energy transition of the built environment
In 2006, an interdepartmental Program-bureau Energy transition was formed in the Netherlands. After this several energy transition platforms were installed for the realization of a sustainable future, these
platforms were formed around several key technologies. One of these platforms focuses on the transition in the built environment: platform for energy transition of the built environment (PeGO). This platform consists of individuals with their roots in different actors of the building process: project development, contractors, local authorities, housing corporations, research and manufacturers in the supply chain. The platform is led by the former minister of economic affairs. Energiesprong originates from this platform. (PeGO, 2013)

In 2007 a common goal was presented: “the realization of an energy neutral built environment in the Netherlands in the middle of this century” (Opstelten et al., 2011). Three plans resulted from this common goal:

1. Regulation: removing legislative obstacles or omissions to stimulate the energy transition of the sector (Opstelten et al., 2011).
2. More with less (started in 2009): More with less is a foundation which aims for accelerating the adoption of cost-effective energy concepts in the renovation sector to lower the energy use in existing buildings (Spies, Brinkman, Alders, & Engels, 2012).
3. Innovation: develop integral concepts and systems for buildings and communities with high energy ambitions (Opstelten et al., 2011).

For these initiatives, the total energy consumption of a building is taken into account, including both building- and user-related energy consumption. This was a major change in the way the actors in the building sector have approached the subject of energy. Up to this point, actors in the building sector, both in the Netherlands and elsewhere, were only concerned with building related energy expressed in the energy performance coefficient. (Opstelten, Weterings, & Versteeg, 2011)

2007: Clean and economical: new energy for the climate
This policy program focused on energy-savings, renewable energy and CO₂ storage (W/E adviseurs, 2010). Important sector agreements following from this program are:

- Spring-agreement energy-savings for new buildings (2008): the government and development and building actors made an agreement concerning energy-saving for new buildings. The aim was to lower the building related energy-use of all new shops, houses and offices with 50% between 2007 and 2015. As indicated in the explanatory notes of the agreement, market parties thought they could mainly affect the building-related energy use and not the domestic energy use. For this reason the domestic energy use is excluded from the goals in the spring-agreement. The intention is that as of 2020 all new buildings will be energy neutral. Another part of this agreement is that ‘excellent areas’ will be selected in which ambitious and large innovative building projects will be realized. (Vogelaar, Cramer, Brinkman, Werner, & Goossens, 2008)
- Covenant energy-savings housing corporations: housing corporations and tenants will be supported by the government to implement energy-saving measurements which should lead to decreasing energy-use and housing costs (W/E adviseurs, 2010).

2007: Sequel BANS climate agreement
Since 2007 the BANS climate agreement originated from 2002 was continued, the national government, provinces and municipalities provided subsidies for projects which aimed for lowering CO₂ emissions
including sustainable building projects. The maximum amount of subsidies provided by this program is 6 million euro. (van Geel, 2006)

2008: Energy labels for existing buildings
Since January the first 2008, existing houses need an energy label if they are sold or leased, this label gives information about the energy efficiency of the house (W/E adviseurs, 2010).

2009: Breeam.nl
The Dutch Green Building Council assigned Breeam.nl as the independent measurement for assessing the environmental quality of buildings (W/E adviseurs, 2010).

2009: Lowering BTW rate
Since 2009 the value added tax for insulation activities and for labour costs for renovations and maintenance is lowered from 19% to 6%. This was done to stimulate investments in energy efficiency measures (Spies, Nationaal plan, 2012).

2010: EU 2020 strategy
The European Union formed five main goals which have to be achieved by every EU-country in 2020 (Europe 2020, 2010). These goals are used to check whether the strategies of the EU-countries are sufficient. One of these goals, consisting of three parts, is focused on climate change and (renewable) energy:

- Reduction of CO₂-emissions by 20% compared with 1990
- 20% of the energy is generated with renewable energy sources
- 20% increase in energy efficiency

2010: Selection ‘excellent areas’
Projects in the excellent areas will be subsidized by the government, which is part of the implementation of the spring-agreement (W/E adviseurs, 2010).

2011: Energy Performance Co-efficient: 0.6
In 2011 for new houses the EPC was set at 0.6 (Spies, Nationaal plan, 2012).

2011: Innovation program ‘Energiesprong’
The innovation program Energiesprong started in 2011, it has three main priorities (Spies, Nationaal plan, 2012):

1. Accelerating the development and implementation of energy saving measurements with high energy ambitions in renovation projects.
2. Accelerating the development of energy saving measurements with an integrated approach of design and implementation.
3. Adding user aspects and usability in the design process of low-energy houses.

More information about this program can be found in chapter 3.

2011: ‘Blok-voor-Blok aanpak’
This approach supports demonstration projects in which in total 10,000 houses will be renovated in 2013 resulting in higher energy efficiency (Spies, Nationaal plan, 2012). The maximum amount of subsidies
provided by this program is 4 million euro (Donner, 2011). The aim of this approach was to gain experience with new financing structures, marketing models and forms of quality assurance (Spies, Nationaal plan, 2012). Within this approach also attention is paid to the end users and behavioural change (Spies, Nationaal plan, 2012).

2013: Deal ‘De Stroomversnelling’
On June the 20th four big construction companies and six housing corporations signed the deal: ‘De Stroomversnelling’. This was done in the presence of the Minister of Dwelling: Stef Blok. This deal consists of three new ideas which will make it possible to renovate 111,000 houses to zero-energy houses.

(1) Tenants will pay their energy bill to the housing corporation instead of the energy companies, (2) this money will be used for investments in renovations (3) which should lead to the realization of houses without energy bills (zero-energy houses) (Keijts, et al., 2013).

The deal consists of three phases (Keijts, et al., 2013):

1. Prototyping: renovation of 1,000 houses between September 2013 and December 2014.
2. Industrialization: renovation of 10,000 houses between January 2015 and December 2016.

2013: Energy agreement
One important and recent agreement in the Netherlands is the energy-agreement (Energieakkoord) (SER, 2013). This agreement was completed on the sixth of September; over forty different parties are involved in realizing four goals in the field of energy-saving and –generation (SER, 2013). These four goals are:

- A yearly on average reduction of the energy consumption of 1.5 percent which stands for a reduction of the energy consumption of 100 petajoule \( (x10^{15}) \) in 2020.
- An increase of the proportion of renewable energy generation which is now 4% to 14% in 2020.
- A further increase of this proportion of renewable energy generation to 16% in 2023.
- The creation of 15,000 jobs mainly in the next few years.

The first three goals are of importance for low energy houses, and are therefore discussed in more detail. First, energy saving is seen as a key point. The starting point is that energy saving must lead to benefits for citizens and companies, and that they will take responsibility to save energy. The measures will consist of a combination of the provision of information, awareness creation, unburdening and funding support (SER, 2013). Measures with importance for the housing sector are shown here:

- All houses will get an energy label to create awareness about the energy performance of their home.
- Energy companies will get new financing options in which consumers will get the option to pay their loan through their energy bills.
- The Dutch government will provide €400 million for landlords in the social housing sector for investments in energy savings.
- An independent office that will provide the whole building sector with expertise will be created, this office will support and inform about the most effective measures for increasing energy efficiency.
The second and third goal both aim for increasing the proportion of renewable energy generation, which is now 4%, to 14% in 2020 and 16% in 2023 (SER, 2013). Measures important for the housing sector are shown here:

- 375 Million will be available till 2020 to support citizens and companies for supporting renewable energy generation.
- Citizens will get more options to generate energy for themselves.
- Local initiatives will be supported by municipalities, provinces and the government.
- From the first of January 2014, cooperative energy generation will profit from tax discounts if the energy will be used close to the place of generation.

2015: Energy Performance Co-efficient: 0.4
The plan is to lower the EPC for new houses to 0.4 in 2015 (Spies, Nationaal plan, 2012).

2020: Energy Performance Co-efficient: 0.0
The plan is to lower the EPC for new houses to 0.0 in 2020 (Spies, Nationaal plan, 2012). So since 2020 new houses must be energy neutral (SER, 2013).
Appendix H: List of recent projects and initiatives

To gain more insight in the recent developments of low-energy houses, an overview is presented of recent projects. According to Energiesprong these projects are considered ‘inspiring’ because of their high ambitions and innovative character (Energiesprong, Inspirerende projecten, 2013). A distinction is made between new build houses and renovation projects. To make more sense of these overviews, first another overview is presented that shows the number of houses with the different energy labels in the Netherlands. Next, an overview of renovation projects is shown, followed by an overview of projects in which new low-energy houses were build.

As shown in table 1, 2.042.714 houses had an energy label in 2011. 86.2% of these houses had an energy label of C or lower. So there are many houses which can be improved in terms of energy efficiency.

<table>
<thead>
<tr>
<th>Number of houses with the different energy labels</th>
<th>Total</th>
<th>A and B</th>
<th>C and D</th>
<th>E, F and G</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.042.714</td>
<td>282.686</td>
<td>1.162.153</td>
<td>597.875</td>
</tr>
<tr>
<td>Proportion</td>
<td>100%</td>
<td>13.8%</td>
<td>56.9%</td>
<td>29.3%</td>
</tr>
</tbody>
</table>

Table 1: Number of houses with the different energy labels (CBS, 2013).

Here a summary of renovation of energy efficient houses is shown:

<table>
<thead>
<tr>
<th>Year, location, name</th>
<th>Houses</th>
<th>Ambition</th>
<th>Building owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed in 2009, Zwolle, Duurzame renovatie Rembrandtflat</td>
<td>One flat with 100 apartments</td>
<td>Energy label: E/F → A. CO₂ reduction of 40%</td>
<td>Housing corporation Openbaar Belang</td>
</tr>
<tr>
<td>Completed in 2012, Amsterdam, restauratieproject ‘de Koningsvrouwen van Landlust’</td>
<td>245 After the restoration/renovation there were 188 (bigger) houses instead of 245 houses.</td>
<td>Energy label: G → A/AA. CO₂ reduction of 49%</td>
<td>Housing corporation Eigen Haard</td>
</tr>
<tr>
<td>Completed in 2009, Biddinghuizen, duurzame renovatie</td>
<td>85</td>
<td>Energy label: E/F/G → A CO₂ reduction of 45%</td>
<td>Housing corporation Oost Flevoland Woondiensten</td>
</tr>
<tr>
<td>Completed in 2013, Vogelenbuurt Ulf, renovatie 115 VANEG-woningen</td>
<td>115</td>
<td>Energy label: ? → A/A+ 30 of the 115 houses will be energy neutral</td>
<td>Housing corporation Wonion</td>
</tr>
<tr>
<td>To be completed in 2013, Kerkrade, ‘Bestaande Wijk van Morgen’</td>
<td>153</td>
<td>Energy label: D → A++</td>
<td>Housing corporation HEEMwonen and five private house owners</td>
</tr>
<tr>
<td>To be completed in 2014, Haarlem, Amsterdamse Buurt in Haarlem renoveert naar A+</td>
<td>108</td>
<td>Energy label: F → A+ Energy reduction: 37 houses 60% energy reduction, 71 houses 80% energy reduction.</td>
<td>Housing corporation Elan Wonen</td>
</tr>
<tr>
<td>Unknown (to be completed), Utrecht, In</td>
<td>30</td>
<td>Energy reduction of 80%</td>
<td>18 private house owners and housing</td>
</tr>
<tr>
<td>Utrecht renoveren particulieren en woningcorporatie naar 80% energiereductie</td>
<td></td>
<td>corporation Lopik</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Unknown, (to be completed) Leeuwarden, In stadsregio Leeuwarden werken particulieren en corporatie samen naar 80% energiereductie</td>
<td>30</td>
<td>Energy reduction of 80%</td>
<td></td>
</tr>
<tr>
<td>Unknown (to be completed), Haarlem, Hof van Egmond</td>
<td>154</td>
<td>Energy label: ? → A Energy reduction of 60% and 80%</td>
<td></td>
</tr>
<tr>
<td>Unknown (cancelled), Apeldoorn, Schilderskwartier</td>
<td>188</td>
<td>Energy label: ? → B</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Overview of renovation projects in the Netherlands in which houses will be renovated towards low-or zero-energy houses (Energiesprong, Inspirerende projecten, 2013).

Here a summary projects of the last year in which new energy efficient houses were build are shown (Energiesprong, Inspirerende projecten, 2013):

<table>
<thead>
<tr>
<th>Year, location, name</th>
<th>Houses</th>
<th>Ambition</th>
<th>Construction company/ principal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed in 2009, Amsterdam, ‘Woonhuis 2.0 = energieneutraal’</td>
<td>1</td>
<td>Energy neutral</td>
<td>Faro architects</td>
</tr>
<tr>
<td>Completed in 2011, Enschede, ‘duurzaam appartementencomplex het kotmanpark’</td>
<td>A flat with 54 apartments</td>
<td>EPC: 0.48 CO₂ reduction of 45%</td>
<td>Housing foundation de Woonplaats</td>
</tr>
<tr>
<td>Completed in 2011, Spaarnwoude/ Haarlemmerliede, ‘Nieuwbouwwijk Spaarnebuiten’</td>
<td>50</td>
<td>EPC: 0.49 CO₂ reduction of 46%</td>
<td>VolkerWessels Vastgoed</td>
</tr>
<tr>
<td>Completed in 2012, Bergschenhoek, ‘nieuwbouw cradle-to-crade’</td>
<td>1</td>
<td>EPC: 0.23</td>
<td>XXarchitecten</td>
</tr>
<tr>
<td>Completed in 2012, Ulft, ‘nieuwbouwwijk de Bomenbuurt’</td>
<td>61</td>
<td>EPC: 0 CO₂ reduction: all houses are energy neutral</td>
<td>Housing corporation Wonion</td>
</tr>
<tr>
<td>Completed in 2012, Roosendaal, ‘duurzame renovatie in de Kroeven’</td>
<td>61</td>
<td>Energy label: ? → A, EPC to 0.4, CO₂ reduction of 60%</td>
<td>Housing corporation Aramis AlleeWonen</td>
</tr>
<tr>
<td>Completed in 2012, Enschede, ‘Passiefhuizen</td>
<td>80</td>
<td>EPC: 0.35 CO₂ reduction of 59%</td>
<td>Housing corporation De Woonplaats</td>
</tr>
<tr>
<td>Project Description</td>
<td>EPC</td>
<td>CO₂ Reduction</td>
<td>Contractor/Developer</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>-----</td>
<td>---------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Completed in 2013, Eindhoven, ‘Nieuwbouwijk Berckelbosch’</td>
<td>900</td>
<td>0.4</td>
<td>Ballast Nedam</td>
</tr>
<tr>
<td>Completed in 2013, Deurne, ‘De Rijtse Vennen’</td>
<td>300</td>
<td>0.55</td>
<td>Municipality of Deurne</td>
</tr>
<tr>
<td>To be completed in 2013, Montferland, ‘61 koop- en huurwoningen door vervangende nieuwbouw energieneutraal’</td>
<td>61</td>
<td>0.24 and 0</td>
<td>Housing foundation Bergh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energiereductie: 60% and 80%</td>
<td></td>
</tr>
<tr>
<td>To be completed in 2014, Eindhoven, Energieneutrale wijk Blixbosch Noordoost</td>
<td>100</td>
<td>0.4</td>
<td>Hurks vastgoed zuid</td>
</tr>
<tr>
<td>Unknown (to be completed), Amsterdam, Woningontwikkeling Buiksloterham</td>
<td>54</td>
<td>0.35</td>
<td>AM &amp; Ymere Ontwikkeling</td>
</tr>
<tr>
<td>Unknown (to be completed), Lith, Hart van Oijen</td>
<td>85</td>
<td>0.4</td>
<td>Mooiland Vastgoed BV</td>
</tr>
<tr>
<td>Unknown (to be completed), Sterksel, Nieuwbouw House of Tomorrow Today</td>
<td>1</td>
<td>0</td>
<td>An-archi and WVTTK</td>
</tr>
<tr>
<td>Unknown (to be completed), Heerhugowaard, nieuwbouwproject Stad van de Zon</td>
<td>2900</td>
<td>0.8</td>
<td>Many construction companies</td>
</tr>
<tr>
<td>Unknown (to be completed), Rotterdam, Nieuwbouw op het water</td>
<td>162</td>
<td></td>
<td>Consortium Waterwonen Rotterdam</td>
</tr>
<tr>
<td>Unknown (to be completed), Kampen, ‘Onderdijks in kampen, 60 energieneutrale nieuwbouwwoningen’</td>
<td>60</td>
<td></td>
<td>Ontwikkelingscombinatie Onderdijks</td>
</tr>
</tbody>
</table>

Table 3: Overview of new construction projects in the Netherlands in which houses will be built towards low-or zero-energy houses (Energiesprong, Inspirerende projecten, 2013).
Appendix I: Original quotes used in the analysis

Below the original quotes (in Dutch) are shown. Numbers and letters between ( ) respectively refer to residents and project leaders. Numbers between [ ] refer to the quotes used in analysis (chapter 5).

1. “We hadden eigenlijk niks te willen, we werden gewoon onder druk gezet. Want doe jij niet mee dan worden alle 4 de woningen niet gedaan. (...) dan moet je wel, want ik wil geen ruzie met de buren. Want dan ben jij het punt, waardoor dat niet gerealiseerd wordt.”

2. “Er waren oudere mensen die helemaal niks wilden, maar die moesten dan toch mee. Dat is dan wel eens triest natuurlijk, want die dachten eindelijk eens rust te hebben in de tent….ja en dan wordt zo’n huis half leeggemacht enzo…”(10).

3. “Dat is een nieuw systeem, zij hebben het voorgesteld, ik dacht laten we dat maar doen, het koste iets meer, een paar honderd euro meer, maar het heeft voordelen, ook energetisch.”(20)

4. “En nu, met de bestaande woningen en de renovatie ervan, moet je op een heel andere manier gaan werken. Nu moeten ze op eens met een onwetende klant gaan praten, business-to-consumer, en ze beginnen zich te beseffen dat die klant, ook als ie er al woont, ook nog vragen heeft…”(20).

5. “ik heb Van Wijnen toen wel gewaarschuwd. Ik zeg ‘jongen, alle huizen zijn dus verschillend. Want iedereen heb zijn eigen ideeën erin gebracht in die 80,90 of 100 jaar’. En ook de huizen aan de overkant zijn weer anders dan deze huizen.”(10).


7. “dat kon niet want die hele vloer moest er nog in. Zij: Ja, en dat hadden we ook al aangegeven, al 8 weken voordat die renovatie begon (...), Hij: “dat die vloer slecht is. Want ik heb 40-50 jaar ervaring in de bouw, ik weet precies wat goed en fout is...en dan geef je dat aan en dan trekken ze zich er niks van aan; (...) Tja en hij is uiteindelijk wel uit gegaan, want daar kwamen ze zelf wel achter. Normaal denk je, als ik zeg dat die vloer slecht is…dan begin je toch met die vloer.” (2).

8. “Het is nu uiteindelijk opgelost na een paar jaar, en ook dat was niet nodig geweest als ze het gelijk hadden gedaan, als ze gelijk geluisterd hadden.”(8).

9. “En nu, buiten de luxe die ik heb, 36 of 38 euro is de isolatie geweest. Ik ben sowieso al, ook al gaat de energie er niet naar beneden door gaat he, de rekening laat ik het zo zeggen. Ik woon geriefelijker nu, dat merk ik nu al. Eerst had ik hier een bank en dan kon je swinters gewoon… nou je voelde gewoon de kou helemaal in je nek gewoon. Enkel glas daar ga je echt dwars doorheen.”(3).

10. “Ja dat vind ik ook wel een klein nadeeltje dat ze binnen niks gedaan hebben. Want als je er 100.000 euro per woning tegenaan gooit, dan denk ik van mooi er nog 5 duizend bij en zet overal nieuwe deurtjes in. Of een nieuwe badkamer... want mensen zitten vaak nog met een badkamer van 40 jaar geleden. En dan wordt gezegd, zolang de tegeltjes nog in orde zijn is er niks aan de hand, maar doe dan ook wel iets in de woning.’(12).


12. “Als je hier de buurt binnen komt is het een leuke wijk.”(15).

13. “En we hebben met de duurzame huizenroute meegedaan, en toen belde de gemeente zo van ‘ja jouw huis is een leuk voorbeeld van hoe je een oud huis – 1896 – duurzaam renoveert. Dat is een
mooi voorbeeld dus onze wethouder die komt dan langs.’ Ik zei ‘ja, leuk.’ Dat vind ik echt leuk. En een week daarvoor bleek dat in Utrecht de meeste huizen opgegeven waren, voor de nationale duurzame huizenroute en toen is afgesproken dat diezelfde wethouder (…) hier de route zou openen, bij dit huis.’(20)


15. “Zij: en wij zijn nu natuurlijk modelwoning voor de warmtepomp. Hij: ja, precies, dat doen we niet voor niks, dat vinden we leuk, (…) hij wil heel graag die unit plaatsen in een bestaande woning….gewoon gat in het dak en klaar (lacht) en wij bleken de eerste plaatsing in NL. En hij heeft het voor een lagere prijs gedaan, want hij wil het heel graag en is ervan overtuigd dat het werkt, hij wil graag testen in een bestaande woning. En zo gaat dat dan. (…) Er is een klik, je hebt beiden wat met duurzaamheid, misschien andere insteek, en dan doe je dat.”(21).


17. “(…) inmiddels kunnen we alles wel weer recht rekenen en met een paar jaar dan verdien je alles weer terug….nou dat vind ik niet zo heel belangrijk. Dus het heeft een idealistische insteek bijna…en die moet je nog hebben want het gaat je niet direct geld opleveren, dat is me wel duidelijk.”(22).

18. “er werd niks meer gedaan aan die woningen, achterstallig onderhoud…(…) ik heb op een gegeven moment tegen die van de woonvereniging gezegd ik heb geen sleutel meer nodig, ik kon zo naar binnen stappen, die deur was rot, die deur. Ik woon hier 36 jaar, nooit iets gedaan. Als andere verwarming en wat lijkjes verf erop, ja uhm. En thats it. (…) Dat raam. Was alles hout, was gewoon aan het rotten (…) het was hard nodig.”(16).


21. “Die eerste bijeenkomst was wel redelijk duidelijk, ze kwamen snel met de intentieverklaringen….maar in de tweede bijeenkomst kwamen er vragen naar boven van ja, je moet met zijn 30en binnen 3 jaar die 80% realiseren en, heel logisch, komen er vragen op van: wat als 2 van de 30 dat niet realiseren? Hoe gaat dat dan, prijstechnisch, met de subsidie? Draaien wij daarvoor op als groep? Compleet niet over nagedacht!”(21).

22. “op 4 maanden na zitten we nu een jaar verder terwijl er niets gebeurd is en we niets gehoord hebben. Dat vind ik heel zwak want al zou je tegen nog zoveel dingen aanlopen die onverhoopt niet lukken, dan nog heb je zo’n groep te informeren, want die hebben getekend met de intentieverklaring van wij gaan ervoor.”(21).

23. “normaal gesproken zou je het voordeel hebben van alle kennis die je deelt, van de gezamenlijke inkoop, iedereen die gewoon zijn toegevoegde waarde kan leveren….en dat mis je nu compleet.”(21).

24. “Daar heb je vakmensen voor nodig. En om goede vakmensen te krijgen, daar heb je geld voor nodig en zo’n samenhangende aanpak van isolatie, technische installaties, opwekking, maar ook gedrag….eh….dat doe je niet met de aannemer van om de hoek die ook nog een loodgieter weet
en een elektricien. Dat moet je in samenhang doen, en dat soort kennis moet je dus te pakken zien te krijgen.”(20)

25. “Want de subsidie, dat is leuk...4000 euro....maar dat is meer gevonden geld: leuk als je het krijgt, hartstikke leuk; als je het niet krijgt dan ga je er niet dood van. Dus ik heb gedacht, ik ga er zo snel mogelijk mee aan de slag, want ik wil dat dit met die deskundigheid op order komt, en voor dat dadelijk het project niet meer doorgaat...zo heb ik toen gedacht.”(20)

26. “Wij hebben gezegd van nou we doen een beetje meer dan we van plan waren en we zagen het als een voordeel om ons aan te sluiten bij het project....hoewel dat niet lijkt te gaan lopen zijn we blij met het voordeel dat we in feite nu hebben omdat we gebruik maken van Seinen en de contacten van Seinen...en ... eigenlijk hebben we verder niet zoveel verwachtingen meer van het project, en dat is jammer want eigenlijk zou dat veel beter moeten.”(21).

27. “Maar we zouden ook graag willen zien dat het uiteindelijk iets oplevert voor....we zijn geen idealisten....maar toch dat zo’n project wat oplevert en dat dat dan gekopieerd kan worden naar andere projecten en vergelijkbare andere…”(21).

28. “Dat heeft wel bijna 2 maanden geduurd een beetje dacht ik. Ze zeiden wel een week of drie, maar het loopt allemaal uit.”(5).

29. “10 werkdagen, maar ze zijn hier 2 maanden over de vloer gelopen, dat hadden ze mij, dat bleef liggen, dat latje was er nog niet, de timmerman kwam niet, de verfman kwam niet. Asbest... twee maanden voordat het klaar was.(...) ... en het is nu nog niet klaar he. Ik moet nu nog de voordeur geschilderd krijgen…”(18).

30. “We zijn ook naar die bijeenkomst geweest en daar word gezegd, hooguit 8, hooguit 10 dagen zit je in de rotzooi. Maar het werd sowieso al veel langer, het werd 3 weken, is het geweest, voordat ze dus, toen moest er nog alles bijgemaakt worden, toen heeft het een paar maanden geduurd…”(16).

31. “Hun noemen het het moment van beginnen als ze daadwerkelijk begonnen met slopen en dat soort dingen allemaal. Maar ik zie ook dingen die van tevoren beginnen want ik zie ene week van tevoren al iemand die hier de gevel komt open graven, de stijgers plaatsen, en en en. Want dat is ook al overlast. Dus als je tegen mij zegt van de renovatie duurt 8 werkdagen, dan ga ik ervanuit dat 8 werkdagen van het begin graafwerk tot einde... renovatie.”(12).

32. “We zouden in het huis kunnen blijven wonen, wat helemaal niet kon (...) we moesten wel vluchten.”. Het was hier ijskoud, geen verwarming, geen douche, geen wc, niks.” (4).

33. “Het voelt alsof we naar Utopia gaan. (...) Ik heb twee weken zonder verwarming en zonder warm water gezeten. We hebben hier anno 1815 een ketel op het vuur gezet”(18A).

34. “ik had drie weken in de kou gestaan voor de deur, terwijl er niks in huis gedaan werd. En dan sta je hier, je kunt je niet wassen, kreeg je zo’n kachelje hier gezet, tja...(...) de hond heb ik weg moeten doen, dat vond ik, uhm eigenlijk nee.”(16).

35. “Het was van Wijnen, en al een opzichter was al opgestapt, die werd er helemaal gek van. Toen kwam er een andere opzichter en ze werden van het kastje naar de muur gestuurd (...) ik vind het slecht. Dat mag je best weten. (...) Alles deden ze door elkaar. (...) En ze deden bijvoorbeeld ook niet huis per huis maken ze het af, ze gingen van hot naar her. En toen gingen ze aan de andere kant weer beginnen en toen moesten ze hier nog dingen doen, gewoon on... niet goed geregeld. (...) Ze werden er zelf gek van, die bouwvakkers.” (7).

37. “Je zit in de rotzooi, zonder verwarming, zonder warm water, en je kon niet douchen. Dat vond ik een van de ergste dingen. En we hadden een briefje gekregen ze hadden een woning ingericht en daar kon je eens gaan douchen. Ik ben alleenstaand, ik heb geen kinderen dus ik stond hier... dus ik ging naar de ‘uitvoerder’, met een zak, ik zeg ‘uitvoerder’ ik ga me douchen. hij zegt douchen? hij wist niet waar ik het over had. Ik had de woningvereniging gebeld, douchen? nee je kunt niet douchen. heb ik bij vreemde mensen moest ik me gaan douchen, dat vond ik wel heel erg...” (16).

38. “Ja we hebben het vaak genoeg aangegeven, en dat heb ook misschien geholpen dat we dus, later, van die 8 of 11 honderd konden krijgen, naar 5500 of 5400 weet ik het. (....) Dus toen hadden ze eigenlijk in de gaten. Maar er zijn veel mensen achteraan gegaan.” (4).

39. “We zouden eerst een vergoeding van 550 euro krijgen, dat is toen door de woningbouw naar 1100 euro gegaan, en dan kreeg je een container om spullen in op te slaan. En daar ben ik niet mee akkoord gegaan. (...) Het zou 20 tot 22 dagen gaan duren. En dat gebeurde dus allemaal niet. Het was gewoon niet meer leefbaar eigenlijk. En toen heb ik dus ook echt geëist omdat ze er zo'n renovatie van gingen maken dat in plaats van 1100, 5630 euro hebben gekregen, ik denk door mij. Daar zijn heel veel mensen mij ook heel dankbaar voor geweest” (3).

40. “We krijgen een vergoeding van 360 euro hier, als ze er 2000 bij doen, is het nog te weinig. Als je ziet wat ze kapot maken (...) Tuinmeubelen kapot, de bestrating kapot, het graswerk achter heb ik achter, moet iets nieuws liggen. En daar krijg je in totaal 50 euro voor” (11).

41. “Nee. Ik kon niks meer gebruiken, ik heb alles nieuw moeten kopen. Op de badkamer hebben ze alles weggegooid van de asbest, lampen, trekschakelaars, noem maar op, ze hadden alles weggegooid. (...) En dat had ik tegen de woningvereniging gemeld, en ze zeiden van je krijgt toch die vergoeding... ze hadden twee van die vazen kapot gegooid, ja maar je krijgt vergoeding. Ja.” (16).

42. “En ook bij de scootmobiel he, ik rij meestal achterom naar buiten, maar hebben ze ook geen rekening mee gehouden dat mensen die een scootmobiel hebben, ze hebben alle materialen gewoon op de stoep gezet. (...) En ook die aannemer, het was bekend dat ik een scootmobiel had, dat ze mij, dat ze, vrij laten, dat ik er zo langs kan. (...) Maar die aannemer heeft dat uiteindelijk niet doorgespeeld aan de werkmensen.” (14).

43. “Ja, en dan geven ze je een huis met een trap waar hij niet op kan. Ik heb hem 8 weken in de keuken moeten wassen. Dat is toch belachelijk. Stond het bed zo in de kamer, want hij kon de trap niet op” (2).

44. “ik zou mijn laminaat laten liggen enne ik kom kijken hier hoe het ervoor staat en ze hebben er gewoon een stuk uitgezaagd. En dan denk ik, nou ik vind niet meer dan normaal dat daar met een bewoner over gepraat wordt, zovan joh...tuurlijk als die grond verrot is van onder, dat ze daar dan wat aan moeten doen, oke, maar ik vind wel dat daar dan overlegd moet worden en dat is ook helemaal niet gebeurd.” (9).

45. “Maar in principe moeten ze de mensen op de hoogte brengen. Al zouden ze een spijker in de muur slaan, dat moeten ze vragen.....vind ik. Je geeft aan ‘we willen dit of dat doen, sta je daarachter?’” (10).

46. “overal waar ze een stuk muur eruit hebben geslagen, doen we wel een latje voor. (...) die mensen hebben alleen maar latjes, dat is het enige wat ze hebben. Eerst slaan ze je alles kapot,
(…) Daar was een heel stuk uit de muur, en dat hebben ze dus niet bijgesmeerd. Heb ik een latje voor. Slaan ze overal latjes op.”(18A).

47. “dus ze hebben gewoon wat fouten gemaakt en alles moest er weer uit, het hele ding moest er weer uit…enne, dat heeft een paar duizend euro extra gekost voor de aannemer. Maar hij zei ok, alles eruit, op onze kosten.”(20).

48. “14 dagen vertraging gehad. We hadden er vlak voor de schoolvakantie willen wonen, maar dat werd hem dus niet, haha… Maar goed, dat had er dus mee te maken dat het nieuwe technologie was, ook voor hun. Ze hebben er ook ontzettend van geleerd. En hoe ze het hebben opgepakt, meteen: ‘geen gezeik, onze schuld, wij betalen’.”(20).

49. “Je moet hier een commissie inschakelen, 1 of 2 of 3 man, die wat voor de bewoners opkomt. (…) Je hebt hier geen aanspreekpartner, in dit soort projecten moet je die gewoon hebben, een waar je op terug kunt vallen van kom eens kijken wat die aan het maken zijn daar.”(11).

50. “95% van wat hier loopt, de een gaat na de ander naar de rechtbank, stuk voor stuk. De mensen worden zo genaaid he en bezeikt van alle kanten en nergens kun je je verhaal opmaken. We krijgen een vergoeding van 360 euro hier, als ze er 2000 bij doen, is het nog te weinig. Als je ziet wat ze kapot maken”(11).

51. “de advocaat schrijft 1 brief, 1 briefje, volgende, twee dagen daarna bellen ze terug. V: We maken een nieuwe overkapping zoals je die wilt. En waarom niet in 1 keer, waarom moet dat dan zo gebeuren.”(18A).

52. “Nee we hebben ze weggeroep, weggeroep.(…)Was niks waar, maar daarvoor is ook wel ruzie geweest. Heb ik iedereen eruit gezet. Ik was het zat.”(18B).

53. “En die aannemer, die van Wijnen, die zegt dan natuurlijk ‘ja dat mag niet van de bouwvereniging’ en zo spelen ze mekaar tegen mekaar uit, weet je…”(2).

54. “Misschien hadden ze vanuit het PvA voor elke ruimte een lijst moeten maken van wat er moest gebeuren...dat was er niet. Hij had het in zijn hoofd. We hadden een opdracht, een soort van begroting....maar daar, daar hadden we toch een slag scherper in moeten zijn, zodat je als uitvoerende partij toch en precies overzicht hebt van wat er allemaal moet gebeuren.”(20).

55. “Dat....je het traject in een bouwteam goed moet documenteren met elkaar. Dat een uitvoerder nog beter....het is vaak een bouwkundige man, vaak met een timmermansachtergrond....een hele goede man....hij had nog beter kunnen weten hoe e en w werkt, wat die met elkaar te maken hebben en hoe die op elkaar inwerken. Ik heb regelmatig met hem overlegd, dan zei hij ‘we kunnen het zo, of zo, zo, zus, zo doen...’ en dan had hij het in zijn hoofd, maar dan hadden de mensen die hier op de werkvloer bezig waren, het niet in hun hoofd. Bijv. als je warmteterugwinning op je douche water wil....maar toen was het plafond al dicht hier (in keuken)....netjes gestukt, verlichting er netjes in....dan ga ik het er niet meer uithalen, een week voordat alles vocht- en stofvrij moet zijn voor de gietvloer....dat soort dingen kom je tegen, kleinere dingen ook.”(20).


57. “Ja en dat is op een geven moment ook met werklui, ik heb ook best wel, want dan zeiden ze weer van daar heb je der weer met die puppy ogen. Want ik ken ze ook allemaal bij naam en... maar het ligt er sowieso aan hoe je het doet en of het reëel is natuurlijk (...) Maar ze hebben ook gewoon heel veel extra voor me gedaan. Niets anders dan lof voor die jongens” (3).
58. “want hier woont een, niet hieronder maar twee deuren verder, die heeft zelf ook altijd in de bouw gezeten die weet ook wel hoe dat werkt. Die heeft best wel een grote mond. En daar hebben ze zijn stoep niet goed gelegd. (...) Dat was niet goed, leg maar opnieuw zei die, en die kreeg dat ook nog klaar, ja. (...) als je maar brutaal was. (...) Die kwam hier die werkmensen uit de hut halen. Die man, die was gek. En dan zeg je er iets van, ik heb het lekker gemaakt zegt die dan. Ja op de ribben van ons, want wij zaten hier in de rotzooi. Als je iemand moest hebben moest je bij hem in de hut gaan, hij had alle mensen daar. (...) Ja die man is gepensioneerd, die was de hele dag thuis en die wist hoe dat moest aanpakken... en uh hij had alles klaar, en wij zaten er ‘s avonds in de shit en in de rotzooi. En omdat wij ook nog werken waren kregen we sowieso, we wisten niet hoe dat werkte”(16).

59. “Omdat ik bij de bewonersgroep zit, dan gaat dat vlugger he.”(13).

60. “dat ze er dan niet eef een service-je erachteraan gooien (...) waarom komen ze niet na een week of 14 dagen nog eens even vragen ‘hoe is het nou, is alles goed of niet goed?’ net zoals ze met die deuren hebben gedaan weet je wel (...) ze zouden gewoon nog eens langs moeten komen om te kijken wat wel en niet goed werkt en hoe dat komt...”(2).

61. “Ja en zij schuiven het af, zij zeggen Heemwonen die... die zijn te traag met beslissingen nemen. Die van Heemwonen zeggen die zeggen je moet bij de uitvoerder zijn, van BAM. En zo is de bewoner, die word van links naar rechts geschoven en niks gebeurd.”(11).

62. “Ja normaal gesproken als je wat aan de apparatuur hebt, komt Heemwonen, firma Verploegen komt dat dan maken. Maar omdat het een garantiekwestie is moet dat gewoon bij de leverancier verhaalt worden dus die schuift het op die af en die op die. En voor dat het dan eigenlijk zover is. Heemwonen geeft dat weer door aan BAM techniek en die heeft dit geplaatst, en BAM techniek zegt van ja we moeten dat bij de leverancier gaan zoeken. En zo gaat dat maar door dan he, maar daar ben je als bewoner dan niet mee geholpen natuurlijk he.”(12).

63. “in het begin was het heel koud hier. Maar dat waren alle woningen hier, die klaagden allemaal van de kou. Maar volgens the uitvoerder was het niet, dat kon niet.(...) En op een gegeven moment had ik zoets van ik zeg niks meer want...”(16).

64. “En ze schuiven het allemaal af, die de verwarming heeft geplaatst. Die zegt van nee dat ligt niet aan ons, dat is niet door de verwarming die ik eraan heb gelegd. Dat ligt aan de zonnepanelen. Nou dan ga je naar de uitvoerder, die staat weer in contact met de mensen die de zonnepanelen hebben gelegd. En die zeggen van dat zijn gekken, hoe komen ze daarbij? Maar het interesseert me allemaal niet, de bewoner moet geholpen worden...”(11).

65. “Hele 7 maanden geen gas. (...) Ja daar heb ik over gebeld en gebeld en gebeld... ze stonden me alleen maar telefonisch beschikbaar. (...) Geen ene keer zijn ze hier geweest. Zegt zo’n man tegen mij ik snap het niet, dan ga ik hem toch gewoon even aan zetten, nou die hebben hem op 26 hier gezet en toen hadden ze het een beetje warm. En daarna niks meer. En ik zeg dat moet niet zo, als je hem normaal doet aanzetten, op 20, dan moet die aanslaan. (...) nou doet die het wel, na 8 maanden.”(17).

66. “En op een gegeven moment is ene hier geweest, die heeft wat aan het water gedraaid en in eens heb ik het wel warm. Maar nu heb ik wel koud water nou, hele koude. Want ik heb het water op 87 graden, toen kwam ene meneer hier, mevrouw zegt die, u heeft het water veel te warm, u verbrand zich eraan, en die heeft het anders ingesteld en die heeft het warme water, het warme water is nu een stuk kouder, en heb ik wel me verwarming warm.”(16).
“het grappige is…dat systeem heb ik nooit begrepen… alles staat op de thermostaat beneden. En beneden als ie het bereikt heeft, doet ie het hier ook niet meer…terwijl ik hier een andere warmtevraag heb. (...) er gaat nu iets op gemonteerd wordend dat ie wel afzonderlijk kan worden afgesteld…wordt ie apart gestuurd…op de warmtepomp…” (20).

“Maar Heemwonen, zeg ik nog eens een keer, is een corrupte bende… en dat meen ik, dat meen ik echt.” (18A).

“Maar ze kloppen zich wel op de borst, ze hebben nu de medailles overal mooi. Alles blinken. (...) Moet je kijken wat wij gedaan hebben, en dan worden wij beschouwd als aapjes. Fotografen maken foto’s terwijl ik hier woon, terwijl ze aan mijn spullen zitten. (...) Wou die de bloemen effe recht zetten, daar heb ie de trek niet voor, wegwezen…(...) hele groepen mensen, scholen met kinderen komen hier. Studenten, uhm noem maar op. Maakt niks uit… je voelt je niet op je gemak. (...) en dat stoort ons.” (18).

“Ik ben klein, maar meerdere mensen hier in de buurt zijn klein…Ik kan daar niet bij. Ik moet altijd even vragen aan mijn zoon of ze effe…” (7).

“Tot nu toe merk ik het boven zeer zeker, en ook heb ik de kachel nog niet boven de 20 gehad. En normaal had ik de kachel rond deze tijd toch wel op 21, 22” (3).

“Dat was voorheen anders. Dan deed ik hem overdag aan want dan was het gewoon niet te houden, dan deed ik hem rond een uur of 4 uit want dan had ik tenminste mijn kou eruit. Ik geloof niet dat dat nu nodig is. Nu staan de ramen open maar het is helemaal niet koud hier.” (3).

“Als ik de deur open heb, dan heb ik geen verwarming nodig. (...) dat is logica” (15).

“Mijn dochter zei tegen mij van laat die maar gewoon aan staan. Je hebt toch het raam open.” (17).

“nou ik moet het ieder ochtend opentrekken (de ramen), want zodra hij de kans heb, gooit hij het weer allemaal dicht (lacht)” (2).

“Kijk en dan gaan ik ervan uit als het met glas niet goed is, het is gehoorvoelig, dan is het ook met de isolatie niet goed.” (2).
schiijnt het zonnetje en denk je waar komt die stof vandaan?! En terwijl we constant de ventilatie aan hebben. Op 1 staan. (...) Er zou eigenlijk weinig stof moeten zijn.”(18A);
84. “En dan aan deze kant, ik denk dat deze... het grove spul eruit haalt (filter is viezer) (...) Ja het werkt wel dus”(19);
85. “Ja dat zou dan, die lucht die van buitenaf naar binnen komt zou voorverwarmd worden met de warmte die je binnen hebt. Maar dat schijnt volgens mij niet zo goed te werken, want de temperatuur zakt hier vaak af naar 18 graden ’s nachts.”(12);
86. “hier kun je ook zien dat die op 1 staat. Als die op 2 staat, staat er een 2, staat die op 3 dan staat er een 3 op. Dan kun je altijd zien dat die werkt.”(19).
87. “ik kan me voorstellen dat als je 70, 75 jaar bent, dat je niet om de twee dagen op zolder gaat kijken of er storingen zijn. (...) Maar die mensen gaan dan echt niet controleren of daar een raar dingetje in het display staat... want warm water krijg je toch, of dat ding nou werkt of niet. Omdat de ketel ertussen zit.”(12).
88. “22 kubieke watt, in total 15...5...1558 kubieke watt”(13).
89. “Ja gewoon een temperatuur is goed, ik laat hem ook gewoon aan staan ’s nachts, ik zet hem niet meer uit want ik ben bang dat die niet meer aan gaat. Maar ze zeggen van je kunt hem gerust uit zetten en je kunt hem gewoon weer aan zetten.”(17).
91. “Maar hun zeggen dus van als dat (het is te koud) is, dan moet je gewoon de verwarming wat hoger zetten.”(19).
92. “Die roosters, oke. Maar als het zomers is je kan nooit een raam open doen dus ze hadden eigenlijk een ander systeem moeten proberen uit te vinden. Ik vind een raam, ook als het warm is of die je gewoon even open kan zetten om te luchten.”(6).
93. “Ja we zijn natuurlijk ook niet helemaal achterlijk he. Het is gewoon een kwestie van op en neer halen, meer niet.”(5).
94. “Ik wil em dicht hebben maar ja, dan probeer ik het wel, omhoog of naar beneden, maar dan denk ik ja, ik weet niet of als ze open staan of het dan omhoog of naar beneden staat.”(9).
95. “Dat hebben we wel bij de filter gehad, dan begon dat ding te knipperen en dat zijn dus wel van die dingen dan moet je dus... ze leggen het wel uit, maar halfgebakken. (...) Daar moet je dus eigenlijk meer duidelijkheid in hebben. dan moet je er zelf dus achteraan wat er moet gebeuren...”(19).
96. “Ja die heb ik op zolder liggen he, maar daar heb ik nog niet in gekeken...”(13).
98. “vooral voor oudere mensen(...) leg zo’n mensens uit hoe zo’n machine werkt. Of hoe je die bedienen moet... (...) Ja dat ze het nakijken. Begreep u wat we u toen gezegd hebben. Zullen we het u nog een keer uitleggen en en en. Want hier worden ontzettend veel oudere mensen(...) Als iemand iets heeft dat er een punt is om waar de mensen dan naar toe kunnen gaan. En uh, dat ze ook direct geholpen worden.”(18A).
“Zeker als je er nu in de gebruiksfase mee te maken hebt en je hebt dat ding en je denkt, nou moet je er wat mee, vroeger was alles gewoon zo dat je op de waterdruk in de CV ketel moest letten en een keer per jaar kwam er een onderhoudsman langs. Maar nou, ik wil meer weten, want het is iets heel aparts, waar kan ik het vinden? Nou nergens. Nergens staat hoe ik het kan bedienen.” (20).

“En dat systeem hebben ze aangelegd en dat hebben ze goed gedaan, maar om het mij als leek uit te leggen....gisteren ook, ik zeg: ik heb een comfortvraag, that’s all. En jullie moeten dat vertalen in systemen, nou dat hebben jullie gedaan....en in hoe ik het moet gebruiken. En dat lukt....dat lukt de bouw in het algemeen niet.” (20).

“maar die huizen zijn tegelijkertijd klaar gemaakt, zouden er iets zijn wat zou moeten dan komt hij (de buurman) en zeggen ze van je moet eraan denken van je moet dit en dit. (...)

“Ja die ventilatie hier he, ik wist niet goed hoe dat ging werken en noem maar op, en ik zeg tegen mijn dochter, dat moet jij maar kijken.” (17).

“Daar hebben ze me niks van verteld, dat weet ik dus echt niet. (...) er zit dus een boekje bij maar dat heb ik eigenlijk dus, dan zou ik het boekje dus door moeten lezen eigenlijk. (...) daar zal wel iets van onderhoud instaan denk ik dus.” (3).

“En als heemwonen van de bewoners verwachten dat ze dus een keer in de 3 maanden de filters schoonmaken en de filters verschonen en weet ik veel allemaal dan moeten hun zich ook aan de afspraak houden en een keer per jaar een monteur sturen.” (12).

“Ja deze filters, maar we zouden dus ieder half jaar een nieuw setje krijgen van Heemwonen. En er zat een stikker op, met een code en die kon je dan invullen en dan kreeg je een setje gratis” "(12).

“En ze zeggen wel eens je moet de ramen niet openmaken want dan gaat uh, het systeem... maar het systeem deugt niet. (...) Want het moet gefilterd worden boven, maar als wij geen schone filters krijgen, en die heb ik al, in 1 jaar al zeker 6 keer gewassen.(...)En in de klapper staat dat we twee per jaar zouden krijgen.” (18A).

“Maar ze zeggen je gaat 30 euro per maand besparen en dat lijkt me een beetje overdreven.” (8).

“Nou ik dacht dat buiten de normale huurverhoging zo’n 35 euro, valt me nog mee met al die renovatie eerlijk gezegd. Ja want je hebt er wel meer comfort voor terug gekregen toch.(....)Ja, en nu heb je dubbel glas, en als je dan ook nog iets van je stookkosten af gaat maakt het in feite ook niet veel uit.(...) Want ik heb wel een prettigere woning natuurlijk. (…) Want hij kan ook voor zoveel jaar weer langer mee natuurlijk. (5).

“we hebben hier dus een huurverhoging gekregen van 40 euro, en 24 euro voor de cellen op het dak. Dat was die verhoging dus van de huurverhoging. En als je die 70 pakt, dan heb je 6 euro voordeel op. Ik denk dat dat wel meer is.” (19).

“mijn god...(...) ik kreeg toen over de 1000 euro terug.(...) daar schrok ik van, ik dacht in eerste instantie van ik moet dat nabetalen, wat hier allemaal openstond. En dan kreeg ik dat terug.” (16).
“(…) gas is dus minder maar mijn elektra is dus een heel stuk hoger dan hier in de buurt….dat geven ze dan aan, hoe het is in de buurt. En dan denk ik…ik doe wat ik altijd doe....” (10).

“Gewoon, ik ben zo opgevoed. (…) dat heb ik van thuis uit meegekregen (…) het zijn toch allemaal mijn centen he.”(15),

“Hoofdzakelijk omdat ik dat zo gewend ben, maar dat gaat meer om de centen. (…)ik heb vroeger ook in de schuldsanering gezeten en daar leer je wel met de centen omgaan he.”(12).

“dat gelul van dat milieu dat eh…daar trap ik niet in. Het is gewoon mijn eigen belang, klaar. (…) kijk als je alleen maar een AOWtje hebt dan wil je graag besparen, geloof dat maar gerust…dan mag je blij zijn als de maand om is en dat je dan net uit het rood gebleven bent.”(2).

“Er zijn nog geen getallen die mij geen… die mij kunnen vertellen zit ik op het goede spoor. Dat zou je toch met een bepaalde marge moeten kunnen zeggen: waar gaat het ongeveer naar toe. zodat ik nu al maatregelen kan nemen. Bijv. hotfill op was en afwasmachine, of meer met warmteterugwinning ofzo…en dat doe ik straks misschien als ik in een keer een veel te hoge rekening krijg.”(20).

“sinds we hier terug zijn, heb je niet zoveel in het ziekenhuis gelegen als daarvoor. Dus dat heeft toch wel invloed.”(2).

“Ja maar met dat wtw heb je natuurlijk wel een heel andere lucht. Ja dus, veel mensen hebben er ook last van, ze zijn meer verkouden enzo.”(12).

“Ja, maar nu heb ik daar laatst de griepe part gekregen, ik was dat niet gewend, ik sliep nooit met de raam open. (…) Ja ze hebben… ze hebben gezegd als je dit hebt hoef je het raam niet open, want je krijgt dan gewoon lucht. Maar toch heb ik, heb ik gewoon het raam open. Want ik heb toch, het meer bedumpter.”(16).

“Maar ze kunnen niet zeggen dat mensen hier met astmatische aandoeningen kunnen blijven wonen. Ik vind dat vanaf we de filters hebben. Stof stof en nog eens stof.”(18A).

“we hebben na de verwarming, dat ik dat merk dat ik druk op mijn borst krijg van die warmte.”(18B),


“Dus dat het zeker qua… of het nou qua geluid, of het nou minder geluid qua isolatiedichtheid, geluid van buiten naar binnen, dat betwijfel ik. Ik heb eerder het idee dat je ons beter hoort van buiten dan voorheen, dus daar heb ik zo mijn twijfels over.”(8).

“En ik hoor inderdaad wel meer geluid van buiten, maar ik denk dat het voornamelijk komt door die roosters, want die roosters kun je dicht doen maar die sluiten uiteraard niet voor 100% af.”(8).

“kijk die schilder kan ook per ongeluk een ruit verkeerd om inzetten natuurlijk. (…) Want een buurman die heeft 20 jaar geleden dubbel glas laten zetten, en daar hoorde je niks van, van buiten, als je daar binnen zat.(…) je heb er de last niet van, maar het hoort niet zo. Kijk en dan gaan ik ervan uit als het met glas niet goed is, het is gehoorgevoelig, dan is het ook met de isolatie niet goed.”(2).

“Nouja zo’n slimme meter gekregen natuurlijk, maar hij is bij mij niet uhh, ik wil niet dat ze op afstand uhh… dat heb ik uitgeschakeld, dat vind ik prive. (…) eigenlijk ging mijn dochter toen mee, en ze zei van mam ik vind dat eigenlijk niet uhh, ja, ze zegt eigenlijk, het zal niet gebeuren, maar eigenlijk, op afstand kunnen ze zien wanneer iemand in huis hebt, of niet in huis
hebt. Als er meer gedacht wordt of weet ik het. Dat hoort allemaal bij privacy en dat wil ik niet inleveren.”(3).

127. “maar hun gaan niet bemoeien met wat ik aan en uit doe. We worden al teveel bemoeit. (...) Als ik mijn droger wil laten draaien, dan laat ik hem draaien. Ik ga toch niet aan hun vragen hoe ik kan besparen, dat weet ik zelf ook wel. Als mijn portemonnee het niet meer toelaat, dan ga ik echt bezuinigen. Maar zolang ik het nog kan betalen...”(4).