SUSTAINABLE RENOVATION PROJECT FOR SOCIAL HOUSING IN AMSTERDAM WEST

Upgrading comfort and improving public space by a zero energy renovation of the Nemavo-Airey dwellings in Amsterdam West

Final Graduation Report - Research & Reflection
15 June 2016

Jasper Sebastiaan Müller - 4002024 – J.S.Muller@student.tudelft.nl
Studio: Heritage & Architecture / Housing Heritage Amsterdam
Tutors: Lidwine Spoormans – Wido Quist – Eric van den Ham
Fig. 1. Figure on title page: “Bouw van flats volgens het Airey-systeem naar ontwerp van professor Berghoef tussen Burgemeester de Vlugtlaan en Johannes Poststraat”, 1953 [Online Archive Amsterdam, 10-10-2015]
COLOPHON

Title
Sustainable Renovation Project for social housing in Amsterdam West

Under title
Upgrading comfort and improving public space by a zero energy renovation of the Nemavo-Airey dwellings in Amsterdam West

Author
Jasper Muller

Student number
4002024

Mail address
J.S.Muller@student.tudelft.nl / jaspersmuller@hotmail.com

Studio
Heritage & Architecture / Housing Heritage Amsterdam

Date
15 June 2016

Graduation tutors
Lidwine Spoormans - TU Delft – L.G.K.Spoormans@tudelft.nl
Wido Quist - TU Delft – W.J.Quist@tudelft.nl
Eric van der Ham - TU Delft – E.R.Vanderham@tudelft.nl

TU Delft
Julianalaan 134
2628 BL Delft
015 278 9111

Amsterdam Institute for Advanced Metropolitan Solutions (AMS)
Mauritskade 62
1092AD Amsterdam
Telephone: 06 380 80 484
This report is the result of research and reflection during my graduation project for the department Heritage & Architecture of the Master of Science Architecture, Urbanism & Building Science at the TU Delft. The total graduation project is divided in four parts within a period of one year. Interesting is the collaboration with the department Architectural Engineering. By working together with students of this department, different knowledge is shared and it gives a broader perspective on the topic.

The research and reflection described in this report is also related to TiSD ‘Technology in Sustainable Development’ programme. During my master I have followed extra courses related to sustainability and I have done an extra project called the boatweek which is also focused on sustainability from a broader perspective. These extra courses and projects are related to the TiSD ‘Technology in Sustainable Development’ programme. In my graduation project I have also focused on the integration of sustainable development because of my intention to learn more about sustainable development and in order to achieve the ‘Technology in Sustainable Development’ annotation. Moreover, because I am also interested in the different stakeholders and interests which are involved in this renovation project in Amsterdam, I joined the Amsterdam Institute for Advanced Metropolitan Solutions (AMS).

By choosing for the project of the Nemavo-Airey dwellings within the studio Housing Heritage in Amsterdam which is part of the Heritage & Architecture department, I actually go back to my roots because I am born in the same neighborhood as the project is located. However, when I was four years old, I moved away from this place so it is interesting to research how this area and the specific project for my graduation in this area have changed over time.

I would like to express my appreciation to architect Hein de Haan (1943-2015). Hein de Haan was one of the first architects I met in 2007 when I was in the fourth class of the secondary school. During that year he showed me some projects in Amsterdam New West and the old faculty of Architecture in Delft. These meetings and trips made me really enthusiastic for the study Architecture in Delft. Because the location of my graduation project is located in Amsterdam New West, I will actually finish my study on a project in the same area where I became enthusiastic about architecture years ago.

Finally, I would like to express my appreciation to my supervisors Lidwine Spoormans, Wido Quist and Eric van den Ham for their expertise and suggestions which guided the process of this report. Moreover, I want to extend my appreciation to Sara Stroux and Tjalling Homans for their feedback and the chair of Heritage and Architecture for guiding the process in the form of lectures, excursions and specific advice.

Jasper Muller,

Delft, June 2016
# TABLE OF CONTENTS

1. **Summary** ............................................................................................................................ 9
2. **Introduction** ......................................................................................................................... 10
3. **Cultural History** .................................................................................................................. 17
   3.1 Historical facts ...................................................................................................................... 18
   3.2 Underlying ideas and ideals .................................................................................................. 22
   3.3 Architect .............................................................................................................................. 24
   3.4 Societal relevance ................................................................................................................ 24
4. **Urban context** ..................................................................................................................... 26
   4.1 Morphology ........................................................................................................................ 26
   4.2 GreenERY ............................................................................................................................ 30
   4.3 Infrastructure & facilities ..................................................................................................... 32
5. **Architectural appearance** ................................................................................................... 35
   5.1 Typology ............................................................................................................................. 35
   5.2 Exterior ............................................................................................................................... 37
   5.3 Interior ................................................................................................................................ 38
   5.4 Materialization ................................................................................................................... 44
6. **Building Technology** .......................................................................................................... 46
   6.1 From Airey to Nemavo-Airey ............................................................................................ 46
   6.2 Construction of the Nemavo-Airey dwellings ................................................................... 48
   6.3 Mass customization ............................................................................................................ 51
7. **Energy consumption** ........................................................................................................... 56
   7.1 Current situation ................................................................................................................ 56
   7.2 Ambition levels ................................................................................................................... 60
   7.3 Case Studies ....................................................................................................................... 60
   7.4 Broader perspective ............................................................................................................ 68
   7.5 EPC after renovation .......................................................................................................... 72
   7.6 BENG (bijna energie neutrale gebouwen) ........................................................................ 73
   7.7 EMI (energie maatregelen index) ....................................................................................... 75
   7.8 Conclusions and reflection on sustainability ...................................................................... 77
8. **Interpretations of the research** ........................................................................................... 79
   8.1 Expert value versus community value ............................................................................... 79
   8.2 Context value versus object value .................................................................................... 81
8.3 Age value versus design value................................................................. 81
8.4 Personal interpretations............................................................................ 81

9. REFLECTION ON THE DESIGN .................................................................. 82

10. Conclusion.................................................................................................. 92
11. Recommendations..................................................................................... 94
12. References................................................................................................. 96
13. Appendix.................................................................................................... 99
1. SUMMARY

Today, the Nemavo-Airey dwellings face two main problems: comfort issues and the high energy consumption. The dwellings have a low comfort due to the way these houses were produced resulting in small rooms with a not comfortable climate. Secondly, the dwellings are not well insulated, resulting in a high energy consumption, noise pollution and draught.

To understand the existing situation and the place of the building from an urban-, architectural- and technological perspective, different kind of analyses are made by pictures, images, drawings and visualizations of the conclusion of my own observations. Secondly, theoretical research is done to serve as a framework for my research findings and eventually the design. Thirdly, case studies are done in order to have more insight in the consequences for the architecture after renovating a building to a certain ambition level. Moreover, calculation of building physics and the EPC value are made by the program Uniec2.2. Finally, different professionals are interviewed to know the state of the art of renovation possibilities and the challenges of today in practice.

Based on the historical research on the building system of the Nemavo-Airey dwellings and research about mass customization, the Nemavo-Airey building system is an innovative system for its time and has a lot of similarities with the production process related to mass customization. Mass customization can provide the possibility to involve the residents in the design process for the interior and housing associations in the design process for the climate systems in order to improve the energy consumption to the preferred energy index and the related improvement of comfort for their tenants. The money which is saved after certain years by less energy consumption can be used to finance the renovation.

Looking to the results of the value assessment, the open building strokes oriented north to south in a way the dwellings are oriented east and west is one the qualities of the Nemavo-Airey building blocks. The location and the good accessibility to the center of Amsterdam with public transportation make the buildings valuable. Moreover, the greenery is very important within the urban structure. However, the greenery and the public gardens are not functioning today like they were intended to do. By looking closer to the architecture of the buildings, the recognizable grid is iconic for the architectural image of these building blocks. With little exceptions, this grid determines the composition of the facades. It is also a reflection of the building system which is based on prefabricated elements. Because the construction is mainly located in the facade, a free floorplan is provided. Architect Berghoef saw this as an opportunity to let people express identity in their interior of their home.

In order to translate these results of the analysis, the value assessment and the research to a design for a renovation for the Nemavo-Airey buildings, the position of the architect in renovation processes of today might change to an innovative connector between the different involved parties. The architect might have to focus on creative and innovative solutions for problems which exist from practice related to the tension between cultural heritage and general renovation products. In order to connect different parties and give the cultural heritage even more value for the society, the architect needs different knowledge in comparison with a traditional renovation process and might have to experiment with new methods like mass customization. So, the challenge for my graduation project is designing an intervention based on sustainable and innovative solutions by involving the residents and housing association in the design process in order to give the Nemavo-Airey building blocks more value for the next generations, taking into account the short term interests of all different parties which are involved in the renovation process.
2. INTRODUCTION

After the Second World War there was a huge demand for housing in the Netherlands, not only because a lot of buildings were destroyed and damaged, but also because an increasing population of 8.8 million people in 1940 to 12.9 million in 1970. Because of the housing shortage and a lack of building materials and qualified building construction workers, alternative building methods were used to build faster and cheaper in order to fulfill the demand for new houses. One of these new building methods was the English Airey system, developed by Sir Edward Airey, which was introduced by the government to increase the industrialization of the housing production in the Netherlands. In order to deal with the housing shortage problems, Van Saane, director of the ‘Nederlandse Maatschappij voor Volkshuisvesting’ (NeMaVo), J. F. Berghoef and H.T. Zwiers developed the Airey system to the Nemavo-Airey system which was a more rationalized system and had some advantages in comparison with the existing Airey-system. Between 1949 and 1968 about 8.500 Nemavo-Airey dwellings were built in the Netherlands, of which 5.000 were built in Amsterdam.

My graduation project and this research are focused on the Nemavo-Airey dwellings at the Burgemeester de Vlugtlaan in Amsterdam New West. The location of these dwellings is showed in Fig. 2 to Fig. 7. This part of Amsterdam West is a conservation area of the municipality of Amsterdam which makes this location interesting. The municipality of Amsterdam describes conservation areas as places which have a general importance because of beauty, mutual cohesion or their scientific or cultural historical values. So, it is not only about an isolated building with a special value, but more about the mutual coherence, the related structure and the history behind it. Because this area is a conservation area, demolition is more difficult and plans will be examined more critically.

Fig. 2. Map of Amsterdam with the location of the Nemavo-Airey Dwellings at the Burgemeester de Vlugtlaan, Amsterdam West [Google earth, adapted]

3 Ibid. p. 3.
Fig. 3. Map of Amsterdam - Focus: Amsterdam New West [Wikimedia Commons, Amsterdam stad 2014Q1, adapted]
Fig. 4. Neighborhood of the Nemavo-Airey dwellings in Amsterdam New West [Gemeente Amsterdam, 2015\(^7\), adapted]

Fig. 5. Location and orientation of Nemavo-Airey dwellings in Amsterdam New West [Gemeente Amsterdam, 2015\(^8\), adapted]

\(^7\) Gemeente Amsterdam, 'Ordekaart Aup Nieuw-West Geuzenveld-Slotermeer', (2015).

\(^8\) Ibid.
Fig. 6. Location of the Nemavo-Airey dwellings in Amsterdam New West [Own illustration based on Google Earth]

Fig. 7. Location of the Nemavo-Airey dwellings in Amsterdam New West [Own illustration based on Google Earth]
Problem Statement

Today, the Nemavo-Airey dwellings face two main problems: comfort issues and the high energy consumption. The dwellings have a low comfort due to the way these houses were produced resulting in small rooms with a not comfortable climate. Secondly, the dwellings are not well insulated, resulting in a high energy consumption, noise pollution and draught. In order to make these dwellings livable for the coming years and to meet national agreements (for example the Energy Agreement which has the aim that rented social housing must have a B-label on average in 2020), a renovation or transformation is needed, concerning the cultural historical values and architectural quality. Fig. 8 shows a scheme of the problems, the main research question with its sub questions, used methods and the general structure of the report.

Main research question

How can mass customization as a tool be used during the design process of an energy friendly renovation for the Nemavo-Airey dwellings in Amsterdam West in order to increase its energy efficiency as well as architectural quality?

Sub questions

- What is mass customization?
- What is an energy friendly renovation?
- What are the architectural qualities and cultural values of the Nemavo-Airey dwellings?
- What are the qualities and the principles of the Nemavo-Airey building system?
- What are the main problems of the dwelling in regard to comfort?
- What will be the impact of using mass customization during the design of a renovation and what influence does this have on the urban environment of Amsterdam West?
- What is the current energy consumption and which technologies and renovation concepts can improve comfort and decrease the energy consumption?

Methods

To understand the existing situation and the place of the building from an urban-, architectural- and technological perspective, different kind of analyses are made by pictures, images, drawings and visualizations of the conclusion of my own observations. Secondly, theoretical research is done to serve as a framework for my research findings and eventually the design. Thirdly, case studies are done in order to have more insight in the consequences for the architecture after renovating a building to a certain ambition level. Moreover, calculation of building physics and the EPC value are made by the program Uniec2.2. Finally, different professionals are interviewed to know the state of the art of renovation possibilities and the challenges of today in practice.
Division of the report

The report is divided in five chapters, corresponding with the five sub-questions visible in Fig. 8. The first chapter describes the history behind the development of the Nemavo-Airey dwellings in Amsterdam New West. The second chapter is about the relation between the urban context and the Nemavo-Airey dwellings itself and the third chapter about the characteristics of the architecture of the Nemavo-Airey dwellings. The fourth chapter is focused on the building technology of the buildings. It describes how the Nemavo Airey building system evolves from the Airey system and how it was used to produce a lot of buildings behind the Second World War. Moreover, new technologies and processes are compared with the principles of the Nemavo-Airey building system. The fifth
chapter describes and shows the values of the current energy consumption. In order to improve the comfort and decrease the energy consumption, different recent renovation concepts are described, compared and analyzed to get insight in the impact of these concepts on the architecture of the building.

Within the chapters, three different icons are used to make clear the differences between the objective analysis, my own interpretations of the values and my personal recommendations for the design.

🔍 Analysis (as objective as possible)

👍 Value Assessment (personal interpretations of a certain value)

🌟 Recommendations (for the design and the design process)

From the recommendations, new design questions will follow, which will be addressed in the next phase of the graduation project. Fig. 9 shows the relationship between the four different periods of the graduation process and the division of designing and the research on the cultural value and the technology. However, the design will also be analyzed in order to check if the design meets the requirements and preferences of the cultural values and technology.

![Scheme triangle Heritage & Architecture during the four periods of the graduation project](own illustration, 2015)
3. CULTURAL HISTORY

This chapter describes the history and the cultural values of the Nemavo-Airey buildings. Based on an understanding and appreciation of the cultural heritage value, both tangible as intangible, design choices can be made during the design process for a renovation of to the Nemavo-Airey dwellings. First, some historical facts are described and showed by pictures from the past. The second part describes the underlying ideas and ideals. These ideas and ideals about building fast with an innovative building system are also reflected in Fig. 10 which showed the construction place of the Nemavo-Airey buildings in 1952. The third part is about the architect of the building and the fourth part about the societal relevance. This is related to the social cultural values of the building which can be described as “values attached to an object, building or place because it holds meaning for people or social groups due to its age, beauty, artistry, or association with a significant person or event or (otherwise) contributes to processes of cultural affiliation”.

Fig. 10. Realisation Remavo-Airy dwellings – 1952 [Online Archive Amsterdam, 10-10-2015]

---

3.1 HISTORICAL FACTS

The Nemavo-Airey building blocks, designed by J.F. Berghoef, were constructed 1952 as is showed in Fig. 11. In this same year, on 7 October 1952, Queen Juliana opened the garden city Slotervaart, the first one outside the ‘Ringspoorbaan’ of Amsterdam. In 1953, the Nemavo-Airey dwellings were finished and the infrastructure was constructed. Fig. 12, Fig. 13 and Fig. 14 show this situation in 1953. Fig. 15 is also made in 1953, but in this picture the infrastructure is finished. Comparing this image with Fig. 16 and Fig. 17, both made in 1981, the main difference is the addition of trees, which give the image a more friendly character. This is also described by the architect Berghoef in 1951 who said that the trees and other elements in the street profile were very useful to interrupt the extreme plasticity of the facades of the buildings. Moreover, although the pictures are not colored and the original buildings in real too, according to Berghoef the use of color for the facade had to be carefully and sparingly added in order to achieve special results within the Nemavo-Airey system.

Fig. 11. De Tourton Bruynsstraat – 1952 [Online Archive Amsterdam, 10-10-2015]

---

Fig. 12. Hilbert van Dijkhof – 1953 [Online Archive Amsterdam, 10-10-2015]

Fig. 13. Jacob Frankhof – 1953 [Online Archive Amsterdam, 10-10-2015]
Fig. 16. Hilbert van Dijkhof – 1981 [Online Archive Amsterdam Beeldbank, 10-10-2015]

Fig. 17. Jacob Frankhof – 1981 [Online Archive Amsterdam Beeldbank, 10-10-2015]
On the corner of the Burgemeester De Vlugtlaan and the Burgemeester Eliasstraat a statue of a construction worker was added, as is illustrated by Fig. 18 and Fig. 19. The statue is from 1962 and made for the municipality of Amsterdam. It is made as symbol for the extension of the capital Amsterdam and can still be found on the same location, as is showed in Fig. 20.

Fig. 18. Burgemeester De Vlugtlaan met standbeeld van Jan Havermans “De Bouwvakker” [Online Archive Amsterdam Beeldbank, 10-10-2015]

Fig. 19. Location of statue [Google maps, adapted]

Fig. 20. Statue made by Jan Havermans, named “De Bouwvakker” [Muller, 2015]

### 3.2 UNDERLYING IDEAS AND IDEALS

The Dutch urbanism from after the Second World War shows an expression of the idea of the manufacturability of the society.\(^{11}\) After the Second World War, a lot of houses were demolished or damaged and the population in the Netherlands was increasing. Because of a shortage of building materials and also of qualified building construction workers, the market in the Netherlands was not able to produce enough houses for the population.\(^{12}\) For this reason, the state started to give subsidies, but with the demand to produce houses for low costs. The reaction on this was the introduction of systemizing and rationalizing the building industry to make the houses more

\(^{11}\) A. Blom, 'Vroeg-Naorlogse Woonwijken', (Rijksdienst voor de Monumentenzorg, 2004).

\(^{12}\) Schoch, Visser, and Van der Zanden, p. 1.
affordable and faster to produce. In order to be able to build in a way like this, companies started to work with prefabricated building elements, called ‘montagebouw’ or ‘systeembouw’.\(^\text{13}\)

Besides the utopic idea about proper housing accommodation for workers and the middle class and the importance of a good structure of an urban area, urbanism became more and more a scientific discipline. The design and planning of an urban area found place after surveys about population, infrastructure, developments and employment. The General Extension Plan of Amsterdam from 1935, showed in Fig. 21 is the first plan based on this kind of research.\(^\text{14}\) This plan was presented in 1935 with the architect Cornelis van Eesteren as the chief urban designer who started developing this urban plan according to the principles of the ideas of garden cities, known by the CIAM congresses. The General Extension Plan, or in Dutch ‘Algemeen Uitbreidingsplan’ (AUP), offered the opportunity to build a city with a vision of the future in which people were living differently than they were used to. To develop the individual, the family and different communities, the old chaotic city with bad dwellings had to be replaced by light, air and space with the goal to make people healthier and the provoke the evolution of the community.\(^\text{15}\) In relation to this, a new way of parceling, open building strokes, was introduced. The strokes were oriented north to south so the dwellings were oriented east west. In 1939 the design for the neighborhood Slotermeer was presented as part of the General Extension Plan of Amsterdam.

---

\(^\text{13}\) Blom, Jansen, and Van der Heiden, p. 25.

\(^\text{14}\) Ibid. p. 12.

\(^\text{15}\) Messchaert, p. 3.
3.3 ARCHITECT

Dutch architect Johannes Fake Berghoef (see Fig. 22) was born in 1903 in Aalsmeer and died in 1994. Educated on the faculty of Architecture in Delft as one of the student assistants of M. J. Grandpré Moliere who is considered as one of the founders of the Delftse School. In first instance, Berghoef designed mainly dwellings in the neighborhood of Aalsmeer, which were not striking due to subtle design, perfectly fitting in the street view. Although Berghoef didn’t appreciate the Nemavo-Airey system, he got a license to use it and designed a lot buildings made by this system because of the housing shortage that time. However, Cornelis van Eesteren once named Berghoef one of the best functionalists ever. When the demand for houses decreased, Berghoef returned to the traditionalist approach.

Regarding to the architecture of the Airey-Nemavo system, Bergman said in 1951 that in principle, after the dimensions of the depth and width based on the module of the wall blocks, every floorplan is possible. Moreover, the dimensions of the window frames are a multiple of the wall blocks, but the place of the openings are free to choice. According to Berghof, one of the difficulties is the plasticity of the facade. So, the urban arrangement had the decisive meaning of the aspect and character of the Nemavo-Airey complexes. Today, colors are used by the renovation of Nemavo-Airey which give the building blocks a different character than the original ones. However, in 1954 Berghoef said for the Bouwkundig Weekblad that he thinks that with subtle and restrained use of colors, special results can be achieved within the Nemavo-Airey system in the long run.

Fig. 22. Johannes Fake Berghoef 1903-1994 [Hilversum2, 20-10-2015]

3.4 SOCIETAL RELEVANCE

The Nemavo-Airey dwellings are intended for the social rented sector, recognizable for example in the tile of the housing association, placed on one of the facades of the Nemavo-Airey buildings which is showed in Fig. 23 and Fig. 24. Until the 70’s the Dutch government was in charge of social housing and the municipalities were the client. However, the state had a lot influence because they regulated all subsidies and decided how many dwellings a municipality was allowed to build each year. Moreover, the state had also influence on the rent and the design of the expansion plans and dwellings. After the state decided how many dwellings a certain municipality was allowed to build, the houses were divided among different housing associations.

17 Zijlstra, p. 41.
18 Ibid.
Unlike many other countries, in the Netherlands the social rented sector has always had a special status and has never been regarded as a segment for especially low-income households. However, since 1990 the low-income households in social rented housing has increased and the high-income households are more and more in the owner-occupied sector. This development has also its consequences for the neighborhood and cultural mix of residents. In 2012 about 120 different nationalities were presented in Amsterdam West. Since the 1990, new plans for social spatial restructuring in Amsterdam West are made because the concentration of affordable social housing in combination with the increasing ethnic minorities might form a risk for the stability of the city. These concerns about safety and problems with ethnic minorities have already changed the old traditional idea of the “sociale maakbaarheid”. According to residents safety problems might be a result of wrong housing allocation policies of the housing associations which allocate a lot of people without work or with already psychological problems to the same place. However, according to Charles Montgomery social connections are the most important aspect which contributes to the happiness and safety of people in a certain area in a city. Moreover, meeting people in a green environment has an even stronger effect on the happiness and safety of people within the city.

Although it can provoke some tension, I think a cultural mix of residents is one of the values of this area of Amsterdam. Moreover, I think the social housing sector in the Netherlands is also something which is special and unique for the Netherlands.

In order to increase the happiness and safety of the different residents in the neighborhood it is important to create social interactions within the greenery spaces. An intervention should consider creating meeting places or social interactions within the public gardens which are now not used as open public space but as ‘kijkgroen’.

---

23 Mepschen, p. 74.
4. URBAN CONTEXT

Based on empirical observations and theoretical research the different Nemavo-Airey building blocks form an integral designed ensemble in a carefully detailed urban structure with a mix of function and good quality of public space. The spatial essence of the design of the public spaces is determined by three network systems, namely infrastructure, greenery structure and the canal network. This is reflected in perspective drawings of the main structure in which the roads and the greenery structure is clearly detailed in contrast to the abstract residential blocks which suggest that the shape and appearance of the residential neighborhoods was open to be determined in the future. This is confirmed by Cornelis van Eesteren who saw the task of the urban planner of that time as designing a plan in a way it can be adjusted over time according to the needs of people without changing the overall idea and structure of the masterplan.

4.1 MORPHOLOGY

The morphology of the Nemavo-Airey blocks, illustrated in Fig. 25, is a reflection of the introduction of open building strokes which were oriented north to south in a way the dwellings were oriented east west. However, in practice it turned out the building in strokes was an architectural challenges because architects were not used to design also the ‘backside’ of a building because normally with closed blocks these ‘backsides’ were not visible from the streets. Moreover, the results of the first experiment with building strokes in the neighborhood Bos en Lommer in Amsterdam West were not the results the architects were hoping for. The back still looks almost the same as the ‘backside’ of closed building blocks instead of a representing a proper facade. Because of this, experiments with shorter building blocks and with ‘hooks’ were done in order to bring less monotony in the repetition of the buildings. Moreover, the design of the urban plan, including infrastructure and greenery, was based on scientific arguments by calculating for example the amount and size of all facilities needed in a certain area.

Fig. 25. Structure of Nemavo-Airey blocks in Amsterdam West [Google Earth, adapted]

What makes the Nemavo-Airey blocks special in relation to other building blocks in Amsterdam West is the variation in position (see Fig. 26). The blocks are not placed in a same direction or at 90
degrees, but slightly different. Besides it gives this neighborhood a playful design, it is not common in this area which has all features of the clear-cut and straight components of the *Nieuwe Zakelijkheid.*

![Fig. 26. Position of Nemavo-Airey blocks in Amsterdam West (Google Earth, adapted)](image)

Through analyzing the position of the different building blocks, a repetition of these building blocks is a striking aspect as is illustrated in Fig. 27. The reason for this might be the industrialization and standardization which gave the possibility to produce many houses in short time.

![Fig. 27. Repetition of the Nemavo-Airey building blocks, Amsterdam West (Google Earth, adapted)](image)

Looking to the existing situation, some of the Nemavo-Airey blocks have already been renovated. In Fig. 28 the red blocks are original (see Fig. 29). The orange blocks have a layer of paint (see Fig. 30). Because of this, the structure and color of the original facade layer is not visible anymore. Three of the seven white painted building blocks still have the original window frames of steal; the other four have wooden window frames. The yellow blocks are even more renovated (see Fig. 30). Insulation is added to these blocks, which gives the buildings a different expression.
Fig. 28. Original Nemavo-Airey building blocks (red), renovated blocks with a layer of paint (orange) and renovated blocks with added insulation (yellow), Amsterdam West [Google Earth, adapted]

Fig. 29. Original building block [Muller, 02-10-2015]
Fig. 30. Renovated building block with a layer of paint [Muller, 02-10-2015]

Fig. 31. Renovated building block with a layer insulation [Muller, 02-10-2015]
After a walk through this neighborhood of Amsterdam West, besides the Nemavo-Airey building blocks many different kind of building blocks are built of which a lot are repeated for certain times. Moreover, on the other side of the Burgemeester van Vlugtlaan, four more buildings of 4 levels are made by the Nemavo-Airey system. These four building blocks are illustrated in Fig. 32.

![Fig. 32. Different building blocks made by the Nemavo-Airey system, Amsterdam West](image)

I think the open building strokes oriented north to south in a way the dwellings were oriented east and west are one the qualities of the Nemavo-Airey building blocks. Especially during the time of the *Nieuwe Zakelijkheid* this morphology with slightly different oriented building blocks was surprising and made the neighborhood special.

The urban structure must be preserved as much as possible. However, the back still looks almost the same as the backside of closed building blocks instead of a representing a proper facade. This is partly covered by the greenery, but it might be interesting to look if an intervention can give this backside a proper facade image.

### 4.2 GREENERY

The greenery between and around the Nemavo-Airey building blocks consist of border green, public gardens and private gardens. The public gardens are orientated towards the Burgemeester van der Vlugtlaan and are mainly decorative greenery (in Dutch: kijkgroen) for the surrounding Nemavo-Airey building blocks. Between these public gardens and the building blocks, private gardens are located, closed off the street by low fences which give these private gardens a semipublic character. However, the open character of the some public and private gardens is lost because of an overgrown of plants and trees and some public gardens are even closed by a low fence which is not in line with the beliefs of the Modern Movement to keep public space as ‘open’ as possible. Fig. 33 illustrates the greenery the intended open structure between the building blocks. Actually, the greenery had to be a part of a bigger and more complex network of different kind of green structures as the purpose of this green network was to connect different neighborhoods of Amsterdam West with each other. Because the fences and the overgrown gardens due to a lack of maintenance, these public gardens are nowadays actually not connecting the different area’s and are not open which is in contrast with the ideas of the Modern Movement. Fig. 34 shows one of these public gardens between two Nemavo-Airey building blocks.
Fig. 33. Green areas between the Nemavo-Airey building blocks which were intended to connect different areas as an open public space, Amsterdam West [Google Earth, adapted]

Fig. 34. Green area between the Nemavo-Airey building blocks [Muller, 02-10-2015]

I think the greenery is very important within the urban structure. However, the greenery and the public gardens are nowadays not functioning like they were intended to do. The ideas behind the greenery are also not visible today.

In order to use the public garden as an open public space which connects different neighborhoods and other greenery, the public garden must be an integrated part of the design of an intervention, just like Berghoef who saw the greenery as important part of the design. Moreover, attention must be paid to the transition between the private gardens of the residents living at the ground floor and the public garden between these private gardens.
4.3 INFRASTRUCTURE & FACILITIES

INFRASTRUCTURE & TRANSPORTATION

The building blocks are facing the Burgemeester de Vlugtlaan, one of the main roads in this neighborhood connecting this area with the city center of Amsterdam (see Fig. 35). Because of this location at the Burgemeester de Vlugtlaan, the Airey blocks actually forms the face of the conservation area. Moreover, because of a tram and bus connection to the city center of Amsterdam, the infrastructure provides a good accessibility for this location. Two different roads are crossing the Burgemeester de Vlugtlaan, which lead to a sub road parallel to the Burgemeester van Vlugtlaan, from where residents of the Nemavo-Airey blocks are able to park their car.

Fig. 35. Main infrastructure around the Nemavo-Airey building blocks with in blue the roads for cars and in yellow the public transportation [Google Earth, adapted]

One of the qualities which was named by one of the residents I have spoken to, was the orientation of the blocks with on the one hand the parking spaces and the other hand the (private) gardens and greenery. This repeated division of greenery and parking places is made visible in Fig. 36.

Fig. 36. Green areas and parking areas between the Nemavo-Airey building blocks [Google Earth, adapted]
In my opinion the location and the good accessibility to the center of Amsterdam with public transportation make the buildings valuable. From the Burgemeester de Vlugtlaan it is for example not far to the center of Amsterdam by public transportation. Even train station Lelylaan is walkable within ten minutes. Moreover, I think the clear division of the greenery and parking places is a high quality of the urban structure. However, the gardens which are openings themselves to the Burgemeester van der Vlugtlaan are not used as they were intended to be used as an open public space connecting different neighborhoods and greenery.

By changing the front and back side, the front side will face the greenery and the backside will face the parking spaces. This will make the public gardens an open public space which is used by residents. Moreover, because all public transportation is located at the Burgemeester de Vlugtlaan, the connection between the Burgemeester de Vlugtlaan and the (new) entrances of the Nemavo-Airey buildings might be important to add.

FACILITIES

Looking at the facilities in the neighborhood of the Nemavo-Airey dwellings, the Burgemeester de Vlugtlaan is important because most facilities are facing this road, which is reflected in Fig. 37. However, if we look to the relation between these facilities at the Burgemeester de Vlugtlaan and the other neighborhoods, not much direct (visible) connections exist. If we look closer to the situation around the Nemavo-Airey dwellings (Fig. 38), the connection between the facilities at the Burgemeester de Vlugtlaan on the one side of the Nemavo-Airey dwellings and the neighborhood with a lot of greenery at the other side is blocked by small buildings and fences. This is also reflected in Fig. 39 by a photo from one of the streets which ends at one side of the garden between two Nemavo-Airey building blocks.
According to the *Modern Movement* the public spaces should be as open as possible. However, the small buildings connected with the Nemavo-Airey buildings are blocking the view and the connection between the neighborhood and the Burgemeester de Vlugtlaan. Looking at which part of these small buildings is blocking the view, it is only the part of the building with a close facade almost without windows. I think the other part of the small buildings has a much more open character and architectural quality.

To make the gardens more open and to connect the Burgemeester de Vlugtlaan visually with the neighborhood, the fences should be removed. Moreover, because all Nemavo-Airey building blocks are located at the Burgemeester de Vlugtlaan, the rooms of the dwellings on the corner which are directly facing the Burgemeester de Vlugtlaan might be suitable for facilities, shops or offices.
5. ARCHITECTURAL APPEARANCE

Fig. 40 shows the differences between all Nemavo-Airey building blocks in Amsterdam West. Because the orange and yellow ones have already been renovated I will focus on the architectural appearance of the four red building blocks. These four building blocks have the most original image and identity because the building blocks which are painted have a different appearance and the ones which are insulated are not recognizable as Nemavo-Airey dwellings anymore due to invisibility of the grid. The four red building blocks can be divided in two types which are different in the amount of dwellings. However, the composition, the facade, the construction principles and the floorplans of the dwellings are the same.

![Different renovated and not yet renovated Nemavo-Airey building blocks](Google Earth, adapted)

This chapter is divided in four parts, beginning with a short description of the typology of the building with the related figures of the floorplans and facades. The second part is about the exterior and the third part about the interior and the floorplans. The fourth part describes the materialization of the Nemavo-Airey dwellings.

5.1 TYPOLOGY

The Nemavo-Airey dwellings at the Burgemeester de Vlugtlaan can be described as so called ‘portiekwoningen’. The building blocks have in total three levels and six or seven dwellings per level. The design is based on the Nemavo-Airey system which will be explained more in depth in the next chapter. Fig. 41 shows the floorplans of the building block and Fig. 42 shows the two main facades of the building. With a depth of 9,2 meters, these building blocks are quite small but with relatively a lot of daylight. The dwellings on the ground floor are 42 m² with one bedroom and the dwellings on the first floor 61 m² with three bedrooms. Instead of storage space on the top of a traditional dwelling under a sloped roof, the Nemavo-Airey dwellings have the storage in the base of the building. Besides this storage space at the base, also some smaller dwellings are constructed in order to increase the amount of residents of the building blocks. Based on empirical observations this building block is undamaged. Because of the absence of exterior insulation, the architectural image is determined by the building system and follows this rigid grid.
Fig. 41.  Floorplan groundfloor & level 1 [Van Hooyshuur architecten]

Fig. 42.  Facades west & east [Van Hooyshuur architecten]
5.2 EXTERIOR

The facades of the exterior of the Nemavo-Airey blocks show a strict grid of 625 x 375 mm in which all windows, doors and tiles are placed. Fig. 43 illustrates the repetition in the facade. Only the dwellings one of the corners has a slightly different facade composition.

Fig. 43.  East and West facade of the Nemavo-Airey dwellings [Van Hooyschuur Architecten, adapted]

The recognizable grid is iconic for the architectural image of these building blocks. With little exceptions, this grid determines the composition of the facades. It is also a reflection of the building system which is based on prefabricated elements.

Because the grid determines the composition of the facades, this grid must be concerned by an intervention. Using this grid or a grid with multiple sizes will enhance the architectural image of the building blocks.
5.3 INTERIOR

The principle floorplans of every house are repeated or mirrored. Only the dimensions of the dwellings located in the corner are different. This makes the corner dwellings interesting, because they have the same interior floorplan principle, but a slightly different facade because of a different composition of window frames. Fig. 44 shows the repetition of the floorplans of the dwellings in this building block.

![Fig. 44. Repetition of floorplan of ground floor and first level of the Nemavo-Airey dwellings (Van Hooysschuur Architecten, adapted)](image)

Fig. 44 and Fig. 46 illustrate the different functions of the dwelling. The bedrooms are colored green in this figure. Looking to the division of spaces inside the dwellings, both the dwellings on the ground floor as the dwellings on the first and second level have their bedrooms at the side of the parking spaces. The living rooms (red), bathrooms (blue) and kitchens (yellow) face the gardens and greenery.

Looking to the amount of square meters and the division of the different spaces (see Fig. 47), in general two types of dwellings can be distinguished. The first types are the dwellings on the ground floor. The second types are the dwellings on the first and second level.
Fig. 45. Floorplans ground floor with functions and square meters [Van Hooyshuur Architecten, adapted]

Fig. 46. Floorplans level 1 with functions and square meters [Van Hooyshuur Architecten, adapted]
Fig. 47. 3D model of the floorplan on the corner on the first level of a Nemavo-Airey building block [own illustration]
In 1951 it was decided that the *Voorlopige Wenken voor het ontwerpen van eengezinshuizen* was not in line with the changed situation and ideas of that time so new requirements and technical criteria were described in the *Voorschriften en Wenken*. Fig. 48 and Fig. 49 show the amount of square meters per type of room in the two different dwellings of the existing situation, the amount of square meters that was required in 1954 according to *Voorschriften en Wenken* and the requirements of 2015 according to the *Bouwbesluit*.

**Ground floor type (with 1 bedroom)**

<table>
<thead>
<tr>
<th></th>
<th>Existing Situation (m²)</th>
<th>Requirements 1954 26 (m²)</th>
<th>Requirements 2015 27 (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total surface</td>
<td>42</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Living room, bedrooms &amp; kitchen</td>
<td>32</td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td>Bedroom</td>
<td>16,5</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Bathroom</td>
<td>11</td>
<td>9,5</td>
<td>5</td>
</tr>
<tr>
<td>Kitchen</td>
<td>2,9</td>
<td>1,6</td>
<td>1,6</td>
</tr>
<tr>
<td>Storage</td>
<td>3,4</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Fig. 48. Ground floor dwellings with surface areas [own illustration, 2015]

**Type dwelling first and second level (with 3 bedrooms)**

<table>
<thead>
<tr>
<th></th>
<th>Existing Situation (m²)</th>
<th>Requirements 1954 26 (m²)</th>
<th>Requirements 2015 27 (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total surface</td>
<td>61</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Living room, bedrooms &amp; kitchen</td>
<td>49,2</td>
<td>38,5</td>
<td>18</td>
</tr>
<tr>
<td>Bedroom</td>
<td>16,5</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>Bedrooms in total</td>
<td>28,2</td>
<td>18,5</td>
<td>15</td>
</tr>
<tr>
<td>Bedroom 1</td>
<td>4</td>
<td>9,5</td>
<td>5</td>
</tr>
<tr>
<td>Bedroom 2</td>
<td>9,2</td>
<td>4,5</td>
<td>5</td>
</tr>
<tr>
<td>Bedroom 3</td>
<td>8,0</td>
<td>4,5</td>
<td>5</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2,9</td>
<td>1,6</td>
<td>1,6</td>
</tr>
<tr>
<td>Kitchen</td>
<td>4,5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Storage</td>
<td>4,3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Balcony</td>
<td>2,8</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

Fig. 49. First level dwellings with surface areas [own illustration, 2015]

Comparing the existing square meters with the in 1954 and 2015 required square meters, most of the areas meet these requirements. However, the red numbers are the most interesting one because they don’t meet the requirements of 1954 or 2015. The kitchen and storage of the dwellings on the ground floor do not meet the requirements of today. For the dwellings on the first level and second level, the kitchen, storage and balcony do not meet the requirements of today and the storage does even not meet the requirements of 1954. This is also reflected in the facade. Balconies of most dwellings are used as storage space instead of outdoor space, which is reflected in Fig. 50.

---

26 Ibid. pp. 3 - 10.
28 Centrale Directie van de Wederopbouw en Volkshuissvesting, pp. 3 - 10.
29 Online Bouwbesluit.
Although the size of the dwellings are small, they are part of social housing which means they will not be affordable anymore by adding a lot of square meters. However, the kitchen, balcony and storage space are too small, which makes these dwellings uncomfortable.

The lack of space of the kitchen, balcony and storage can be improved with an expansion of the dwelling by adding more square meters or use the floorplan more efficient by a rearrangement of the floorplan or by combining different rooms. An example of adding more square meters is the renovation of some of the Nemavo-Airey building blocks. For these renovated blocks, a balcony was added as an exterior structure so the existing balcony could be added as inside surface area to enlarge the kitchen. Another options is to located the storage space somewhere between the building blocks so the inside storage space can be used for other functions.

**Stichting Goed Wonen**

In 1946 the *Stichting Goed Wonen* was founded, based on the idea of “Smaak is een kwestie van opvoeding”. The foundation created and promoted appropriate interiors which provided the people the maximum freedom to develop their houses and themselves. Simplicity, ease and living pleasure were the central themes. The furniture was strict, light and therefore easy to move. These ideas about *Goed Wonen* are reflected in the show house of the Van Eesteren Museum. If we compare different rooms of the show house with the existing situation in the Nemavo-Airey dwellings, a lot differences but also similarities are visible. Fig. 51 shows the bathroom in this show house and Fig. 52 shows the existing situation of the bathroom in the Nemavo-Airey dwelling. The

---

amount of space, the tiles and the position of the sink and the mirror are the same. However, the floor is in the Nemavo-Airey dwellings also clad with tiles in contrast with the show house.

Fig. 51. Picture of the Van Eesteren Museumwoning [Muller, 11-09-2015]

Fig. 52. Picture of the existing situation of the bathroom in the Nemavo-Airey dwelling [Muller, 08-09-2015]

Fig. 53 shows the kitchen in the model house and Fig. 54 the existing situation of the kitchen in the Nemavo-Airey dwellings. Comparing these two images, many differences can be found. An example is the replacement of the geyser and the added extractor.

Fig. 53. Picture of the kitchen in the Van Eesteren Museumwoning [Muller, 11-09-2015]

Fig. 54. Picture of the existing kitchen of the Nemavo-Airey dwellings [Muller, 08-09-2015]
The ideas of the foundation Goed Wonen are for some people still valuable qualities. However, nowadays it is not common that one foundation is determining the way of how your interior of your house should look like. Moreover, a lot of the residents in Amsterdam West are not born in the Netherlands and have different traditions or ideas about how the interior should look like.

Because the idea of Goed Wonen is outdated, residents should have the choice what kind of interior they want. Moreover, in the existing situation, many small rooms are dividing the houses into small spaces and the place of the bathroom is the division between the kitchen and the living room. This should actually be determined by the residents who live in these houses. For a design for an interior intervention, participation of the residents should be considered.

5.4 MATERIALIZATION

The walls of the original Nemavo-Airey building block are cladded by prefabricated concrete panels (625 x 375 x 40 mm) with a gravel top layer on the exterior side. In general, these blocks are undamaged with some exceptions of which one is showed in Fig. 55. The main construction exists of columns and beams of steel. Moreover, the columns are sheathed with concrete. The window frames and rafters are made of steel and the roof sheathing is of wood, finished with bitumen. Although most window frames are undamaged, Fig. 56 shows one of the exceptions. Moreover, some other degradation processes and facades fixes can be found. Examples are discoloration (see Fig. 57), moisture problems, algae and oxidation of the window frames.

Fig. 55. Damaged concrete panel [Muller, 11-10-2015]

Fig. 56. Damaged window frame [Muller, 11-10-2015]

---

The concrete panels of the Nemavo-Airey building blocks are iconic for the architecture of the building and the reflection of the building process based on prefabricated elements.

In order to keep the image of the building, the concrete panels must be preserved and in some cases be cleaned. At the place of an intervention, these concrete panels might be reused for different functions like pavement or demarcation.
6. BUILDING TECHNOLOGY

This chapter includes the technical analysis of the construction of the Nemavo-Airey dwelling and the theoretical historical research of the Nemavo-Airey building system. Moreover, this building system is compared with building processes related to mass customization. The chapter is divided in three parts. The first part describes the theoretical historical research of the development of the Airey system to the Nemavo-Airey system and the similarities and differences between these two systems. The second part is the analysis of the existing construction of the building. The third part is about the building process. Both traditional building and renovation processes as the processes based on the Nemavo-Airey system and mass customization are compared.

6.1 FROM AIREY TO NEMAVO-AIREY

After the Second World War, the role of the architect in building processes and the influence of mass production on the architecture of housing was researched. Because construction companies had to pay for research and development themselves not much housing was directly build by prefabricated but a lot was written about the possibilities of prefabrication. Moreover, a lot of researched building systems did not developed to prototypes or physical experiments. However, in 1946 the government approached the ‘Nederlandse Maatschappij voor Volkshuisvesting’ (NeMaVo) to research the possibilities of the Airey-system from England.32 The NeMaVo was a corporation of the ministry, institutional investors and the construction and building industry. Van Saane, director of the NeMaVo started already in 1928 his own company as contractor with which he focused on social housing based on ideas in Germany and Austria and striving for affordability and central heating, warm water, bathrooms finished with tiles, fully equipped kitchens and a connection to the radio distribution.33 In 1947 he started, based on contracts he made during the Second World War, founding the ‘nNederlandse Maatschappij voor Volkshuisvesting’n. Already in 1946 he got the mission of the ‘nCollege van Algemene Commissarissen voor de Wederopbouw’n to research new prefabricated building systems in England. One of the systems was the Airey system, developed by Sir Edward Airey. In order to increase the industrialization of the housing production in the Netherlands, the Airey-system was introduced.34 The Airey-system was a combined system for which steel, wood and vibrated concrete was used.35 The frame structure consisted of light weighted concrete stiles, covered by inside and outside overlapped panels of 24 centimeter by 90 centimeter. All elements were light weighted so it was possible to transport and assemble these elements by just one worker. However, for a decisive solution for the housing shortage to make it proof for a serial production of 1000 dwellings, a translation of the Airey-system for the Netherlands was needed. The challenge was to make the system industrial and architectural. In collaboration with the architects J. F. Berghoef and H. T. Zwiers, Van Saane improved and rationalized the fabrication of the elements and the building details in collaboration with representatives of De Vries Robbé and N.V. Betondak.36 Although this new system needed higher investments for molds and machinery, it had some major advantages. The new Nemavo-Airey system eventually differs in a lot of aspects and also the construction is different. The concrete stiles got a different shape and were placed with more distance to the other stiles. For the floors, iron trusses were developed for the construction. The exterior panels got the dimensions of the distance between two stiles and the overlapping shape

32 Messchaert, p. 8.
33 Zijlstra, p. 62.
34 Schoch, Visser, and Van der Zanden, p. 3.
35 Messchaert, p. 8.
36 Zijlstra, p. 64.
disappeared. For the interior, panels of *Heraklith* were used instead of the English plasterboard.\textsuperscript{37} Moreover, an important constructional advantage was the assemblage of the window frames of steal with a special profile to the stiles instead of using concrete stiles and sills. According to Berghoef, this resulted in the disappearance of the white window frames between the grey wall and the window itself, but it gave more freedom in the composition of the windows.\textsuperscript{38} Moreover, comparing the construction place of the Nemavo-Airey dwellings with the construction of a building on the right side of Fig. 58, the main difference is the absence of scaffolding. This was also one of the advantages of the Nemavo-Airey building system in relation to the traditional way of building. No scaffolding was needed and the construction period was much faster.

![Image](image.jpg)

*Fig. 58. Realisation Remavo-Airey dwellings – 1952 [Online Archive Amsterdam Beeldbank, 10-10-2015]*

In the end, the Nemavo-Airey system was constantly improved and also used for building with three or four levels by using the frame construction of steal as a stacking of *tafels met vele poten*.\textsuperscript{39} The first 1000 dwellings based on the Nemavo-Airey system were initiated by the State. After that, municipalities were the client. In 1950 about 3000 Nemavo-Airey dwellings were finished and about 1200 in construction. In total about 8000 dwellings are produced based on the Airey system in the Netherlands.\textsuperscript{40}

I think the translation of the Airey system to the Nemavo-Airey system and especially the reason why a system like this was needed in that time, is one of the main values of the Nemavo-Airey buildings in Amsterdam West. The fact that a lot of these Nemavo-Airey dwellings already are demolished, might be an extra reason to preserve these ones.

During the time these buildings were erected, this system was cheap, fast and innovative. These three aspects might be also the challenge for the renovation of the Nemavo-Airey dwellings. Because the renovation is about social housing, the renovation must be relatively cheap. An expensive renovation will lead to an increase of rent and the residents who are now living in the Nemavo-Airey houses cannot afford this. Fast in a way that the residents do not have to move for a long time to a different place. Residents might be happier if the renovation takes not more than a

\textsuperscript{37} Messchaert, p. 9.
\textsuperscript{38} Zijlstra, p. 67.
\textsuperscript{39} Messchaert, pp. 9-10.
\textsuperscript{40} van Elk, p. 6.
few days. This will also save costs for the housing association. Finally, because of experimenting with innovative building systems and new technologies, better solutions can be provided. So, the renovation should be innovative in a way we can learn from this project and use the general concepts as a starting point to increase the energy efficiency and architectural quality of other portiekwoningen.

### 6.2 CONSTRUCTION OF THE NEMAVO-AIREY DWELLINGS

The Nemavo-Airey dwellings are built from a framework of steel and concrete which is also the load bearing structure and could be seen as three stacked tables with many legs. In this comparison the top of each table is the floor and the legs are the construction in the facade. The floors are nailed on beams that are connected with a rigid joint to a \( L \) shaped beam of steal which is connected with the framework of gewapende betonstijlen. These legs are also joined rigidly to protect the construction against lateral forces. This way of construction provides a freedom in the design of the facade and the floor plan. Berghoef saw this as the possibility for the residents to express their identity in the interior of their home. However, an extra column and steel beam is added to middle of the construction because of the length of the span direction of the dwellings. Fig. 59 shows the load bearing columns, Fig. 60 shows the beams of steal and Fig. 61 illustrates a section of the construction of the building with the visible tralieliggers supporting the wooden floor.  

---

*Fig. 59. Floorplan Nemavo-Airey building with load bearing columns [Hooyschuur Architecten, adapted]*

---

Fig. 60. Floorplan Nemavo-Airey building with beams of steel [Hooyshuur Architecten, adapted]

Fig. 61. Section of the Nemavo-Airey building block [Hooyshuur Architecten, adapted]
Moreover, walls of blocks in ‘halfsteensverband’ are used to divide the different houses from the storage spaces and the other houses inside the building block. These walls also contribute to the stability and the fire safety. Fig. 62 shows the location of these walls in the Nemavo-Airey building.

![Diagram of Nemavo-Airey building with Gibo walls](image)

**Fig. 62.** Floorplan Nemavo-Airey building with Gibo walls [Hooyshuur Architecten, adapted]

Because the construction is mainly located in the facade, a free floorplan is provided. Architect Berghoef saw this as an opportunity to let people express identity in their interior of their home. I think this is a quality of the construction and the building system of the Nemavo-Airey dwellings. It also related to the theory of John Habraken and the subject of participation of residents in mass produced buildings. According to Habraken, the mass produced buildings gave people not enough possibilities to their own lifestyle. He aims for a division in the constructive part which is built by professionals and the individual part in which the residents are involved. In this case, the role of the architect is designing the constructive system by prefabricated elements and together with the residents the individual part.

Because free floorplans are possible due to the way the building is constructed, this opportunity to redesign the interior in combination with the residents and housing association should be considered. The free floor plan gives the opportunity for example to remove all indoor walls, except the walls in red in Fig. 62 in order to give the residents or housing association the freedom to make a new floorplan. Especially if the dwellings will be insulated from the inside and new climate installations must be added, already a lot of interventions must be done in the interior. In this way it is relatively little effort to place new walls. In this way, people can also express themselves in their interior, just like the vision of Berghoef.

---

42 van Elk.
6.3 MASS CUSTOMIZATION

“This project is not about houses, but about homes” – J.S. Muller

The Nemavo-Airey houses were as stated before built by mass production to decrease the housing shortage. However, after more than fifty years, the building has been used by many residents. Therefore, I name this project a project about homes instead of houses. Houses are initially designed with the function to provide shelter. However, after a certain time, users have added more meaning and depth that will exceed the original function as a shelter. In this way, the term houses gains deeper purpose and are named homes, which already are customized by their residents with all involved memories and cultural values. Nowadays, by innovation, automation and digitalization, new (communication) technologies are developed to involve the user in the process. Moreover, building companies are focusing on products, product technologies and industrialized processes which actually look like the mass production movement of years ago. Because of these developments and the focus on homes instead of houses, research is done to the differences and similarities between mass production of the Nemavo-Airey building system as example and mass customization which is nowadays possible by innovative technologies. These two processes are also compared with a scheme of a traditional renovation and building process, as showed in Fig. 63.

Fig. 63. Scheme of a traditional renovation process for social housing of the last 50 years [own illustration]
The first scheme is based on a traditional building and renovation process for social housing which is showed in Fig. 64. This process has not been changed so much over the last sixty years. The traditional way of building after the Second World War was almost the same as a traditional building and renovation process is done nowadays. However, exceptions exist. Because of the housing shortage and a lack of construction workers and materials in the period after the Second World War, the traditional process was replaced by new processes based on mass production. One of the examples is the Nemavo-Airey system. Fig. 64 shows the process based on the Nemavo-Airey building system in the period after the Second World War.

Fig. 64. Scheme of building process based on the Nemavo-Airey building system [own illustration]
Fig. 65 shows a possible renovation building process of nowadays based on mass customization. If we compare those two schemes, a lot of similarities can be found. More interesting is to look at the differences. One of the big differences in the process is the position of the residents, the users of the building itself. In the process scheme of after the Second World War, the residents are visible below in the scheme whereas the mass customization scheme starts with the residents. One of the reasons for this difference is that after the Second World War the buildings were made for new residents instead of renovating a building for residents who are living in the dwelling for many years. So, placing the residents at start of the process and involve them into the design process is one of the most important differences between the mass customization scheme and the schemes of the traditional renovation and building processes and the building process based on the Nemavo-Airey building system.

![Diagram of building process based on mass customization](fig65.png)
The schemes of the building processes of the Nemavo-Airey building system and the process of mass customization have a lot of similarities with the theory of Hennis de Ridder, written down in his book ‘Legolisering van de Bouw’. De Ridder writes that instead of making unique buildings or renovations, choosing products of the market from suppliers who are responsible for the products for their entire life cycle, will increase the innovation and sustainability within the building sector. De Ridder describes that the role of the architect will be change to more an innovative connector who decides which parameters will be set up based on the field of technical and aesthetic possibilities and the cultural values of a project in order to give other parties like residents and housing associations the possibility to be involved in the design process.

For the renovation of the Nemavo-Airey dwellings I see the changing role of the architect described by De Ridder as an innovative approach of the way the architect works in the field of both engineering as heritage. On the one hand, the architect must have the knowledge in the field of building technology and climate installations in order to achieve certain ambitions for energy savings and sustainability. On the other hand, the architect must also, based on the cultural values and historical research, translate all interests and ambitions of the different involved parties to a possible parametric model which can be communicated to all suppliers who can produce, customize and change their products to this case.

Involving the residents and the housing association in the design process for a certain part of the design is possible by for example a woonconfigurator, software which is nowadays developed by many different companies. An example is the woonconfigurator of the company ibuildgreen which is showed in Fig. 66 and Fig. 67.

Fig. 66. Woonconfigurator ibuildgreen [ibuildgreen, 2015]

---

In general, residents select first their house and after that they will see all possible options, step by step. The selection of choices is often made by the architect and is also based on different requirements and the *Bouwbesluit*. Setting up these choices and the freedom residents will have in their choices is an important aspect within mass customization related to the Nemavo-Airey dwellings. I think the options must be based on the analysis and value assessment of all cultural and architectural values of the building. With these values in mind, the architect might design a framework within certain choices can be made by parties like residents or housing associations but without losing the identity of the total building. In the case of the Nemavo-Airey building blocks, the interior part is in my opinion less important the exterior walls which is also the constructive part of the building and reflects the building system of the time the building was made. In this way, residents might have more choices to form the interior of the building instead of having many choices for elements on the exterior. Fig. 67 shows an example of the interior options and possibilities for a housing project in Delft. All choices are also directly connected with the building costs. However, these houses are sold in the open market so in relation to social housing, the costs might be an increase in rent.

![Image](image.png)

Fig. 67. Woonconfigurator ibuildgreen [ibuildgreen, 2015]

However, the design process after this research report will explore the possibilities and limits of mass customization by trial and error and by reflecting the possible options with the desires and preferences of the different parties involved, like the residents, the housing association and professionals of the Van Eesteren Museum.
7. ENERGY CONSUMPTION

According to the requirements of the *Energieakkoord*, the built environment must be energy neutral in 2050 and in 2020 at least 14 percent of the energy must be generated in a sustainable way.\(^{46}\) Today, only 0.1 percent of the built environment is energy neutral and according to the *Nationale Energieverkenning* (NEV) the target of 2020 will be difficult to achieve.\(^{47}\) However, in order to meet the requirements, Minister Henk Kamp of Economic Affairs recently announced he will make a subsidy of 8 billion euro available next year to generate more clean energy. The subsidy is meant for both companies as private parties to invest in the generation of energy from thermal heat, solar panels, wind turbines and heat pumps. This chapter describes the current situation of the energy consumption of the Nemavo-Airey building with 18 dwellings and explores the different renovation options to make the building more sustainable. Although the term sustainability is nowadays often used for many different meanings, the focus in this research is about the energy consumption in relation to the embodied energy of the building materials. In the end, also the financial aspects are researched in order to get insight in the relation between the investments and payback time by saving costs for energy. In this way, the different ambition levels of renovation concepts are compared in order to choose the best option for the renovation of the Nemavo-Airey dwellings.

7.1 CURRENT SITUATION

In order to be able to compare the energy consumption of today with the energy consumption after a certain renovation, energy labels are used. The energy labels are based on the Energy Index, which represent the energetic performance.\(^{48}\) Dwellings which are constructed after 1995 are represented by the *EPC* (Energie Prestatie Coefficient). These values are not similar because different methodologies are used to determine these values.\(^{49}\) It is for example more difficult to know specific data by old existing building, so fixed values are used. However, by some calculations these two values can be converted. This also means different ways to calculate the Energy Index exists. In this research, the Energy Index is calculated by the EPC value, the amount of square meters of the floor surface of the dwelling and a ratio based on the floor surface and the total amount of square meters of external divisions based on heat loss by transmission.\(^{50}\)

To calculate the EPC value, the software Uniec2.2 is used (see Appendix A). In order to be able to calculate the EPC value, the RC values must be calculated first. Fig. 68 shows the RC values for the different components of the Nemavo-Airey dwelling.

If we compare the RC values of the Nemavo-Airey building with the minimum requirements of different years in the past, visible in Fig. 69, the Nemavo-Airey building was far ahead with the RC values.\(^{51}\)


\(^{49}\) Agenschap NL, ‘Feiten En Fabels Rond De Aanscherping Van De Epc Van 0,8 Naar 0,6’, (2010), 2-3.

\(^{50}\) Isso-Publicatie 82 Deel 1 - Energieprestatiecertificaat, p. 8.

**Fig. 68.** RC values of different components of the Nemavo-Airey dwelling [own illustration]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dak</td>
<td>0.86</td>
<td>1.03</td>
<td>1.29</td>
<td>1.3</td>
<td>2.0</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Buitenwand</td>
<td>0.43</td>
<td>0.69</td>
<td>1.29</td>
<td>1.3</td>
<td>2.0</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Vloer begane grond</td>
<td>0.17</td>
<td>0.26</td>
<td>0.52</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Dubbel glas woonvertrek</td>
<td>nee</td>
<td>nee</td>
<td>ja</td>
<td>ja</td>
<td>ja</td>
<td>ja</td>
<td>ja</td>
</tr>
<tr>
<td>Dubbel glas slaapvertrek</td>
<td>nee</td>
<td>nee</td>
<td>nee</td>
<td>nee</td>
<td>nee</td>
<td>nee</td>
<td>ja</td>
</tr>
</tbody>
</table>

*Minimum isolatie-eisen voor de sociale woningbouw volgens de Voorschriften en Wenken 1965, de Modelbouwverordening 1976-1990 en het Bouwbewust 1992, uitgedrukt in de warmte weerstand van constructiedelen (Rc) in m²K/W*

**Fig. 69.** Minimum requirements RC value [Liebregts, et al. 2011]
From the Uniec2.2 calculation (see Appendix) the dwellings in the middle of the Nemavo-Airey building block on the first level have an EPC value of 2.08, as showed in Fig. 70. With this EPC value and some extra calculations the ratio between the EPC value and the Energy Index is determined and has a value of 0.78. This mean the Energy Index is 2.08*0.78= 1.62. However, the EPC calculation is based on assumptions for the ventilation and heating system, so a more detailed calculation with fewer assumptions would be preferable for a next research.

Fig. 70. Summary of Uniec EPC calculation [own illustration based on results of calculation by Uniec2.2, 2015]

With the Energy Index of 1.62, an energy label can be determined. According to Fig. 71, the dwelling will get an energy label D. However, since 1 January 2015 changes are made in the field of energy labels. In the new energy label system no distinction is made between new buildings and renovation projects. The simplified energy label system gives energy label in the range between G

---

and A. Energy labels A+ till A++++ are expired. Moreover, till 2015 it was possible to get an energy label based on representation in a way the label was determined by comparable dwellings in order to save costs. From 2015 this is not possible anymore and because energy labels are mandatory calculations must be made.

Fig. 71. Energy labels based on the Energy Index. [Retrieved from: http://www.verbouwkosten.com/energielabel-huisberekenen/]

According to the website of the Energy Atlas, the Nemavo-Airey dwelling has a label G which is illustrated in Fig. 72. However, these values are based on the year of construction and type of dwelling. Renovations of changes after the construction year are not taken into account. So, the value of the calculation should be more exactly than the labels which can be found in the Energy Label Atlas.

Fig. 72. Energy label atlas. [Energie Label Atlas, 11-10-2015 53, adapted]

According to Niek Schaap from Eigen Haard the actual Energy labels of the dwellings are mainly F with some exceptions of G. For the energy efficiency calculations and the financial feasibility, label F is used.

7.2 AMBITION LEVELS

To make dwellings energy neutral within the coming years, different strategies can be applied which are described here as different ambition levels. One of the highest ambition levels is the Plus Energy Building concept which means that a building will produce more energy than needed in average over a year.\(^{54}\) Recently, the popularity for Net Zero Energy buildings (ZEB), or the Nul op de meter (NOM) dwellings is increasing in the Netherlands. Because of programs like the Energiesprong, the Stroomversnelling and Ons huis verdient het, more and more renovation concepts are put in the market. However, a question is if this high ambition level is suitable for all buildings and especially the Nemavo-Airey dwellings this research is focused on. A different strategy might be to renovate the dwellings by steps during the years. For example not directly renovating to NOM but first to label B in 2020 with a lower investment and a less radical renovation without renovating in a way it is not possible anymore to make it energy neutral in 2050, illustrated in Fig. 73.

![Fig. 73. Targeted and the needed energy transition [Haytink, et al. 2015](image)](image)

At the request of the Ministry of Internal Affairs, Nieman Raadgevende Ingenieurs has done research about energy efficient renovation projects.\(^{55}\) The research is divided into projects with an ambition level of energy label B or A and project with an ambition of the former labels A+ or A++, so almost Net Zero Energy. It can be concluded that the renovation projects with a higher ambition level used different methods and approaches than the projects with a lower ambition level. An example is the general five different insulation methods, illustrated in Fig. 74. In order to have more insight in these consequences of renovation concepts with different ambition levels, projects are compared by their approach, technical qualities, renovation methods, the investment costs, the consequences for the renovation on energy consumption, the embodied energy in the materials and the aesthetics.

![Different examples of insulation options [Haytik, et al. 2015](image)](image)

7.3 CASE STUDIES

In order to explore the consequences of different ambition levels in practice, seven case studies are done. This will give an overview of the possible renovation techniques of today to compare the consequences of different ambition levels related to investments and architectural image.


CASE STUDY 1: PASSIVE RENOVATION LUTTEBRINK – ENSCHEDE

The building blocks with 28 drive-in dwellings from 1969 are renovated to passive houses which increased the energy label from E to A++. A solar boiler system, a WTW-system, triple glazing and an insulated facade are some of the characteristics of this passive houses. The execution of the renovation is partly due to the involvement of the tenants who had a vote in the choice of the design of the facade of the building. Moreover, the tenants were able to choose the composition of the windows. Because of these choices, every dwelling is individual and recognizable today. However, these mass customization aspects did not lead to a fragmented facade. Because the tenants had only some choices about the composition of the window frames, the facades looks coherent. If the tenants would also have the free choice in the materialization, the size and color of the window frames, the facade probably would look more fragmented and chaotic. Moreover, more plasticity is gained after the renovation. However, in order to really make these dwellings energy efficient, the tenants were educated by an energy coach how to save energy in their new house. Fig. 75 shows the situation before the renovation. Fig. 76 shows the situation after the renovation. Fig. 77 is the general concept of the renovation with in Fig. 78 the energy consumption. More information about the different climate installations can be found in Appendix D.

Surface area per dwelling: 126 m²
Investment per dwelling: Unknown

---

57 Haytink, Geurts, and Valk.
CASE STUDY 2: RENOVATION OF 78 PORTIEKETAGEWONINGEN IN SATERLOSTRAAT - HENGELO

The project exists of a ‘portieketageflat’ of three levels of in total 78 dwellings. The most innovative part of the project is the balcony of composite materials, which is constructed as a coat over the original balcony. This will also insulate the original construction of the balcony. Because the dwellings were small, the loggia on the back side is added to the dwelling. The renovation itself had a span of 12 days including the replacement of the kitchen, the douche, the toilet, the window frames and the roof finishing. Moreover, mechanical ventilation was added and due to HR++ glass and extra insulation, the energy label improved from F and G to B. Fig. 79 shows the situation before the renovation. Fig. 80 shows the situation after the renovation. Because of the intervention in the balconies and entrances, more plasticity is visible in the situation after the renovation. Moreover, the balconies on the ground floor are connected with the new entrance of the dwellings which gives more attention to the entrance in comparison with the situation before. Fig. 81 shows the general concept of the renovation and Fig. 82 the energy consumption. More information about the different climate installations can be found in Appendix D.

Surface area per dwelling: 45 – 70 m²

Investment per dwelling: € 56.500,- & Rent increase: € 65,-

Fig. 79. Photo before renovation [Haytik, et al. 2015]

Fig. 80. Photo after renovation [Haytik, et al. 2015]

Fig. 81. Renovation concept [Haytik, et al. 2015]

Fig. 82. Energy use and generation [Haytik, et al. 2015]

58 Haytink, Geurts, and Valk.
CASE STUDY 3: JAN VOERMANSTRAAT, AMSTERDAM

Due to the financial crisis, these dwellings were renovated instead of demolished. With a simple renovation, the complex of dwellings is now part of the ‘top 100’ of postwar heritage of Amsterdam. For 25,000 euro’s, the dwellings now have central heating, mechanical ventilation, extra insulation and new window frames with HR++ glass. Because of these measurements, the dwellings now have energy label B instead of G. Fig. 83 shows the situation before the renovation. Fig. 84 shows the situation after the renovation. The image of the exterior is still the same after the renovation. Fig. 85 shows the general concept of the renovation and Fig. 86 the energy consumption. More information about the different climate installations can be found in Appendix D.

Surface area per dwelling: 52 m²
Investment per dwelling: € 25,000

Fig. 83. Photo before renovation [Haytik, et al. 2015]
Fig. 84. Photo after renovation [Haytik, et al. 2015]

Fig. 85. Renovation concept [Haytik, et al. 2015]
Fig. 86. Energy use and generation [Haytik, et al. 2015]

60 Haytink, Geurts, and Valk.
CASE STUDY 4: RENOVATION LUCELLESTRAAT, AMSTERDAM

Starting point of this renovation is the use of innovative products and methods in order to regenerate the original image. The insulation layer with so-called 'steenstrips' and new aluminum window frames are obvious new. However, the building has with the application of new methods and products the 40 looks back. In less than 15 days the facade and roof were renovated, the porches improved, the dwellings insulated, the new installation added, the bathroom, kitchen and toilet replaced and for the mutation dwellings the floorplan changed. Fig. 87 shows the situation before the renovation. Error! Reference source not found. shows the situation after the renovation. Because the composition of all facades after renovation is exactly the same as before the renovation, the building has the same looks and identity. However, the building looks newer because the facade is cleaned. This small intervention has actually a huge impact on the image of the building. Fig. 89 shows the general concept of the renovation and Fig. 90 the energy consumption. More information about the different climate installations can be found in Appendix D.

**Surface area per dwelling:** 64.5 – 97.2 m²

**Investment per dwelling:** € 45,000,-

---

62 Haytink, Geurts, and Valk.
CASE STUDY 5: RENOVATION BEETHOVENLAAN, DOETINCHEM

The project in Doetinchem exists of the renovation of four flats. For the renovation anew staircase and galleries are added, the roof finishing is replaced, the facades are insulated and the window frames were replaced by frames with HR++ glass. For this project, housing association Sité focused on the Social Return of Investment (SROI). This means during the renovation, people from the neighborhood were selected to work on this renovation. In this way, not only the technical part of the renovation is important but also the social positive side-effects. Fig. 91 shows the situation before the renovation. Fig. 92 shows the situation after the renovation. Because of the addition of many elements, the architectural image changed a lot. The building has after the renovation more plasticity. The new staircase also makes the experience of the approach of the building different than the situation before the renovation. Fig. 93 shows the general concept of the renovation and in Fig. 94 the energy consumption. More information about the different climate installations can be found in Appendix D.

Surface area per dwelling: 31 – 66 m²
Investment per dwelling: Unknown

---

64 Haytink, Geurts, and Valk.
Foundation Woonvaste choose for this project to improve the dwellings to an ambition level of passive renovation. After the renovation, the apartments need only little energy because of an airtight construction. Moreover, the dwellings are ventilated by a balanced ventilation system with a big return on heat recovery. Fig. 95 shows the situation before the renovation. Fig. 96 shows the situation after the renovation. The passive renovation had a lot impact on the architecture. By comparing the pictures, the original building is almost not recognizable anymore. Due to the extension of a box of glass for the new entrance, the plasticity of the building changed. Moreover, also the materialization is totally different with makes the building after the renovation looking more modern but without having the same identity as before. Fig. 97 is the general concept of the renovation and Fig. 98 the energy consumption. More information about the different climate installations can be found in Appendix D.

Surface area per dwelling: 65.5 m²
Investment per dwelling: € 100,000,-

Fig. 95. Analysis of photo before renovation [Haytik, et al. 2015]
Fig. 96. Analysis of photo after renovation [Haytik, et al. 2015]
Fig. 97. Renovation concept [Haytik, et al. 2015]
Fig. 98. Energy use and generation [Haytik, et al. 2015]

66 Haytink, Geurts, and Valk.
CASE STUDY 7: NOM RENOVATION VOERMANSTRAAT, GRONINGEN

In May 2014 the first three Nul op de meter (NOM) renovation prototypes were realized (see Fig. 99) in order to renovate in the coming years the other 110,000 post-war portiek dwellings to NOM. In the end of 2015, all the 48 dwellings will be renovated by this concept. The tenants of these dwellings do not have any rent increase after the renovation because the tenants pay the amount of money they would pay for their energy bill to the housing association who invests in these renovations. NOM means that the dwellings generate in average the same quantity of energy than what is needed for a general family. Optimizing the comfort was one of the focus points of the renovation. In order to improve the comfort, on both sides a new facade was added. However, the new facade could not be added to the old one, so it had to be connected to the new added foundation around the building. Besides the new facade on both sides, new technologies are used for the climate design. Besides triple glass and new insulation, a mechanic ventilation system with heat recovery is added and can be controlled by hand. Moreover, a solar water heater and a heat pump will provide hot water and heating.

![NOM Energiesprong Renovatio by Vereniging de Stroomversnelling, Groningen [Bos, 2015]](Fig. 99)

Because the new facade has a slightly different composition, more plasticity and different materialization, the image of the building has changed after the renovation. However, residents are quite positive and satisfied with the result because the design looks more contemporary. Moreover, their dwellings are more insulated and comfortable without paying for it. This has resulted in the fact almost all residents of the building has agreed to the NOM renovation, so the requirement for the housing association of 70% participation of the residents is achieved and the renovation will probably be finished in the end of 2015. After the total renovation is done, the project will be monitored and evaluated in order to decide if the project will be copied to more houses in the neighborhood.

---

70 Energiesprong.
CONCLUSIONS OF THE CASE STUDIES

Although the different case studies are difficult to compare, Fig. 100 shows the results of the different case studies in order to have an overview of the consequences of different ambition levels for the investment of the renovation and the architectural change. In general, the higher the ambition level to decrease the energy consumption, the higher the investment costs and the more the architectural image change. However, the improvement of the comfort and the decrease of the energy consumption by a ‘Nul op de meter’ renovation has to be considered against the possible disadvantages of a higher investment and more change in the architectural image of the building.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>TYPOLOGY</th>
<th>LEVELS</th>
<th>YEAR OF RENOVATION</th>
<th>NUMBER OF HOUSES</th>
<th>ENERGY INDEX BEFORE</th>
<th>ENERGY LABEL BEFORE</th>
<th>ENERGY INDEX AFTER</th>
<th>ENERGY LABEL AFTER</th>
<th>SURFACE AREA OF DWELLING</th>
<th>INVESTMENT PER DWELLING</th>
<th>INCREASE IN COSTS PER MONTH*</th>
<th>ARCHITECTURAL CHANGE **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lottoelink Boschendaal</td>
<td>Drive-in dwellings</td>
<td>3</td>
<td>2012-2013</td>
<td>28</td>
<td>2.35</td>
<td>A</td>
<td>0.48</td>
<td>A**</td>
<td>126 m²</td>
<td>unknown</td>
<td>unknown</td>
<td>-</td>
</tr>
<tr>
<td>Saterheidestraftehoegelo</td>
<td>Portiek</td>
<td>3</td>
<td>2014</td>
<td>78</td>
<td>-0.06</td>
<td>B</td>
<td>-1.13</td>
<td>B</td>
<td>45 - 70 m²</td>
<td>€ 56.000.00</td>
<td>unknown</td>
<td>-</td>
</tr>
<tr>
<td>Jan Vieremontstraat Airey</td>
<td>Portiek</td>
<td>4</td>
<td>2013-2014</td>
<td>362</td>
<td>2.33 - 2.44</td>
<td>E</td>
<td>1.31 - 1.47</td>
<td>B - C</td>
<td>52 m²</td>
<td>€ 25.000.00</td>
<td>€ 40.00</td>
<td>-</td>
</tr>
<tr>
<td>LucRosastraat Airey</td>
<td>Portiek</td>
<td>4</td>
<td>2013-2014</td>
<td>179</td>
<td>2.05 - 2.27</td>
<td>B</td>
<td>1.66 - 1.82</td>
<td>A - B</td>
<td>65 - 98 m²</td>
<td>€ 45.000.00</td>
<td>unknown</td>
<td>-</td>
</tr>
<tr>
<td>Beethovenstraat Dordtshem</td>
<td>Gallery apartments</td>
<td>4</td>
<td>2015-2015</td>
<td>126</td>
<td>1.97 - 3.00</td>
<td>D - E</td>
<td>-0.56 - 1.27</td>
<td>A - B</td>
<td>31 - 66 m²</td>
<td>unknown</td>
<td>€ 20.00</td>
<td>- / +</td>
</tr>
<tr>
<td>Aansla/Magazine Nieuwkoop</td>
<td>Apartments</td>
<td>2</td>
<td>2010-2011</td>
<td>16</td>
<td>1.92 - 2.77</td>
<td>D - E</td>
<td>0.58</td>
<td>A++</td>
<td>66 m²</td>
<td>€ 100.000.00</td>
<td>€ 100.00</td>
<td>+</td>
</tr>
<tr>
<td>Vieremontstraat Graafenberg</td>
<td>Portiek</td>
<td>3</td>
<td>2014-2015</td>
<td>3 of 48</td>
<td>onbekend</td>
<td>onbekend</td>
<td>-0.4</td>
<td>A (NOM)</td>
<td>unknown</td>
<td>€ 65.000.00</td>
<td>€ 0.00</td>
<td>- / +</td>
</tr>
</tbody>
</table>

* calculated by (increase of rent - savings of energy bill) / month
** architectural image changed a lot + / architectural image did not change a lot -

Fig. 100. Comparison of qualities, energy labels, characteristics and investment of the case studies [own illustration]

Reflecting to the cultural values of the building, I think the renovation of the Nemavo-Airey building has to have a high ambition level because the Nemavo-Airey building system was innovative for its time. To achieve new innovation in the building and renovation industry, it might be important to set up high ambition levels in order to get the best possible result.

7.4 BROADER PERSPECTIVE

With regard to the case studies of different renovation concepts three systems can be distinguished:

- Performance boiler (‘HR-ketel’, using gas)
- A bivalent system (a combination of gas and electricity)
- All-electric (only electricity)

Although energy network companies like Enexis have some doubts about ‘all electric’ systems because of the costs of the infrastructure, consultant Hans Crone of Crone Advies believes ‘all electric’-heating systems are in many cases the cheapest, climate friendliest and with highest energy savings. 71 Moreover, besides the lower CO2 emissions, the costs for extra insulation are lower than the savings on the costs of purchase of natural gas. 72 In addition, electric cars can serve as a battery to store energy which is collected at a moment is not directly needed. In that case fewer costs are needed for infrastructure and the first electric cars are already in use by tenants of the Nemavo-Airey dwellings which is showed in Fig. 101.

In order to compare the different renovation concepts on energy consumption, it is also needed to look at the embodied energy in the materials which are used for the renovation which will reduce the energy consumption. The embodied energy includes the energy required to extract the raw materials to make the building component, transport these raw materials to a factory where the building components are manufactures, manufacture the building components, transport the building materials from the factory to the construction site, maintain a building component throughout its life and finally recycle or upcycle an element at a certain time. Moreover, the life time of a building plays also a role in how to compare the embodied energy of different renovations or building.

Fig. 101. Charging of an electric car between two Nemavo-Airey building blocks [Muller, 02-10-2015]

Looking from an even broader perspective to sustainability, it should also be needed to look to more different aspects, like to what extent materials can be re-used and where the materials have to come from. In order to compare the environmental impact, the effects can be compared by numbers which will be translated to one shadow price and eventually to one overall shadow price. This is the theoretical estimation of the costs that the government will do what it takes to achieve preventing or solving the environmental impact. So if the government thinks a certain effect is more important, the shadow costs will be higher. However, for this research, only the energy consumption and the consequences of renovations that are needed to achieve increasing the energy consumption are researched. In the next phase of the graduation project, the embodied energy and the shadow price of the different possible designed renovations will be calculated and compared in order to make choices in the design process regarding to sustainability.

FINANCIAL ASPECTS

In order to make the renovation concept realistic and sustainable, the concept must have a proper business case for the housing association. Otherwise, the renovation will never be constructed. Moreover, when the costs for the renovation to save energy are too high, it will not be financially feasible and it is also not sustainable anymore because by investing the same amount of money probably more energy could be saved. So, in order to design a renovation for the Nemavo-Airey dwellings, the maximum initial investment for renovations of different ambition levels must be known depending on the exploitation period of the building and the current market value of the existing building. The market value can be described as “the amount of money that can be obtained for it on a particular day from persons able and willing to buy it”. It can be seen as an estimate of the contract price at that time and under those market conditions.

WWS points / Maximum rent

In cooperation with the Nederlandse Woonbond and Vastgoed Belang, Huurcommissie developed a tool to calculate the maximum rent housing associations are allowed to ask. The tool consists of six components and asks for the square meters of the different rooms of the dwelling, the type of heating system, the WOZ-value, the energy performance and the facilities in the kitchen and bathroom. With this tool it is calculated that the dwellings of 61m² have 120 WWS point (see also Appendix B). The maximum rent which can be asked by the housing association is based on this 120 points which is € 667,09. However, according to Niek Schaap from Eigen Haard the actual rent fluctuate between € 178,- to € 490,- per month. Moreover, the tenants pay between € 120,- and € 150,- for their energy bill. For the calculations, an energy bill of € 150,- is used.

WOZ value

According to Niek Schaap from Eigen Haard the WOZ-value of a Nemavo-Airey dwelling is € 120.000,-

Subsidies

For a renovation in the social rental sector, different subsidies are possible. One of them is the Stimuleringsregeling energieprestatie huursector (STEP). The height of the subsidy is dependent on the decrease of the Energy-Index. From an Energy-Index of for example higher than 2,11 to lower 1,40 € 2.000,- subsidy is possible. From an Energy-Index of higher than 2,71 to lower than 1,20 € 4.500,- subsidy is possible.

Initial investment for different renovation concepts

With the values of the WWS and WOZ and the possibilities of subsidies the initial investment per dwelling is calculated for four different scenario’s with each their own ambitionlevel (see Appendix C). Scenario 0 is the situation when no renovation will be done. For this reason, no values will be added, the energy bill and the rent will remain the same but the exploitation period will be maximum 15 years. Scenario 1 can be described as a renovation which brings an energy improvement from label F to B with an exploitation period of 25 years. Scenario 2 can be described as a renovation which brings an energy improvement from label F to A with an exploitation period of 30 years. Scenario 3 is a NOM (Nul op de Meter) renovation which will increase the exploitation period to 40 years.

---

76 Rijksdienst voor Ondernemend Nederland, ‘Stimuleringsregeling Energieprestatie Huursector (Step)’, (2015).
The initial investment per dwelling:

Scenario 0: € 34.222,-
Scenario 1: € 65.939,-
Scenario 2: € 83.735,-
Scenario 3: € 96.845,-

Although the differences in initial investment between scenario 2 and 3 are not so big, the ambition level is quite different and so the measurements which have to be taken to achieve scenario 3 is more difficult for only about € 13.000,- extra. However, an important consequence of the different scenarios is the increase in rent for the residents. Below the different increase in rents:

Scenario 0: € 30,-
Scenario 1: € 75,54
Scenario 2: € 82,54
Scenario 3: - € 8,33

This means the 70% of participation will be achieved must easier with scenario 3 because residents do not have to pay extra rent. Especially if residents pay about 200,- each month, an increase in rent of 80,- is possible not affordable for them. So, the scenario 3, the NOM renovation, might be seen as the best ambition level for the renovation of the Nemavo-Airey dwellings if we look to the financial aspects and business case for the housing association. However, the calculation is both based on facts as assumptions, so the real values might be different in practice. One of these assumptions is the current rent residents of the Nemavo-Airey dwellings pay. According to Niek Schaap from Eigen Haard the actual rent fluctuate between € 178,- to € 490,- per month. For the calculations of the different scenarios I have used a rent of € 467,- (based on the harmonisatiegraad of 70% of the maximum rent the housing association is allowed to ask based on the WOZ value and the WWS points). If I change the rent to € 178,- the following initial investments are the result:

Scenario 0: - € 5.527,-
Scenario 1: - € 1.686,-
Scenario 2: € 1.872,-
Scenario 3: € 21.145,-

This is totally different than the initial investments based on a higher rent. This means the renovations for all different scenarios are not possible for residents who pay € 178,- rent, but for the residents who pay € 490,- a NOM renovation might be possible, looking at the financial aspects and the business case. However, the embodied energy is not calculated in this case.

LEGAL ASPECTS

Finally, legislation also plays in important role before starting a renovation. During a conversation with Gijs van Wijk, project manager of Urgenda, Gijs indicated that Urgenda is able to apply NOM renovations which can be leased. People only have to pay their energy bill to Urgenda for a certain amount of years. However, leasing a construction which is connected to a property of someone else is yet not allowed by law. However, this might change in the near future.
7.5  EPC AFTER RENOVATION

The EPC value of the building after the designed renovation is calculated by the software programme Uniec2.2. This is a complete EPG (Energie Prestatie Gebouwen) calculation programme which calculate the EPC value according to NEN 7120, NEN 8088 and NEN 1068.\textsuperscript{77} In appendix A the EPC calculation can be found. The result of the calculation is a EPC value of -0.55. Figure 102 gives an overview of the amount of energy which is generated and used for ventilation, heating, cooling, water heating and lighting. Moreover, it also reflects the CO2 emission. However, this does not included the CO2 emission for the production of the needed materials, the embodied energy in these the materials and the transportation of the products and materials for the renovation. By using for example NIBE’s Milieuclassificaties Bouwproducten Tabellenboek an indication of the impact on the environment based on schaduwkosten can be found per material and supplier.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
Jaarlijkse hoeveelheid primaire energie voor de energiefunctie & \\
\hline
verwarming (excl. hulpenergie) & $E_{\text{LP}}$ 95.333 MJ \\
\hline
hulpenergie & 2.908 MJ \\
\hline
warmtapwater (excl. hulpenergie) & $E_{\text{LP}}$ 8.535 MJ \\
\hline
hulpenergie & 2.560 MJ \\
\hline
koeling (excl. hulpenergie) & $E_{\text{CP}}$ 0 MJ \\
\hline
hulpenergie & 0 MJ \\
\hline
zomercomfort & $E_{\text{DCP}}$ 10.085 MJ \\
\hline
ventilatoren & $E_{\text{CP}}$ 2.938 MJ \\
\hline
verlichting & $E_{\text{LP}}$ 20.782 MJ \\
\hline
geëxporteerde elektriciteit & $E_{\text{exp}}$ 92.656 MJ \\
\hline
op eigen perceel opgewekte & $E_{\text{peri}}$ 250.658 MJ \\
\hline
& niet gebruikt & 0 MJ \\
\hline
\hline
Opperflakken & \\
\hline
totale gebruiksoppervlakte & $A_{\text{tot}}$ 451.00 m$^2$ \\
\hline
totale variëertoppervlakte & $A_{\text{var}}$ 2.267.06 m$^2$ \\
\hline
\hline
Elektriciteitsgebruik & \\
\hline
gebouwgebonden installaties & 15.532 kWh \\
\hline
niet-gebouwgebonden apparatuur (stapel) & 12.642 kWh \\
\hline
op eigen perceel opgewekte & 28.174 kWh \\
\hline
& niet gebruikt & 12.888 kWh \\
\hline
geëxporteerde elektriciteit & 12.888 kWh \\
\hline
TOTAAL & -12.888 kWh \\
\hline
\hline
CO$_2$-emissie & \\
\hline
CO$_2$-emissie & $m_{\text{CO2}}$ -14.410 kg \\
\hline
\end{tabular}
\end{table}

Fig. 102. Overview of results EPC calculation

\textsuperscript{77} Uniec2, ‘Wat Is Uniec 2?’, (2016).
7.6 **BENG (BIJNA ENERGIE NEUTRALE GEBOUWEN)**

From the end of 2020, all new buildings in the Netherlands have to be BENG (Bijna Energie Neutrale Gebouwen).  
Minister Blok (Wonen en Rijksdienst) presented on 2 July 2015 the requirements for the ‘energieprestatie’ for new buildings which will be built after 2020. For buildings of the government these requirements will be already starting in the end of 2018 with the idea that the government will start with this first.

The BENG criterion will be determined by 3 requirements:

- Maximum *energiebehoeften* in kWh per m² per year
- Maximum *primair energiegebruik*, also in kWh per m² per year
- Minimum share of renewable energy in %

For these requirements a division is made for different type functions for a building: residential, utility, educational and healthcare building. Each function has different BENG requirements. Figure 108 will give an overview of these different BENG requirements. For my graduation project I will only focus on the residential requirements because the project is about social housing. The requirements are connected with the definition of *Bijna Energie Neutrale Gebouwen*, written down in the European Energy Performance of Buildings Directive (EPBD) and with the starting-points of the *Energieakkoord* with the focus on energy savings.  

<table>
<thead>
<tr>
<th>Gebouwfunctie</th>
<th>1 - Energiebehoeften kWh/m².jr</th>
<th>2 - Primair energiegebruik kWh/m².jr</th>
<th>3 - Aandeel hernieuwbare energie %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woningen en woongebouwen</td>
<td>25</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Utiliteitsgebouwen</td>
<td>50</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Onderwijsgebouwen</td>
<td>50</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Gezondheidszorggebouwen</td>
<td>65</td>
<td>120</td>
<td>50</td>
</tr>
</tbody>
</table>

Fig. 103. Overview of BENG requirement per function of the building

---

The maximum *energiebehoefte* is determined by the need of energy for heating and cooling. For utility building also the lighting is added.

The maximum *primair energiegebruik* is based on the primarily energy use for heating, cooling, water heating and ventilation. For utility buildings also the lighting and humidification can be added. For residential and utility buildings, generated energy will reduce this value. For the calculation of the *primair energiegebruik*, the energy losses due to systems, *hulpenergie* and efficiency of the generators are included.

The minimum share of renewable energy is calculated by the amount of generated renewable energy shared by the total of the renewable energy and the *primair energiegebruik*.

Looking at the results based on my EPC calculation with Uniec2.2 we will see that the designed renovation will not let the building meet the requirement of BENG. Figure 104 shows that the building will meet the EPC requirement and the second and third step of the BENG requirements. However, the first BENG criterion is by far not reached. The value is more than four times too much. In the Reflection Chapter of this report I will reflect on this.

<table>
<thead>
<tr>
<th>Criterium</th>
<th>Prestatie</th>
<th>Eis (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EPC</strong></td>
<td>-0,55</td>
<td>&lt; 0,4</td>
</tr>
<tr>
<td><strong>BENG-criteria</strong></td>
<td>Berekend</td>
<td>Voorlopige Eis (2020)</td>
</tr>
<tr>
<td>1. <em>Energiebehoefte</em></td>
<td>106,7 kWh(_{th}/m^2)</td>
<td>&lt; 25 kWh(_{th}/m^2)</td>
</tr>
<tr>
<td>2. <em>Primair fossiel energiegebruik</em></td>
<td>-61,6 kWh / m(^2)</td>
<td>&lt; 25 kWh / m(^2)</td>
</tr>
<tr>
<td>3. <em>Aandeel hernieuwbare energie</em></td>
<td>155 %</td>
<td>&gt; 50%</td>
</tr>
</tbody>
</table>

Fig. 104. Overview of BENG requirements and calculated BENG values
7.7 EMI (ENERGIE MAATREGELEN INDEX)

People of the architectural office of Wessel de Jonge Architecten were asking themselves to what extent the sustainability of an existing building can be improved and if there is a way how to measure this regarding the fact some buildings have cultural historical values resulting in conservation areas and a monumental status. Therefore, Wessel de Jonge have done research in collaboration with Climatic Design Consult and supported by Herbestemmings-team, established by the ‘Rijksadviseur voor Erfgoed’. The conclusion of the research is the EMI (Energie Maatregelen index) and is a method based on four points:

1. The energie prestatie of the original building = EP\textsubscript{high}
2. The energie prestatie of the building after the renovation = EP
3. The maximum possible (ideal) energie prestatie = EP\textsubscript{low}
4. The relation between the EP and the EP\textsubscript{low} and EP\textsubscript{high} which is the EMI score

A score of 10 reflects everything is done what is energetically possible. One of the strong points of the EMI is the fact the calculation of the building will be assessed based on itself, so the influence of other characteristics will be filtered. Because the market asks about a verifiable statement of the sustainability of a building and the fact this can be quite difficult for buildings with cultural historical values, this new method has to give more insight in how sustainable a renovation will be.

Examples of other common used assessment methods are BREEAM (Building Research Establishment Environmental Assessment Method), GPR Gebouw (Gemeentelijke Praktijk Richtlijn voor duurzaam bouwen) and Greencalc+. However, all of them do not take into account monumentality or cultural historical values. DuMo (Duurzame Monumentenzorg) is one of the assessment methods which is developed for monuments and is based on greencalc+ for the sustainability index and a Mo-coefficient for measuring monumentality. However, there is no standard assessment criterion for this coefficient which makes this assessment not overall accepted within the real estate sector. The methods to determine the EMI score is based on the GRP Gebouw method which fits to the conditions of the research of Weesel de Jonge Architecten.

The formula to calculate the EMI is based on NEN7120 and can be described as followed:

\[ EMI = f_{EMI} \times \frac{(EP_{\text{high}}-EP)}{(EP_{\text{high}}-EP_{\text{low}})} \]

\( f_{EMI} \) is de dimensieloze schaalfactor \( f_{EMI} = 10; \)
\( EP_{\text{high}} \) = energieprestatie of the building without energy saving measures in MJ/m²
\( EP \) = energieprestatie of the building in MJ/m²
\( EP_{\text{low}} \) = energieprestatie after maximum energy saving measures in MJ/m²

---

Figure 105 gives an overview of the characteristics for determining the $EP_{\text{high}}$ and $EP_{\text{low}}$ and are based on NEN7120.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Voor $EP_{\text{high}}$</th>
<th>Voor $EP_{\text{low}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Woning</td>
<td>U-bouw</td>
</tr>
<tr>
<td>$q_{\text{w0,ext}}$</td>
<td>1,6</td>
<td>0,8</td>
</tr>
<tr>
<td>$R_{\text{dichte geveldelen}}$</td>
<td>0,2 m²K/W</td>
<td>0,2 m²K/W</td>
</tr>
<tr>
<td>$R_{\text{vloeren}}$</td>
<td>0,2 m²K/W</td>
<td>0,2 m²K/W</td>
</tr>
<tr>
<td>$U_{\text{w, puien}}$</td>
<td>5,1 W/m²K</td>
<td>5,1 W/m²K</td>
</tr>
<tr>
<td>Opwikkingsrendement verwarming</td>
<td>0,75</td>
<td>0,70</td>
</tr>
<tr>
<td>Opwikkingsrendement koeling</td>
<td>n.v.t.</td>
<td>n.v.t.</td>
</tr>
<tr>
<td>Warmtepwaterrendement</td>
<td>0,3</td>
<td>0,3</td>
</tr>
<tr>
<td>Leidingen</td>
<td>Ongeisoleerd</td>
<td>Ongeisoleerd</td>
</tr>
<tr>
<td>Verlichting</td>
<td>n.v.t.</td>
<td>Forfaiar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilatie</td>
<td>Natuurlijk</td>
<td>Natuurlijk</td>
</tr>
</tbody>
</table>

Fig. 105. Characteristics for $EP_{\text{high}}$ and $EP_{\text{low}}$ to determine EMI

By applying these values within my Uniec2.2 calculation I have calculated the following values:

$EP_{\text{high}}$: 1,97
$EP_{\text{low}}$: 1,04
$EP$: 0,46 (= $EP$ after renovation and without PV panels and solar collectors)
$EMI$ score: $10 \times \frac{(1,97-0,46)}{1,97-1,04} = 10 \times (1,51-0,93) = 10 \times 1,63 = 5,8$

Six case studies are analyzed during the research of Wessel de Jonge and have the following EMI score:

1. HUF – 7,9
2. Van Nelle – 6,9
3. St. Jobsveem – 7,1
4. Ambachtsschool – 9,0
5. Rohm en Haas – 8,8
6. Justus van Effen – 9,9

Comparing the EMI score of 5,8 for the Nemavo-Airey dwellings after the renovation with the scores of the case studies chosen for the research of Wessel de Jonge, this score is lower than the scores of the six case studies which are all between the 6,9 and 9,9. From this result it can be concluded that the reduction of energy demand is not enough to have a high EMI score. In the Reflection chapter I will elaborate on this more.
7.8 CONCLUSIONS AND REFLECTION ON SUSTAINABILITY

After the renovation the Nemavo-Airey building block will have a EPC value of -0.55 instead of the original EPC value of 2.08. This means the building will be energy neutral or even nul-op-de-meter. However, it does not meet the requirements of the first BENG criterion (energiebehoefte) because this value is 106.7 and has to be lower than 25. However, striking is the low score on the second BENG criterion (primaire fossiele energie) with a value of -61.6 which is lower than 25. Moreover, the percentage of the generation of renewable energy is 155% which also meets the BENG requirement of at least 50%. Finally, the building will have a EMI score of 5.8 which is in comparison with other renovation projects quite low. From these results it can be concluded that the reduction of energy demand is not enough. However, the thermal layer has insulation values which are equal to reference projects which meet the BENG criterion. The reason for this can be found in three aspects:

- East West Orientation. The building is East West oriented. In this case the building can not profit from the south orientation for heating when this is needed.
- A lot of glass at the East and West facades. Because of the architectural vision, a lot of glass is used to have the connection with the communal garden and the urban square. However, these surfaces of glass do not insulate as well as insulated walls.
- No insulation layer on the ground floor is applied because of the costs. Because it is not possible to add an insulation layer on top of the existing concrete ground floor (due to the Bouwbesluit and the needed height) and because there is not space beneath the ground floor to add an insulation layer, adding an insulation layer beneath will cost a lot. So I decided not to insulate the ground floor with a thick insulation layer, but using only the Fermacell floor and the floor heating system. Moreover, during winter, the loss of energy will be bigger at the side of the windows instead of the not well insulated floor because the ground will have a higher temperature than the air outside, so the difference in temperature is bigger in horizontal way than the vertical way through the ground floor.

One of the consequences of the BENG requirements is that building will be insulated better and will be more airtight. Because of this, it will be important to look at the possible facilities for refreshing air in order to realize a healthy indoor climate. With the development of better insulated renovation concepts, the air quality has to be an important aspect in my opinion, which is not taken into account in calculations for BENG or EMI.

A different question is if these calculations are realistic. Many of the calculation are done by the programme Uniec2.2, which is also used as the common programme in practice to determine the EPC value. However, during the process of making the calculation with Uniec2.2, a lot of assumptions must be made. These assumptions are quite difficult to make because in the phase of the project the calculations are made, not everything is determined or will be built according to plan. Moreover, Uniec2.2 will give a lot of options for certain installations and variants which means that the person who is calculating with this programme needs a lot of knowledge on the field of (sustainable) climate installations and the different products and suppliers for these installations. So, I think the value of the EPC calculation is not a clear score, but an score based on assumptions, which means this is more an indicator of how sustainable or energy efficient a building will be, but will not exactly shows in what way this building is sustainable. Reflecting on my own EPC calculation, the score of the EPC is
quite well in a way it is energy neutral. However, looking at the BENG requirements and the EMI, my design for the renovation of the Nemavo-Airey dwellings scores quite low. This has to do with the amount of PV panels and solar collectors I will integrated on the roof. However, the score of the EPC will not show this. Therefore I think it is good to have besides the EPC calculation also BENG requirements and for monumental buildings the EMI. However, it still remains an indication and includes not every aspect of the container concept sustainability. Moreover, looking at the kind of materials I have used, the embodied energy and the climate impact of the materials, a different score on sustainability will be the result. For the design of the renovation I have also design a grey water system by collecting the water from rainwater which will also results in less impact on the sewage system in the city. These aspects are not included in the energy efficiency calculations as EPC, BENG and EMI but are in my opinion as import as the energy aspects if we talk about sustainability. Moreover, by only focusing on these energy efficiency values, it reduces the creativity and the overview of a project and its sustainable impact on different scales.

So, in conclusion I would say the EPC, BENG and EMI scores will give an general indication about the energy efficiency which is important but which is a certain aspect of sustainability. If you really want to say more exactly how sustainable a building is or will be, also the other aspects has to be considered and new calculations must be made after a renovation is executed. Finally, also the investment costs have to be considered in other to think about if a certain design for a renovation is the best investment to make a certain area or building more sustainable.
8. INTERPRETATIONS OF THE RESEARCH

In order to increase the chances of success of the renovation for the Nemavo-Airey building, it is important to combine the knowledge from science with knowledge from practice. Moreover, different parties are involved in the process of renovation, each with their own interests. In the case of the renovation of the Nemavo-Airey building blocks, the most important parties are the owner (housing association Eigen Haard), the tenants (residents of social housing) and visitors (professionals and interested people from the Van Eesteren Museum). To increase the change of actually achieving the objectives it might be interesting to use the Merger of Interests Perspective. This way of looking at the task emerged from an interaction between science and practice to evoke a desire even in people who are not yet concerned about the public interest and energy efficiency. In order to use this Merger of Interest Perspective the Merger of Interest strategy is developed and can be divided in three steps. The first step is to gather information of the different parties who are in the process involved. The second step can be described as defining the interests in a way that account is taken of the interests of future generations. The third step is looking for innovate funding models which make investment in such measures possible. Fig. 106 shows these three steps based on the triptych of Elkington (People, Planet & Profit).

Fig. 106. Het snijvlak binnen de Triple-P-benadering van Elkington [Van Hal, 2014]

This Merger of Interest strategy is based on the following logic. If an involved party is able to get something which meets its needs, an inner wish will be created to have the possibility to get access to it by for example generating innovative funding models. Focusing on the first step, it is for example important for the corporation to know what the residents want and think about the existing situation of their house and the different possible renovation options in order to reach a 70% agreement for the renovation. For this reason, research about improvements of post-war building blocks, done by Motivaction, is analyzed in combination with the results of short interviews with four residents of the Nemavo-Airey building. The chapter is divided in three subchapters which reflect the tension between different perspectives on the same values of the Nemavo-Airey dwelling.

8.1 EXPERT VALUE VERSUS COMMUNITY VALUE

The architectural values of the Nemavo-Airey dwellings are different for experts and the residents who are living in the building itself. Research done by Motivaction about improvements of post-war building blocks, indicates that residents in general don’t like the original architecture and the size of

---

post-war building blocks of which the Nemavo-Airey dwellings are an example. Fig. 107 shows that residents in general think the architecture and the amount of square meters floor surface are one of the main aspects which have to be improved for post-war building blocks in general. This is confirmed by the four residents who like the location but don’t like the architecture and size of the building itself. However, these Nemavo-Airey dwellings are a part of the conservation area of Amsterdam New West and are one of the most important examples for the Van Eesteren Museum which is located nearby these building blocks.

As can be seen in Fig. 108, research done by Motivation indicates that people find the accessibility, parking space, public space (playgrounds) and greenery of the post-war building districts much more attractive than those in other districts. This is confirmed by the four residents of the Nemavo-Airey building. In relation to these aspects, both the experts as the residents appreciate these values.
8.2 CONTEXT VALUE VERSUS OBJECT VALUE

The analysis of the cultural historical value shows both context values as object values. Although these values are interrelated, each value has either more to do with the context or with the object. Whereas the context values of the research mainly focus on the urbanism after the Second World War and also the intangible values behind that, the object value is more about the specific building blocks, produced according to the Nemavo-Airey system. However, in this case, the context values are the explanation for the object values. However, the object values also make the context and the neighborhood interesting, which is reflected by the location of the Van Eesteren Museum at the Burgemeester de Vlugtlaan.

8.3 AGE VALUE VERSUS DESIGN VALUE

The contrast between the age value and the design value is also reflected in the community and expert value. Most residents do not appreciate the design of the Nemavo-Airey dwellings. Moreover, knowing its history and the ideas of mass production behind the construction of it, the age value might be more interesting than the design value.

8.4 PERSONAL INTERPRETATIONS

Based on a combination of my personal interpretation of the subjects of every chapter and the different perspectives, my overall position in general is reflected in Fig. 109. The most important values for me are those from the perspective of the community and the age value.

![Diagram](image)

Fig. 109. Personal interpretations of the six different values based on the research on the Nemavo-Airey building [own illustration, 2015]
9. REFLECTION ON THE DESIGN

In the coming years, a lot of houses in the Netherlands have to be renovated to meet the national and international agreements based on concerns about our environment and climate. The most important national agreements in the Netherlands might be the 2013 Energy Agreement, which has the aim that for example in 2050 the built environment must be energy neutral and in 2020 the rented social houses must have a B-label on average. Because a lot of existing buildings in the Netherlands do not yet meet these requirements of 2030, the challenge is to renovate these buildings in the coming years in order to be able to still use these buildings in the near future. Besides an increasing amount of renovation projects in the Netherlands, some techniques and information technologies are nowadays developed to a stage it can be used to organize more advanced production processes by the digitalization, automatization and mass customization. In this case, suppliers and contractors develop renovation products like complete energy boxes or energy saving extensions which can be added or placed as one product. However, these renovation products might not be suitable for houses with cultural historical and architectural values, a status as monument or located in a conservation area.

According to ICOMOS, cultural heritage is “an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values”. This explanation shows that cultural heritage is more than historical monuments or historic sites. It actually refers to a total evidence of human creativity and expression. In this way, looking at the renovation of a building with a lot of cultural values is not only limited to the material object itself but also consists of intangible values and immaterial elements. According to UNESCO the content meaning of the term cultural heritage has changed considerably during last decades because the term also includes traditions and living expressions inherited from our ancestors and passed on to our descendants. Moreover, cultural heritage is also the result of a selection process of memory and oblivion which characterizes human society that for both different reasons choose what is worth to be preserved for future generations and what not. This question and choice is also related to my graduation project because the Nemavo-Airey dwellings at the Burgemeester de Vlugtlaan in Amsterdam New West are located in a conservation area of the Amsterdam municipality. The Amsterdam municipality describes that conservation areas have a general importance because of beauty, mutual cohesion or their scientific or cultural historical values. So, it is not only about the dwellings as material objects, but more about the mutual coherence, the related structure and the history behind it. However, it is hard to protect these dwellings because of the difficult relationship between the interest of individuals and companies, the different interpretations of the values from an expert and resident perspective and the balance between private and public. In the case of the Nemavo-Airey dwellings at the Burgemeester de Vlugtlaan, most of the residents do not like the architecture of this type of buildings but many

---

86 Gemeente Amsterdam.
experts do like the architecture because the dwellings have a lot of cultural historic values referring to the situation after the Second World War. In this period there was a huge demand for housing in the Netherlands, not only because a lot of buildings were destroyed and damaged, but also because an increasing population of 8.8 million people in 1940 to 12.9 million in 1970. Because of the housing shortage and a lack of building materials and qualified building construction workers, alternative building methods were used to build faster and cheaper in order to fulfill the demand for new houses. One of these new building methods was the English Airey system, developed by Sir Edward Airey, which was introduced by the government to increase the industrialization of the housing production in the Netherlands. In order to deal with the housing shortage problems, Van Saane, director of the ‘Nederlandse Maatschappij voor Volkshuisvesting’ (NeMaVo), J. F. Berghoef and H.T. Zwiers developed the Airey system to the Nemavo-Airey system which was a more rationalized system and had some advantages in comparison with the existing Airey-system. However, after more than fifty years, these Nemavo-Airey dwellings have been used by many residents. Because of this, a renovation of these dwellings is a project about homes instead of houses. Houses are initially designed with the function to provide shelter. However, after a certain time, users have added more meaning and depth that will exceeds the original function as a shelter. In this way, the term houses gains deeper purpose and are named homes, which already are customized by their residents with all involved memories and cultural values.

So, cultural heritage might help us remember and understand our cultural diversity in relation to its time and to develop respect and renew dialogue by discourse. From a sociological perspective, discourse includes all that a particular category of agents say or write in a definable thematic area. However, the fact that houses are sometimes the domain of fashion, suggests the general validity of the concept of criticality and the primacy of socio-cultural factors. In this way, the academic consensus, expressed in charters for architectural conservation, differs from the everyday practice of renovation of monuments or historic buildings. The charters do not provide a blueprint for planning and assessment of renovation proposals because every project requires a specific consideration and customized solutions. In addition, besides all different kind of buildings from different kind of periods and ideals, almost every renovation can be justified or criticized because there are so many different charters on heritage conservation which are a product of the time they were published and a reflection of the professionals who wrote them. For this reason, determining in an early stage what is essential to a monument or a project might be an option to legitimate and assess renovations. This can be done by making a specific cultural historic analysis and a value assessment as tools to discuss and examine cultural values and the impact of a renovation or intervention.

87 Blom, Jansen, and Van der Heiden, p. 6.
88 Schoch, Visser, and Van der Zanden, p. 1.
89 Messchaert, pp. 8-9.
90 M.S. Larson, Behind the Postmodern Facade: Architectural Change in Late Twentieth Century America, (Berkeley: University of California Press, 1993), p. 5.
Research & Design

I started my research with an analysis of the cultural history, the urban context, the architectural appearance, the building technology and the energy consumption. Within the building technology part I analyzed the construction for example (see figure 110) but I also explored the possibilities of mass customization as a tool for a renovation concept. Moreover, for the energy consumption chapter I calculated the existing energy consumption and studied several case studies of examples of projects with high energy ambitions in order to learn from these examples.

Fig. 110. One of the analysis drawings of the construction of the Nemavo-Airey dwellings

During the research and design phase I used different methods to do research. First of all, I did different literature studies in the beginning to read and know more about the period of time the urban area was designed and the buildings were erected. In combination with different visits of the location and guided tours I analyzed the area and the building from different perspectives in order to know the values and to decide which values are important for the new design. An example of this is the research based on the original drawings of the part of building with a retail function (see figure 111). Another example of the analysis is the comparison of the existing square meters and the required square meters of the Bouwbesluit (see figure 112). By making this comparison, I gained more insight in which rooms need more square meters than the existing situation of today.

Fig. 111. Analysis of the part of the building with a retail function
For the energy efficiency I looked to different case studies of projects and buildings which are similar to the Nemavo-Airey building. By analyzing these example and comparing the hard criteria like energy savings, investment cost and energy labels with the soft criteria like architectural image and the impact for the area I have gained more insight in the possibilities and consequences of renovation methods to reduce the energy consumption which I have used for my design for the renovation of the Nemavo-Airey building blocks. Figure 113 shows the comparison of hard criteria and soft criteria.

### Table 1: Comparison of Existing Situation and Requirements

<table>
<thead>
<tr>
<th>Location</th>
<th>Typology</th>
<th>Levels</th>
<th>Year of Renovation</th>
<th>Number of Houses</th>
<th>Energy Index Before</th>
<th>Energy Label Before</th>
<th>Energy Index After</th>
<th>Energy Label After</th>
<th>Surface Area of Dwelling</th>
<th>Investment Per Dwelling</th>
<th>Increase in Costs Per Month</th>
<th>Architectural Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luttebeek (Oudsche)</td>
<td>Drive-in dwelings</td>
<td>3</td>
<td>2012-2013</td>
<td>28</td>
<td>2.23</td>
<td>A</td>
<td>0.68</td>
<td>A++</td>
<td>126 m²</td>
<td>unknown</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Saterbosch (Nagode)</td>
<td>Portiek</td>
<td>3</td>
<td>2014</td>
<td>78</td>
<td>1.10</td>
<td>A</td>
<td>1.20</td>
<td>B</td>
<td>45 - 70 m²</td>
<td>€ 56 400.00</td>
<td>unknown</td>
<td>-</td>
</tr>
<tr>
<td>Zaanstraat (Amsterdam)</td>
<td>Portiek</td>
<td>4</td>
<td>2013-2014</td>
<td>362</td>
<td>2.35</td>
<td>A</td>
<td>2.37</td>
<td>A++</td>
<td>53 m²</td>
<td>€ 25 000.00</td>
<td>€ 40.00</td>
<td>-</td>
</tr>
<tr>
<td>Zaanstraat (Amsterdam)</td>
<td>Portiek</td>
<td>4</td>
<td>2013-2014</td>
<td>179</td>
<td>2.92</td>
<td>A</td>
<td>1.27</td>
<td>B</td>
<td>65 - 98 m²</td>
<td>€ 45 000.00</td>
<td>unknown</td>
<td>--</td>
</tr>
<tr>
<td>Boehtnau (Dwetteitan)</td>
<td>Gallery apartments</td>
<td>4</td>
<td>2015-2015</td>
<td>128</td>
<td>1.97</td>
<td>A</td>
<td>1.37</td>
<td>A++</td>
<td>31 - 66 m²</td>
<td>unstrengthened</td>
<td>€ 20.00</td>
<td>-</td>
</tr>
<tr>
<td>Acadia/Magnolia (Nieuweveen)</td>
<td>Apartments</td>
<td>2</td>
<td>2011</td>
<td>16</td>
<td>1.92</td>
<td>A</td>
<td>2.77</td>
<td>D</td>
<td>66 m²</td>
<td>€ 100 000.00</td>
<td>€ 100.00</td>
<td>+</td>
</tr>
<tr>
<td>Vosravenstraat (Gezein)</td>
<td>Portiek</td>
<td>3</td>
<td>2014-2015</td>
<td>3 of 48</td>
<td>0.89</td>
<td>A</td>
<td>1.04</td>
<td>A++</td>
<td>60 - 100 m²</td>
<td>€ 65 000.00</td>
<td>€ 0.00</td>
<td>-</td>
</tr>
</tbody>
</table>

* calculated by (increase of rent - savings of energy bill) / month
** architectural image changed a lot + architectural image did not change a lot -

During the research I divided my findings into three categories, the analysis (as objective as possible), the value assessment (personal interpretations of a certain value) and recommendations (for the design and the design process). This division made clear how to interpret the results of the analysis and gave me tools for the design phase. Moreover, the total graduation period was an iterative process in which research by analyzing and assessing the values and design continually followed each other. An example of this is the analysis of specific trees and plants in the areas between the Nemavo-Airey building blocks. During my research I analyzed the greenery from a broad perspective in order to relate it to the ideas of the Modern Movement which were dominant in the period the urban plan and the buildings were erected. However, when I decided to explore the possibilities of an extension of the building and to redesign the space between the buildings I had to deal with the existing elements like some trees which are there for many years. Therefore I analyzed the type of trees, the age, the ecological value (determined by the amount of different type of insects which eat the leaves of trees) and the possibilities to replace these trees (see figure 114). After this analysis I
looked to the values of the results of the analysis and developed my design to a design more based on the existing elements. After this redesign I discovered also more and more interesting reference projects and sustainable solutions which I studied in order to look which aspects were interesting to develop and use for my own design. In this way the research of reference projects during my graduation project continually influenced my design.

Fig. 114. Analysis of existing trees in the area between the Nemavo-Airey building blocks

Besides analyzing results of case studies and literature I also spoke to different tenants who live in the Nemavo-Airey building blocks. Because I have chosen to focus on the existing tenants as target group for after the renovation I think it is really important to speak with these people. I have chosen for this target group because the houses are now social houses of housing association Eigen Haard. This means that in real it would be difficult for Eigen Haard to rent these houses in the free sector because they are not allowed to rent these houses for high prices because the subsidies Eigen Haard receives from the government. Because my ambition is to make these dwellings energy neutral, the savings in energy costs after the renovation can be invested in the renovation itself by an ESCo (Energy Service Company) in order to prevent an increase in rent and to keep the social houses affordable for the existing tenants. Besides the tenants obviously don’t want or are even not able to pay more rent, I have learned a lot more of the conversations with these existing tenants. However, the most interesting talks were in the second part of my graduation project. I would recommend for others to try to have interesting talks with the residents in an earlier stage of the project because you will discover more problems and the information you get, can help you by making design decisions and to give your research a more realistic approach. I discovered for example not only the problems the tenants were facing now (see figure 115) and in the past, but I learned also a lot about their desires for their homes in the future.
An example of one of the desires of the existing tenants is the relation between the living room and the kitchen. For families from Turkey, Morocco and other countries it is desirable to have a separate kitchen without an open connection with the living room. This is because of two reasons. First reason is that these families cook with a lot of herbs which you can smell clearly. The second reason is that within these families the women will do the cooking and that it is not desirable if the man has some friends over the floor in the living room and these friends are able to see his wife. Almost all tenants of the Nemavo-Airey dwellings are from countries like Turkey and Morocco. This lead to the discussion to what extent the designer has to take into account the desires of to the existing tenants and to what extent the existing tenants have to adapt themselves to the new design. This has also to do with mass customization and how much choice you will give to the tenants. By making different impressions of situation in which I simulate the tenants have a choice between certain facade elements for example, I tried to look what kind of results and image this will have as consequence. Figure 116 shows an illustration of how the Nemavo-Airey blocks might look if I add a new layer of which the materialization can be chosen by the tenants based on some pre-defined options. In my opinion, this results in a messy image without unity and respects to the old existing building and its cultural values. However, if you give four different options for facade elements, it is hard to expect how the facade will look like, because if almost all tenants will choice for the same option, less variety in the facade is the result. For me it was hard to decide how to involve the residents in the design process and for which elements. For a next time I would figure this out by a more elaborate research by giving the existing tenants a survey with some options to look what the consequence of the results would be for the design.
The tension between choices within the design process is also reflected during the design process of Van Hooijschuur for the renovation of the Nemavo-Airey dwellings of housing association Eigen Haard. Because 8 tenants do not agree with the floorplans Van Hooijschuur designed, these 8 tenants decided to go to the judge. This is now a process between the lawyer of the 8 tenants and the housing association Eigen Haard.

In the beginning of the process I focused on my ambition to make these social houses energy neutral by improving the energy efficiency, because according to the requirements of the Energy Agreement, the built environment must be energy neutral in 2050 and in 2020 the rented social houses must have a B-label on average. However, by taking into account all restrictions and requirements of the practice for this building in the conservation area of Amsterdam-West, it is almost impossible to make an interesting design from an architectural perspective. Realizing this, I had some difficulties to leave these requirements and restrictions and to think in an architectural way and design from a more architectural approach. The retake I had for my P2 with the aim to mainly focus on an architectural vision, forced me to approach the design of the renovation more from an architectural point of view. This has resulted in more architectural quality and a stronger concept for my design.

**Design Process**

One of my research ambitions was to explore mass customization as a tool to be used in the design process to improve the comfort and energy efficiency. Moreover, I wanted to use a mass customization tool as a way to create architecture which would increase identification and participation. By involving the residents in the design process, the chance will be bigger that the
housing association convinces more than 70% of the residents to agree the renovation because without convincing 70% agreement among the tenants, the housing association cannot start with the renovation. In addition, I also wanted to raise the livability for the tenants by increase the value of the existing qualities of the urban area and the building blocks itself. However, during the design process I started to experience that by using mass customization, the architectural outcome was most of the time in contrast with my starting points and value assessment based on my research and analysis. So, in order to create more identity and to strengthen the modernistic image of the building blocks, I decided to leave the idea of mass customization for the exterior of the buildings. However, I wanted to involve the tenants in the design process of the floorplans in which they were able to translate their desires into some design options.

To explore the architectural parameters in order to accomplish my ambition to improve the comfort and energy efficiency and to increase the quality of the area between the Nemavo-Airey building blocks, I looked back to my starting points based on the value assessment and analysis of my research. With this information I reflected the design variants I made of several aspects of the area and the building. Figure 117 shows an example of drawings of different variants in the first stage of the design process. However, in a later stage of the graduation project I started again making different kind of sketches in order to express the ideas and ambition for the project. By doing this, I gained more insight in the consequences of design choices and for me it was also a good way to communicate my ideas to others.

![Fig. 117. Sketches of different situations and design options](image)

During the design process I took into account the restrictions of the Bouwbesluit. Looking at the parking situation, I designed different options and assessed them by different criteria. Figure 118 gives the example of the design study of different parking places and their measurements.

---

This was important to know before I could design the new parking places in the area around the Nemavo-Airey buildings. Figure 119 gives some different options of possible parking solutions in the beginning of the design process. However, these drawings were made before my P2 and are reconsidered after.

Moreover, during the design process I worked on scales from 1:200 to 1:5. However, during the design process I discovered different design problems on a scale of 1:5 and looked for solutions for these problems which had consequences for also the scale of 1:200. An example of this was the process of designing a new floor for the dwellings on a scale 1:5 which has consequences for the image of the facade in a scale of 1:200. This had to do with the *doorvalbeveiligingen* of the windows in the facade. After investigating different options for floor systems and by comparing them on the
acoustic insulation values, I designed the floor on a scale of 1:5 and 1:20. The type of floor I designed resulted in an extra height of the total new floor and had as consequence that I had to think about how to design the *doorvalbeveiligingen*. In order to research the consequence of the different options of *doorvalbeveiligingen* I designed the *doorvalbeveiligingen* also on a scale of 1:100 and 1:200 to look how this would be integrated in the total facade image. The problem of adding extra floor height for the *doorvalbeveiliging* is a generic problem which is common in renovation projects. However, the way how you design this *doorvalbeveiliging* might be project specific. In my case, I designed this *doorvalbeveiliging* based on the results of my value assessment. I would recommend others also to look at details like this in an early phase of the design because of the influence it might have on the total image of the facade. By knowing the consequences and options in the beginning of the design process, it is possible to integrate these aspects in the total design instead of adding a standard solution for a *doorvalbeveiliging* after the design phase, which might have negative consequences for the image of the total facade.

The eventually product of the graduation studio is a design for a renovation of the Nemavo-Airey blocks, from a scale of 1:500 to 1:5. In order to design this renovation, I discovered during the process that a clear focus is important and will help you during the research and design phase with structuring all involved aspects and results from research. Not only a focus based on your ambition, but also a focus on the scale of the project. In my case, I focused on the four most original Nemavo-Airey building blocks instead of all building blocks because the other blocks were already renovated which could mean a different approach and design is needed. This is an interesting question to reflect on. If I look to the design for the four original building blocks, some of the original elements are important aspects for my concept, the design and the materialization. Because some of the other building blocks already have a new extra layer on the outside, the original facade panels are for example not visible anymore on these blocks. So if I want to use my design also for the already renovated building blocks, the renovated building blocks first have to change in order to have the same result after applying my design to these building blocks. I also chose to make a redesign for the area between these Nemavo-Airey building blocks because Berghoef, the architect of the Nemavo-Airey building blocks also designed this area between the building blocks and used for example the trees to create a contrast with the modern building blocks which had a low plasticity.

Finally, the results of my calculations on the energy consumption and generation show my designed renovation will make the dwellings energy neutral. In this way my ambition to make these dwellings energy neutral is become reality. However, I did not calculate the expected costs for this renovation exactly, which probably will be too much to be realistic.

In short, in order to increase the comfort and energy efficiency by a design for a renovation for the Nemavo-Airey dwellings in the conservation area of Amsterdam West, the architectural and cultural historic values are interpreted and translated to a renovation concept in which architecture and technology is integrated in one design. In order to achieve my ambitions, several preconditions have been formulated in front and the architectural vision for the projects is reflected in the design and the design choices I have made during the process of research and design. During this iterative process of research and design I have learned a lot about the relationship and tension between design, technology and heritage. For my future profession and career, I want to use the things I have learned during this interesting process of research and design.
10. CONCLUSION

The two main problems of the Nemavo-Airey buildings today are comfort issues and the high energy consumption. The dwellings have a low comfort due to the way these houses were produced resulting in small rooms with a not comfortable climate. Secondly, the dwellings are not well insulated, resulting in a high energy consumption, noise pollution and draught. In combination with my fascination for mass customization, these two problems formed the main research question about how mass customization as a tool can be used during the design process of an energy friendly renovation for the Nemavo-Airey dwellings in Amsterdam West in order to increase its energy efficiency and comfort as well as architectural quality. This final chapter concludes and compares the results of the analysis of the Nemavo-Airey buildings and its context, the results from my value assessment based on the cultural values and the results from the research on mass customization and energy friendly renovation concepts.

Based on the historical research on the building system of the Nemavo-Airey dwellings and research about mass customization, the Nemavo-Airey building system is an innovative system for its time and has a lot of similarities with the production process related to mass customization. This lead to the design question to what extent residents should be involved in the design process to customize their home and what consequence this might visually have for the architecture of the building. However, mass customization can provide the possibility to involve the residents in the design process for the interior and housing associations in the design process for the climate systems in order to improve the energy consumption to the preferred energy index and the related improvement of comfort for their tenants. The money which is saved after certain years by less energy consumption can be used to finance the renovation.

Looking to the results of the value assessment, the open building strokes oriented north to south in a way the dwellings are oriented east and west is one the qualities of the Nemavo-Airey building blocks. The location and the good accessibility to the center of Amsterdam with public transportation make the buildings valuable. Moreover, the greenery is very important within the urban structure. However, the greenery and the public gardens are not functioning today like they were intended to do. By looking closer to the architecture of the buildings, the recognizable grid is iconic for the architectural image of these building blocks. With little exceptions, this grid determines the composition of the facades. It is also a reflection of the building system which is based on prefabricated elements. Although the size of the dwellings are small, they are part of social housing which means they will not be not affordable anymore by adding a lot of square meters. However, the kitchen, balcony and storage space are too small, which makes these dwellings uncomfortable in a way of the amount of space within the house. Because the construction is mainly located in the facade, a free floorplan is provided. Architect Berghoef saw this as an opportunity to let people express identity in their interior of their home. I think this is a quality of the construction and the building system of the Nemavo-Airey dwellings. Whereas the main goal of Berghoef was to produce affordable houses with in a short time, my goal will be to renovate these dwellings to affordable comfortable homes within a short period of time so residents do not have to stay somewhere else for more than a few days.
Based on the results of the calculations, the dwellings are small, not comfortable and have an energy label F or G. Because the Nemavo-Airey building system was innovative for its time, I think the renovation of the Nemavo-Airey building has to have a high ambition level in order to achieve new innovation in the building and renovation industry.

Reflecting to the methods and findings, more research and calculations must be made in order to come with stronger arguments for certain design recommendations. Many calculations are based on assumptions, because not all detailed information was available so far. However, much of this information can be obtained by further research and investigation of the existing situation. Moreover, speaking with more residents would make some assumptions stronger and elaborating more proper case studies will give better results about the relation between the different ambition levels and the consequences for the architecture.

However, in order to increase the comfort and energy efficiency by a design for a renovation for the Nemavo-Airey dwellings in the conservation area of Amsterdam West, the architectural and cultural historic values are interpreted and translated to a renovation concept in which architecture and technology is integrated in one design. In order to achieve my ambitions, several preconditions have been formulated in front and the architectural vision for the projects is reflected in the design and the design choices I have made during the process of research and design. During this iterative process of research and design I have learned a lot about the relationship and tension between design, technology and heritage. For my future profession and career, I want to use the things I have learned during this interesting process of research and design.

In conclusion, the position of the architect in renovation processes of today might be seen as an innovative connector between the different involved parties, focusing on creative and innovative solutions for problems which exist from practice related to the tension between cultural heritage and general renovation products. In order to connect different parties and give the cultural heritage even more value for the society, the architect needs different knowledge in comparison with a traditional renovation process and might have to experiment with new methods like mass customization. So, the challenge for my graduation project is designing an intervention based on sustainable and innovative solutions by involving the residents and housing association in the design process in order to give the Nemavo-Airey building blocks more value for the next generations, taking into account the short term interests of all different parties which are involved in the renovation process.
11. RECOMMENDATIONS

Based on the conclusions of my analysis, research and value assessment, recommendations are made in order to define the starting points for the design of an intervention for the Nemavo-Airey dwellings.

First of all, I think the urban structure should be preserved as much as possible. However, the back still looks almost the same as the ‘backside’ of closed building blocks instead of representing a proper facade. This is partly covered by the greenery, but it might be interesting to look if an intervention can give this backside a proper facade. To make the public gardens an open public space based on the ideas of the Modern Movement, it might also be an option to change the front and backside of the Nemavo-Airey buildings. In this way the front side will face the greenery and the backside will face the parking spaces. Moreover, because all public transportation is located at the Burgemeester de Vlugtlaan, it might be important to enhance the connection between the Burgemeester de Vlugtlaan and the Nemavo-Airey buildings.

In order to increase the happiness and safety of the different residents in the neighborhood it is important to create social interactions. In order to use the public garden as an open public space which connects different neighborhoods and other greenery, the public garden should be an integrated part of the design of the intervention, just like Berghoef who saw the greenery as an important part of the design. Moreover, attention must be paid to the transition between the private gardens of the residents living at the ground floor and the public garden between these private gardens.

The lack of space of the kitchen, balcony and storage can be improved with an expansion of the dwelling by adding more square meters or with a more efficient use the floorplan by a rearrangement of the interior walls and combining different rooms. An example of adding more square meters are the Nemavo-Airey building blocks which are already renovated. For these renovated blocks, a balcony was added as an exterior structure so the existing balcony could be added as inside surface area to enlarge the kitchen. Another option is to located the storage space somewhere between the building blocks so the inside storage space can be used different.

Because the grid determines the composition of the facades, this grid must be concerned by an intervention. Using this grid or a grid with multiple sizes might enhance the architectural image of the building blocks. Because the Nemavo-Airey building system has a lot of similarities with mass customization, it might be interesting to use mass customization for the renovation. In this way, new renovation products can be added and integrated in a design in which the residents will be involved too. However, during the further design process, I have to investigate what the limitatios of mass customization are and what influence it has on the architectural image of the buildings. Moreover, involving the residents and the housing association in the design process for a certain part of the design is possible by for example a woonconfigurator, software which is nowadays developed by many different companies. Because the idea of Goed Wonen is outdated, residents should have influence on what kind of interior they want. Moreover, in the existing situation, many small rooms are dividing the houses into small spaces and the place of the bathroom is the division between the kitchen and the living room. This should actually be determined by the residents who live in these
houses. For a design for an interior intervention, participation of the residents should therefore be considered.

Because free floorplans are possible due to the way of the building is constructed, this opportunity to redesign the interior in combination with the residents and housing association should be considered. Especially if the dwellings will be insulated from the inside and new climate installations must be added, already a lot of interventions must be done in the interior. In this way it is relatively little effort to place new walls. In this way, people can also express themselves in their interior, just like the vision of Berghoef.

Finally, an important design question is how Berghoef would have designed the Nemavo-Airey building if the technologies and innovations of today were already available in the period just after the Second World War. This question is reflected in Fig. 120 which shows the new Mini that has the same concept and looks as the type of years ago but with the technologies of today. Because of the new technologies integrated in the car and in order to meet the requirements of today, the newest type looks different than the oldest type. This might also be the basis of an important recommendation for the design of the renovation of the Nemavo-Airey dwellings, namely designing a renovation that will meet the requirements of today, integrate new technologies using mass customization and make the dwellings more comfortable as well as increasing the architectural quality and the energy efficiency.

---

Fig. 120. New technologies incorporated in a design for Mini based on the old design of Mini [Auto Express, 2013]

95 Auto Express, 'Mini Mania', (2013).
12. REFERENCES


30. Mil, Rob van, 'Optimisme over Kansen Voor 'All Electric'-Woningen', *E&I* 2014.


34. NL, Agenschap, 'Feiten En Fabels Rond De Aanscherping Van De Epc Van 0,8 Naar 0,6', (2010).

35. Online Bouwbesluit, 'Verblijfsgebied En Verblijfsruimte'2015) [http://www.onlinebouwbesluit.nl/].


...
13. APPENDIX

- A. EPC Calculation existing situation – Uniec2.2 [calculated on 14-10-2015]
- B. WWS punten / huurprijscheck - Huurcommissie [calculated on 20-10-2015]
- C. Calculation maximum initial investment per dwelling [calculated on 20-10-2015]
- D. Information about climate installations of the case studies
- E. EPC Calculation after the designed renovation – Uniec2.2 [calculated on 12-06-2016]
A. EPC CALCULATION EXISTING SITUATION – UNIEC2.2

Uniec2.2
Nemavo-Airey - Graduation Project - Nemavo-Airey dwellings
Nemavo-Airey building block with 18 dwellings

Algemene gegevens

<table>
<thead>
<tr>
<th>projectomschrijving</th>
<th>Nemavo-Airey - Graduation Project - Nemavo-Airey dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>variant</td>
<td>Nemavo-Airey building block with 18 dwellings</td>
</tr>
<tr>
<td>straat / huisnummer / toevoeging</td>
<td>Burgemeester de Vlugtlaan</td>
</tr>
<tr>
<td>postcode / plaats</td>
<td>Amsterdam</td>
</tr>
<tr>
<td>bouwjaar</td>
<td>1952</td>
</tr>
<tr>
<td>categorie</td>
<td>Energieprestatie Woningbouw</td>
</tr>
<tr>
<td>aantal woningbouw-eenheden in berekening</td>
<td>1</td>
</tr>
<tr>
<td>gebruiksfunctie</td>
<td>woonfunctie</td>
</tr>
<tr>
<td>datum</td>
<td>11-10-2015</td>
</tr>
<tr>
<td>opmerkingen</td>
<td>Made by Jasper Muller</td>
</tr>
</tbody>
</table>

Indeling gebouw

<table>
<thead>
<tr>
<th>Rekenzone</th>
<th>omschrijving</th>
<th>interne warmtecapaciteit</th>
<th>( A_g ) [m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>verwarmde zone</td>
<td>apartment level 1</td>
<td>traditioneel, gemengd zwaar</td>
<td>61,00</td>
</tr>
</tbody>
</table>

Infiltratie

<table>
<thead>
<tr>
<th>Rekenzone</th>
<th>omschrijving</th>
<th>( Q_{\text{instap}} ) [m³/h per m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>nieuwbouw</td>
<td>nieuwafge bouw, tussengelegen laag (standaard geveltype)</td>
<td>0,42</td>
</tr>
</tbody>
</table>

Rate verbrandingstoestellen

Het gebouw bevat geen open verbrandingstoestellen.

Bouwkundige transmissiegegevens

Transmissiegegevens rekenzone apartment level 1

<table>
<thead>
<tr>
<th>constructie</th>
<th>( A_g ) [m²]</th>
<th>( R_c ) [m²K/W]</th>
<th>U [W/m²K]</th>
<th>( q_H ) [-]</th>
<th>zonwering</th>
<th>beschaduwing</th>
<th>toelichting</th>
</tr>
</thead>
</table>

Voorgevel O - buitentuin, O - 24,4 m² - 90°
**Verwarming- en warmtapwatersystemen**

**verwarming/warmtapwater**

**Opwekking**

- type opwekker
  - individueel cv-toestel, buiten EPC begrenzing
- indeling L7/T voor opwekker
  - hoge temperatuur
- toepassingsklasse (CV-klasse)
  - 4 (CW 4, 5 en 6)
- type CV-ketel - verwarming
  - conventionele ketel
- type CV-ketel - warmtapwater
  - gaaggestookt combinatetoestel HPVw 67,9%
- aantal opwekkers
  - 1
- transmissieverlies verwarmingssysteem - januari (Hh)
  - 298 WIK
- warmtebehoeft verwarmingssysteem (Qonwu)
  - 63.152 MJ
- hoeveelheid energie t.b.v. verwarming per toestel (Qonthuwu)
  - 66.476 MJ
- hoeveelheid energie t.b.v. warmtapwater per toestel (Qonthwuw)
  - 7.843 MJ
- opwekkingssrendement verwarming - CV ketel (ηwuw)
  - 0,700
- opwekkingssrendement warmtapwater - CV ketel (ηwuw)
  - 0,564

**Kenmerken afgiftesysteem verwarming**

<table>
<thead>
<tr>
<th>Type warmteafgifte (in woonkamer)</th>
<th>positie</th>
<th>hoogte</th>
<th>R50</th>
<th>ηaang</th>
<th>ηnorm</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiator- en/of convectorenwarming</td>
<td>buitenwand</td>
<td>&lt; 8 m</td>
<td>≥ 2,5 m²/KAV</td>
<td>&gt; 50 *</td>
<td>0,95</td>
</tr>
</tbody>
</table>

regeling warmteafgifte aanwezig

ja
Ventilatie

ventilatiesysteem

systeemvariant

luchtvolume/roomlacoir voor warmte- en koudedeelhoeveel (\(V_{\text{L}}\))

correctiefactor regelsysteem voor warmte- en koudedeelhoeveel (\(f_{\text{L}}\))

Kenmerken ventilatiesysteem

werkelijk geïnstalleerde ventilatiecapaciteit bekend

warmeroomboiler(s) in gebouw

lichtrichtheidsklasse ventilatiekanalen

Passieve koeling

max. benutting geïnstal. ventilatiecapaciteit voor koudedeelhoeveel

max. benutting geïnstal. spuicapaciteit voor koudedeelhoeveel
Kenmerken ventilatoren

Totaal nominaal vermogen (P nom) centrale ventilaties-units 52,00 W / 1 unit

Aangesloten rekerzones

apartment level 1
### Resultaten

<table>
<thead>
<tr>
<th>Jaarlijks hoeveelheid primaire energie voor de energiefunctie</th>
<th>( E_{TP} )</th>
<th>94.965 MU</th>
</tr>
</thead>
<tbody>
<tr>
<td>verwarming (excl. hulpenergie)</td>
<td>( E_{TP} )</td>
<td>3.228 MU</td>
</tr>
<tr>
<td>hulpenergie</td>
<td>( E_{TP} )</td>
<td>13.896 MU</td>
</tr>
<tr>
<td>verwarming (excl. hulpenergie)</td>
<td>( E_{TP} )</td>
<td>0 MU</td>
</tr>
<tr>
<td>koeling (excl. hulpenergie)</td>
<td>( E_{TP} )</td>
<td>0 MU</td>
</tr>
<tr>
<td>hulpenergie</td>
<td>( E_{TP} )</td>
<td>0 MU</td>
</tr>
<tr>
<td>zomercomfort</td>
<td></td>
<td>72 MU</td>
</tr>
<tr>
<td>ventilatie</td>
<td>( E_{TP} )</td>
<td>1.528 MU</td>
</tr>
<tr>
<td>verlichting</td>
<td>( E_{TP} )</td>
<td>2.811 MU</td>
</tr>
<tr>
<td>geëxporteerde elektriciteit</td>
<td>( E_{Pexp} )</td>
<td>0 MU</td>
</tr>
<tr>
<td>op eigen perceel opgewekte &amp; verbruikte elektriciteit</td>
<td>( E_{Pnaar} )</td>
<td>0 MU</td>
</tr>
</tbody>
</table>

### Oppervlakten

| totale gebruiksoppervlakte | \( A_{geb} \) | 61.06 m² |
| totale verliesoppervlakte | \( A_{v} \) | 257.46 m² |

### Aardgasgebruik (exclusief koken)

| gebouwgebonden installaties | | 3.095 m³ aeq |

### Elektriciteitsgebruik

| gebouwgebonden installaties | 826 kWh |
| niet-gebouwgebonden apparatuur (stelpost) | 1.710 kWh |
| op eigen perceel opgewekte & verbruikte elektriciteit | 0 kWh |
| geëxporteerde elektriciteit | 0 kWh |
| TOTAAL | 2.536 kWh |

### CO₂-emissie

| \( m_{equ} \) | 5.977 kg |

### Energieprestaties

| Specificatie energieprestatie | \( EP \) | 1.910 MWh/a |
| karakteristieke energiegebruik | \( E_{k} \) | 116.503 MU |
| toelaatbare karakteristieke energiegebruik | \( E_{Pmax} \) | 22.503 MU |
| energieprestatiecoëfficiënt | \( EPC \) | 2.071 - |
| energieprestatiecoëfficiënt | \( EPC \) | 2.06 - |

Uniec 2.2 is gebaseerd op NEN7120:2011 "Energieprestatie van gebouwen" (inclusief het Nader Voorzicht) en NEN 8088-1 "Ventilatie en luchtcirculatiethed van gebouwen" inclusief alle wettelijk van kracht zijnde correctielagen.

Alle bovenstaande energiegebruiken zijn genoteerde energiegebruiken gebaseerd op een standaard Minimaaljaar en een standaard gebruiksgedrag. Het verkrijgbare energiegebruik zal afwijken van het genoteerde energiegebruik. Aan de berekende energiegebruiken kunnen geen rechten ontleend worden.
## Woonruimte

### 1. Oppervlakte van vertrekken

<table>
<thead>
<tr>
<th>Ruimte &amp; vertrekken</th>
<th>m²</th>
<th>verwarmed</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woonkamer</td>
<td>16,00 m²</td>
<td>Ja</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slaapkamer (1)</td>
<td>11,00 m²</td>
<td>Ja</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slaapkamer (2)</td>
<td>9,00 m²</td>
<td>Ja</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slaapkamer (3)</td>
<td>8,00 m²</td>
<td>Ja</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Badkamer</td>
<td>3,00 m²</td>
<td>Nee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keuken</td>
<td>5,00 m²</td>
<td>Nee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Punten vertrekken: 52,00 m², Totaal: 52,00

Subtotaal: 52,00

### 2. Oppervlakte overige ruimten

<table>
<thead>
<tr>
<th>Ruimte &amp; vertrekken</th>
<th>m²</th>
<th>verwarmed</th>
<th>Punt</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berging</td>
<td>4,00 m²</td>
<td>Nee</td>
<td>3,00</td>
<td></td>
</tr>
</tbody>
</table>

Punten overige ruimten: 4,00 m², Totaal: 3,00

Subtotaal: 55,00

### 3. Verwarming & installaties

<table>
<thead>
<tr>
<th>Installaties</th>
<th>Punt</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verwarming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aantal verwarmde vertrekken</td>
<td>4</td>
<td>8,00</td>
</tr>
</tbody>
</table>

Punten verwarming: 8,00

Huistelefoon met video: Nee, 0,00

Subtotaal: 63,00
### 4. Energieprestatie

<table>
<thead>
<tr>
<th>Woonvorm</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meergezinswoning (b.v. een flat of etagewoning)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bouwjaar</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976 of eerder</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

| Punten energieprestatie | 0     |        |

| Subtotaal              | 63.00 |        |

### 5. Keuken

<table>
<thead>
<tr>
<th>Het aanrecht is langer dan 2 meter</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>7.00</td>
</tr>
</tbody>
</table>

| Punten keuken *                  | 7.00   |        |

| Subtotaal                         | 70.00  |        |

### 6. Sanitair

<table>
<thead>
<tr>
<th>Toiletten</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>3.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wastafels</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alleen aparte douche</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>4.00</td>
</tr>
</tbody>
</table>

| Punten sanitair *               | 8.00   |        |

| Subtotaal                       | 78.00  |        |

### 7. Woonvoorzieningen gehandicapten

| Punten voorzieningen gehandicapten | 0     |        |

| Subtotaal                         | 78.00  |        |
8. Privé-buitenruimten

<table>
<thead>
<tr>
<th>Ruimte &amp; vertrekken</th>
<th>m²</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balkon (1.00 x 3.00)</td>
<td>3.00 m²</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Subtotaal 78,00

9. Punten voor de WOZ-waarde

<table>
<thead>
<tr>
<th>WOZ-waarde</th>
<th>€ 150.000,00</th>
<th>Punten</th>
<th>41,00</th>
</tr>
</thead>
</table>

Subtotaal 119,00

Gemeenschappelijke ruimten & voorzieningen

<table>
<thead>
<tr>
<th>Ruimte &amp; vertrekken</th>
<th>m²</th>
<th>wooneenheden</th>
<th>verwarmd</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berging</td>
<td>3.40 m²</td>
<td>2</td>
<td>Nee</td>
<td>1,13</td>
</tr>
</tbody>
</table>

Subtotaal 120,13

12. Zorgwoning

<table>
<thead>
<tr>
<th>Zorgwoning</th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotaal 120,13
### Puntenwaarde totaal

<table>
<thead>
<tr>
<th></th>
<th>Punten</th>
<th>Totaal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totaal aantal punten (afgerond)</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Maximale huurprijs op basis van punten</td>
<td></td>
<td>€ 580,08</td>
</tr>
<tr>
<td>15% toeslag voor beschermd stads- en dorpsgezicht</td>
<td></td>
<td>€ 87,01</td>
</tr>
<tr>
<td>Maximale huurprijs per 1 oktober 2015 (kale huurprijs)</td>
<td></td>
<td>€ 667,09</td>
</tr>
</tbody>
</table>

* Deze uitkomsten zijn gebaseerd op complexe berekeningen. Indien u meer wilt weten over de exacte rekenregels, kunt u dit nalezen in de *Handleiding zelfstandige woningruimte*.

### Toelichting bij *

- Afdek voor toilet in badkamer
  Als er een toilet in de bad- of douchesuikade, wordt 1 m² van de oppervlakte van deze ruimte afgetrokken.

- Afdek voor ontbreken vaste trap
  Als er geen vaste trap naar zolder is, wordt 5 punten afgetrokken van het aantal punten van de oppervlakte van de zolderruimte. Krijgt de oppervlakte minder dan 5 punten, dan kan het resultaat niet negatief zijn

- Afdekking extra kwaliteit keukens
  Het aantal punten voor extra kwaliteit is nooit meer dan het aantal punten voor de lengte van het aanrecht.

- Afdekking extra kwaliteit sanitair
  Het aantal punten voor extra kwaliteit is nooit meer dan het aantal punten voor douche en/of bad.

- Punten gemeenschappelijke ruimten en voorzieningen
  De berekening van het aantal punten is hetzelfde als voor de eigen ruimten en voorzieningen. De punten worden alleen verdeeld door het aantal wonenheid die hiervan gebruik maakt.

### Disclaimer

Deze puntentelling is samengesteld op 20-10-2015 met de online Huurprijscheck (geldig vanaf 1 oktober 2015) van de Huurcommissie. U vindt de Huurprijscheck op [www.huurcommissie.nl](http://www.huurcommissie.nl).

Zowel huurders als verhuurders kunnen gebruik maken van de online Huurprijscheck. Als gegevens correct zijn ingevuld is de uitkomst een zorgvuldige indicatie van het puntentotaal en de bijbehorende maximale huurprijs. Toch kan een onderzoek door de Huurcommissie tot een afwijkend puntentotaal leiden. Bijvoorbeeld omdat de oppervlakte preciezer wordt opgemeten, of omdat de Huurcommissie een ander oordeel heeft over aard of kwaliteit van voorzieningen.

Onderhoudsgerelateerde hebben geen invloed op het puntentotaal, maar kunnen wel zorgen voor een (tijdelijke) verlaging van de huur. Daarvoor moet dan wel een procedure bij de Huurcommissie worden gevoerd.
## C. Calculation Maximum Initial Investment Per Dwelling

**[Calculated on 20-10-2015]**

### Gegevens winstvorming

**Kenmerken**

<table>
<thead>
<tr>
<th>Project / exemplaar</th>
<th>Opruimings / lieting</th>
<th>Scenario 0</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aantal woningen</td>
<td></td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Bouwjaar</td>
<td></td>
<td>2013</td>
<td>2013</td>
<td>2013</td>
<td>2013</td>
</tr>
<tr>
<td>Openbare (BOB)</td>
<td></td>
<td>61</td>
<td>61</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Woontes</td>
<td>€ 1.050.820</td>
<td>€ 1.050.820</td>
<td>€ 1.050.820</td>
<td>€ 1.050.820</td>
<td>€ 1.050.820</td>
</tr>
<tr>
<td>Energiebeleid voor renovatie</td>
<td></td>
<td>F</td>
<td>F</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>Energiebeleid voor wonen</td>
<td></td>
<td>F</td>
<td>F</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>max. te vragen voor renovatie</td>
<td></td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>WVS punten voor renovatie</td>
<td></td>
<td>€ 667.05</td>
<td>€ 667.05</td>
<td>€ 667.05</td>
<td>€ 667.05</td>
</tr>
<tr>
<td>max. te vragen voor wonen</td>
<td></td>
<td>140</td>
<td>140</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Bij Scenario 2 (vanaf 2014 geen wonenrenovatie)</td>
<td></td>
<td>€ 667.05</td>
<td>€ 783.70</td>
<td>€ 945.61</td>
<td>€ 667.05</td>
</tr>
</tbody>
</table>

### Huis inkomsten

**Inkomsten en kosten**

- **Percentage van woning, waar het inwonersinkomen betreft:**
  - **Huisvestingsadaptatie:**
    - **Gerealiseerde kosten per woning:**
      - **€ 466.96**
  - **€ 466.96**

### Exploitatie

**Exploitaatie inkomsten**

- **Aantal jaren dat de woningen voor leefdoel kunnen worden en renovatie**
  - **Gemiddelde kosten per woning per jaar voor onderhoud:**
    - **€ 1.303**
  - **Gemiddelde kosten per woning per jaar voor onderhoud:**
    - **€ 1.303**
  - **Gemiddelde kosten per woning per jaar voor onderhoud:**
    - **€ 1.303**

### Winstvorming

**Winstvorming per maand**

- **Verdieling tussen huur en de renovatie. Het bedrag dat hier staat moet de huur en bescherming betrekken:**
  - **€ 0.00**
  - **€ 0.00**

### Nieuwbouw

**Nieuwbouw per maand**

- **€ 0.00**

### Energiewarmte

**Energiewarmte inkomsten**

- **Gemiddeld energieverbruik 3600 kWh / 0.22 Cth/m per jaar**
  - **€ 1.303**

### Verkoop

**Verkoop op energiewarmte per maand**

- **€ 0.00**

### Verantwoording

**Verantwoording voor bouwkosten**

- **€ 0.00**

### Renovatie

**Renovatie**

- **€ 0.00**

### Nieuwbedrijfswaarde

**Nieuwbedrijfswaarde**

- **€ 0.00**

### Netto totaal

**Netto totaal**

- **€ 0.00**

---

### Maximum initiële investering per woning

- **€ 32.222**
- **€ 10.599**
- **€ 9.795**
- **€ 46.584**

---

---

**Nieuwbouw**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
</table>

### Dissociatie

**Dissociatie**

- **€ 0.00**
- **€ 0.00**
- **€ 0.00**
- **€ 0.00**

---

### Overige subsidies

**Overige subsidies**

- **€ 0.00**
- **€ 0.00**
- **€ 0.00**
- **€ 0.00**

---

### Aandelen

**Aandelen**

- **€ 0.00**
- **€ 0.00**
- **€ 0.00**
- **€ 0.00**

---

---

**Drumpfsumme**

34.222
### Tabel 1

|   | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 |

### Tabel 2

|   | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 | € 6902 |
D. INFORMATION ABOUT CLIMATE INSTALLATIONS OF THE CASE STUDIES

CASE STUDY 1: PASSIVE RENOVATION LUTTEBRINK – ENSCHEDE

Calculations conform ISSO 82.1 & Details renovation before and after [Haytik, et al. 2015]

Characteristics after renovation [Haytik, et al. 2015]
CASE STUDY 2: RENOVATION OF 78 PORTIEKETAGEWONINGEN IN SATERLOSSTRAAT – HENGELO

Calculations conform ISO 82.1 & Details renovation before and after [Haytik, et al. 2015]

<table>
<thead>
<tr>
<th>Na renovatie</th>
<th>Saterlostraat en Havenzatenlaan</th>
<th>EI = 1.07 - 1.17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermische schil</td>
<td>R-value</td>
<td>1.0 - 2.5</td>
</tr>
<tr>
<td>kierdichting</td>
<td>aanwezig</td>
<td>niet aanwezig</td>
</tr>
<tr>
<td>Type Glas</td>
<td>Isolierend effect</td>
<td>HR++</td>
</tr>
<tr>
<td>PV-panelen</td>
<td>m² PV-panelen / woning</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Verwarming</td>
<td>Type opwekking</td>
<td>CV</td>
</tr>
<tr>
<td>Tapwater</td>
<td>Type tapwater</td>
<td>HR-107</td>
</tr>
<tr>
<td>Ventilatiesysteem</td>
<td>systeem</td>
<td>C</td>
</tr>
<tr>
<td>Energielevering</td>
<td>gas / elektra / extern</td>
<td>gas/electra</td>
</tr>
</tbody>
</table>
Calculations conform ISSO 82.1 & Details renovation before and after [Haytik, et al. 2015]

<table>
<thead>
<tr>
<th>Na renovatie - Jan Voermanstraat</th>
<th>EI = x₁xx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermische schil</td>
<td></td>
</tr>
<tr>
<td>R₁, gevel</td>
<td>1,0 - 2,5</td>
</tr>
<tr>
<td>kierdichting</td>
<td></td>
</tr>
<tr>
<td>aanwezig</td>
<td></td>
</tr>
<tr>
<td>niet aanwezig</td>
<td></td>
</tr>
<tr>
<td>energielabel B</td>
<td></td>
</tr>
<tr>
<td>Isolerend effect</td>
<td></td>
</tr>
<tr>
<td>HR ++</td>
<td></td>
</tr>
<tr>
<td>triple</td>
<td></td>
</tr>
<tr>
<td>PV-panelen</td>
<td></td>
</tr>
<tr>
<td>m² pv-panelen / woning</td>
<td>10 - 15</td>
</tr>
<tr>
<td>Verwarming</td>
<td></td>
</tr>
<tr>
<td>Type opweking</td>
<td>CV</td>
</tr>
<tr>
<td>Tapwater</td>
<td></td>
</tr>
<tr>
<td>Type tapwater</td>
<td>HR-107</td>
</tr>
<tr>
<td>Ventilatiesysteem</td>
<td></td>
</tr>
<tr>
<td>systeem</td>
<td>C</td>
</tr>
<tr>
<td>Energielijvering</td>
<td></td>
</tr>
<tr>
<td>gas / elektra / extern</td>
<td>gas/electra</td>
</tr>
</tbody>
</table>

Characteristics after renovation [Haytik, et al. 2015]
**CASE STUDY 4: RENOVATION LUCELLESTRAAT, AMSTERDAM**

### Project Gegevens

- **Project**: Renovatie Bodegraven te Amsterdam
- **Opdrachtgever**: Gemeente Amsterdam - middelflak buurt
- **Uitvoering renovatie**: 2013 - 2014
- **Doelstelling**: Label A

### Bouwkundige Informatie

<table>
<thead>
<tr>
<th>Voor renovatie</th>
<th>Na renovatie - Label B, A en A+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bouwmaterialen</td>
<td>Isolatie</td>
</tr>
<tr>
<td>Binnenmuren</td>
<td>30 mm Paperback 6016/10 - R = 1.62 m²K/W</td>
</tr>
<tr>
<td>Neutrale isolatie</td>
<td>30 mm Paperback 6016/10 - R = 1.62 m²K/W</td>
</tr>
<tr>
<td>Plafond</td>
<td>Open</td>
</tr>
<tr>
<td>Paneel</td>
<td>Open</td>
</tr>
<tr>
<td>Behandeling</td>
<td>Nieuwe bouwlaag</td>
</tr>
<tr>
<td>Koepels</td>
<td>Hout</td>
</tr>
<tr>
<td>Voorgevel</td>
<td>Standaard ingepleisterde deur</td>
</tr>
<tr>
<td>Kierrichting</td>
<td>Niet toegelaten</td>
</tr>
<tr>
<td>Bloezen</td>
<td>Nieuw</td>
</tr>
</tbody>
</table>

### Installatietechnisch

- **Verwarming**: combi boiler
- **Ventiel systeem**: natuurlijke toename/natuurlijke afname
- **Elektrische energie**: n.v.t.
- **Zonnepanelen**: PV-pannen (zeal apartementen)

### Resultaat

- **Appartement**
  - Energieindex (EI) = 2.42 - 3.12
  - Energieindex (EI) = 0.66 - 1.12
  - Energie label A
  - Energie label B
  - Totaal renovatielastend, BTW 0.037.000-

### Na renovatie - Lucellestraat

<table>
<thead>
<tr>
<th>Thermische schil</th>
<th>EI = 1.11 - 0.66</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-value</td>
<td>1.0 - 2.5</td>
</tr>
<tr>
<td>Kierdichting</td>
<td>aanwezig</td>
</tr>
<tr>
<td>Type glas</td>
<td>Isolierend effect</td>
</tr>
<tr>
<td>PV-panelen</td>
<td>m² PV-panelen / woning</td>
</tr>
<tr>
<td>Verwarming</td>
<td>Type opwikking</td>
</tr>
<tr>
<td>Tapwater</td>
<td>Type tapwater</td>
</tr>
<tr>
<td>Ventilatiesysteem</td>
<td>systeem</td>
</tr>
<tr>
<td>Energielevering</td>
<td>gas / elektra / extern</td>
</tr>
</tbody>
</table>

Characteristics after renovation [Haytik, et al. 2015]

Calculations conform ISO 82.1 & Details renovation before and after [Haytik, et al. 2015]
CASE STUDY 5: RENOVATION BEETHOVENLAAN, DOETINCHEM

Calculations conform ISO 82.1 & Details renovation before and after [Haytik, et al. 2015]

Characteristics after renovation [Haytik, et al. 2015]
Calculations conform ISSO 82.1 & Details renovation before and after [Haytik, et al. 2015]

<table>
<thead>
<tr>
<th>Characteristics after renovation [Haytik, et al. 2015]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermische schil</td>
</tr>
<tr>
<td>R&lt;sub&gt;c&lt;/sub&gt;-gevel</td>
</tr>
<tr>
<td>1,0 - 2,5</td>
</tr>
<tr>
<td>2,5 - 4,0</td>
</tr>
<tr>
<td>4,0 - 5,5</td>
</tr>
<tr>
<td>5,5 - 7,0</td>
</tr>
<tr>
<td>&gt;7,0</td>
</tr>
<tr>
<td>Kierdichting</td>
</tr>
<tr>
<td>aanwezig</td>
</tr>
<tr>
<td>niet aanwezig</td>
</tr>
<tr>
<td>Type glas</td>
</tr>
<tr>
<td>Isolerend effect</td>
</tr>
<tr>
<td>HR++</td>
</tr>
<tr>
<td>triple</td>
</tr>
<tr>
<td>PV-panelen</td>
</tr>
<tr>
<td>m&lt;sup&gt;2&lt;/sup&gt; PV-panelen / woning</td>
</tr>
<tr>
<td>10 - 15</td>
</tr>
<tr>
<td>15 - 20</td>
</tr>
<tr>
<td>20 - 30</td>
</tr>
<tr>
<td>30 - 40</td>
</tr>
<tr>
<td>&gt; 40</td>
</tr>
<tr>
<td>Verwarming</td>
</tr>
<tr>
<td>Type opwarming</td>
</tr>
<tr>
<td>CV</td>
</tr>
<tr>
<td>Hybride</td>
</tr>
<tr>
<td>WP-water</td>
</tr>
<tr>
<td>WP-lucht</td>
</tr>
<tr>
<td>Extern</td>
</tr>
<tr>
<td>Tapwater</td>
</tr>
<tr>
<td>Type tapwater</td>
</tr>
<tr>
<td>HR-107</td>
</tr>
<tr>
<td>WP</td>
</tr>
<tr>
<td>extern</td>
</tr>
<tr>
<td>douche-WTW</td>
</tr>
<tr>
<td>zonnaboiler</td>
</tr>
<tr>
<td>Ventilatiesysteem</td>
</tr>
<tr>
<td>systeem</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>C+ (sturing)</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>D+ (sturing)</td>
</tr>
<tr>
<td>(sturing/zone)</td>
</tr>
<tr>
<td>Energielevering</td>
</tr>
<tr>
<td>gas / elektra / extern</td>
</tr>
<tr>
<td>gas / elektra</td>
</tr>
<tr>
<td>extern</td>
</tr>
<tr>
<td>all-electric</td>
</tr>
</tbody>
</table>
E. EPC Calculation – Uniec2.2 [Calculated on 12-06-2016]

Algemene gegevens

projectomschrijving
variant
straat / huisnummer / toevoeging
postcode / plaats
bouwjaar
categorie
aantal woningbouw-onderhoud in berekening
gebrauchsfunctie
datum
opmerkingen

Indeling gebouw

Eigenschappen rekenzones

Type rekenzone
omschrijving
interne warmtecapaciteit $A_g$ [m²]

Verwarmde zone
Airey woonblok 18 woningen
traditioneel, gemengd zwaar
451.00 m²

Infiltratie

meetwaarde voor infiltratie grondtype:

lengte van het gebouw
38,96 m

breedte van het gebouw
9,21 m

hoogte van het gebouw
9,21 m

Eigenschappen infiltratie

Rekenzone

Airey woonblok 18 woningen
meetlaags gebouw, geheel (standaard gevestigde type)
0,42

Open verbrandingsbeestellen

Het gebouw bevat geen verbrandingsbeestellen.

Bouwkundige transmissiegegevens

Transmissiegegevens rekenzone Airey woonblok 18 woningen

constructie
$A_g$ [m²]
$R_e$ [m²K/W]
$U$ [W/m²K]
Dr [h]
zonwering
beschaduwing
tunneling

Voorgevel O - buitenlucht, 0 - 450,9 m² - 90°

Gevel met Airey panelen
353,72
6,71

minimale belen.
<table>
<thead>
<tr>
<th>Constructie</th>
<th>$A$ [m²]</th>
<th>$R_e$ [m²K/W]</th>
<th>$U$ [W/(m²K)]</th>
<th>$g_r$ [kW/(m²K)]</th>
<th>Zonering</th>
<th>Bouwtekening</th>
<th>Omlaag</th>
<th>Voegwerk</th>
<th>Zonering</th>
<th>Bouwtekening</th>
<th>Omlaag</th>
<th>Voegwerk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kozijnen Reynaers ...</td>
<td>97,20</td>
<td>1,80</td>
<td>0,00</td>
<td>nee</td>
<td>minimale belen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Achtergevel W - buitenlucht, W - 459,9 m² - 90°</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gevel met Airy paneelen</td>
<td>32,12</td>
<td>5,71</td>
<td></td>
<td>nee</td>
<td>minimale belen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers ...</td>
<td>126,60</td>
<td>1,80</td>
<td>0,00</td>
<td>nee</td>
<td>minimale belen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zijgevel Z - sterk geventileerd, wand - 84,8 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gevel met Airy paneelen</td>
<td>63,22</td>
<td>5,71</td>
<td></td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers ...</td>
<td>24,50</td>
<td>1,80</td>
<td>0,00</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zijgevel N - sterk geventileerd, wand - 84,8 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gevel met Airy paneelen</td>
<td>77,82</td>
<td>5,71</td>
<td></td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers ...</td>
<td>7,20</td>
<td>1,80</td>
<td>0,00</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Begane grond vloer - sterk geventileerd, HOR, vloer - 459,9 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fermacell vloer</td>
<td>450,02</td>
<td>5,71</td>
<td></td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dak - sterk geventileerd, HOR, dak - 450,9 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geïsoleerd dak</td>
<td>450,02</td>
<td>8,48</td>
<td></td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Balkongevel O - buitenlucht, Z - 293,8 m² - 30°</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gevel met CAREA paneelen</td>
<td>130,76</td>
<td>5,71</td>
<td></td>
<td>minimale belen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balkon gevel paneelen</td>
<td>7,00</td>
<td>3,05</td>
<td></td>
<td>minimale belen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meta glas M-view bad...</td>
<td>126,00</td>
<td>1,50</td>
<td>0,50</td>
<td>nee</td>
<td>minimale belen.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lineaire transmissiegereedschappen rekenzone Airy wooneenheid woningen</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructie</td>
<td>$T$ [m]</td>
<td>$G_{Re}$ [m²K/W]</td>
<td>Omschrijving</td>
<td>$R_e$</td>
<td>Applicatie</td>
<td>$T$</td>
<td>$G_{Re}$</td>
<td>Omschrijving</td>
<td>$R_e$</td>
<td>Applicatie</td>
<td>$T$</td>
<td>$G_{Re}$</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>--------------</td>
<td>--------------</td>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td>--------------</td>
<td>--------------</td>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td>--------------</td>
</tr>
<tr>
<td>Voorgevel O - buitenlucht, O - 459,9 m² - 90°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers</td>
<td>30,446</td>
<td>0,046</td>
<td>Reynaers bouwdetail...</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Achtergevel W - buitenlucht, W - 459,9 m² - 90°</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers</td>
<td>30,446</td>
<td>0,046</td>
<td>Reynaers bouwdetail...</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zijgevel Z - sterk geventileerd, wand - 84,8 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers</td>
<td>0,046</td>
<td>0,46</td>
<td>Reynaers bouwdetail...</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zijgevel N - sterk geventileerd, wand - 84,8 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kozijnen Reynaers</td>
<td>33,00</td>
<td>0,046</td>
<td>Reynaers bouwdetail...</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Begane grond vloer - sterk geventileerd, HOR, vloer - 459,9 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Begane grond vloer</td>
<td>118,00</td>
<td>0,032</td>
<td>R 301.8.0.01</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundering</td>
<td>118,00</td>
<td>0,338</td>
<td>R 101.7.3.01</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dak - sterk geventileerd, HOR, dak - 450,9 m²</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dak</td>
<td>118,00</td>
<td>0,038</td>
<td>R 401.7.3.01</td>
<td>nee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Verwarmingsystemen

verwarming

Opwekking

<table>
<thead>
<tr>
<th>type opwekker</th>
<th>warmtepomp</th>
</tr>
</thead>
<tbody>
<tr>
<td>bron warmtepomp</td>
<td>bodem</td>
</tr>
<tr>
<td>ontwerp aanwarmtemperatuur</td>
<td>65°C ≤ 30°C</td>
</tr>
<tr>
<td>toestel - warmtepomp</td>
<td>Alpha-InoTec (Netherlands) SW, 170 HK</td>
</tr>
<tr>
<td>vermogen warmtepomp</td>
<td>16,85 kW</td>
</tr>
<tr>
<td>β-factor warmtepomp</td>
<td>0,46</td>
</tr>
<tr>
<td>aantal warmtepompen</td>
<td>1</td>
</tr>
<tr>
<td>type bijverwarming</td>
<td>elektrisch eelten</td>
</tr>
<tr>
<td>bijstroomtoestel geïntegreerd</td>
<td>ja</td>
</tr>
<tr>
<td>transmission en intensiteit verwarmingsysteem - januari (H-H)</td>
<td>596 W/K</td>
</tr>
<tr>
<td>warmtebalans verwarmingsysteem (Qint)</td>
<td>16,49 MJ</td>
</tr>
<tr>
<td>hoeveelheid energie (H-K)</td>
<td>166,4 MJ</td>
</tr>
<tr>
<td>opwikkelsnedenment - warmtepomp (ηgen)</td>
<td>1,000</td>
</tr>
<tr>
<td>opwikkelsnedenment - bijverwarming (ηnegen)</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Regeneratie

- zone-energiesysteem voor regeneratie
- ja

Zone-energiesysteem voor regeneratie - eigenschappen

<table>
<thead>
<tr>
<th>orientatie</th>
<th>helling [°]</th>
<th>beschaduwing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>45</td>
<td>300</td>
</tr>
</tbody>
</table>

Kenmerken afgiftesysteem verwarming

<table>
<thead>
<tr>
<th>Type warmteafgifte (in woonkamer)</th>
<th>positie</th>
<th>hoogte [m]</th>
<th>FC</th>
<th>θeising</th>
<th>ηeen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speedhaat vloeiverwarming, FRF A1 L1 R2 130V, 120W</td>
<td>n.v.t.</td>
<td>&lt; 8 m</td>
<td>n.v.t.</td>
<td>n.v.t.</td>
<td>1,00</td>
</tr>
</tbody>
</table>

regeling warmteafgifte aanwezig | ja
afgifteraadmet (ηnegen) | 1,000

Kenmerken distributiesysteem verwarming

| buffervat buiten verwarmingsruimte aanwezig | nee |
| verwarmingsleidingen voor verwarmde ruimten en/of kruiwanden | nne |
| distributiesnedenment (ηap) | 1,000

Hulpenergie verwarming

| hoofdcirculatiepomp aanwezig | ja |
| hoofdcirculatiepomp voorzien van pompregeling | ja |
| aanvullende circulatiepomp aanwezig | nne |

Aangesloten rekenzones

| Airey woonblok 18 woningen |
Warmtapwatersystemen

wamtpwater

Opwekking

type opwekker (CW-klasse) 4 (GW4)
toestel Duurzame Techniek - Jenatec SW 200 en LBW 300 LW
aantal toestellen 18
hoeveelheid energie t.b.v. warmtapwater per toestel (Qmax [kW]) 709 [kW]
opwekingsrendement warmtapwater - WDP (η WDP [kW]) 1,600

Kenmerken tapwatersysteem

aantal woningbouw- en hobbyheden aangesloten op systeem 1
warmtapwatersysteem ten behoeve van keuken en douches
gemiddelde leidinglengte naar badruimte 2-4 m
gemiddelde leidinglengte naar aanrecht 2-4 m
inwendige diameter leiding naar aanrecht 0,53 mm
afgifterendement warmtapwater (q [l/min])

Douchewarmwateropwinning

douchewarmwateropwinning ja

type douchewarmwaterboiler
aangesloten op aangesloten op kustdeel douchemangeraan en inlaat toestel

Zonneboiler

zonneboiler ja
zonneboiler(combi) ten behoeve van: warmtapwater en verwarming
coal怎样
warmtepompwater: in verwarmde ruimtes
type ravelwater: geleed
(collectortype: vlakke plaats of kunststof)
collectortype ja
aldekking collectortype geen PVT systeem
spetraal selectief ja
PVT systeem nee
zonneboiler thermoson of IG nee

Zonneboiler eigenschappen

orientatie heling (°) A sol [m²] V SP [dm³] V BS [cm³] P tot (W) beschaduwing
Z 45 45,00 100 0 0 minimale beperking

verwarmingssysteem aangesloten op zonneboilercombi verwarming
Ventilatie

ventilatie
ventilatiesysteem
systeemvariant
luchtvolumestroomfactor voor warmte- en koudebehoefte ($f_{ve}$)
correctiefactor regelingsysteem voor warmte- en koudebehoefte ($f_{bc}$)

Kenmerken ventilatiesysteem
werkelijk geïnstalleerde ventilatiecapaciteit bekend
warmtepompboiler(s) in gebouw
warmtapwatersysteem met warmtepompboiler(s)
luchtdichtheidsklasse ventilatiekanalen

Passieve koeling
max. benutting geïnst. ventilatiecapaciteit voor koudebehoefte
max. benutting geïnst. spu Capaciteit voor koudebehoefte

Kenmerken ventilatoren

totaal nominale vermogen ($P_{nom}$) centrale ventilatie-units
reductiefactor luchtvolumestroomregeling centrale ventilatie

totaal effectief vermogen ($P_{ef}$) van alle ventilatie-units

Aangezette rekkenzones

Aircy woonblok 19 woningen

Zonnestroom

Zonnestroom

PVT systeem
type zonnestroompaneel

Zonnestroom eigenschappen

ventilatie

<table>
<thead>
<tr>
<th>beschaduwing</th>
<th>helling [°]</th>
<th>orijntatie</th>
<th>Aev. [m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>minimale belemmering</td>
<td>45</td>
<td>Z</td>
<td>364.02</td>
</tr>
</tbody>
</table>
Resultaten

<table>
<thead>
<tr>
<th>Jaarlijkse hoeveelheid primaire energie voor de energiefunctie</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>verwarming (excl. hulpenergie)</td>
<td>E_EP</td>
<td>06.333 MJ</td>
</tr>
<tr>
<td>hulpenergie</td>
<td></td>
<td>2.908 MJ</td>
</tr>
<tr>
<td>warmtepwater (excl. hulpenergie)</td>
<td>E_EP</td>
<td>8.535 MJ</td>
</tr>
<tr>
<td>hulpenergie</td>
<td></td>
<td>2.500 MJ</td>
</tr>
<tr>
<td>koeling (excl. hulpenergie)</td>
<td>E_ECP</td>
<td>0 MJ</td>
</tr>
<tr>
<td>hulpenergie</td>
<td></td>
<td>0 MJ</td>
</tr>
<tr>
<td>zomeroosters</td>
<td>E_ECP</td>
<td>10.088 MJ</td>
</tr>
<tr>
<td>ventilatoren</td>
<td>E_ECP</td>
<td>2.939 MJ</td>
</tr>
<tr>
<td>verlichting</td>
<td>E_ECP</td>
<td>20.702 MJ</td>
</tr>
<tr>
<td>geïncludeerde elektriciteit</td>
<td>E_EPgesl</td>
<td>02.858 MJ</td>
</tr>
<tr>
<td>op eigen perceel opgewekte &amp; verbruikte elektriciteit</td>
<td>E_Percesl</td>
<td>259.855 MJ</td>
</tr>
<tr>
<td>in het gebied opgewekte elektriciteit</td>
<td>E_Percesl</td>
<td>0 MJ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oppervlakken</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>totale gebruiksoppervlakte</td>
<td></td>
<td>451.00 m²</td>
</tr>
<tr>
<td>totale verliesoppervlakte</td>
<td></td>
<td>2.287.00 m²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elektriciteitsgebruik</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>gebouwgebonden installaties</td>
<td></td>
<td>15.532 kWh</td>
</tr>
<tr>
<td>niet-gebouwgebonden apparatuur (stelpost)</td>
<td></td>
<td>12.942 kWh</td>
</tr>
<tr>
<td>op eigen perceel opgewekte &amp; verbruikte elektriciteit</td>
<td></td>
<td>23.124 kWh</td>
</tr>
<tr>
<td>geïncludeerde elektriciteit</td>
<td></td>
<td>12.909 kWh</td>
</tr>
<tr>
<td>TOTAAL</td>
<td></td>
<td>-12.909 kWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO2-emissie</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2-afgifte</td>
<td>t</td>
<td>-14.410 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energieprestatie</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>specifieke energieprestatie</td>
<td>EP</td>
<td>-404 MJ/m²</td>
</tr>
<tr>
<td>karakteristiek energieverbruik</td>
<td>E_E</td>
<td>-209.169 MJ</td>
</tr>
<tr>
<td>installatie karakteristiek energieverbruik</td>
<td>E_P</td>
<td>150.955 MJ</td>
</tr>
<tr>
<td>energieprestatiecoëfficiënt</td>
<td>EPC</td>
<td>-0.500</td>
</tr>
<tr>
<td>energieprestatiecoëfficiënt</td>
<td>EPC</td>
<td>-0.500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DENG indicatoren</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>energiebehoefte</td>
<td></td>
<td>103.7 kWh/m²</td>
</tr>
<tr>
<td>primair energiebehoefte</td>
<td></td>
<td>81.8 kWh/m²</td>
</tr>
<tr>
<td>aandeel hernieuwbare energie</td>
<td></td>
<td>155 %</td>
</tr>
</tbody>
</table>

Het gebouw voldoet aan de eisen inzake energieprestatie uit het Bouwbesluit 2012.

Unieo 2.2 is gebaseerd op NEN7120,2011 “Energieprestatie van gebouwen” (indien het Nader Voorschrift) en NEN 3088-1 “Ventilatie en luchtstofluchtheid van gebouwen” inclusief alle wetgeving van kracht zijnde verordeningen.

Alle bovenstaande energiegebruiken zijn genormeerde energiegebruiken gebaseerd op een standaard klimaatjaar en een standaard gebruikersgebruik. Het werkelijke energieverbruik zal afwijken van het genormeerde energieverbruik. Aan de berekende energiegebruiken kunnen geen rechten ontleend worden.
Verklaringen

GELOOFWAARDIGHEIDVERKLARING

OPWEKKINGSRENDEMENT VERWARMING
t.b.v. de NEN 7120:2011 voor de Alpha InfiniC
warmtepompen, type SWC 120HK en SWC 150HK

In opdracht van Alpha InfiniTeC
heeft TNO voor de functie
ruimteverwarming het
opwekkingsrendement bepaald
van de warmtepompen type
SWC 120HK en SWC 170HK
voor gebruik in de NEN 7120:2011.
De hier gegeven waarden mogen
worden gebruikt in plaats van de
waarden die in paragraaf
14.6.4.3.1, tabel 14.15 worden
gewezen.
Op de volgende pagina is het
opwekkingsrendement van de
warmtepompen weergegeven met
gegrondwater en de bodem als
warmtepomp.

FABRIKANT:
Alpha InfiniTeC GmbH

LEVERANCER:
Nathan Import/Export B.V.

TYPE:
SWC 120HK en SWC 150HK

Ondertekend door:
Ing. H. Schrijnwater
Projectleider

Geadviseerd door:
Dr. A.M. van Rikst
de Rekenmanagers

TNO
innovation
for life

Alle rechten voorbehouden.
Geen enkel deel mag worden vrijgegeven of in kaart gebracht op iedere wijze, enkel als volgt:
reproductie, verwerking, verspreiding en deeltijds in elke vorm of op elk medium, of voorbehouden.
Deze speciale klus is onderzocht en is voldoende voor de toepassing van TNO.
Deze verklaring bestaat niet voor de klus die afgedrukt wordt en wordt alleen op de stippen van naderhand.
Deze verklaring is niet voor direct gebruik en deeltijds in elke vorm of op elk medium, of voorbehouden.
Deze speciale klus is onderzocht en is voldoende voor de toepassing van TNO.

© TNO 2016
**GEENWAARDIGHEIDSCALIBRERING**

### OPWEKKBEGRENZING $\eta_{SWC} \text{ en } SWC_{170HK}$

<table>
<thead>
<tr>
<th>Opwarmingsmethode</th>
<th>$\eta_{SWC}$</th>
<th>$\eta_{SWC_{170HK}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuele of collectieve elektrische warmtepomp, niet beheerst tot warmtelevering voor dieren, met als bruc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WMC 120HK</td>
<td>5,34 x $c_e$</td>
<td>5,33 x $c_e$</td>
</tr>
<tr>
<td>Bodem-</td>
<td>0,04 x $c_e$</td>
<td>0,03 x $c_e$</td>
</tr>
<tr>
<td>grondwater-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- buikdodendijk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WMC 170HK</td>
<td>5,83 x $c_e$</td>
<td>5,93 x $c_e$</td>
</tr>
<tr>
<td>Bodem-</td>
<td>0,06 x $c_e$</td>
<td>0,05 x $c_e$</td>
</tr>
<tr>
<td>grondwater-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- buikdodendijk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Waarbij:

- $c_e$: verwerktvreurende temperatuur
- $c_{ef}$: exponent voor collectieve warmtepomp van bovengenoemde tering van een individuele bodemwarmtelevering, volgens bepaald in NEN 7520:2011. Indien dit niet van toepassing is: $c_{ef} = 1.0$.

Het resultaat van de vermenigvuldiging moet naar beneden worden bereikt met minimaal $80\%$ van $C_{0,5}$.

Zoals in de NEN 7520:2011 is aangegeven, is dit scenario voor situaties met een collectieve of opwekkingsmoeilijk te smeren van de warmtepomp in een situatie te benaderen voor de methodiek in paragraaf 4.5.3.2 worden gesteld.

<table>
<thead>
<tr>
<th>Verslaguitschakel</th>
<th>normaal, voor foto's en tekeningen</th>
<th>Druk</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SWC 120HK</td>
<td>10,05</td>
<td>10,54</td>
<td></td>
</tr>
<tr>
<td>SWC 170HK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alle normen en vereisten in deze tekst zijn van toepassing op NEN 7520:2011.

---

**TNO.NL**

**CONTACT**

Technische Diensten
Bouwcentrum
Laan van Westeren 5015
7314 DT Apeldoorn
Postbus 914
7300 AN Apeldoorn
Tel: 068 868 92 94
Fax: 068 868 92 46
E-mail: info@buowg@tno.nl

---

Uniec v2.2.6  Pagina 8/13  Printdatum: 12-0-2016 14:21
Gelijkwaardigheidsverklaring

Vooral gegeven verklaring geeft, op basis van door ons verricht lichtmeting en een aangepaste waarde van het afgelezen gemiddelde van de gemiddelde waarde van de tijdelijke temperatuur van de vloerverwarmingssystemen in tabel 14.1 van NEN 7120, ter vervanging van de inNEN7120 genoemde waarde voor vloerverwarmingssystemen in tabel 14.1 van NEN 7120.

De verklaring is van toepassing op de volgende elektrische vloerverwarmingsapparaten, waarin de in tabel 14.1 van NEN 7120 genoemde waarde voor vloerverwarmingssystemen in tabel 14.1 van NEN 7120, ter vervanging van de in NEN7120 genoemde waarde voor vloerverwarmingssystemen in tabel 14.1 van NEN 7120, voorzien is van een isolatielag van of gelijkwaardig aan 10 mm. De isolatieschaal, direct onderdeel van de vloeroverlaag, wordt toegepast.

<table>
<thead>
<tr>
<th>Leverancier</th>
<th>Speedheat Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FR 120 / 12 MP, 230 V, 120 W</td>
</tr>
</tbody>
</table>

Het Speedheat verwarmingselement bestaat uit een isolatieplaat die wordt genomen, waarop een dunne, gecorrugde, verwarmingskabel is aangebracht. De isolatieplaat is aan de bovenzijde afgesloten met een platen en voorzien van een vloerverwarmingssysteem. Het gehele gehele vermogen is 120 W/m². Tijdens het onderzoek was een 99% warmteafname waargenomen met een temperatuursensor aangesloten, ingen.

Door de plaatsing van de vloerverwarmingssysteem wordt een veel snellere en effectievere warmteoverdracht tot de installatie mogelijk gemaakt, ten behoeve van het energiebeheer en het onthaal van warmte. Dit effect wordt zeer benut bij aanwarming in de wintermaanden.

Het volkomen onderwerp van de aanverwante documenten is in ons rapport 8 1271-1-RA-002, d.d. 17 augustus 2015. De gelijkwaardigheidsverklaring is geldig tot 2 jaar na uitgifte.

Ing. H.M. Bruggeman

peutz bv, postbox 66, 5988 ZW, moe., +31 24 107 01 01, moed@peutz.nl, www.peutz.nl

Ken, 120092033, voorwaarden volgens DIN-EN-16762/1, kwaliteitscertif., ISO 9001:2008
Gelijkwaardigheidsverklaring

Opwekkingserendement warmtepomp boiler t.b.v. de NEN 5128:2004


Op de volgende pagina's is nagegaan het opwekkingserendement ook het primaire energiegebruik van de ventilatoren weergegeven.

Te ondertekenen:

Ing. H. Schuh
Projectleider

Ing. A.A.L. Traversari, MBA
Afdelingshoofd

Te gegevelen door:

Leverancier:
Bahn BV

Adres:
Am Geldern 10
5966BG EMDEN

Type:
Dimplex LBW 300 en LBW 500 LW
met warmtepomp voor oppervlakte energie

Onderzoeksrapport:
Rapport 3144/112
Bepaling van de Dimplex LBW 300 LW
warmtepomp voor gas warmte
Mei 2007

In opdracht van:

Te onder tekenen

Te gegeveelden door

Te ondertekenen

Te gegeveelden door

Te ondertekenen
Het verwarmingsteam heeft de volgende waarden opgedragen:

| Klass 4 | 1400 | 1,05 m³ | 821,4 m³/h |

**Waar:**
- $Q_{\text{woonruimte}}$: de bruikbare energiewaarde voor warmtepompverwarming voor woonruimte volgens 9.1.2.
- $Q_{\text{openlucht}}$: de productieve energiewaarde voor openlucht volgens 9.1.4.
- $Q_{\text{woonruimte + openlucht}}$: de totale energiewaarde van de woonruimte en openlucht volgens 9.1.5.

Deze bepaalde waarden moeten worden geanalyseerd en op een overeenkomstige manier bij warmtepomp en ventilatiesysteem worden toegepast. De verwarmingseffectiviteit moet op een laag niveau worden gehouden om de energieproductie te optimaliseren.
VERKLARING

ten aanzien van de geldigheid van gelijkwaardigheidsverklaringen en verklaringen &
norm voor energieprestatie van warmtepompen voor de energieprestatienorm CEN

Door TNO zijn voor verschillende warmtepompen verklaringen gegeven voor de waardeing van de
energieprestatie voor de energieprestatienorm NEN 5128. Het betreft twee typen verklaring:
- Gelijkwaardigheidverklaringen voor het opwektings-
  rendement voor verwarming
- Verklaringen conform norm voor het opwektings-
  rendement voor warmwater

Alle kiezen door TNO algegen verklaringen met een
geldigheid tot 1 januari 2011 of later zijn tevens geldig voor
toepassing in NEN 7120. De bepalingenmethoden van deze
opwektingsrendementen zijn in NEN 7120 namelijk gelijk
aan de methoden in NEN 5128.

Hiertoe moet worden aangetekend dat in NEN 7120 de
opwektingsrendementen anders versteld worden dan in
NEN 5128. In NEN 7128 wordt het opwektingsrendement
op primaire energie gegeven, terwijl in NEN 7120 het op-
wektingsrendement ten opzichte van de toegestel-
gedrag wordt gegeven. De verrekering naar primaire
energie gebeurt in hoofdstuk 8 van NEN 7120. Alle gege-
hien van moeten voor het opwektingsrendement
72:02 uitsluitend de getallen en eventuele getallen
arbechen maar niet het rendement voor de
verklaring worden gebruikt.

[Tabellen en formules]

CONTACT
Technical Sales
department
Laan van Westerhem 901
7384 DT Apeldoorn
Postbus 262
7300 AH Apeldoorn

T 088 866 22 19
F 088 866 22 48
E hans.vanwolteren@tno.nl

8 september 2011
**Verklaring**

**regarding the efficiency of a shower head recovery unit**

**VERKLARING VAN KIWA**

Deze verklaring is gebaseerd op een éénmalige besturing door Kiwa van een product, zoals op deze verklaring vermeld, van

**Itho Daalderop BV**

Hiermee geeft deze verklaring geen commerciële aanbeveling door de leverancier te leveren producten.

Het product is beoordeeld conform verordening EN NEN 7120/2011/C2:2011

**PRODUCT NAME**

Itho Daalderop dubbelware badkamer, WTW, DWTW-P-DDS

<table>
<thead>
<tr>
<th>Klasse</th>
<th>Debiet (liter/min)</th>
<th>Volumen (l)</th>
<th>Rendement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>9,2</td>
<td>100</td>
<td>57,6</td>
</tr>
<tr>
<td>4,5,6</td>
<td>12,5</td>
<td>100</td>
<td>56,0</td>
</tr>
</tbody>
</table>

Itho Daalderop dubbelware badkamer, WTW, DWTW-P-DDS-SD

<table>
<thead>
<tr>
<th>Klasse</th>
<th>Luchtvolume (m³)</th>
<th>Volume (l)</th>
<th>Rendement (%)</th>
<th>Druk verschil (ΔP) (bar)</th>
</tr>
</thead>
</table>
| 4,5,6  | 12,5             | 100        | 56,2          | 0,11

Leverancier:

Itho Daalderop BV  
Adm. de Reyistraat 1  
3111 VB Schiedam  
Nederland  
+31(0)47-5800  
info@ithodaalderop.nl  
www.ithodaalderop.nl

Kiwa Nederland  
Witserbroekstraat 10  
Postbus 43  
5600 AE Apeldoorn  
Tel: 053 454 30 50  
Fax: 053 454 30 67  
E-mail: info@kiwa.nl  
www.kiwa.nl