

**Renovate or new estate?**  
The challenge towards a sustainable future

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## TABLE OF CONTENTS

<b>PREFACE:</b>	<b>9</b>
<b>SUMMARY:</b>	<b>11</b>
<b>CHAPTER 1: INTRODUCTION</b>	<b>13</b>
1.1 Problem definition:	14
1.2 Research question:	14
1.3 Sub question:	14
1.4 Area of the research:	14
1.5 Research relevance:	15
1.6 Expected result:	15
1.7 Research boundary:	15
1.8 How this thesis is organized	16
<b>CHAPTER 2: RESEARCH DESIGN</b>	<b>17</b>
2.1 Research Methodology:	18
2.2 System Dynamics:	18
2.3 Validation of the model:	18
<b>CHAPTER 3: CONTEXTUAL ORIENTATION</b>	<b>19</b>
3.1 Why the early post-war neighbourhood?	19
3.1.1 <i>Neighbourhood characteristics:</i>	20
3.1.2 <i>Conclusion:</i>	21
3.2 Social developments:	22
3.2.1 <i>Population</i>	22
3.2.2 <i>Inhabitants:</i>	23
3.2.3 <i>Society:</i>	24
3.2.4 <i>Household composition:</i>	25
3.2.5 <i>Urbanization:</i>	26
3.2.6 <i>Floor space:</i>	28
3.2.7 <i>Conclusion:</i>	29
3.3 Technical:	30
3.3.1 <i>Body of the building</i>	31
3.3.2 <i>Windows</i>	31
3.3.3 <i>Thermal insulation:</i>	32

3.3.4 Rc-value	33
3.3.5 EPC	34
3.3.6 Dampness and condensation:	35
3.3.7 Heating/ hot water supply:	36
3.3.8 Ventilation	36
3.3.9 Electrical installation	37
3.3.10 Number of rooms:	37
3.3.11 Conclusions:	38
3.4 Legislation and regulations:	39
3.4.1 Energy label	39
3.4.2 WWS (WoningWaarderingsStelsel)	40
3.4.3 National support (90 percent rule):	41
3.4.4 Dutch building decree	42
3.4.5 Conclusions:	43
<b>4 MODEL DESCRIPTION:</b>	<b>45</b>
4.1 Social development:	46
4.2 Energetic/ technical quality:	49
4.3 Construction/ renovation time	50
4.4 Finance	51
<b>5 CASE STUDY:</b>	<b>52</b>
5.1 Neighbourhood description:	52
5.2 Supply existing housing stock:	54
5.3 Starting points/ demand in 2040:	56
5.3.1 Social:	56
5.3.2 Technical (building level):	56
5.3.3 Legislation and regulation:	57
5.3.4 Finance:	57
5.3.5 Overview:	58
5.4 Simulations:	59
5.5 Results of simulations:	61
5.5.1 Social development:	61
5.5.2 Financial:	65
<b>6 CONCLUSION:</b>	<b>69</b>

6.1 Answer main research question:	69
6.1.1 <i>The importance of lifestyle</i>	70
6.1.2 <i>Social development</i>	70
6.1.3 <i>Financial</i>	71
6.2 Conclusions sustainable development	71
6.2.1 <i>Dutch building decree</i>	71
6.2.2 <i>Energy label</i>	72
6.2.3 <i>New WWS</i>	72
6.2.4 <i>National support (90 percent rule):</i>	73
<b>7 DISCUSSION</b>	<b>75</b>
7.1 Renovation	75
7.2 Housing stock	75
<b>8 RECOMMENDATIONS AND FURTHER RESEARCH:</b>	<b>77</b>
8.1 Recommendations:	77
8.1.1 <i>Housing corporation De Alliantie:</i>	77
8.1.2 <i>Organization</i>	77
8.2 Further research:	78
<b>REFERENCES</b>	<b>79</b>
<b>APPENDIX 1: WWS SCORING SYSTEM</b>	<b>87</b>
<b>APPENDIX 2: REFERENCE DWELLING (WWS SCORING)</b>	<b>89</b>
<b>APPENDIX 3: ENERGY LABEL UPGRADE</b>	<b>91</b>
<b>APPENDIX 4: DEMAND STABILIZATION</b>	<b>93</b>
<b>APPENDIX 5: CONSTRUCTION/ RENOVATION TIME</b>	<b>95</b>
<b>APPENDIX 6: SUMMARY RENOVATE OR NEW ESTATE</b>	<b>97</b>



**“The great danger for most of us lies not in setting our aim too high and falling short, but in setting our aim too low, and achieving our mark.”**

- Michelangelo -



## **PREFACE:**

### **Mission accomplished!**

Many sleepless nights, hundreds cups of coffee and many eureka moments later this master piece is the end result of my master thesis. This thesis is been written as final closing for the master course CME, Construction Management & Engineering at the Eindhoven University of Technology.

Now by writing this preface, I realize that besides this report also my school career will 'finally' end. It was a long and sometimes hard road to come here, but it was it all worth!

The thesis probably did not have the quality like it have now without three persons, Wim, Erik, and Jurgen. Wim and Erik thank you for your support, motivation and having trust in me during this research. Jurgen, also thanks to you for your information and criticism which makes this research complete.

Thank you gentleman!

**Danny van der Weerd**  
Eindhoven, March 2011



## SUMMARY:

The early post-war neighbourhoods are mainly characterized today by a lot of technical and social problems. This is the result of the then used building systems, the poor construction materials and the today monthly rent. The majority of the dwellings located within those areas are owned by housing corporations. In line of this it will be the same housing corporations which are facing a real challenge. In order to solve the dwelling and neighbourhood related problems housing corporations have two options. Renovate or replacing the existing housing stock by new estate. This decision depends mainly on two aspects, financial and environmental. For the financial decision the feasibility study is mainly been used as decision support model. From the environmental perspective the environmental impact will be taken into account.

Based on those two aspects could be concluded that housing corporations mainly prefer renovation over new estate. It is 'cheaper' and the environmental impact is by renovation substantially lower in comparison to new estate (Jonge, 2005; Sunikka, 2006). But what housing corporations do not take into account is the changing lifestyle and the growing expectations of living. And it is especially these aspects which will be the decisive factor between renovate or new estate.

The importance of change in lifestyle and the growing expectations of living are often underestimated, and certainly the effect on the housing market. This research however will show this importance and the effect it will have towards this more sustainable future. Change in lifestyle and our expectations of living are dynamics processes, and are continuously changing, influenced by many different factors. One of those factors which influence, and has influenced our expectations of living is the dwelling. In comparison to 60 years ago could be concluded that the dwelling floor space demand is doubled and it is still developing. This will have an amazingly effect on as well renovation as well new estate.

Another aspect which is changing rapidly today is the importance of sustainable buildings, energy efficiency and energy saving. Sustainability is the buzzword of today. To stimulate sustainable development the national government has set up some (new) rules or guidelines to achieve this. The first major step towards a more sustainable future needs to be realized by the different housing corporations. They own almost one-third of the total housing stock in the Netherlands (Blijie et al., 2009). Beside the regular technical, social and financial aspects also the sustainability goals needs to be taken into account. This will make decision making only even harder! In order to make the best decision a DSM (Decision Support Model) is developed, based on the System Dynamics principal. In comparison to other (existing) DSM this model will combine all the different aspects and beside this it will also take the social developments, with regard to e.g. floor space development into account.

The combination of all those aspect led to the conclusion that in comparison what was stated first, new estate should be preferred over renovation! Renovation cannot meet the expectations of living, and the sustainable requirements of today in comparison to new estate. Consequence of this is that the renovated early post-war dwellings needs to be demolished over a couple of years anyway, because there will be no market for. In line of this replacing the early post-war dwelling today will lead to a more sustainable future because there will serve the market of today and in the future.



## CHAPTER 1: INTRODUCTION

Renovate or new estate is not an easy question to answer. But why is it so hard? Renovation has in general more advantages in comparison to new estate. Not only financially but also from an environment perspective. Buildings that can be reused do not have a negative effect on the environmental impact. They do not have to be demolished and the old building materials do not have to be decomposed. In line of this the materials do not have to be burned down or stored under soil. It is also preferred over new estate because it directly saves the use of raw materials and fossil fuels, which are needed for the production of new materials. Indirectly it will save the environment by saving energy and in line of this the discharge of carbon dioxide. Take into account that 81 percent of the total energy consumption is generated by fossil fuel (IEA) 2010. In the Netherlands this is almost 93 percent (Dekker et al., 2006). So in the extension of this renovation will reduce the environmental impact on many fields. Different researches concluded that extending the buildings lifetime is more sustainable in comparison to new estate (Jonge, 2005; Sunikka, 2006). According to the research of Klunder (2005) are the best strategies to reduce the environment impact, lower down the material use, material type and also lifetime extension. Not only from an environmental perspective is renovation advisable, it is also from a practical perspective. Prof. ing. Thomsen (Thomsen, 2002) has concluded that as a result of the 'low' production ratio, 1 percent per year (CBS, 2011a) the current lifetime of houses (50 years) will expand significant. A lifespan of 100 year will not be an exception anymore.

In the battle to make the Netherlands more sustainable the national government see housing corporations as the party which will play an important role in this process. Reason for the national government to focus on the housing corporations is because they have a market share of 33 percent (Blijie et al., 2009) New policies which are been implemented or will be implemented, will stimulate or force housing corporations to reduce energy consumption by upgrading their existing housing stock.

Beside this housing corporations are facing another, maybe more important challenge, which is the early post war housing stock. They are characterized by many technical and social problems. In order to solve this two options are possible, renovate or new estate. Take thereby all the changing legal regulations and policies into account, making the good decision will be far from easy.

So renovation looks like the best option from many points of view in order to create a more sustainable future. But there is one factor which is not mention yet but which will definitely have enormous influence, the market demand. Prof. ing. Thomsen (Thomsen, 2002) stated also that new estate should only be considered if renovation could not serve the demand from the market anymore. But when is a building not serving the demand anymore? In line with the rising lifespan meeting the demand of today but also in the future will be a real challenge. Therefore it is important to determine the demand in the future and the consequence this will have for the future. What if a building is renovated and after couple of years it should be demolished anyway because the market demand is changed. Was demolishing not the best option in the first place? **When is sustainable sustainable?**

### **1.1 Problem definition:**

Today housing corporations are facing a real challenge, which are the early post-war neighbourhoods. Beside the new policies, in order to a more sustainable future, housing corporations simultaneously are dealing with a different problem. These are the social and technical related problems of the early post-war dwellings. Taking as well the social, the technical and the political challenges into account it will be even harder to make the right decision, renovate or new estate. Not only now but it certainly will be in the future in order towards a more sustainable future.

### **1.2 Research question:**

In order to try to solve the stated problems the following main research question is been formulated and will be investigated.

*“What will be the most sustainable solution for the early post-war dwellings, owned by housing corporation ‘De Alliantie’, renovate or new estate?”*

### **1.3 Sub question:**

The main research question consists of multiple sub questions which are:

- Is there a relation between, society, technical quality and the early post-war neighbourhood?
- What will be the demand for living up to 2040?
- Which policies will influence as well the social as well the technical aspects?
- What is the technical/ energetic quality of the early post-war buildings today?

### **1.4 Area of the research:**

This research will cover the following research fields, sociology, construction technology, public science and financial management. Those aspects are not been chosen without a reason. Large scale (re-) development projects will always contain different fields of interest and different parties. The majority of those fields can be categorized into three different fields which are, social, technical and political. The aim is this research is to investigate the relation and the influence of the social-, technical-, and political developments in relation to the financial position of a housing corporation. Those aspects will be the backbone for this research in order to determine the influence of those aspects towards the demand until 2040.

### **1.5 Research relevance:**

In line with the mission, to built a more sustainable future, and the existing housing stock which become older and older over time. The importance of a good DSM (Decision Support Model) for this more sustainable future will only grow.

New estate is almost meeting the requirements towards a more sustainable future, but the existing buildings do not. In fact the stricter the rules become for new estate, the further the existing housing stock will be from this sustainable mission. Taking hereby the 'low' production rate of new estate into account, only 1 percent of the existing housing stock, it will take decades to become more sustainable. The solution for this challenge could be found by the existing housing stock, in the sense of renovation.

But it is not only the sustainability mission which should be taken into account, but also some social developments. They have changed over time and they are still changing, and it probably will never stop changing. Beside that it changes the social aspects it will also change e.g. our expectations of living.

The change in as well in the sustainability mission, compared to today, as well in social developments making this research very relevant toward a more sustainable future. This research will focus on the early post-war neighbourhoods. But in line with the developments of the earlier mentioned aspects and the importance of it, it also will be relevant for other building periods.

### **1.6 Expected result:**

By using and integrating as well the social developments, the technical quality, policy changing's, and the financial aspects, a Decision Support Model (DSM) will be result of this research. This decision support model will be a Systems Dynamics based model, which means that it will simulate processes and decision over time. The aim of this model is to simplify the decision for choosing for renovation or for new estate by taking the social, technical, political and financial aspects into account.

This System Dynamics model will not only combine the different aspects it will also be possible to make a decision which is only based on one of those aspect.

### **1.7 Research boundary:**

This research needs to be executed within a very strict time frame and as a result of this it is not possible to discuss all the elements, which are important to make a well balanced decision for renovation or new estate. As consequence of the availability of the needed, and used, information this research has a time frame of just 30 years, until 2040.

The focus of this research is the early post-war dwellings located within the neighbourhood called Sloterveer Noord Oost, Amsterdam. The dwellings within this area are owned by different housing corporations but only those dwellings which are be owned by housing corporation *De Alliantie* Amsterdam will be taken into account.

For the technical developments only traditional processes and production times will been used.

## **1.8 How this thesis is organized**

After the introduction chapter, which is chapter 1, both the research design and the methodology are been described in chapter 2. Chapter 3 is the contextual orientation. Within this chapter the theoretical background will be described with regard to the social, technical and political changing's. The purpose of chapter 4 is the design of the System Dynamics based Decision Support Model (DSM).

After the model is been designed it is been applied on a case study, which is been described in chapter 5. Based on the available information and in collaboration with housing corporation *De Alliantie* different simulations are been determined and simulated. The results and findings are also showed and described within this chapter.

The conclusions of the report are been described in chapter 6. In chapter 7 the report, the Systems Dynamics model, the case study and the conclusions will be discussed. And finally chapter 8, central in this chapter are the recommendations and some further research points.

## CHAPTER 2: RESEARCH DESIGN

This research will be executed according to the following research model (figure 1) and will consist of four main parts. The aim of this research design is to be a sort guideline during this research. The research consists of four main parts, which are represented in figure 1 by columns. Each colour has its own goal. A short description will be given about the research design.

The contextual orientation, part **one**, is been used to clarify the social, technical and the political developments until 2040. A desk research has been done to underpin the statements until 2040, the importance of it and the relation between the different statements and aspects.

In collaboration with housing corporation *De Alliantie* a neighbourhood in Amsterdam is chosen to inventory the existing housing stock, which will be the supply. This is realized within part **two**, the practical orientation. Not only the practical information is been inventoried also the demand up to 2040 will be determined. To ensure that if demand up to 2040 will be in line with the available information and can be simulated, the demand up to 2040 will be determined simultaneously with the practical orientation, part two.

Part **three** combines as well the demand in 2040 as well the supply of today. A system dynamics model will been used to simulate how *De Alliantie* could meet the demand in 2040 with the supply of today.

Should the buildings be renovated or should they be replaced by new estate?

The last part, part **four**, will describe and discuss the best option from different point of views e.g. social, technical, political and financial. Beside this some recommendations and future perspectives will been given of this research and her findings.

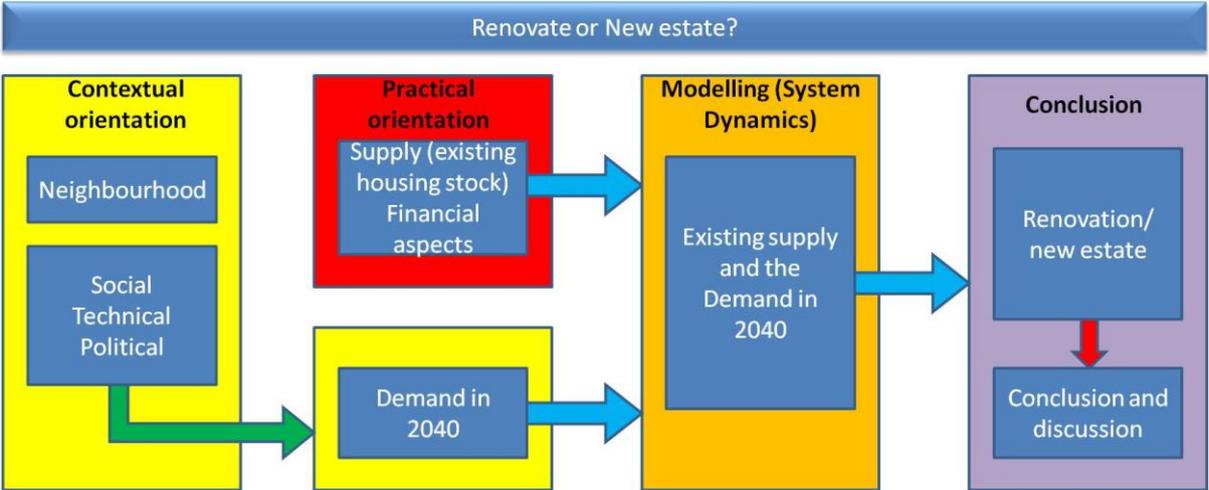


Figure 1; Research design

## 2.1 Research Methodology:

This paragraph will describe the System Dynamics research methodology and the relevance for this research. Making a well base decision for as well renovation as well new estate a simulation over time will be needed. The social, technical and the political aspects will be combined and simulated.

## 2.2 System Dynamics:

Decision making is always hard, especially making the right decision, but when it a decision the right decision? More important to know what the effect will be of this decision over a certain period of time. In order to make the right decision the effect of this decision needs to be simulated.

SD is a modelling method that allows a system (in this case supporting as well renovation as well new estate) to be represented as a feedback system (Thompson and Bank, 2010). The feedback structure of a system is described by using causal loops. Those could be balancing (capturing negative feedback) or reinforcing (capturing positive feedback) (Smith and Ackere, 2002). It is based on the original work of Forrester, who defined it as *“the investigation of the information-feedback character of industrial systems and the use of models for the design of improved organizational form and guiding policy”* (Forrester, 1961).

The System Dynamics method is already been applied on many fields e.g. political instability (Ellis, 2004), land reclamation in the mining industry (Elshorbagy et al., 2005), energy and power systems (Kadoya et al., 2005), aviation systems (Quan and Trani, 1997), solid waste forecasting (Dyson and Chang, 2005), and agenda setting and public policy making (Deegan, 2003). But beside this SD is also been used in a wide variety of applications, in the **social sciences** and in **engineering** (Thompson and Bank, 2010). The area of (civil) engineering that has most commonly used the SD method is construction project management, where it has been used, for example, to study performance enhancement of a construction organization (Ogunlana, Li, Sukhera, 2003), quality management (Lee, Pen~a-Mora, and Park, 2005), and the design-build process (Pen~a-Mora, and Li, 2001). Shen et al. (2005) developed a SD model to assess the sustainable performance of projects using a triple bottom line of: 1.) economic; 2.) social; and 3.) environmental performance. One of Forrester’s early works in the SD area modelled urban growth and decay (Forrester, 1969). After all System Dynamics is already applied in a wide variety of research fields which make it, in combination with the over time simulation, by far the best (DSM) decision support model to apply within this research.

## 2.3 Validation of the model:

The validation of the Decision Support Model, based on System Dynamics, differs in comparison with other Decision Support Models. SD simulates decision over time in this light the outcome is a result of the models simulation and her input. Unfortunately there was no ‘useful’ data available, which makes is not possible to validate the model by using historical and comparing this to what is happened during the years in the real world.

As a result of this only the input and the structure of the model can and will be validated with as well housing corporation *De Alliantie* as well the graduation committee and some System Dynamics experts from Eindhoven University of Technology.

## CHAPTER 3: CONTEXTUAL ORIENTATION

This paragraph will give a short introduction of the early post-war neighbourhood, and why especially this neighbour is chosen for this research. But the aim of this chapter is to get clear which aspects are important and relevant to take into account during this research. Within this paragraph the main starting points for the contextual orientation will be collected.

Further an overview of the characteristic of the early post-war neighbourhood will be described within this paragraph. What went good, what went bad over time, and how did those developments influenced the neighbourhood in the past?

Choosing for renovation or for new estate is not only a dwelling issue, it will be of great importance for the whole neighbourhood but also for the future of this neighbourhood.

### 3.1 Why the early post-war neighbourhood?

Focus of this research will be the early post-war neighbourhood, developed right after World War II (1945 - 1960). The need for housing was enormous, over 260.000 new houses needs to be built in the battle against the housing shortage (Blom et al., 2004) New building techniques and systems should speed up the construction process and lower down the construction costs. Beside the advantages it has also its backside. Quantity was preferred over quality, standardization and rehearsing became the buzzword of that time. This results in monotonously designs and standardized dwelling floor plans.

At the moment the early post-war neighbourhoods and her buildings are over 50 years old and the majority is still standing.

But are those neighbourhoods and her buildings still functioning and are they still meeting the expectations of living today and the future? And if they do not why are they still standing?

Housing corporations are well represented in those areas, the majority of those dwellings belongs to them. They have a market share in those areas between 50 and in some cases even 100 percent (Priemus, 2006). So they should be that party which could and should reduce the problems in those areas, but are the really?

By many people the early post-war neighbourhoods are better known as '*Reinforcing districts*' (Dutch *Vogelaarswijken*). They are dealing with a lot of technical, social and political problems. A couple of years ago the then minister of *Housing, Neighbourhood and Integration* (Dutch; *Wonen, Wijken en Integratie*) pointed out 40 areas which need to be upgraded, as well social as well technical. Remarkable is that majority of those '*reinforcing districts*' are early post-war neighbourhoods. This resulted in a high level of urgency for (re-)developing those areas.

The social problems are related to the type of dwellings and there maximum rent. Those are the result of the monotonous design. Also the technical problems are on their turn related to the poor construction systems. To solve those problems should the early post-war neighbourhood be renovated or replaced by new estate?

The neighbourhood plays a major role in the attractiveness and the overall quality of the neighbourhood. Especially for renovation it will be meaningful to know of the neighbourhood is still functioning today and of it will in the future.

Jansen and Lee (2009) showed already in their master thesis the importance of the neighbourhood (quality) in relation to the building value (WOZ-waarde). Also by the determination of the monthly rent the neighbourhood quality will be taken into account. A dilapidated neighbourhood can result in a maximum diminishing of 40 points on the WWS scoring system (VROM, 2010). This will be elaborated further in paragraph 3.4.2.

### **3.1.2 Neighbourhood characteristics:**

Most of the early post-war districts are designed according to the neighbourhood unit principle. This principle has its origin in the 19<sup>th</sup> century by urban planner/ social reformer Ebenezer Howard. He developed a new urban concept called 'Garden city'. This concept should encourage a cooperative society and discourage the more and more capitalistic society.

Characteristics for Howard's 'Garden City' are the widely spaced, the amount of green, and the presence of daily functions, facilities, work, and living which are all located within walking distance.

The American urban planner and pedagogue Clarence Arthur Perry adopted the vision from Howard and made this more specific (Blom et al., 2004). According to Perry a carefully planned neighbourhood should provide a safe and quiet environment in which the individual development could flourish. For realizing this, the following points need to be taken into account (Wassenberg, 2006):

- I) Safe traffic (Accessibility),
- II) Primary school,
- III) Daily amenities and its own community centre, and
- IV) An attractive environment with green spaces and play grounds (de Klerk, 1980; van der Cammen and de Klerk, 2003).

As a result of World War II, where mainly Rotterdam was heavily bombed, a rebuilding program needs to be set up. For the realization of this program a study group was formed and chaired by Bos, director of the Rotterdam Housing Department (Wassenberg, 2006). Their vision of the early post-war neighbourhood was published in a report called "De Stad der Toekomst, de Toekomst der Stad" (*The city of the future, the future of the city*), in 1946 (Bos, 1946). Starting point for the city of the future becomes the neighbourhood idea (Wassenberg, 2006). Chaotic urban growth and conglomerated rows of houses should belong to the past. Urban growth has to be ordered and structured in a better way. Elements like light, air and space got a lot of attention within this new neighbourhood (Turkington et al., 2004). In line with this high-rise buildings were allowed with a maximum height of four/ five stories high (Korthals Altes, 2005).

But it was not only this new urban structure which was different in comparison to the existing neighbourhoods, also the architectural plans got changed. In line with the more ordered and structured urban plan the architectural starting point became standardization, repetition, and functionality (Wassenberg, 2006).

All those starting points were translated by W.F. Geyl into a new and for Dutch standards revolutionary urban design, which was called 'de gelede stad' (Blom et al., 2004). This plan has not only influenced the rebuilding of the city of Rotterdam, it is also been used in many cities nationwide.

W.F. Geyl was by this new design aware of the fact that he and/or the government could not force people to live in these new neighbourhoods. Social processes are hard to steer, they will develop themselves along the years. But W.F. Geyl had the opinion that the urban designer could and should create elements and circumstances that could speed up the social process. These circumstances should be the catalyst to encourage a more sustainable, healthy and cooperative society.

W.F. Geyl created the material conditions for a healthy urban community life. An important element in this condition is the interpretation of the public space. It is not only valuable in the sense of money but it certainly is very valuable for the quality of life. In combination with the more open building blocks it increased the overall value of these neighbourhoods.

Still today those elements are characterizing the early post-war neighbourhoods. But are they still functioning?

### **3.2.2 Conclusion:**

In order to determine if renovation or new estate is advisable first some aspects need to be investigated. Is the neighbourhood still functioning like it did 50 years ago? To answer this question three aspects need to be investigated further those are, social, technical, and the political developments.

During the years those elements have had already an enormous influence on the existing neighbourhood. Is it still meeting our expectations of living of today and will it fit the expectations of living in the future?

## **3.2 Social developments:**

During the years a lot of social aspects are changed, especially over a longer period of time. We do not act like fifty years ago. Our family composition is changed, our social expectations are changed our perceptions of living are changed, in other words our social environment is completely changed.

When we look to e.g. our personal life with friends and families, it is changed dramatically. In the past we met each other on the street, in the local shop or at one of the many public spaces in the neighbourhood. Today we do almost not know who our neighbour is and we stay in contact with our friends buy telephone, e-mail or social network sites. It is clearly that our social environment is changed rapidly.

This chapter will focus on the most elementary elements which are on one hand related to the social developments. All the elements are described over time, the past, the present and the future. This information will be used in order to determine the social developments up to 2040 and their influence on the (existing) building environment.

### **3.2.1 Population**

This paragraph is of that importance because it shows how the population developed itself over the last decades and how it will develop itself the coming years.

The population in the Netherlands is, compared to 1940, almost doubled. Nowadays almost 16.6 million people lived in the Netherlands, in 1940 this was 8.8 million (CBS, 2011b).

According to prediction of the CBS, Central Statistical Office (Dutch; Centraal Bureau voor de Statistiek) the population in the Netherlands will increase to approximately 17.5 million in 2040 (CBS, 2011c). This is an increase of approximately 900.000 people, 5.4 percent, in thirty years

Remarkable within this population growth are the number of singles. They will rise from 2.6 million singles in 2010 to approximately 3.5 million by 2040. This is a massive increase of 32.4 percent or 900.000 people (CBS, 2011d). This means that from another perspective the number of singles will grow to approximately 20 percent, which is one-fifth, of the total population.

It does not take rocket science to understand that this growth will also have a major influence on the number of dwellings. More singles means also more dwellings, this will be elaborated in paragraph 3.2.4, household composition.

The following figure, figure 2, shows the population development compared to the number of singles from 1940 to 2040.

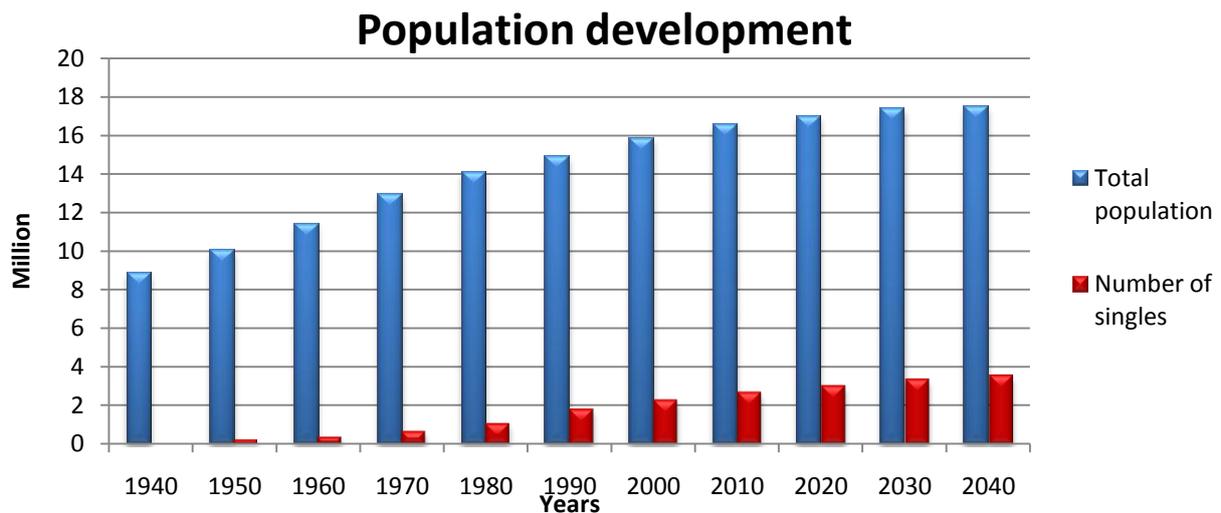


Figure 2; Total population and single growth, The Netherlands

### 3.2.2 Inhabitants:

Within a neighbourhood the number of dwellings and the average household composition says something about the number of inhabitants. The early post-war neighbourhoods were designed according to a fixed grid. According to this grid the maximum numbers of dwellings were determined, and as a result of this the number of inhabitants could be calculated (Blom, Jansen, Heide, 2004). And on the basis of number of inhabitants the number and the type of facilities were carefully planned.

The carefully balanced number of inhabitants and the facilities should have a positive effect on the society, in order to encourage a sustainable, healthy, and cooperative society. But by balancing those aspects the impact will be enormous if the number of inhabitants changes.

According to a research of Wassenberg (2004) the number of early post-war inhabitants is declined by 30 percent on average, between 1960 and 2002, see figure 3 (Wassenberg, 2006). This decrease could be explained by mainly one thing, the household composition which is changed during the years. This aspect will be described further in paragraph 3.2.4, household composition.

A decreasing number of inhabitants have a negative effect on the society, the local facilities and the local economy, the snowball effect. A declining number of inhabitants mean a declining number of customers, which result in less profit. Less profit finally will result in the closing of the local shops, which will affect the neighbourhood attractiveness and liveability.

Predictions made by the CBS (Central Statistical Office) have showed that the average household composition will decline further until 2040, see paragraph 3.2.4. This will again have an enormous influence on the carefully planned early post-war neighbourhood.

## Neighbourhood development

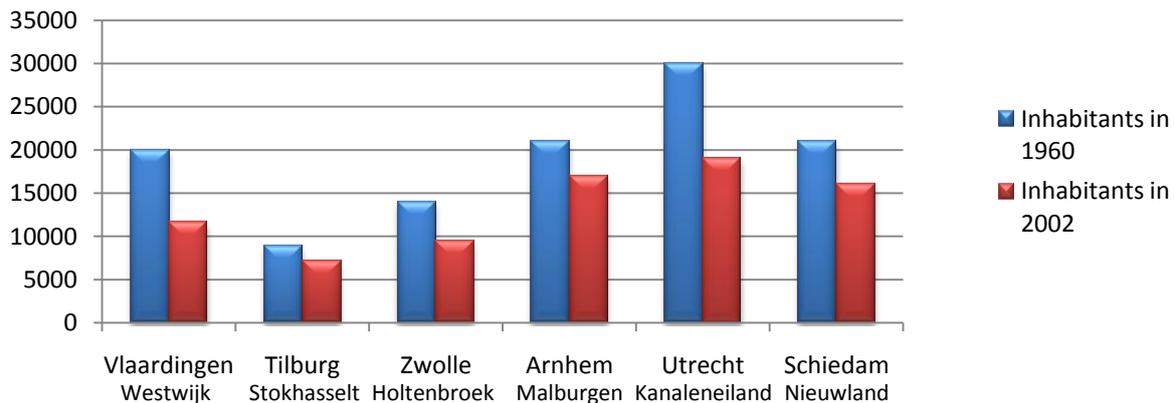


Figure 3; Neighbourhood development in the Netherlands, based on table 1 Wassenberg (2006)

### 3.2.3 Society:

Not only are the numbers of inhabitants changed over time, also their age, their social status (single, cohabiting or married) and their nationality. This last element has influenced the (existing) society and the inhabitants of the early post-war neighbourhoods the most, especially the last decades. For two reasons this will be described further. One, understanding what the influence was in the past, second what this will mean for the future.

In the past, as result of the typology of the early post-war neighbourhoods, it was almost only families that took place in these (new) areas. Just like the designers wanted to. Over time the family situation changed, children became adults and moved out, and choose for a bigger and or newer house. But also as a result of the economic growth and their career possibilities a lot of people moved. Elderly people also moved out, they went to a home for elderly, or they died.

For many decades autochthon Netherlands were in the majority in those areas, the last fifteen years this is changed rapidly. This could be devoted to the low rental price of the dwellings, mainly determined by the WWS (WoningWaarderingsStelsel), see paragraph 3.4.2. A lot of those houses got occupied by low educated people and immigrants (Nicis, 2008). The majority of those immigrants are from Turkey, Morocco and Surinam (Van Beckhoven & Van Kempen, 2005; Aalbers et al., 2005). Unfortunately with this growing number of immigrant also the numbers of drug-related problems (Nicis, 2008) vandalism and contamination rise (Heeger, 1993; Wassenberg, 1993; Power, 1997; Murie e.a., 2003; Skifter Andersen, 2003; Turkington et.al., 2004; Musterd & Van Kempen, 2005).

Different studies have showed that a growing number of immigrants have a negative effect on first, the image/ reputation of the neighbourhood. As a result the higher incomes are leaving (Knorr-Siedow & Droste, 2003) Second it has a negative effect on the overall quality of live within the neighbourhood (Dekker & Bolt, 2005; RIGO, 2004). In other words the ethnicity ratio (percentage of immigrant), within the early post-war neighbourhoods, is of great importance for a sustainable neighbourhood.

The social cohesion which Howard, Perry, and Bos saw as the backbone for a healthy society is hard to find nowadays in the early post-war neighbourhoods. Many studies have showed

that a good social cohesion would be an important element in the battle against a declining neighbourhood (Nicis, 2008). To realize this it is important that people can and will identify themselves with their neighbourhood. A good social mixture and having a good relationship with their neighbours will be of great importance (Van Bergeijk e.a., 2008).

In line with the trend of the last couple years, focusing more on lifestyle and less on quantity, it will be doubtful if the early post-war neighbourhoods do have a future anyway. In order to meet our lifestyle with regard to a sustainable society and neighbourhood the percentage of immigrants needs to be decreased dramatically!

Creating differentiation in the housing market will result in better social mixture. But could this be realized by renovation or only by placing new estate?

### 3.2.4 Household composition:

The household composition is changed, declined, over time. Change in lifestyle is probably the catalyst for this change. It is still changing and it certainly will in the future. In the search for a sustainable future, for renovation either new estate, the change in household composition is important to notice.

In the first place the number of persons per household is changed. In 1950 a household consist on average of 3.93 persons (CBS, 2011c). Gradually the average household composition decreased to 2.22 persons nowadays, see figure 4. In line with the growing number of singles also this average household composition will change. Predictions of the CBS, Central Statistical Office (Dutch: Centraal Bureau voor de Statistiek) show that the average household composition will decrease further to 2.09 persons by the year 2040 (CBS, 2005). In a timeframe of almost 100 years the average household composition is almost halved, from almost 4 in 1950 to 2 in 2040.

## Household composition

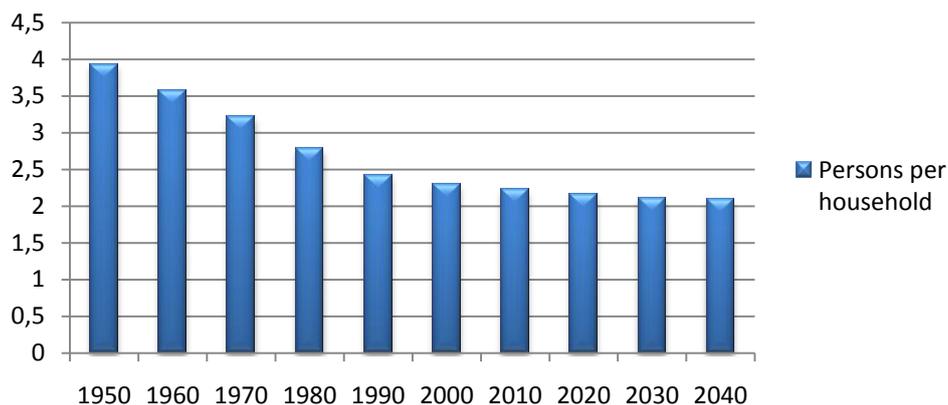


Figure 4; Household composition in the Netherlands

The growing importance of career and the decreasing average household will result in a growing number of single households, see figure 5. The sharp rise of the ageing population is the main cause of this growing number of single households (PBL, 2008). But also the factor like e.g. change in lifestyle is an important cause.

More and more people between the twenty and thirty prefer a job career over a ‘standard’ family life, the suburban bliss, marital bliss in the suburbs. In the future the need for single family dwellings like e.g. apartment will only increase.

Within this research the number of singles will not be divided by age groups.

## One person households

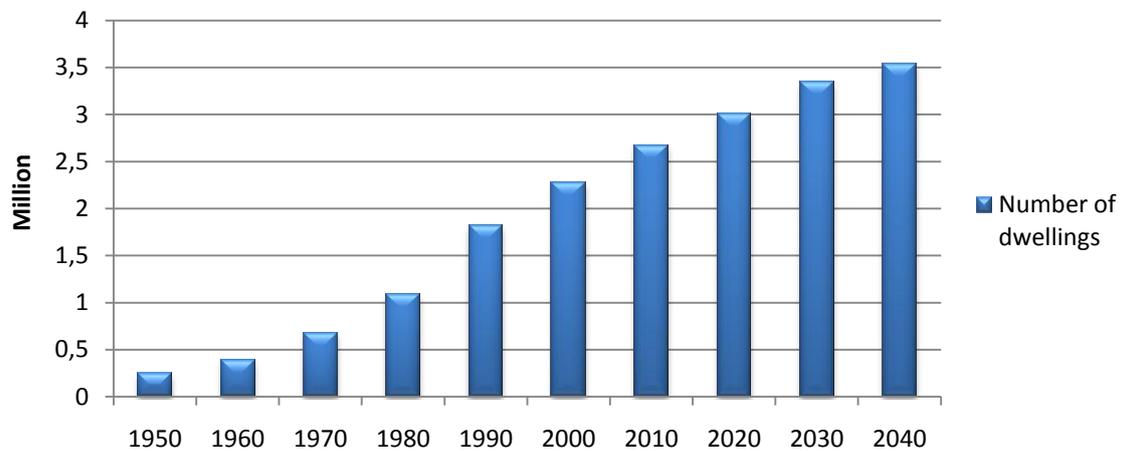


Figure 5; One person households in the Netherlands

### 3.2.5 Urbanization:

More and more people will move from the countryside toward the city/ urban areas, this is called the urbanization process. For the Netherlands this so called urbanization process is not really new. After World War II a lot of people moved from the country side towards urban areas, the agglomeration of Western Holland (Dutch; Randstad). They moved for two reasons one, to help rebuilding the Netherlands and make sure that they got a better life. Two a lot of people, which worked in the agriculture sector, became unemployed as consequence of the industrialization and searched for a new job in the city. This migration process resulted in a spectacular growth of the agglomeration of Western Holland, of more than 20 percent, namely from 4.3 million people in 1945 to 5.4 million in 1960, (Blom, Jansen, Heide, 2004). This of course had a large impact on the housing sector.

Between now and 2050 almost 70 percent of the world population will live in urban areas (Watson, 2009). According to predictions of the CBS the population will increase by 5.4 percent nationwide, see paragraph 3.2.1. But that is on average nationwide, for four provinces, Noord-Holland, Zuid-Holland, Utrecht, and Flevoland which encloses the agglomeration of Western Holland this will be different. Predictions shows that for the four provinces the population will grow with 8 to 24 percent, see figure 6 (StatLine, 2011). A more detailed prediction is given by figure 7, it shows the population growth by the largest cities which are been located within the provinces. For the Netherlands this means that again a lot of new inhabitants will search for housing within the agglomeration of Western Holland. This will again have a major impact on the housing sector.

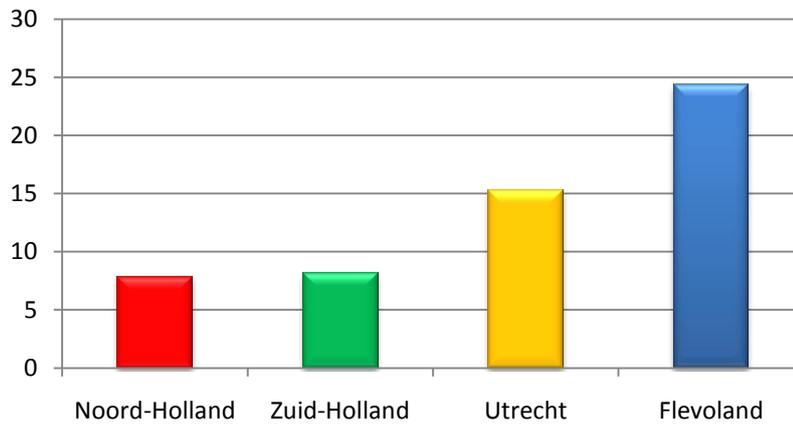


Figure 6; Population growth in percentage (province)

This research will focus on the city of Amsterdam. In this light not the average population growth nationwide of 5.4 percent will be used but a population growth of 12 percent (StatLine 2011, PBL, 2008) will be used by 2040. The population in Amsterdam will grow from 747.093 (CBS, 2009; StatLine, 2011) to 836.744, an increase of 90.000 people.

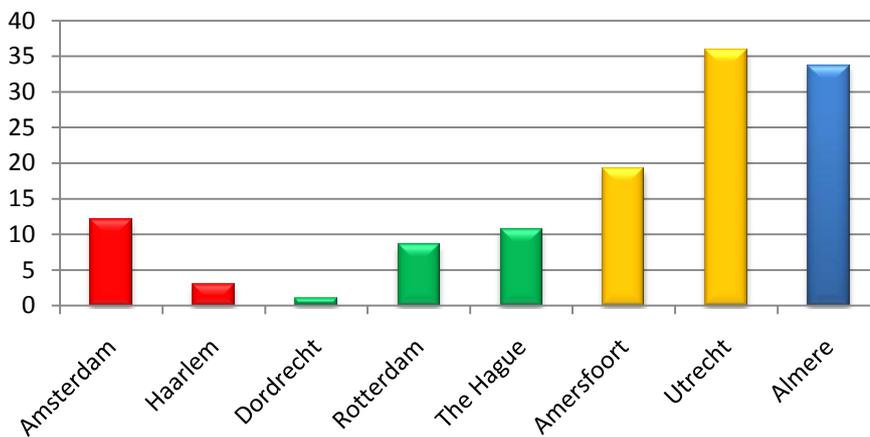


Figure 7; Population growth in percentage (city)

As a result of the growing population the need for housing will also rise. The national government has stated a vision, 'Structure vision 2040' (Dutch; Structuurvisie 2040). This report concluded that 500.000 houses needs to be added to the existing housing stock until 2040, (VROM, 2007; VROM, n.d.). For the municipalities enclosed by the four provinces this will be a major challenge. Almere and Utrecht do still have vacancy land left. But for Amsterdam it will be a complete different story it will be a real challenge to realize almost 43.000 new houses until 2040. This number is based on the population growth divided by the average household composition in 2040, see paragraph 3.2.1 and 3.2.4. In the challenge to accommodate all those potential inhabitants redevelopment, in sense of renovation or new estate, will be needed.

### 3.2.6 Floor space:

In line with the household composition there was a high need for terraced single-family dwellings, after World War II. The baby boom accelerates only this need. On average the household composition consisted of 3.8 people per person, paragraph 3.2.4. In spite of the high household composition the average dwelling floor space was rather small, compared to our standards of today.

Most of the early post-war dwellings do have a floor space between the 50 and 70 square metres. 50 square metres for multifamily dwellings (apartment blocks). And 70 square metres for single-family dwellings. At the moment a minimum floor space of 90 to 100 square metres is already been used and required for new estate (Uytenhaak, 2008).

As mentioned before our lifestyle is changing and simultaneously with this also our household composition. This change in lifestyle does also have an enormous influence on the floor space demand and requirements. Striking is that in contrast to the average household composition the average floor space is rising. In other words the household composition is declining while on the other hand the average floors space is increasing. This trend will only continue.

According to the book 'Steden vol ruimte: kwaliteit van dichtheid' of Prof. ir. Rudy Uytenhaak (Uytenhaak, 2008) the average floor space as well per person as well per household will increase to 2050, to 108 respectively 195 (gross) square metre, see figure 8. After interpolation it will result in a floor space per households in 2040 of approximately 175 square metres.

### Floor space development

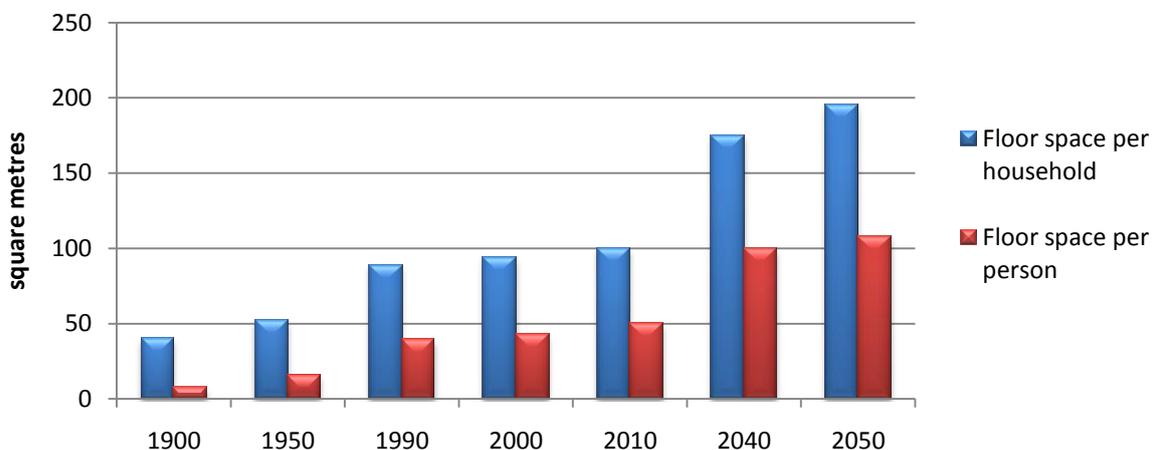


Figure 8; Floor space development in the Netherlands

Remarkable is to see that the average floor space demand per person today equals the floor space per dwelling, in 1950. And by 2040 the floor space demand per person will be equal to the average dwelling floor space of today. In other words, families will move-out and the one person households will move-in. This process is visualized by figure 9.

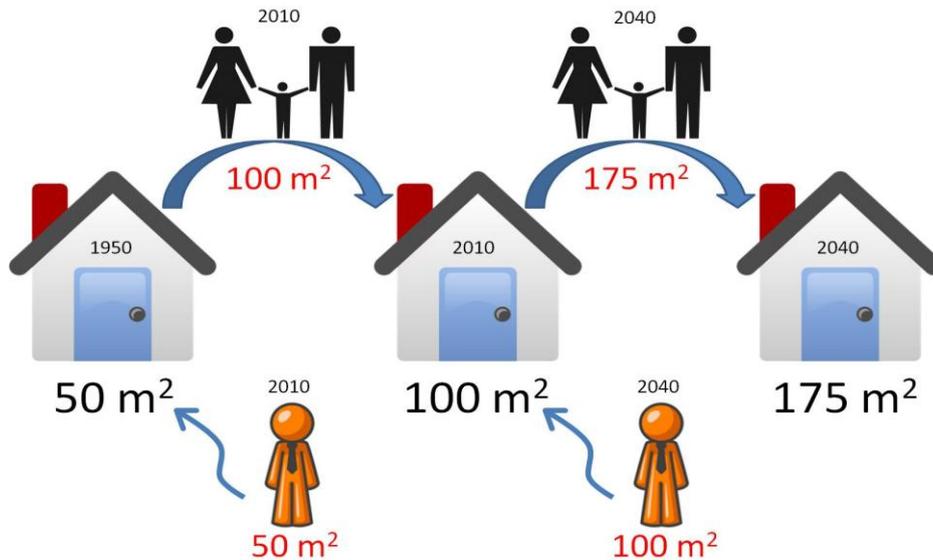


Figure 9; Change in supply and demand, with regard to the floor space

The above mentioned figure, figure 9, shows the supply and demand with regard to the dwelling floor space and the effect of it. The three houses are the supply. The demand is divided in one, the family households and two, the one person households. The demand for both as well families as well one person households is represented in red and the supply in black. When the supply is not meeting the demand of living anymore, in sense of floor space, then the inhabitant(s) will leave.

### 3.2.7 Conclusion:

A lot different social factors are given which all have their own influence. This overview will give a short description and conclusion of each particular aspect, which are mentioned earlier within this chapter.

- Population  
 At the moment the population is approximately 16.6 million people. According to predictions of the CBS this will increase until 2040 by 5.4 percent to 17.5 million, growth of approximately 900.000 people. Remarkable are the growing number of singles. Until 2040 this will increase by almost 20 percent, from 2.6 million today to 3.5 million in 2040, which are 900.000 people. This is an increase of 32.4 percent compared to today.
- Inhabitants  
 As a result of many factors, some of them will be discussed later on, the early post-war neighbourhoods have seen the number of inhabitants declining. Compared to their building period the average numbers of inhabitants are declined by 30 percent, until 2002. Will this trend continue or not and what will this mean for the early post-war neighbourhood?

- **Society**  
There is a strong relation between social housing, income, society and the neighbourhood. The majority of the early post-war neighbourhoods consisting of low rent social housing, in some cases almost 100 percent. The majority of those people are from abroad, which brings a lot of problems with them. A social mixture (in income and nationality) is needed to build a sustainable future!
- **Household composition**  
At the moment the average household composition is 2.22. According to a prediction of the CBS this number will decline to 2.09 until 2040. Compared to the building period of the early post-war neighbourhood this number is almost halved.
- **Urbanization**  
In spite of the population growth of 5.4 percent nationwide by 2040, the population growth in the city of Amsterdam would be 12 percent. This will have an enormous effect on the housing market. This growth means an increase of almost 90.000 people. In line with the declining household composition this will result in addition of 43.000 dwellings, at least, by 2040.
- **Floor space**  
Early post-war dwellings have a floor space of 50 or 70 square meters, depending on the dwelling type. In line with the expectations and the quality of living this will increase to approximately 195 square meters (gross) in 2050, so they will not be sufficient anymore! After interpolation a floor space of approximately 175 square metres (gross) will be achieved in 2040.

### **3.3 Technical:**

Between 1945 and 1960 the construction industry had one purpose, 'building as much as possible for as less as possible'. A consequence of the lack of building materials and construction workers new building systems were introduced. The use of those systems got stimulated by the national government. Contractors got financially supported when they make use of such a systems. And municipalities got the permission to build over 25 percent more houses, then was outlined by the zoning plan, by making use of these new building systems (Blom, Jansen, Heide, 2004).

Those systems did have a major advantage, it reduced the construction time and the construction costs. This makes them seen as the 'solution' against the housing shortage. But of course those systems did also have a downside, the technical quality. In line with the growing expectations of living, in sense of living comfort and health, the technical quality will be inventoried to determine if those aspects will meet the expectations of living of today and in the future.

As consequence of the production boost between 1945 and 1960 the technical quality of those houses is far from our standards today. According to the doctoral thesis of Heeger (1993), three elements on building level are of great importance and influencing the building quality. Those are construction problems, building physics and living problems (internal

design). Those aspects will be investigated and described. In line with the scope and the boundary of this research only a few elements will be described, those which will influence our living comfort at most.

### **3.3.1 Body of the building**

It is very frustrating hearing your neighbours watching TV, talking, or even yelling. What to think about the road, which you are living next to. But do they really influencing our living comfort? According to the doctoral thesis of, Heeger (1993) it does! Almost 90 percent of the interviewee (inhabitants of early post-war dwellings) experience noise nuisance as a problem (Heeger, 1993).

A research done by Thijssen (1991) concluded that most of the early post-war buildings consist of brick (as well cavity as well non-cavity) and concrete walls. In line with the focus of this research other wall types will be outlined. The same goes for floors made from wood or other materials. It is exactly those elements which separate the different dwellings. And in the battle against noise nuisance it is the wall and the floor which will play an important role to make the difference. In the past the floors and the walls did only had a constructive function. Today the floors and walls do not only have a constructive function but also the function to resist sound. To reduce sound (from neighbours) mass is needed, and the easiest way to realize this is to modify the thicknesses and the materials of the floors and walls.

Over time many legal regulations are changed the same goes for regulations regarding sound. There is a clear relation between reducing noise nuisance and the living comfort, the higher the sound reduction, the higher the living comfort. According to the Dutch building decree 2003 air and contact sound, between two or more houses, should have a characteristic insulation-index of 5dB. This corresponded to a sound reduction of approximately 53 dB (Dessing, 2005). To achieve this reduction the wall should have a thickness of 250 mm and the floor 280 mm ([www.gietbouwcentrum.nl](http://www.gietbouwcentrum.nl)). Looking forward in line with our changing living comfort, the higher expectations of living and new legal regulation Gietbouw Centrum has set up some guideline for sustainable buildings. According to these guidelines walls should be expand to 280 mm and floors to 330 mm concrete.

Be aware of the fact that the majority of the early post-war dwellings are executed with a non-cavity wall of only 120 mm concrete. This means that the required sound reduction of today will not be achieved by far. And if it is not meeting the expectation of living anymore less people become interested.

### **3.3.2 Windows**

Beside noise nuisance which we experience from our neighbours, sound from outside could also be very uncomfortable. Windows got much more attention than decades before. This is the result of legal regulations, knowledge and the technical features.

Most of the buildings from the early post-war period are characterized by steel windows and single glass. Those windows functioned very well for many years and they should function for many years. Only if our living standards did not change and aspects like sustainability and energy use become not important. But they changed and they become important.

In spite of the old windows new windows are made from better and sustainable materials and offer many advantages. The biggest advantage is double glazing. It will save sound from outside, which encourage the living comfort. But more important in the challenge towards a more sustainable future it will reduce the energy consumption for heating.

But of course the main purpose of windows is to providing daylight into a building. Daylight has a positive effect on the human health and peoples activities (Leslie, 2003). This is why daylight is so important in housing and offices. The importance of daylight is also been discovered in the retail sector. A study, for example, done in 1999 by (Heschong et al., 1999) concluded a significant relation between skylight and higher retail sales. As a result of skylight their sale was increased by 40 percent.

Beside the positive effect on human's health it also will have a positive effect on the energy consumption. Leslie (2003) investigated that daylight will not only save directly the energy consumption through dimming down or switching off electric lights. Indirectly it will save energy through the air-conditioning system. Lights produce beside light also heat which needs to be cooled down. Leslie (2003) concluded that a combined saving of lighting and cooling can be substantial.

Within the Dutch building decree also the amount of daylight is determined, this to ensure a healthy living environment. In general the amount of daylight (window surface) depends on the floor space. According to the Dutch building decree 2003 a minimum daylight equivalent of 10 percent is required, for new estate (Bouwbesluit, 2010). For renovation no strict rules are set. In line of this it will be doubtful if renovation will take place anyway if this will provide a healthy living environment with regard to the existing building/ window structure.

A minimum daylight equivalent of 10 percent is required, for new estate. For renovation nevertheless no strict rules are been set.
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### **3.3.3 Thermal insulation:**

It is common know that thermal insulation will enhance the reduction of energy use, needed for heating. But the majority do not know that it simultaneously will have a positive effect on our expectation of living, in sense of living comfort (Howdan-Chapman et al., 2009). This two sided effect is an advantage, but also a disadvantage, especially for those companies who are the supplier and not the user, like a housing corporations. They do not see the direct benefits of this (thermal insulation) investment. They are not saving money by reducing the energy consumption.

Main purpose of thermal insulation is still reducing heat losses and reduces the energy consumption needed for e.g. heat. But does it? According to a study, done in Denmark by Tommerup and Svendsen (2006) it does! They concluded that a massive reduction of 50 percent could be realized by adding I) roof insulation, II) energy-saving glazing, and III) external wall insulation. But it will be the tenants which experience the lack of it.

As already mentioned the buildings built right after World War II does not meet our expectations of living of today anymore. And they will certainly not meet the legal regulation of today with regard to energy saving. But what does this mean directly?

Tommerup and Svendsen (2006) has shown that the heat loss of buildings built between 1931 – 1950 and 1951 – 1970 is on average almost twice as high compared to the housing stock built between the period 1998 and 2003 (Tommerup and Svendsen, 2006). In the Netherlands one-fourth of the houses build before 1960 do not have any thermal insulation. Even the halve of those houses do not reach the minimum requirements of today, an Rc-value of 2.5 m<sup>2</sup> K/W (Zoethout, n.d.). This can be devoted to the construction systems and the legal regulation. Tommerup and Svendsen (2006) concluded also that the biggest energy losses are devoted to the exterior wall, the floor, and roof of the building (Tommerup and Svendsen, 2006). And it are especially those elements which are not very suitable for thermal insulation, it is also relatively 'easy' to realize (Lloyd et al., 2008).

The legal regulations in reference to the building industry are in the Netherlands determined in the so called Dutch building decree (Dutch; Bouwbesluit). The Dutch building decree will be adjusted each several years. This is needed to first, encourage a more sustainable future and second to be in line with the expectations of living.

Requirements regarding energy efficiency, heat resistance, and energy performance are also been specified in the Dutch building decree. In accordance to the scope of this research two main items that should encourage energy reduction will be mentioned. These are the Rc-value (Dutch; Rc-waarde) and the EPC (Energy Performance Coefficient). There is an essential difference between those two, which will describe below.

### 3.3.4 Rc-value

The Rc-value is the minimum heat resistance, in K/W per square meter (m<sup>2</sup> K/W), for a particular construction component e.g. a roof. The heat resistance relies on the material and the thickness. The Dutch building decree has raised the Rc-value many times and in line with the growing importance of energy saving it will only raise in the future, see figure 10. Figure 10 is based on information from NEN 1068, Dutch building decree and Senternovem.

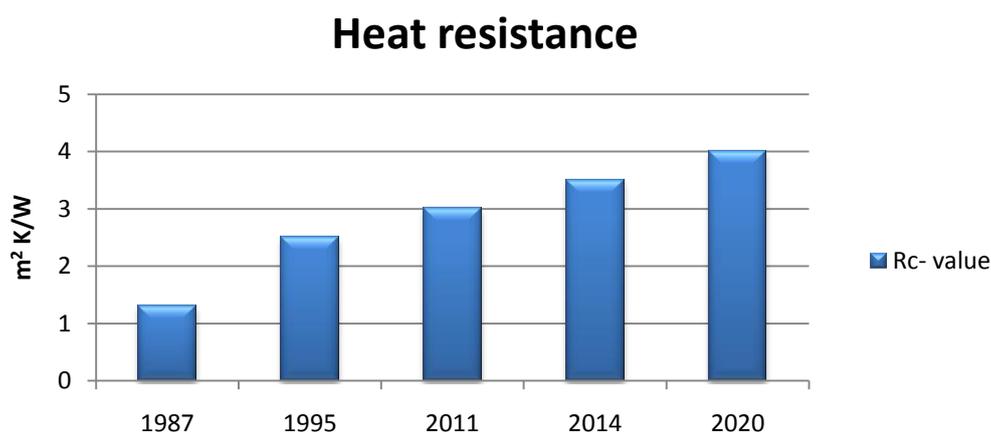


Figure 10; Heat resistance development

### 3.3.5 EPC

The EPC conversely is much more sophisticated. It is a coefficient that represents the real energy consumption divided by a standardized energy consumption (Overveld, 2001). The real energy consumption is based on; I) building properties, e.g. Rc-value and surface. II) Building related installations, e.g. heating, ventilation, etc. The standardized energy consumption is based on an, on beforehand calculated, average rate of occupation, average living temperature etc. The closer this equation meets zero the better the building will perform in sense of energy need and energy use.

Notice: within the EPC the energy consumption for household use e.g. cooking, wash machine, dryer, fridge etc. are not taken into account! It depends too much on occupant behaviour and does not have a relation with the energetic quality. (SenterNovem, 2005). But should it really not be taken into account?

According to the study of (Isaacs et al., 2004) one-third of the energy consumption within the residential sector is needed for space heating. 35 percent of the annual energy consumption will be used for warm tap water (Lloyd et al., 2008). Concluded almost one-third (32 percent) of the annual energy consumption will be used for household use and is not taken into account within the EPC calculation!

Almost one-third of the energy consumption is needed for household use (Lloyd, 2008). This is not being taken into account by the EPC calculations.

Like the Rc-value also the EPC has tighten up over time and it will also be in the future, see figure 11. The figure is based on information from, (SenterNovem, 2008) and (Staatsblad, 2001).

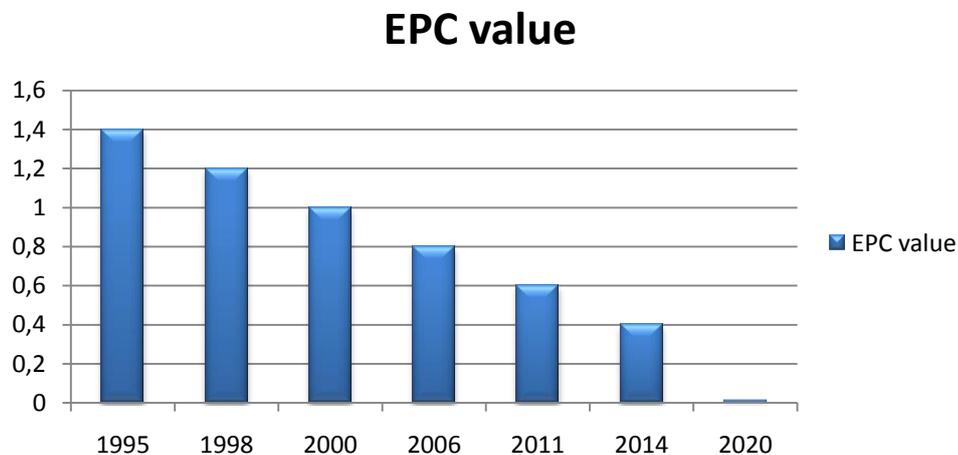


Figure 11; EPC (Energy Performance Coefficient) for the residential sector

Notice: There is a strong relation between on one hand the Rc-value and on the other hand the EPC. But for all the new building means that the EPC is leading. The Rc-value is more or less the result of the EPC, but it should always meet the minimum requirements determined in the Dutch building decree.

Striking is that in spite of the importance of increasing comfort, energy saving and energy efficiency measurements only new estate have to meet those requirements. For renovation the EPC is not applicable, and the Rc-value does only have to meets the minimum requirements.

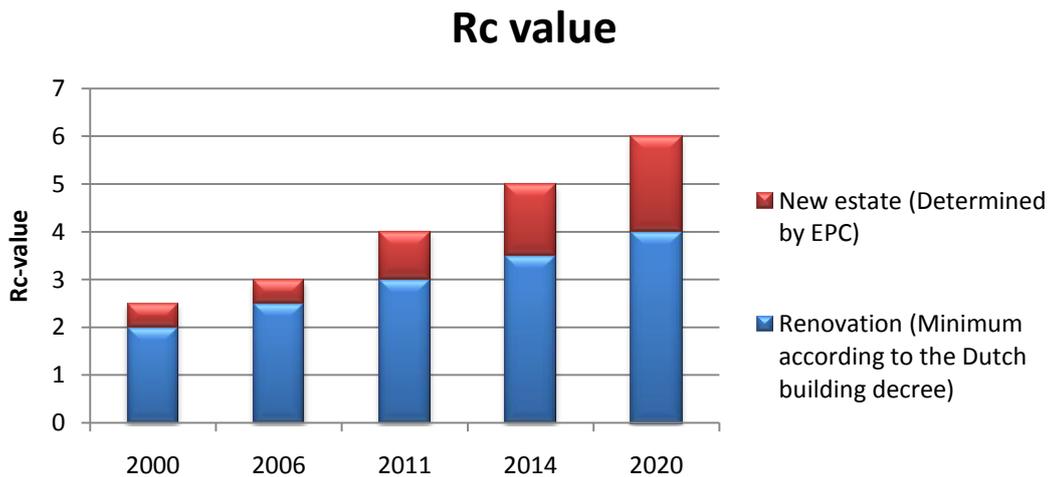


Figure 12; Rc-value for new estate and renovation

As figure 12 will show there will be always a difference between the Rc-value for new estate and renovation. So to what extent does renovation contribute towards a sustainable future?

To what extent does the Rc-value for renovation contribute towards a sustainable future, if it will not meet the minimum requirements for new estate?

### 3.3.6 Dampness and condensation:

Most people do know what dampness and condensation is, and how it arises. Good example of this is of course the condensation of the damp on the interior side of the glass when it is outside colder in comparison to the inside. It is the result of the lack of ventilation and insulation (Hyndman, 1990).

What most of those people do not know is that mould is mainly caused by dampness and condensation. Mould is that black/ gray deposit which you e.g. can found in an upper corner of the bathroom. It is not only very unpleasant, it will also have a negative effect on humans health. Hyndman (1990) concluded that there is a significant relationship between the presence of mould and the people's health. There is measured a higher level of e.g. hidden asthma in comparison to homes which do not deal with problems like mould.

According to the research of Ellaway and Macintyre (1998), over 40 percent of the inhabitants experience dampness as a real problem. Applying thermal insulation, ventilation and a (new) heating system will reduce those problems. The majority, maybe all, of the early post-war buildings are poor or not insulated and ventilated very well. Platt et al., (1989); Hymand, (1990) and Packer et al., (1994) concluded that the presence of mould was seriously higher in the public sector (owned by a housing corporations) in comparison to the private sector. In line with the social responsibility housing corporations have they cannot permit to offer poor and bad buildings which increase the chance of (chronic) illness significant. Also from this perspective, insulation, ventilation and a well heating system are definitely needed.

### **3.3.7 Heating/ hot water supply:**

The majority of the early post-war buildings were provided in their warmth and warm tap water by two different systems. Between 1945 and 1960 most of the buildings were heated by a coal-fired stove, which were later on replaced by a gas stove. For the provision of warm tap water a little boiler or geyser was been used.

As consequence of the higher living standards the majority of the early post-war buildings do not use any of those systems for heating their warm tap water today.

Over time the provision of warmth and warm tap water has changed on many fields, and it certainly will in the future. In the battle against dampness, condensation, energy saving and efficiency installation types with regard to heating and warm tap water should not be forgotten. A research done by Lloyd (2008) has concluded that two-third, 67 percent, of the total energy consumption is needed for the supply of warm tap water and for heating. Guler et al., (2001) stated that upgrading the heating systems provides the largest energy savings potential. Followed by basement and ceiling insulation. But in spite of the replacement of the existing heating system, the annual energy savings are rather small. The annual energy consumption in Canada was reduced by only 8.2 percent. But it still will be the easiest way to reduce energy the energy consumption.

This research will not describe the different types but it will prescribe a minimum central-heating boiler, the (HP 107), High Performance, central heating boiler (Dutch; HR 107-combi ketel). This is at the moment one of the most energy efficient heating and warm tap water systems.

### **3.3.8 Ventilation**

Ventilation is needed to secure a good indoor air quality and to avoid problems with regard to moisture e.g. mould (Voss, 2000). It will remove the indoor pollutions (Niu, 2004) and lowers down the concentration of CO<sup>2</sup> and other hazardous material (Makaka et al., 2008). But it will also bring down the indoor room temperature in hot days, which will be a major advantage towards a sustainable building.

A good indoor air quality is the result of a well balanced supply of 'fresh' air and the drainage of 'hot' air. The supply of fresh air is mainly realized by the placement of the so called ventilation grilles in the windows. The drainage of hot air is realized by the placement of an extractor fan. The amount of ventilation is specified in the Dutch building decree. The amount of ventilation relies on the floor space, the type of room and household composition. The importance of ventilation is many times underestimated, but is should be taken really seriously. A lack of ventilation and/ or an incomplete combustion (by e.g. cooking or hot water supply, by use of a geyser) could lead to its deathly CO (Carbon-Monoxide) gas.

Mainly it is the early post-war dwellings which are not being ventilated very well. The majority of the existing buildings still have only natural ventilation (Meijer et al., 2009) As well natural as well mechanical ventilation where not integrated into the design, so they were not realized. It has been realized, if it is been realized anyway, afterwards. It will be doubtful if the afterwards placement of ventilation is in line with the requirements of today.

In the mission to reduce the energy consumption new and efficient ventilation systems will fulfil a massive role in the future. It is still doing already. At the moment the majority of new buildings are equipped with a so called HRU (Heat Recovery Unit) (Dutch; Warmte Terug Win unit). This is the result of the lowering EPC. According to the research of Fehrm et al. (2002) the annual energy consumption can be reduced by almost 20 percent by installing this so called HRU (Heat Recovery Unit).

The legal regulation regarding ventilation and energy saving are for new estate strongly related with each other, as a result of the lowing EPC. For renovation conversely only the minimum ventilation requirements are applicable and not the energy saving aspect.

For new estate ventilation is part of the lowering EPC, for renovation it is not. To what extent will this contribute to a sustainable future?

### **3.3.9 Electrical installation**

Over time our living standard has the largest influence on how we behave, act, feel and expect our today living. In comparison to two decades ago we do not only use more electricity in our home but we do also need more electric points. Between 1945 and 1960 we did not have that electrical equipment like we have today. In line of this it is doubtful of the electrical installation, especially the fuse box, still meets the legal regulations of today.

Most of the households, also within the social housing sector, do have today a washing machine and a drier. A consequence of the number of groups they do not have their own connection, which means that both could not be used simultaneously. Does this meet our expectations of living today? Also the number of electrical points in e.g. the living room is not sufficient anymore. In comparison to 1950 there is a need for more electrical points as a consequence of the growing number of electrical products, types and lightning. DIY (Do-It-Yourself) solutions done by the tenants could result in very dangerous situations, with e.g. fire or explosions as consequence.

### **3.3.10 Number of rooms:**

Like mentioned before in paragraph 3.2.6 the floor space will have a major influence on our expectations of living today. Beside this it is also the number of rooms, the average room space and the (sanitary) equipment which is important (Turkington et.al., 2004). The average floor space of the early post-war dwellings is not that big. In combination with the number of persons per household it resulted in the number of rooms. In general the houses consisted of a living room, a kitchen/ dining room (mainly separated from the living room), a toilet, a bathroom and two bedrooms. By terraced single-family houses the bathroom and the bedrooms were located at the first floor. All situated on just 50 to 70 square metres, which makes the different rooms not that big.

Those houses still offers all the needed facilities and spaces, but maybe not in the way we like it today. They do not meeting our expectations of living today anymore, unfortunately. Changing the internal design is possible anyway. However it will be doubtful if it will contribute to a higher living standard, in the sense of e.g. the provision of daylight, mentioned in paragraph 3.3.2.

### **3.3.11 Conclusions:**

This overview will give a short description of those aspects which are important, why they are important and how they will influence as well renovation as well new estate.

- *Sound insulation*

As a result of the poor construction materials, construction faults and the lack of legal regulation with regard to sound insulation, most of the early post-war buildings are dealing with noise nuisance. Almost 90 percent of the inhabitants experience noise nuisance as unpleasant. This is not surprisingly if you consider that the body of the building consist of concrete with a thickness of 120 mm. This is by far from the standards of today, which prescribed a thickness of 250 mm at least.

- *Thermal insulation*

Thermal insulation will be determined by on one hand the Rc-value while it on the other hand is determined by the EPC. The Rc-value represents only the heat resistance of one particular construction component. While the EPC is a collective of different factors (mainly insulation, ventilation and heating), and shows the relation between real energy need and the modified energy need. Remarkable is that within the EPC calculation energy use with regard to household use e.g. washing, drying, cooking is not taken into account.

As a result of the EPC the Rc-value will be determined, which is in most cases much higher than the minimum Rc requirements. Lower down the EPC means a higher Rc-value.

At the moment the minimum Rc-value is 2.5 m<sup>2</sup> K/W and the EPC is 0.8. As soon as the new Dutch building decree will be introduced those values will be changed in 3.5 m<sup>2</sup> K/W respectively 0.6 (Rijksoverheid, 2010a).

- *Dampness and condensation*

As a result of poor insulation, the lack of ventilation and the lack of legal regulation most of the early post-war building dealing with dampness and condensation problems. Those problems need to solve because they have a negative effect on peoples health. Solving those problems could easily be realized by adding insulation and adding ventilation. Especially for renovation this point needs some attention!

- *Installation*

A new installation for heating and warm tap water should not be forgotten in the battle against energy saving and energy efficiency. Within this research a HR-Combi ketel will be used, as well for renovation as well for new estate. A (new) ventilation system should be taken into account by renovation, as already mentioned before. Unfortunately a HRU is hard to realize with the existing housing stock as it is possible anyway, so only natural ventilation will be taken into account for renovation.

Another point which definitely needs some attention is the electrical installation, especially the existing fuse box. In line with the living expectations of today it needs to be adapted to make those buildings sustainable for the future!

### 3.4 Legislation and regulations:

This chapter will describe some political changing's which could have as well a positive as well a negative effect on the social housing market.

#### 3.4.1 Energy label

To stimulate the reduction of energy use and make people more aware of this fact the national government introduced a so called energy label. Purpose of this energy label is to show the energetic quality of a dwelling compared to another similar dwelling. It was introduced in 2008 (renewed by 2010) and 'represents' the energetic quality of a building. Before 2010 the energy label does only shows the presence of insulation, e.g. wall insulation or double glazing.

In 2010 the label is modified and is shows also the building type and a prediction of the annual energy consumption, divided in gas, electricity and (district) heat (VROM, 2009). Beside this also the score of the label is changed, before 2010 the highest mark that a house could get was an A. In 2010 this is upgraded to A++ which shows of course a good energetic house. While the letter G still represents a bad energetic house, see figure 13.

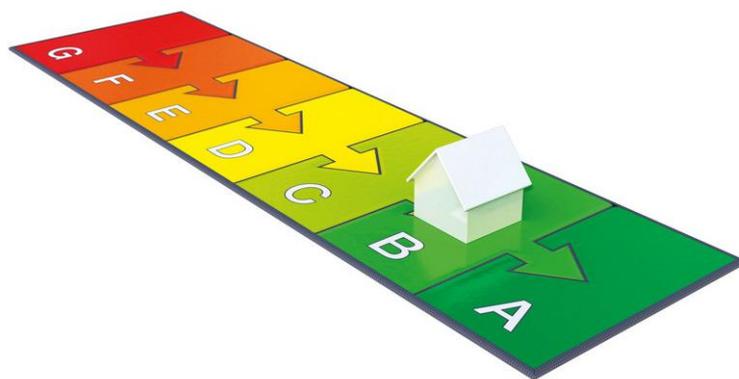


Figure13; The different energy label for the residential sector (Source; [www.passiefhuismarkt.nl](http://www.passiefhuismarkt.nl))

But does this label really show the energetic quality? The energy label is namely only based on the architectural features and installations types, needed for heating and ventilation. Remarkable is that e.g. the type and thickness of the insulation are not 'important' and are not be taken into account! Insulation will only be quantified as, poor, moderate or good (VROM, 2009)!

The energy label quantifies thermal insulation only as poor, moderate, and good. But it is the insulation material and thickness which really make sense. So what does this energy label say?

Based on these elements and aspects like a standardized family life and behaviour a prediction of the annual energy consumption will be made. Notice this energy label do not shows the actual energy consumption! So this energy label really makes sense, does it?

The energy label does only shows a prediction of annual energy consumption, not the real energy consumption. So this energy label really makes sense, does it?

For private houses which are older than 10 years this label is mandatory if the property will be sold. Idea was that potential buyers could take the energetic quality in consideration in their choice. But does it? Will it really influence people's choice? Buying a house will be influenced by factors like price, location, surface, neighbourhood, accessibility, appearance etc. Those are factors which also determine the price of a building (Jansen and Lee, 2009).

In spite of that the energy label is mandatory not all the houses which are for sale have one. This could be explained as follow, the label is only needed if the buyer wants so. 2 years (by the end of 2009) after introduction only 25 percent of the total housing market does have a label (CBS, 2010). Of this total merely 5 percent (approximately 70.000) is devoted to the private property market. Does this make sense? The rental market conversely is responsible for 95 percent, which is 1.5 million. This number will make sense!

Figure 14 shows the energy label, in percentages, categorized by social housing, non-controlled and private property (Blijie et al., 2009). Remarkable is the low percentage of label A and the high percentage of label F and G in all the three segments. The low percentage of label A could be explained by the 'low' production ratio of new dwellings.

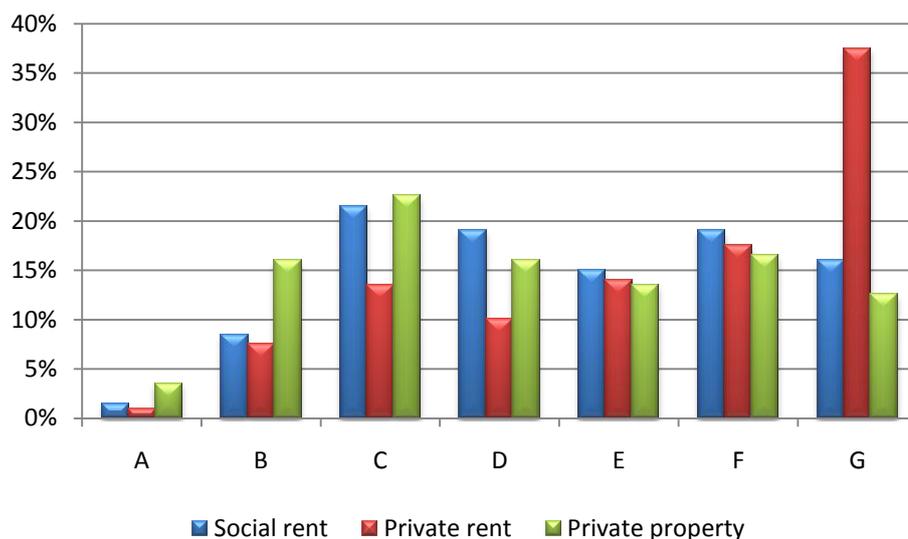


Figure 14; Share of the energy label in the three differ market segments

### 3.4.2 WWS (WoningWaarderingsStelsel)

The WWS is a (new) scoring system to determine a 'reasonable' monthly rental price, for as well the social housing sector (controlled rental accommodations) as well the private housing sector (non-controlled rental accommodations). The social housing sector is one, owned by housing corporations. And two, those dwellings are 'controlled' by the national government in sense of maximum monthly rental price. In 2010 the maximum monthly rental price was € 647.53 and for 2011 this will be € 652.52 (Rijksoverheid, 2010c).

There will become a new WWS which differs not that much in comparison to the scoring systems which is been used nowadays. But on one element it does, which is the energetic quality. Within this new WWS the energy label will be adopted. It will replace the existing

scoring system which only devotes points for insulation and heating, with a maximum of 26 points (VROM, 2010). Within this new WWS system a maximum score for single-family dwellings of 44 points is obtained (label A++) and a minimum for label G, 0 points. For multiple family dwellings this will be 40 points for label A++ and 0 point for label G. See appendix 1 for the scoring system and the scoring points.

This new WWS should already been introduced on July 1<sup>th</sup> 2010 but it was not, as a result of the political situation in that period. Until today it is still not clear when this new WWS will be introduced. In line with the perspectives of this research it will be assumed that new WWS, including the energy label, will be introduced in 2011.

Integrating the energy label within this new WWS has as main purpose realizing an energy reduction of 24 PetaJoules nationwide until 2020 (Rijksoverheid, 2009). This ambition is based on the covenant *Meer met minder* and *Energiebesparing Corporatiesector*. 1 Petajoule equals 31.6 million m<sup>3</sup> natural gas or 277.78 million kWh electricity, (CBS, 2011e). In extremes this means a reduction of over 750 million m<sup>3</sup> natural gas or 6666 million kWh electricity.

Main purpose for making the energy label part of the new WWS is to reduce the nationwide energy consumption by a massive 24 PetaJoules by 2020.

Beside this massive reduction of 24 Petajoule housing corporations needs to upgrade their existing housing stock to label B, if possible, or by two energy step at least, e.g. from label F to label C. In comparison to the existing scoring system the new WWS makes it possible to pass on the investment costs (of energy saving measurements) to the tenants. This should probably stimulate housing corporations to upgrade their housing stock, to label B or maybe even higher.

To enforce housing corporations a penalty system is introduced in the new WWS. When housing corporations do not offer houses which are improved by two energy steps or at least or to label B, tenants will get a discount in their monthly rental price. At the moment it is not clear if they will come a minimum or maximum.

Housing corporations need to upgrade their existing housing stock by two energy steps at least or to label B, before the year 2020.

### **3.4.3 National support (90 percent rule):**

From January 1<sup>th</sup> 2011 a new and important temporary policy will be introduced by the EU (European Union) and executed by the national government. This policy will have a major consequence for housing corporations and social tenants in the Netherlands. It is called National support for housing corporations (Dutch; Staatssteun voor Woningcorporaties). Main purpose of this policy is to stand surety for the finance of (re-) development plans. Simultaneously this policy will also affect the purchase price of (vacancy) land. Housing corporations which need to buy land from a municipality, for realizing their development projects, will get a 'special' (lower) land price (Rijksoverheid, 2010b). This should stimulate the (re-)development project in a time of economic crises where bank loans are hard to get. But does it really?

But of course there is no such thing as a free lunch, so there will be some conditions within this policy. In line with this research only two conditions are important to mention which are, the 90 percent and the 10 percent rule (Rijksoverheid, 2010b). The 90 percent rule means that 90 percent of all the new contract within the social sector (maximum rent of € 652.52 per month) will be devoted to those people who do not have a combined annual income of more than € 33.614,-. This is approximately 43 percent of the Dutch population (Europese commissie, 2009).

The other one is the 10 percent rule. The remaining 10 percent will housing corporations devote to people who have a high level of priority.

Only new tenants who do not have a combined annual income of more than € 33.614,- are been qualified to move towards the social housing sector.

In the other way around this temporary policy will stimulate the non-controlled housing sector and the private property market. Households which have a combined annual income of more than € 33.614,- will move to the expensive non-controlled houses or to the private property. Due the economic crisis this last one is a little bit doubtful. It does not take rocket science to understand that those conditions will have a major influence on many aspects. For this research it will be interesting to know what the influence of this policy is for as well renovation as well new estate, in sense of social, economical and technical aspects.

#### **3.4.4 Dutch building decree**

The Dutch building decree (Dutch; Bouwbesluit) encloses all the building related requirements for all the buildings in the Netherlands, housing, industry, temporary, renovation or new estate (Overveld, 2001; It is a collective of different aspects, which could mainly be divided into four different main subjects;

- I) Safety (e.g. construction safety/ strength and fire safety)
- II) Health (e.g. Sound, ventilation and dampness/ condensation)
- III) Practicability (e.g. accessibility, bathroom size and toilet size)
- IV) Energy (e.g. thermal insulation and energy performance)

All those aspects have passed the review and will not be described in detail anymore. But in general the Dutch building decree and her regulations needs some attention. Remarkable is that most of the regulation are only bear on new construction projects. And it is especially this point which will be discussed.

The Dutch building decree (Dutch; Bouwbesluit) has two purposes first, encourage a more sustainable future. Second ensure that mainly new estate is in line with the (growing) expectations of living.

The Dutch building decree are only 'minimum' requirements which a building have to meet. To make sure that those requirements can and will meet our expectations of living and our quality of life today, they will be adjust and updated each couple of years. But when it only prescribes and determines the minimum requirements, does it really fit our expectations of living and our quality of life, today and in the future? Maybe for new estate it does, but what to think about renovation. The 'minimum' requirements concerns only new estate

construction projects. When a building will be renovated it does not have to meet those 'minimum' standards! Renovation projects have to meet their 'own' requirements, which are in almost all the cases much 'lower' compared to the 'minimum' requirements of new estate. In some cases renovation will be preferred over new estate to avoid the higher minimum standards.

Renovation can be preferred over new estate to avoid the newer and stricter 'minimum' requirements, which are been stated in the Dutch building decree.

The last ten years the production of new dwellings is more or less steady, between the 1 and 1.2 percent a year (CBS, 2011a). Keeping in mind this 'low' production rate and that only those buildings have to meet the new 'minimum' requirements. It will be interesting to know of this really make sense in order toward a sustainable future.

Unfortunately there is no clear annual percentage of renovated houses versus the existing housing stock. But when there was it probably could show that the percentages for renovation are much higher, which makes renovation projects a much better target group to realize this better and sustainable future.

Does the Dutch building decree really contribute to a sustainable future if only new estate do have to meet those 'minimum' requirements?

Another interesting point will be, 'when is renovation, renovation?' This is not only interesting from a technical point of view, how to avoid those 'higher' standards. But it is also interesting to know when a property can be categorized as renovation or as a new, from a financial point of view. For project developers this is much more important. How much tax they have to pay after the property will be sold depends on the question, "is it just renovated or is it new estate"? Properties which can be assigned after renovation as new estate are financial very beneficial! If they can, project developers do not have to pay conveyance tax (Dutch; *overdrachtsbelasting*). The same goes for housing corporations. But when is new, new and when is renovation only renovation and not new estate?

When is renovation, renovation and when is renovation being considered as new estate?

### **3.4.5 Conclusions:**

From a political point of view there will be two factors which will have a major influence on as well renovation as well new estate. The following bullet points will describe briefly the importance and the relation between this new policy and the existing housing stock.

- *Energy label*

This label indicates a prediction of the annual energy consumption of a house, and not the actual energy consumption! Other point is that the energy label do shows the presence of insulation but the thickness and the material are not be taken into account! According to the energy label, label A++ (green) should indicate a good energetic quality home while label G (red) indicates a poor one. But as already mentioned the label does not make sense if the most elementary elements were not taken into account. In other words the label shows the possible adoptions and measurements which can be execute to upgrade the energetic quality.

- *WWS (WoningWaarderingsStelsel)*

To determine a fair monthly rental price for an accommodation a scoring system is set up, called the WWS. Within this scoring system points will be granted towards e.g. floor space and the number of rooms, also points will be granted to the energetic quality of a house. This will be determined by the energy label, within the new WWS. Integration of this energy label has as main purpose to reduce the energy consumption within the social housing sector with 24 Petajoule. This will be ensured by forcing housing corporations to upgrade their housing stock by at least two energy steps or to label B.

The national government had determined that within the social housing sector a maximum of € 652.52 per month is required. In other words, is matters of a house, within the social housing sector, has an A++ label or an e.g. D label. In both situations the maximum monthly rental price is already been determined! Will this still stimulate housing corporations to upgrade their social housing stock to a maximum of label A++ in order to reduce the energy consumption by 24 Petajoule?

- *National support housing corporations*

The national government will give housing corporations temporary national support to stimulate and regulate their (re-) development projects. Nothing is for free and so is this. Condition for this national support is that housing corporations will devote 90 percent of their social housing stock (max. € 652.52 a month) to new tenants which do not have a combined income of more than € 33.614,- annually. For those who have a combined income higher than € 33.614,- are more or less forced to move towards a non-controlled dwellings or even private property!

On one hand this policy will stimulate the non-controlled housing sector and the private property market, which of course will have a positive effect for the housing corporations. To say nothing of the financial household problems this probably will course for the tenants. But on the other hand will this policy not only reinforce the social related problems in the so called reinforcing districts (Dutch; Vogelaarswijken)? What will be the effect of this policy, as well social as well economical?

- *Dutch building decree*

The Dutch building decree gives an overview of the 'minimum' requirements for all buildings, for new estate as well for renovation. Remarkable is that for renovation the 'minimum' requirements are much lower in comparison to new estate. In this way renovation can be seen as an escape to avoid the 'higher' standards which concerns new estate!

Another discussion which is on one hand related to the technical requirements and on the other hand the financial aspects are. 'When is renovation, renovation?' And 'when will renovation be marked as new estate?'

## 4 MODEL DESCRIPTION:

The time horizon of the SD model is 30 years, from 2010 to 2040, as a result of available information.

There are four sub-systems in this SD model, which are, namely, social developments, technical and energetic quality, construction and renovation time and finance. The effective relations between the four sectors, within this research, are visualized in figure 15, the causal loop diagram. All the different aspects and developments are situated around the central decision loop, number 2. Loop 1 represents the social loop. Loop 2 is the central decision, loop 3 is the technical loop and loop 4 represents the financial loop. This causal loop diagram is been more or less the backbone of the other SD (sub-) models.

Causal loop diagrams like this are simply showing the causal links among variables with arrows from a cause to an effect (Sterman, 2000). Not all the loops will be described but to understand the principle of it loop 1 will be described. If the *social mixture* within the existing neighbourhood is bad, than the *neighbourhood attractiveness* will decline, see paragraph 4.1. This declining *neighbourhood attractiveness* will have negative effect on as well the existing inhabitants as well the *potential inhabitants*. With that result that potential inhabitants will stay away and that the existing inhabitants will leave. And this will mean that if inhabitants are leaving the social mixture will decline, which makes the circle round. This can be done for each loop.

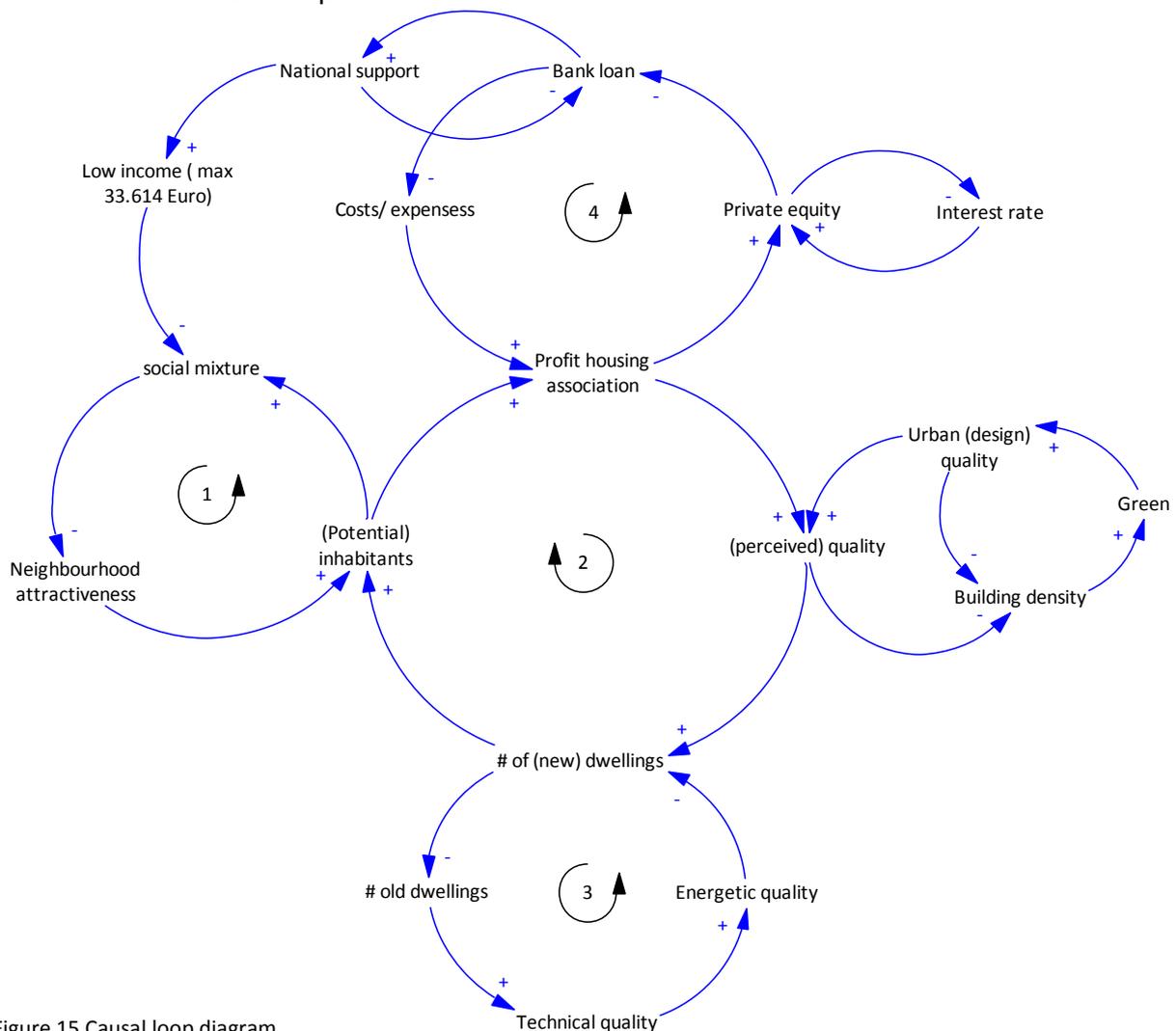


Figure 15 Causal loop diagram

The aim of this model is to discover what the social, technical and political effects are on the level of occupation of the existing social housing stock until 2040. In order to make a well based decision for as well renovation as well new estate.

This SD model is divided into four sub-systems, namely, social developments, energetic/ technical quality, construction/ renovation time and finance. Like the causal loop represents, figure 15 . Each sub-system will be described below.

**4.1 Social development:**

The social aspects and developments are of great importance for urban (re-) development projects. Population growth and higher living standards are the central elements within this sub-system. In line with the scope of this research the relation between the increasing floor space demand and the move-out percentage is been modelled, in order to determine how this will change over time.

First the floor space development and the existing floor space in relation to the move-out rate is been modelled, with use of different stocks and a flows, showed by figure 16. It is estimated that the average floor space for households will increase by a 75 percent up to 2040, in comparison to today (Uytenhaak, 2008). The floor space per person will have been increased by 100 percent by 2040, also in comparison to today (Uytenhaak, 2008). The growing percentages are been modelled with use of the only stock and flow within this sub system. This is modelled by the variables *Floor space growth households (%)* and *Floor space growth one person households (%)*. Notice, those growing percentages relying on the *existing floor space*, like the so called variable.

This increase in floor space (higher living standards) will have an enormous effect on the level of occupation of the existing dwellings. A questionnaire, executed by the municipality of Amsterdam (Gemeente Amsterdam, 2008), has already showed that for 37 percent of the potential leavers the existing floor space is not sufficient anymore. Spread over family households and single households. This information is stored in the variables called, *Move-out family (percentage)* and *Move-out one person households (percentage)*.

With use of this SD model, figure 16 a prediction can be made of the move-out percentage up to 2040. This is based on the existing floor space, the *supply*, and the expected floor space, the *demand*.

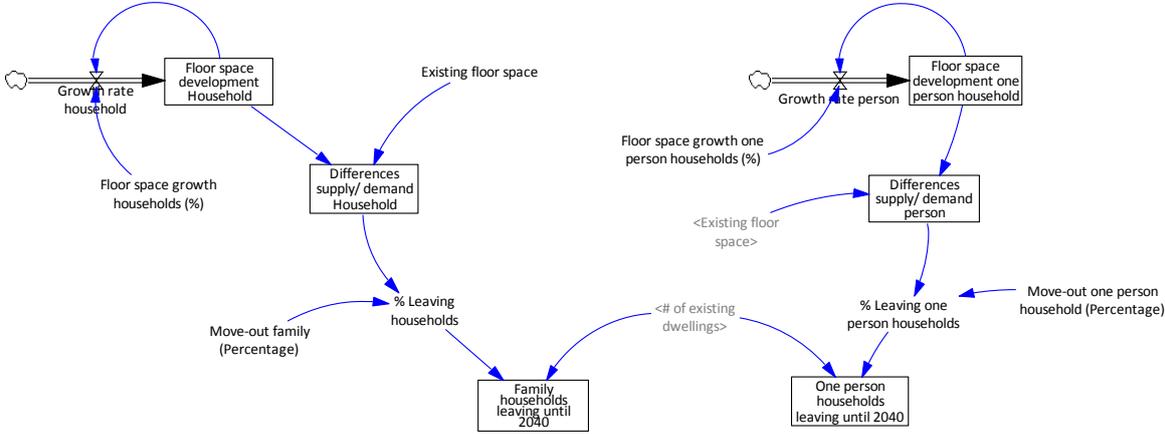


Figure 16; Social sub-system, outflow of households (determined by the differences between supply and demand)

Second part of the social development is determining the (extra) number of potential new tenants up to 2040. Basis for this prediction are the population increase of the agglomeration of Western Holland, 12 percent, variable is called *family growth percentage* (StatLine, 2011). And the nationwide increase of singles which is 32.4 percent, variable is called *single growth percentage* (StatLine, 2011). To determine the potential new inhabitants up to 2040 the stock and flows on the left hand side are been used. Also here a clear distinguishing is been made between the families and the one person households. This is the result of the differences in growing percentages and the different influences. Within the model the growing percentages, variables are called respectively *Family growth percentage* and *Single growth percentage*.

The dwelling development depends on the potential new move-in rate and the possible move-out rate. Figure 16 shows two stocks at each end, which are *Family households leaving until 2040* and *One person households leaving until 2040*. Within figure 17 they are also been mentioned, because they have an enormous influence on the potential new inhabitants. The more dwellings will come free, the more new inhabitants can take place.

As already mentioned before and showed in figure 16 the number leaving inhabitants relies on the existing floor space, but of course the *existing floor space* will also determine the number of the new potential inhabitants. This number is based on the opposite of the (growing) move-out percentage, the more people will leave the less people will be interested.

Paragraph 4.1 described the relation between the supply and the demand, for families and one person households, regarding floor space. If e.g. families will leave because of the floor space, probably one person households will move-in. This move-in/ move-out development is also modelled, showed by the arrow between *Family households interested* and *Houses reserved for single households*.

This part of the sub-system, figure 17 will end up with a stock and flow, on the right hand side which shows the *dwelling development until 2040*. The input for this is of course the family and one person developments.

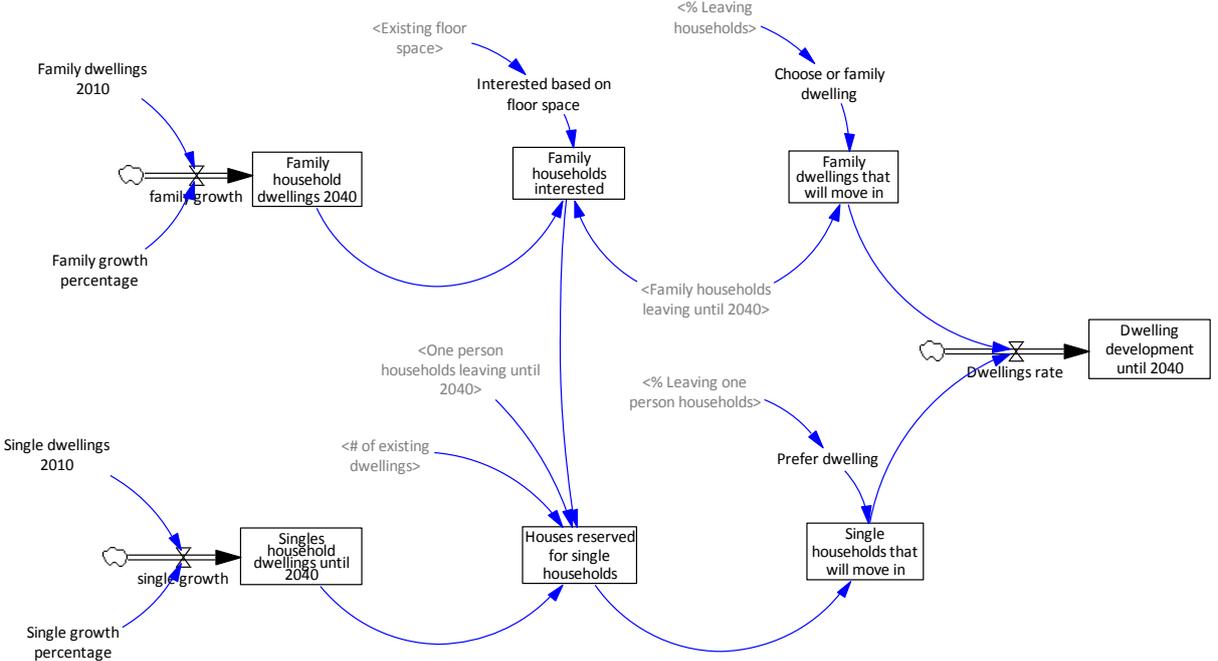


Figure 17; Social sub-system, determines the households inflow

The third, and maybe the most important part of the ‘social development’ sub-system, is the stock and flow, figure 18. This stock (in grey) will represent the *total number of occupied dwellings until 2040*. The inflow is called *potential occupied houses until 2040*, and is determined by figure 17. The outflow represents the *number of free dwellings until 2040*, which is based on the stock flow the stock and flow at the right hand upper corner, see figure 18. Predicting the number of free dwelling until 2040 is determined by three different variables. Those are *% Leaving households*, *% Leaving one person households* and the *Technical quality after maintenance*. The first two are already been determined by figure 16, but the third one will be determined by the second sub-system, called ‘*energetic/ technical quality.*’ According to paragraph 5.2 those are responsible for respectively 37 and 24 percent of the move-out percentage.

Also mentioned by paragraph 5.2 was the move-out rate as a result of criminality 32 percent. This is not being taken into account within this model, for two reasons. One, it is out of the scope from this research in spite the influence of it. Two, it is not the field of research were I am expert in. So to make sure that maybe wrong conclusions can be drawn it is not be part of this System Dynamics model.

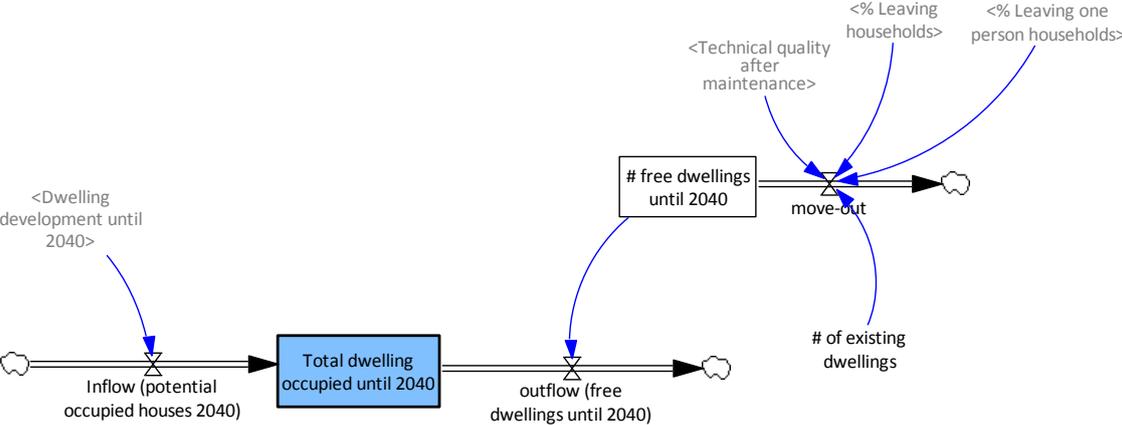


Figure 18; Social sub-system, represents the occupied dwellings up to 2040

## 4.2 Energetic/ technical quality:

The move-out percentage of inhabitants depends not only on the social developments, which is already showed in figure 18. Another important element which is responsible for the move-out percentage is the energetic/ technical quality, figure 19.

The purpose of this sub-system is two-sided, one determine the move-out percentage as a result of the (declining) technical quality. And two, determine the energetic quality, represented by the energy label.

Starting point for this sub-system is the variable *year of built*. The technical quality and the energetic quality are both directly and indirectly relying on the *year of built*. To determine the technical quality the existing situation will be used. For the energetic quality or energy label also the existing situation will be used.

This whole sub-system consists only of two stocks, *energy label* and *technical quality after maintenance*, see figure 19. Reason is that almost all the different variables are 'real' fixed numbers and do not change over time, excluding the two stocks. The first stock, the *energy label* will shows the number of points, according to the new WWS, appendix 1. This will simultaneously influence the rental price, which will be determined by the sub-system finance, figure 22. By changing the other variables other options can be chosen for e.g. large scale renovation or label upgrade. This will influence the WWS scoring.

Critical element in the battle against technical decline is the *maintenance period*. Like figure 19 shows the maintenance period relies on the *technical quality*, which a derived from the *year of built* is. In paragraph 5.2 the move-out percentage as a result of the poor dwelling quality is described, in this case 24 percent. The result of the technical quality and the move-out percentage is represented in the stock *technical quality after maintenance*. This output is been used as input in the first sub-system, figure 18, in order to predict the number of free dwellings as a result of the technical quality.

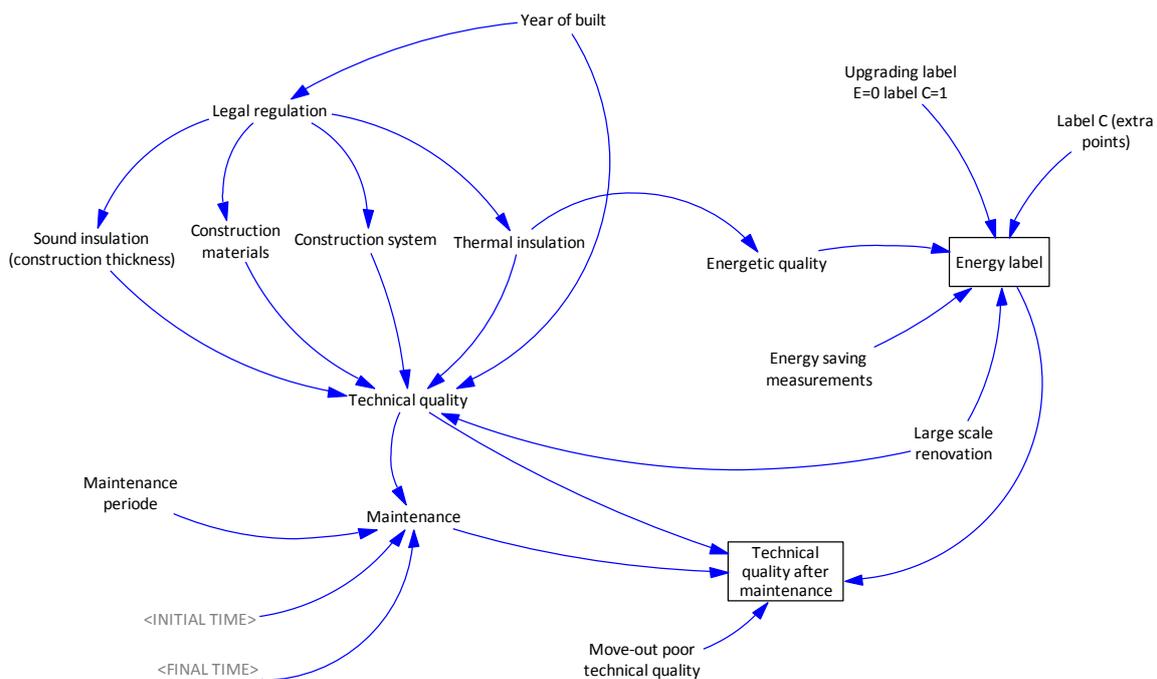


Figure 19; Sub-system energetic and technical quality

### 4.3 Construction/ renovation time

The construction or renovation time is modelled with the purpose to discover the financial impacts, described in the next paragraph, paragraph 4.4.

Before new estate could be placed first the old apartments blocks needs to be demolished. It does not take rocket science to understand that not all the apartment blocks can be demolished and rebuild simultaneously. This redevelopment process is based on the so called first in, first out (FIFO) principle and is represented in the following stock and flow model (pipeline delay), figure 20.

The apartment blocks will be demolished until all the existing blocks are been demolished. After the first blocks are been demolished the construction of new estate can begin, until all the blocks are been rebuild.

The demolition speed is determined by the variable *demolition per year* based on previous redevelopment projects. Same goes for the variable *construction rate*. Variable *construction start* depends on the number of demolished blocks, the construction of new estate will only start if the first blocks are been demolished.

With use of this model the total redevelopment can be determined. Simultaneously it shows also the number of apartment blocks which are still standing, which are been under construction and which are been occupied or finished, see appendix 5. This will have a great impact on the financial situation, see figure 22.

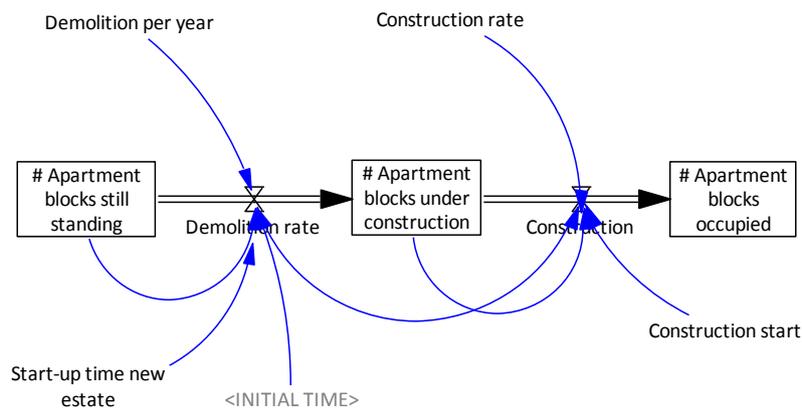


Figure 20; Sub-system, construction time new estate

Figure 21 differs not that much in comparison to the above mentioned figure. In spite of that it is less complicated in comparison to figure 20. The existing dwellings do not have to be demolished first.

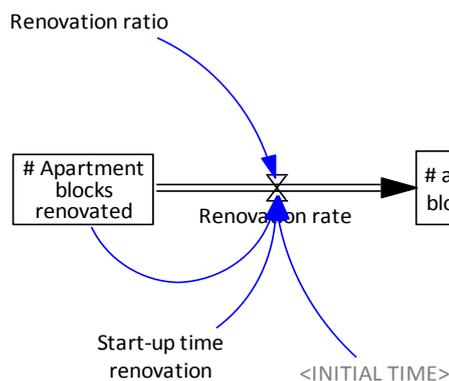


Figure 21; Sub-system, renovation time new estate

## 4.4 Finance

The social developments, the energetic/ technical quality and the construction/ renovation time are all influencing the financial position of the housing corporation. The extent to which the earlier mentioned sub-systems will have on the financial position of the housing corporation, will be determined by the following stock and flow, figure 22.

The inflow consists of the annual income, based on the variable *total dwellings occupied until 2040* see figure 18 and their monthly rent. The monthly rent is based on the so called WWS scoring, which is influenced by the different variables mentioned in figure 22. Some of those aspects are the *floor space* and the *energetic quality*, see figure 19.

The outflow is based on the variable *annual overhead costs* and *renovate/ new estate costs*. Also within this sub-system the result of the inflow minus the outflow is the stock, called *turnover per year*.

For as well renovation as well the construction of new estate money is needed. It can be assumed that the housing corporation do not have enough private equity that they can finance their own (re-) developments projects. Within this research there is chosen for a bank loan situation with an interest rate of 5 percent. This is already being taken into account in the shadow variable *renovation/ new estate costs*.

In paragraph 5.5.2 (construction renovation time) the number of dwellings in rent will also have a large influence on the financial situation. During as well renovation as well the construction of new estate the majority of the dwelling can still be rent. This is been taken into account within this model, by the variable *dwellings in rent during redevelopment*, see figure 20.

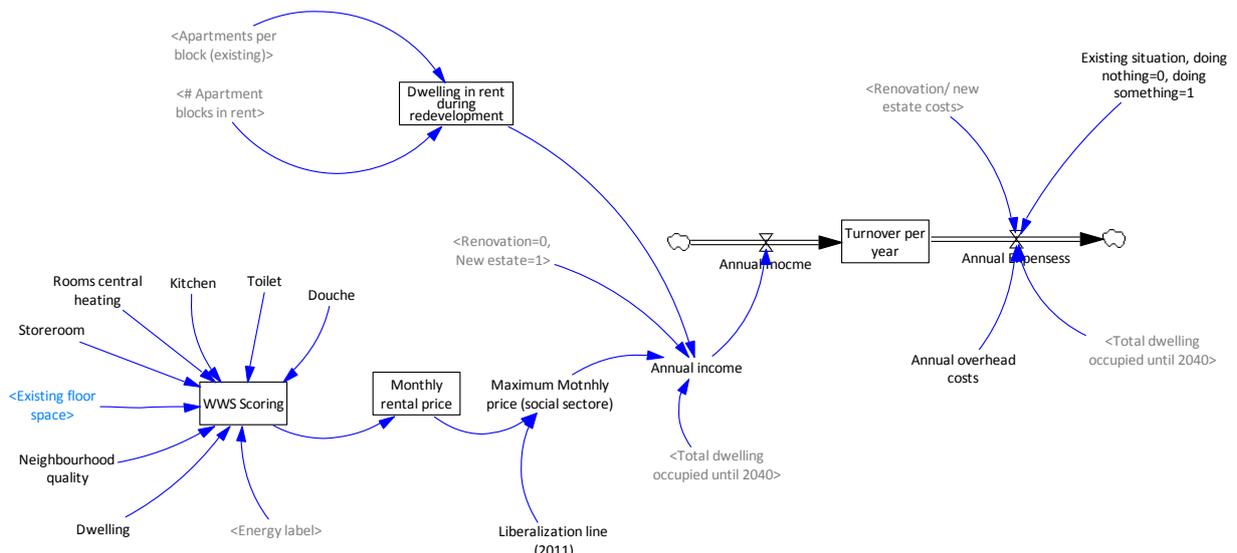


Figure 22; Sub-system, financial

## 5 CASE STUDY:

The designed System Dynamics model will be applied on a real case, the case study. Aim of this case study is to determine the demand up to 2040, based on the contextual orientation, chapter 3. In order to make a well balanced decision between renovation or new estate.

For this case study the following neighbourhood is chosen in collaboration with housing corporation *De Alliantie* Amsterdam, Slotermeer. This neighbourhood is divided into two different areas, Slotermeer Noord Oost and Slotermeer Zuid West. Within this research only Slotermeer Noord Oost will be used.

*De Alliantie* does not own the entire neighbourhood, they own only a percentage of the total 4200 dwellings. This means that there will be some differentiation between the simulated 'entire' neighbourhood and the real neighbourhood. As already mentioned the early post-war neighbourhood are characterized by standardization. In the extension of this the differences between the simulated and the real neighbourhood will mainly differ on building level, like technical aspects. There will also not be made a distinguishing between the apartments and the terraced houses. Within this short and tight time frame it will be too complex to divide the apartments and the terraced houses as well, with in the simulation model. The remaining elements will be based on neighbourhood wide information.

### 5.1 Neighbourhood description:

The selected neighbourhood is located at the west site of Amsterdam, like showed in figure 23. And like many early post-war neighbourhoods also this one is located at the boundary of the city. Two main roads are connecting this area one, from Amsterdam to Haarlem N200, and two the ring way A10.



Figure 23; Map of Amsterdam Slotermeer Noord Oost (source; Google Earth)

Slotermeer Noord Oost is a typically early post-war neighbourhood. Beside that it is built right after World War II, it has also the typically early post-war characteristics, like mentioned in paragraph 3.1.2 This means that the elements like green, light, and air are well recognizable, see figure 23 and 24. The same goes for the urban structure.



## 5.2 Supply existing housing stock:

Based on the information from *De Alliantie* this paragraph will determine the supply of the existing housing stock, in Amsterdam Sloterveer Noordoost. The following figure, figure 25 will give a clear overview of the existing neighbourhood situation. Afterwards a short description will be given.

Inventory Sloterveer Noordoost		
<b>Social:</b>		
Total dwellings		4200
Dwellings owned by housing corporations		2982 (71 percent)
Population/ inhabitants		9240
Singles/ one person households		2100 (50 percent)
Household composition		2.2 persons per household
Move-out/ rate on average (within 2 years)		31 percent
- Insufficient floor space		37 percent
- Criminality		32 percent
- Dwelling quality		24 percent
<b>Technical:</b>		
Body/ 'Sound insulation' (between two or more houses)		120 mm
Thermal insulation (Rc-value)		0.0 m <sup>2</sup> ·K/W
Thermal insulation (EPC)		n.a.
Heating/ warm tap water		CR-Ketel
Window		HR ++ (Double glazing)
Ventilation		Ventilation grills
Energy label		E
Floor space per dwelling (situated within apartment block)		50 m <sup>2</sup>
<b>Legalisation and regulation:</b>		
90 percent policy; maximum combined annual income		€ 33.614,-
Maximum monthly rent social housing		€ 652.52
<b>Financial:</b>		
Monthly rental price tenants, <i>De Alliantie</i> dwelling		€ 509.47,-
Exploitation costs per dwelling e.g. maintenance		€ 2000,-/ year
Renovation costs		€ 1800,- m <sup>2</sup>
New estate costs		€ 2000,- m <sup>2</sup>
<b>Other:</b>		
Renovation time (based on previous projects)		20 blocks per year
Demolition time (based on previous projects)		12 blocks per year
Construction time (based on previous projects)		8 blocks per year

Figure 25; Overview of Sloterveer Noord Oost and the reference dwelling

Sloterveer Noordoost consist of 4200 dwellings today [www.cbsinuwbuurt.nl](http://www.cbsinuwbuurt.nl) which a collective of as well low rise as well high-rise. 71 percent (2982) of those dwellings are in hands by different housing corporations (*Gemeente Amsterdam, 2010*). The majority of the dwellings are situated in apartment blocks. Dwellings which are situated within the apartment blocks do have a floor space of 50 square metres and the terraced houses do have an average floor space of 60 square metres. 66 percent of the total dwellings do have a floor space between the 40 and 59 square metres (*Gemeente Amsterdam, 2010*).

In line of this an average of 50 square metres will be used. In cooperation with *De Alliantie* the terraced houses will not be taken into account within this research.

Remarkable are the number and differentiation of inhabitants. The total number of inhabitants is 9240 people, which means an average household composition of 2.2 persons. This is closely to the average household composition nationwide, which are 2.22 persons. But that in on average the real numbers are a little bit different. 50 percent (Gemeente Amsterdam, 2010) of the existing dwellings (2100) are owned by one person households. The other 50 percent are owned by families, consisting of 3.4 persons per household.

As already mentioned in paragraph 3.2.3 the majority of the inhabitants, in the early post-war neighbourhood, are immigrants from foreign countries. Sloterveer Noordoost is not an exception in this, 70 percent of the total inhabitants are immigrants [www.cbsinuwbuurt.nl](http://www.cbsinuwbuurt.nl). Like mentioned in paragraph 3.2.3 this will lead to a higher level of criminality (Heeger, 1993; Wassenberg, 1993; Power, 1997; Murie e.a., 2003; Skifter Andersen, 2003; Turkington et.al., 2004; Musterd & Van Kempen, 2005), which will speed up the move-out rate (Knorr-Siedow & Droste, 2003). This is exactly what is going on within this area. For almost one-third, 32 percent, of the tenants this is the number two reason to move (Gemeente Amsterdam, 2008).

First reason to move out is the insufficient floor space of the dwelling. 37 percent of the tenants discover this as a problem (Gemeente Amsterdam, 2008). Second reason, which will not be taken into account is criminality, 32 percent. The third reason to move out is the technical dwelling quality of the existing dwelling, 24 percent (Gemeente Amsterdam, 2008).

Three main reasons to move-out; insufficient floor space **37 percent**, criminality **32 percent**, and existing dwelling quality **24 percent**.

As already mentioned 24 percent of the tenants discover the existing dwelling quality as a problem, and not without a reason. The body of those apartment buildings constructed of a concrete structure with a thickness of 120 mm. This do not reduce noise nuisance from neighbours, like also mentioned in paragraph 3.3.1.

Another point which is related to the dwelling quality is the presence of thermal insulation. The buildings do not have any form of thermal insulation. The only thermal and living quality increasing measurement which is been taken are new windows. As a result of large scale maintenance in the late 1990's the existing (steel or wooden) windows are replaced by windows made from plastic and double glazing (HR++). Simultaneously some ventilation grills are been placed, in line with the then requirements. In combination with the replacement of the existing geyser for a central heating boiler (Dutch; CR-ketel) the dwellings have an 'energetic quality' of label E.

All the above mentioned aspects results in a monthly rent of € 509,47 net, which is based on the existing WWS. For specifications of the used reference dwelling see appendix 2.

As described earlier this research will not make a differentiation between dwellings. In line of this the annual income will by 4200 multiplies by the monthly income.

Housing corporation *De Alliantie* work with a annual overhead cost of approximately € 2000,- per dwelling per year. This will be marked as expenses.

The renovation, demolition and construction time are been based on previous projects from housing corporation *De Alliantie*.

### **5.3 Starting points/ demand in 2040:**

In line with the scope of this research and the time not all the previous mentioned subjects will and can be used as a starting point for the case study. Based on as well the literature study, their practicability and their relevance, and in collaboration with experts interviews by *De Alliantie* the following bullet points will be used as a starting point for the case study. The purpose of those starting points is to describe the demand in 2040.

#### **5.3.1 Social:**

Until 2040 the number of one person households will increase by 32.4 percent, from 2.6 million today to 3.5 million in 2040, which are 900.000 people. In spite of the population growth of 5.4 percent nationwide by 2040, the population growth in the city of Amsterdam would be 12 percent. This will have an enormous effect on the housing market. An addition of at least 43.000 dwellings will be needed until 2040.

#### Floor space

In line with the expectations and the increasing quality of life the average dwelling floor space will grow significant until 2040. The average dwelling floor space demand will grow to an astonishing 175 square metres. By 2040 the floor space per person or single family dwelling the floor space demand will be doubled in comparison to today. It will increase to 100 square metres.

This growth in floor space demand will also have its effect on the average household composition. This will decline to 2.09 persons per household in 2040.

#### **5.3.2 Technical (building level):**

In the extension of higher living standards sound insulation certainly will get more attention in the future. According to the Dutch building decree a concrete wall thickness of 250 mm is required to reduce noise nuisance. By 2040 the wall thickness will be increased to 280 mm of concrete. Within this research a wall thickness of 250 mm concrete is been taken into account for renovation, and 280 mm concrete for new estate.

Thermal insulation is one of those elements which have a positive effect on our living comfort. But it has a higher goal which is reducing the energy consumption for heating. As already mentioned for new estate the Rc-value will be qualified by the EPC. For renovation conversely the EPC is not leading instead of this the Rc-value is prescribed separately.

Higher living standards and the growing importance of energy reduction will result until 2040 in the following requirements for new estate in: EPC 0.0 and a Rc 6.0 m<sup>2</sup> ·K/W. For renovation a Rc 4.0 m<sup>2</sup> ·K/W will be used.

Achieving this lowering EPC depends not only on insulation, but also on ventilation and heating. For this reason a HRU (Heat recovery Unit) will be considered for new estate. For renovation the instalment of natural ventilation will be sufficient enough. A HRU is not required by renovation because renovation does not have to meet the (lowering) EPC.

Heating and warm tap water will in both situations renovation and new estate, be provided by a HP-107 (High Performance) central heating boiler (Dutch; HR-107 combi ketel). At the moment this is the most energy efficient central heating boiler which is on the market.

### **5.3.3 Legislation and regulation:**

In the future (unfortunately it is not clear when) a new scoring system will be introduced the WWS (WoningWaarderingsStelsel). In spite of that it is not clear when it will be introduced it will be taken into account within this research. The scoring card and system of this new WWS is enclosed in appendix 1.

In comparison to the existing scoring system the energy label will be implemented within the new WWS. This is done by the growing importance of energy consumption and energy reduction. In line with the scope of this research only the multifamily dwellings/ apartment blocks will be considered. This means that a maximum score of 40 points can be devoted to an energy label A++.

Within the Dutch building decree the minimum requirements for the construction industry are set. It developed over time and it is still developing to ensure that it will meet our expectations of living. Within this research the minimum requirements specified in the Dutch building decree draft 2010 will be used ([Bouwbesluit 2010, 2010](#)). And when possible the presumed requirements until 2040, with regard to e.g. insulation, will be used. Notice that there will be a difference between the requirements with regard to renovation and new estate.

### **5.3.4 Finance:**

The monthly rent will be determined with use of the WWS scoring system. Beside this the national government has set a maximum monthly rent for the social housing sector which is € 652,52. Within this research nor the inflation nor the annual rent increase will be taken into account.

### 5.3.5 Overview:

The following figure will summarize the 'demand' up to 2040, based on the above mentioned starting points.

Category	Until 2040 w.r.t. 2010
<b>Social:</b>	
Population growth (nationwide)	5.4 percent (17.471.000)
Population growth Amsterdam	12 percent (836.744)
Singles growth (nationwide)	32.4 percent increase
Household composition	2.09 persons per household
<b>Technical:</b>	
Sound insulation (between two or more houses)	280 mm concrete
Thermal insulation (Rc-value)	6.0 m <sup>2</sup> ·K/W (determined by EPC)
Thermal insulation (EPC)	0.0
Heating/ warm tap water	HR 107 -Combi (at least)
Floor space (per household)	175 m <sup>2</sup>
Floor space (per person)	108 m <sup>2</sup>
<b>Political: (legalisation and regulation)</b>	
New WWS (WoningWaarderingsStelsel) Maximum monthly rent in 2010 for social housing: No maximum is set for the non-controlled housing sector	€652.52

Figure 26; Overview of the dwelling changing's up to 2040

## 5.4 Simulations:

To make a well based decision between renovation and new estate, first the demand in 2040 and the supply will be compared, which is been showed in figure 27. The political aspects are been described individually because they are influencing the social and technical aspects of the dwelling and the neighbourhood. All the aspects are based on the starting points, mentioned in paragraph 5.3.

Demand and supply Sloterveer Noordoost		
Category	Supply today	Demand 2040
<b>Social:</b>		
Dwellings	4200	4952 (752)
Population/ Inhabitants	9240	10349 (1109)
Singles	2100	2780 (680)
Household composition	2.2	2.09
<b>Technical:</b>		
Sound insulation (between two or more houses)	120 mm concrete	280 mm concrete (160mm)
Thermal insulation (Rc-value)	0.0 m <sup>2</sup> ·K/W	6.0 m <sup>2</sup> ·K/W (determined by EPC)
Thermal insulation (EPC)	n.a.	0.0
Heating/ warm tap water	CR-ketel	HR- 107 ketel
Ventilation	Natural (Ventilation grills)	HRU (Heat Recovery Unit)
Energy label	E	A++ (6 steps)
Floor space (per household)	50 m <sup>2</sup>	175 m <sup>2</sup> (125)
Floor space (per person)	50 m <sup>2</sup>	108 m <sup>2</sup> (86)
(...) = differences		

Figure 27; Supply and demand overview

The supply of the existing housing stock will be used as starting point. In line with the technical quality, the living quality and from a financial point of view three different options will be simulated.

All the three simulations are all in collaboration with *De Alliantie* determined, and all the simulations will take the new WWS scoring system and national support rule into account. Four different settings will be simulated by use of the earlier described System Dynamics model, chapter 4. The four different simulations are:

- **Simulation 1:**  
Simulation 1 will only contain the necessary maintenance up to 2040.
- **Simulation 2:**  
Within simulation 2 only the energy label will be upgraded, from label E to C, as required within the new WWS. According to the energy label calculation in appendix 3 this can be achieved by replacing the existing central heating boiler (CR-ketel) for a HP-107 (High-Performance) central heating boiler (Dutch; HR-107 ketel). Based on the information from *De Alliantie* this will cost approximately € 1.800,- per dwelling.
- **Simulation 3:**  
Addition on simulation 2 is simulation 3. Within this simulation all the dwellings will completely renovated. Within this simulation only the legal regulations for renovation, stated in the Dutch building decree 2011, will be applied. Aspects like dwelling numbers and floor space will not change.

- Simulation 4:

This simulation will contain new estate. All the existing buildings will be demolished and new estate will be built. This simulation will meet all the expectations of living of today, a floor space of 100 square metres will be used. And it will meet all the 'minimum' requirements for new estate, stated in the Dutch building decree 2011.

From as well a financial point of view as well a quality point of view the existing urban structure will be maintained, there where possible. Financially it will save a lot of money because the existing infra structure can be reused.

The four different simulations are compared and visualized within the following figure, figure 28.

Simulations					
Category	Existing situation	Simulation 1 (Maintenance)	Simulation 2 (Label upgrade)	Simulation 3 (Renovation)	Simulation 4 (New estate)
<b>Building characteristics:</b>					
Dwellings	4200	4200	4200	4200	4200
Floor space (dwelling)	50 m <sup>2</sup>	50 m <sup>2</sup>	50 m <sup>2</sup>	50 m <sup>2</sup>	<b>100 m<sup>2</sup></b>
Energy label	E	E	<b>C</b>	<b>A</b>	<b>A++</b>
Rc- value	0 m <sup>2</sup> ·K/W	0 m <sup>2</sup> ·K/W	0 m <sup>2</sup> ·K/W	<b>3.5 m<sup>2</sup>·K/W</b>	<b>6.0 m<sup>2</sup>·K/W</b>
EPC	n.a.	n.a.	n.a.	n.a.	<b>0.6</b>
Heating/ water	CR- ketel	CR-ketel	<b>HR-107 ketel</b>	<b>HR- 107 ketel</b>	<b>HR- 107 ketel</b>
Ventilation	Natural	Natural	Natural	<b>Nat. + mech.</b>	<b>HRU</b>
Sound insulation equal to:	120 mm	120 mm	120 mm	<b>250 mm</b>	<b>280 mm</b>
Execution speed	-	-	<b>1000 dwel./ year</b>	<b>20 blocks/ year</b>	<b>8 blocks/ year (new)</b>
-Additional speed					<b>12 blocks/year (demolition)</b>
Execution costs	-	-	<b>€ 1.800,-/ dwelling</b>	<b>€ 1.800,-/ m<sup>2</sup></b>	<b>€ 2.000,-/ m<sup>2</sup> (new)</b>
-Additional costs	-	-	-	-	<b>€ 100.000 per block (demol.)</b>
Overhead costs	€ 2.000,- dwel./ year	€ 2.000,- dwel./ year	€ 2.000,- dwel./ year	€ 2.000,- dwel./ year	€ 2.000,- dwel./ year
* Cells written in <b>bold</b> differs in comparison to the existing situation					

Figure 28; Simulation overview

All the four different simulations are been simulated with Vensim PLE, the System Dynamics software, in order to make the right the decision for a sustainable future. Renovate or new estate.

### 5.5 Results of simulations:

Within this paragraph an overview will be given of the most striking and important results of the four System Dynamics simulations. All the four the simulations are based on the existing situation in Slottermeer Noord Oost, like described in paragraph 5.1 and 5.2.

#### 5.5.1 Social development:

The following figures will show the dwelling development for the four different simulations, until the year 2040. In line with the structure of this thesis and the structure of the System Dynamics model and the sub-systems, first the social developments will be described.

The aim of the first sub-system was to predict the number of households which are leaving as a result of the existing floor space. Also a clear distinguishing was noticed. This because on one hand the existing floor space was maybe not sufficient enough for the families but maybe for the one person households it was. The move-out percentages were conducted by a research done by the municipality of Amsterdam. After simulation the following values are been found, for the number of family households which will leaf until 2040.

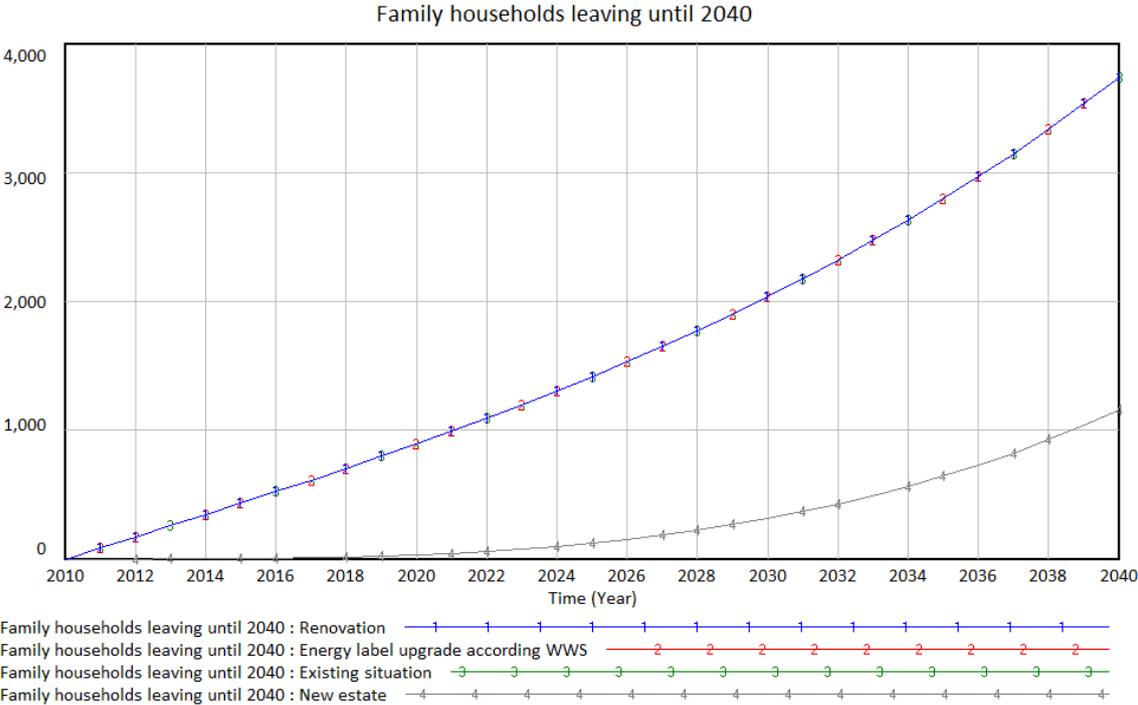


Figure 29; Development family households

Figure 29 shows the number of households which are leaving, notice this are dwelling numbers and not the number of inhabitants. Remarkable is to see the enormous differences between the simulation 1,2,3 and simulation 4. When the floor space, the supply, is not sufficient to with regard to the demand this will happen. By the year 2040 approximately 3740 of the family households will have left the neighbourhood, by a floor space of 50 square metres. By a floor space of 100 square metres conversely the number of leaving households is significant lower. Approximately 1150 family households will have left. But these are only the number of leaving family households. The following figure, figure 30 will show the number of single households which will leave until 2040.

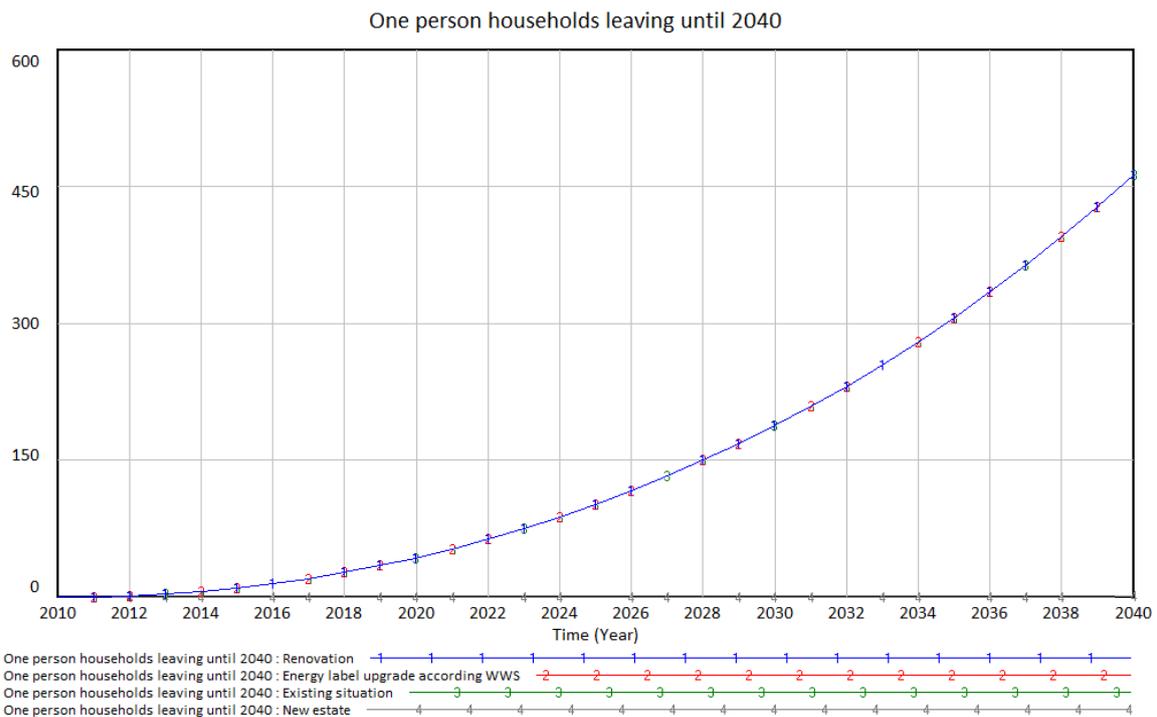


Figure 30; Development one person households

What strikes immediately is the number of one person households that will leave, figure 30. In comparison to the leaving family households, figure 29, (vorige) this is almost one-tenth. By 2040 just more than 450 one person household have left the neighbourhood as a result of the existing floor space, simulation 1, 2, and 3. Simulation 4 is based on a floor space of 100 square meters resulting in a move-out rate of 0 (zero) one person households. This is devoted to the change in supply and demand for the one person households, mentioned in paragraph 3.2.6.

But of course there will be not only inhabitants leaving. As a result of the housing shortage in Amsterdam and the increasing population in Amsterdam and the agglomeration of Western Holland, new potential inhabitants will move in, see paragraph 3.2.5.

The following figure, figure 31 shows the total dwelling development until 2040. This dwelling development is a collective of as well the family households as well the single households. Based on the potential inhabitants, predicted by use of the sub-system *social developments*, part two, see figure 17.

The outcome of the figure is maybe not what you would expect at first sight. Simulations 1, 2, and 3 are increasing until 2026 to just above the 2500 tenants, and then it will start to decline. Those simulations will by 2040 have reached an inflow of 1500 new tenants.

But remarkable is simulation 4, which stay more or less steady. This could be explained by the floor space, which is 100 square metres, and the move-out percentage which is related to this floor space. As already described in paragraph 4.1 the number of free dwellings will be filled by new tenants immediately, as consequence of the housing shortage in Amsterdam. Within simulation 4 not that much tenants will leave so not that much new tenants will move in.

### Dwelling development until 2040

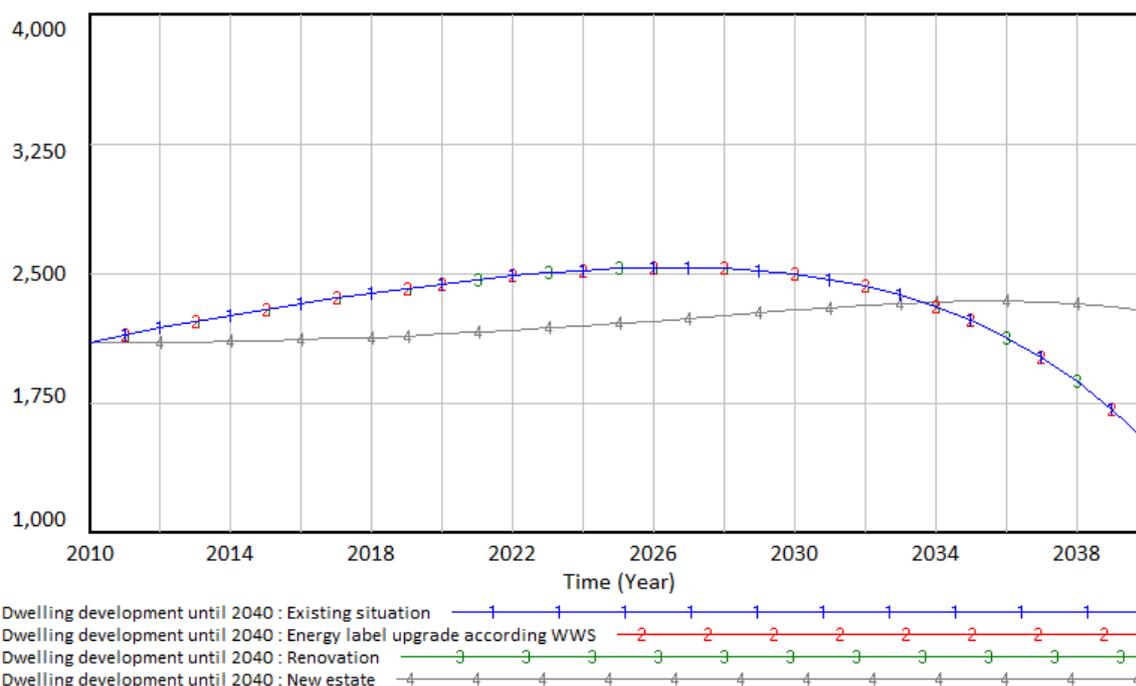


Figure 31; Dwelling development, move-in

On one hand the number of free dwelling is determined and on the other hand the number of new tenants is been predicted. With use of the stock and flow model in figure 18 the total number of occupied dwellings can be determined. This resulted in the following figure, figure 32.

### Total dwellings occupied until 2040

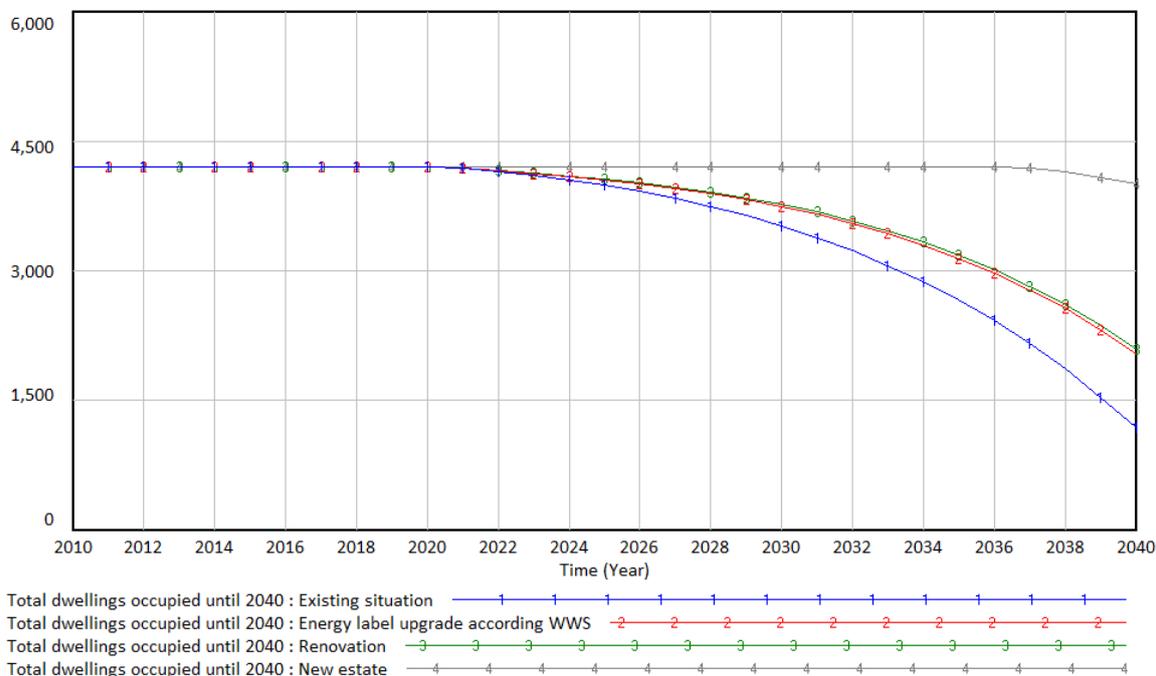


Figure 32; Dwelling development, move-out

Remarkable is the large differences between the existing situation, simulation 1 and new situation, simulation 4. In all the four simulations the number of occupied dwellings will drop, but by one harder than the other one. Striking is it that three of the four simulations,

simulation 1, 2, and 3 the starting point/ year of decline is almost the same. They will all start to decline at the same time, around the year 2020. But what differs is the decline acceleration. In all the three the simulations this is different, resulting that in all the three the simulations the level of occupied dwellings is different until 2040.

Simulation 1, blue line, will end up around the 1175 occupied dwelling in 2040, simulation 2, red line, will end on approximately 2040 occupied dwelling. And in simulation 3, green line, the level of occupied dwellings will be declined to almost 2100 in 2040.

Simulation 4, grey line, conversely is really a different story. Also here the level of occupied dwellings will decline, but it will start 16 years later, namely in 2036, in comparison to simulations 1,2, and 3. The number of occupied dwellings will only drop by approximately 190 dwellings, to 4010 in 2040.

That also simulation 4 will start to decline around the year 2036 can be explained by the lack of information after 2040. Today we see that the early post-war dwellings are totally in line with the requirements of the one person households, with regard to floor space. The singles of today will take place in dwellings of the past. This is also the same process which is going on around 2036. If e.g. the floor space per one person household will increase to 150 square metres around 2060. Then the singles of 2060 will move in the family dwelling of 2040, with a floor space of 175 square metres. For this principle see figure 9 and 17.

Figure 32 shows clearly that renovation or new estate will definitely influence the number of occupied dwelling in comparison to the existing situation. Beside that the number of occupied dwellings will have an effect on the financial situation of the housing corporation. It also will influence the liveability within the neighbourhood. If the inflow of new inhabitants cannot meet the outflow of inhabitants dwelling will become empty and the more dwelling become empty the more people will also move. This could be compared to the snowball effect. Nobody wants to life in an abandoned area.

The differences between simulation 1 and 4 is significant. By the year 2040 simulation 1 will end up by 1175 occupied dwelling. Simulation 4 conversely will end up by 4010 occupied dwellings. This is a difference of 2835 occupied dwelling. Even in the renovation simulation the level of occupant dwellings will decline, to approximately 2100 by 2040. Still this is a significant difference of almost 2000 occupied dwellings.

Not only on social level will the four different simulations have an enormous influence. It does not take rocket science to understand that the less dwellings are occupied the less income will be generated for the housing corporation. The financial consequences for as well renovation, new estate and the number of occupied dwellings will be described in the next paragraph.

### 5.5.2 Financial:

As mentioned within this research two aspects will have an influence on the financial situation of a housing corporation. First aspect is the number of occupied dwellings, which determines the annual income, represented by figure 32. And second the expenses, all the four simulations will have a different impact on the financial situation, figure 33.

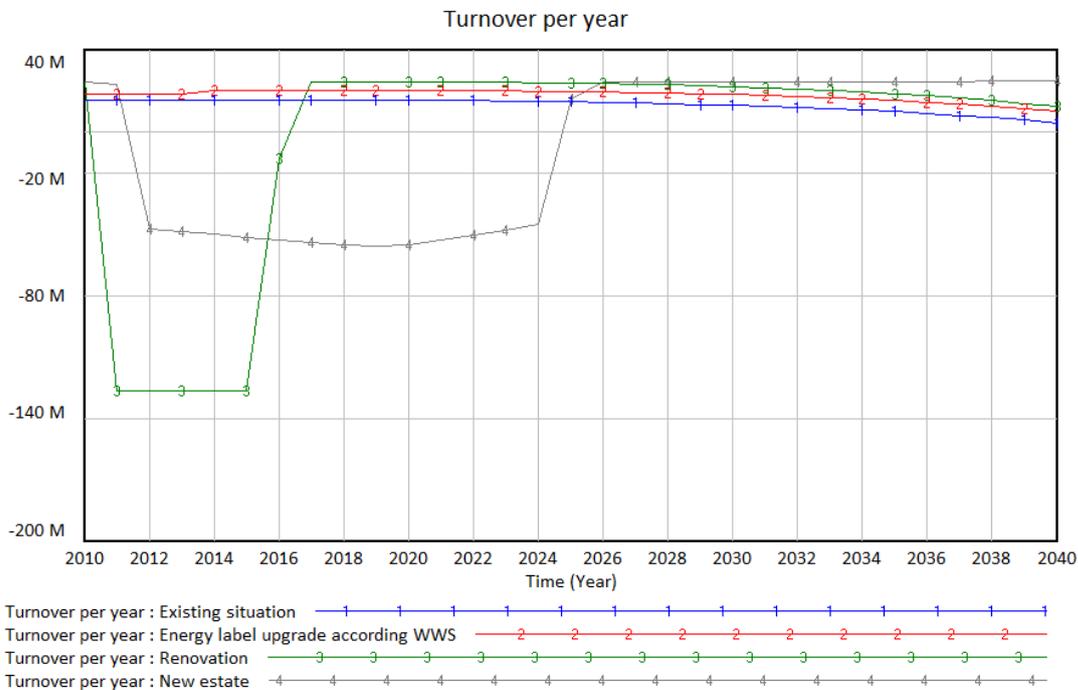


Figure 33; Turn over Housing Corporation

Figure 33 shows the housing corporations annual turnover. As a result of the declining number of occupied households in simulation 1 and 2 also the annual turnover will decline. The blue line, simulation 1, shows that the annual turnover, which is today approximately € 14.5 million, will decline to approximately € 4.3 million in 2040. Compared to today that is a decline of € 10.2 million or 70 percent!

Within simulation 2, red line, a higher turnover is represented, which could be explained by a higher rental price. This higher monthly rental price is the result of the higher energy label, which is part of the WWS scoring.

Striking are the differences between simulation 3, renovation and simulation 4, new estate. On the first sight renovation will costs much more in comparison to new estate, but is it? The green line, simulation 3 renovation, shows that during 4 years an investment of approximately € 128 million per year is needed to renovate the existing housing stock. The grey line, simulation 4 new estate, shows that new estate will costs less money annual but over a longer period of time. New estate will costs approximately € 55 million a year, 12 years long. The differences in years and expenses can be explained by the differences between the different costs and development times.

Remarkable is further that in only one simulation, simulation 4 new estate, the turnover will not decline over time, like the other simulations do. The turnover of simulation 4, the grey line, will more or less stay steady around the € 24.5 million. In all the other simulations the

turnover will drop, as a result of the declining number of occupied households. This will have a negative effect for reaching its break-even point.

The following figure, figure 34 will show the total profit of all the four different simulations. In comparison to figure 33 this figure will show the financial situation of the housing corporation, will they make profit or will they make loss?

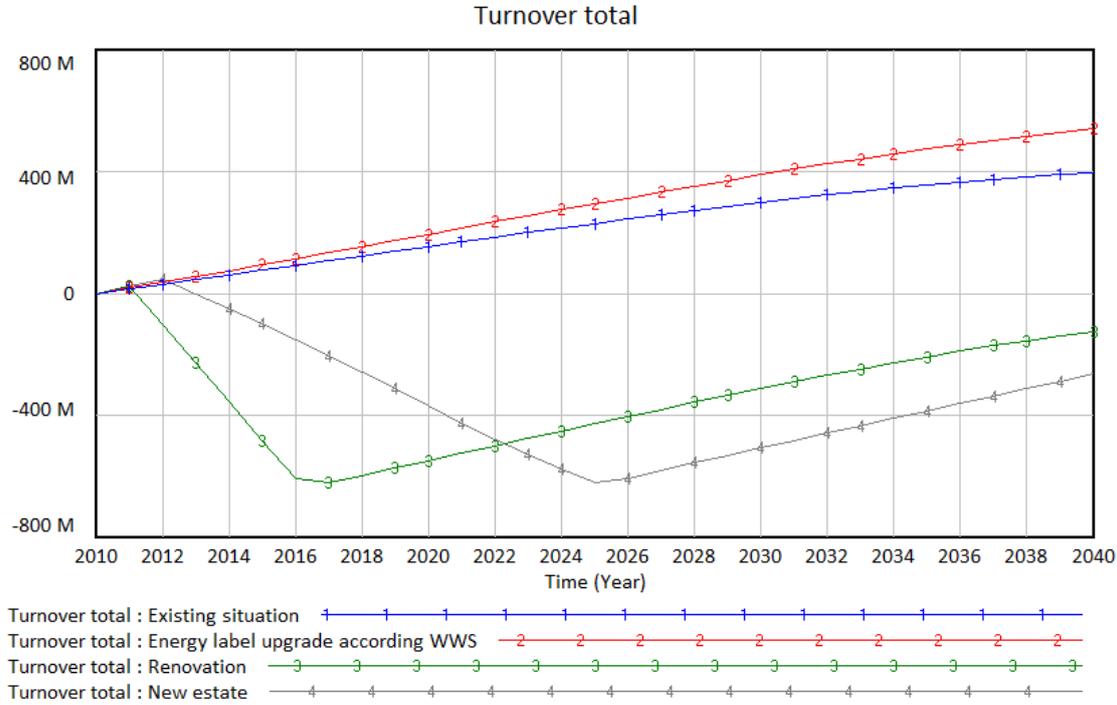


Figure 34; Financial situation

At first glance it is to see that as well simulation 1, blue line, as well simulation 2, red line will have a positive effect on the financial situation. In both simulations a total profit is generated of € 395 respectively € 540 million up to 2040.

As well the renovation simulation, green line, as well the new estate simulation, grey line, are both not making any profit in a timeframe of 30 years. Simulation 3 will result in a loss of approximately € 127 million by 2040, simulation 4 conversely will have a loss of approximately € 263 million by 2040. This does not mean that simulation 3 and 4 will not make any profit at all, they will but over a longer period of time. Extrapolate will give roughly the position of the breakeven point which is for simulation 3 around 2054 and for simulation 4 around the year 2052.

Housing corporations do have some private equity, but they certainly do not have enough to finance projects like large scale renovation or new estate. Like already mention in this case there is chosen for a bank loan situation, with an interest rate of 5 percent, annually. The following figure, figure 35, will show what the actual bank loan will be after completion of the four different simulations.

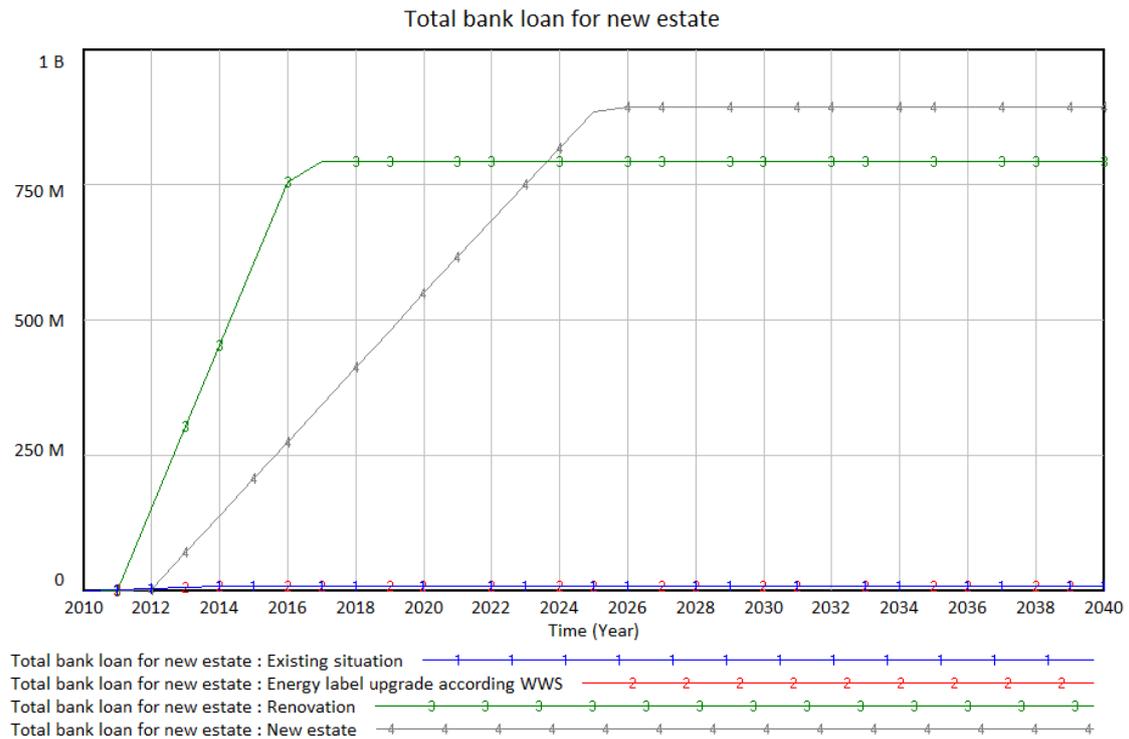


Figure 35; Total (bank) loan needed

Renovation is mainly preferred over new estate because it is cheaper, but is it, and if it is cheaper how much is the difference. Figure 35 shows the total bank loan needed in the four different simulations. If renovation, simulation 3, will be executed a total bank loan of almost € 800 million will be needed. For new estate, simulation 4, a total bank loan of almost € 900 million will be needed. Renovation is indeed cheaper in comparison to new estate, the difference is 'only' € 100 million.

Upgrading the energetic quality to label C, simulation 2, will only costs € 8 million.

Figure 35 shows beside the height of the needed bank loan also the development of the loan. For financial managers this information could be very valuable in order to make a well based decision.



## 6 CONCLUSION:

In this chapter the conclusion and finding of this research will be described. Within the first paragraph the research question will be answered and described. Afterwards some particular aspects will be described which the conclusion is based on. In the second part some conclusions will be written with regard to sustainable development and the influence on as well renovation as well new estate.

But first an answer on the research question will be given.

### 6.1 Answer main research question:

Starting point for this research was the following research question:

*“What will be the most sustainable solution for the early post-war dwellings, owned by housing corporation ‘De Alliantie’, renovate or new estate?”*

This research concludes that in the challenge to solve the technical, social and political problems, new estate has to be preferred over renovation towards a more sustainable future.

Motivation for this, maybe remarkable outcome is as follow.

Renovation is from different perspectives, maybe more sustainable in comparison to new estate. But renovation will only upgrade the energetic and technical quality and not the dwelling floor space. And in line with the expectations of living it is particular this element will become more and more a decisive factor. Meeting the demand of the expectations of living (e.g. floor space development) is much more important than upgrading the energetic and technical quality. This is the result of System Dynamics model which is applied on the case study Amsterdam Sloterveer Noord Oost. Different simulations have showed that only new estate will contribute to a more sustainable future because it will meet the expectation of living for at least 26 years! Renovation conversely will only meet the expectations of living for a maximum of 10 years. In line of this could be concluded that renovation will not contribute to a more sustainable future because 10 years after renovation the buildings should be demolished anyway. From an environmental perspective the impact will be even more than demolishing the buildings right now. It does not take rocket science to understand that this will also not be advisable from a financial perspective.

Renovation is not an option towards a more sustainable future if the dwellings cannot meet up the expectation of living in the future.
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Overall could be concluded that making the right decision for renovation or new estate should not be made from an environmental perspective and it certainly cannot be made on financial aspects. Making the right decision for as well renovation as well new estate should also be made on the expectations of living.

A sustainable future is much more than only adding some energetic measurements. A sustainable future is a future in which buildings can still meet the demand in the future. If they can meet up the expectations of living in the future and after some technical decline renovation is needed, than a sustainable future is created.

### **6.1.1 The importance of lifestyle**

The floor space development has become a central element within this research. This because one, it shows the change in lifestyle and, two which is much more important this variable is measurable. This is a condition for the use into the System Dynamic model.

The change in lifestyle in relation to the floor space is already been going on. This research concludes that there is a significant relation between the supply (the existing dwelling) and the demand, regarding the dwelling floor space.

At the moment the existing floor space of 50 square metres is totally in line with the demand for single or one person households. For most of the families the dwelling floor space is not sufficient anymore. As consequences of this they will move out.

This research has also showed that the expectations of living are changing and that they still will change up to 2040. Remarkable is the floor space development in relation to the average household composition. The average household composition will be declined to 2.09 persons per household. The dwelling floor space demand will conversely increase from 100 square metres today to 175 square metres in 2040. This means that in spite of the declining household composition the average dwelling floor space will only increase. This could be devoted to the change in lifestyle and the expectations of living.

As a result of the floor space development more surface needs to be lightened and heated. To realize this is an efficient and sustainable way will be a real challenge in the future.

Also related to the dwelling floor space and the development of it is of course the energy consumption. The larger the dwelling floor space the more surface needs to be lightened and heated. Mainly this last aspect will be a real challenge for the future in order to reduce the energy consumption. At the moment it is already a real challenge let alone it will be in the future.

Even when the floor space demand will stabilize on the level of today, even then the number of occupied dwellings will decline, see appendix 4.

### **6.1.2 Social development**

Another point why new estate should be preferred over renovation is the social developments and mainly the urbanization process. As already mentioned in paragraph 3.2.5 a massive increase in population of 12 percent is predicted for the city of Amsterdam. To accommodate all those potential new inhabitants Amsterdam had to add 43.000 dwellings, at least by 2040. It is common known that the city centre will be a realistic option because vacancy land is scarcity and intensify is not the option. The early post-war neighbourhood conversely are characterized by their widely setup, so vacancy land will be available here. From this point of view also new estate should be considered over renovation.

It does not take rocket science to understand that if intensify take place it also will have some financial consequences. But mainly by intensifying an area also the profit will rise.

### **6.1.3 Financial**

Of course choices cannot rely on social predictions and conjectures only, it also has to be financial attractive and financial profitable. With use of the System Dynamic model 4 different simulations are been simulated with their own entire financial outcome, see figure 33 and 34.

For renovation a total of around € 800,- million will be needed, new estate conversely will cost € 900,- million, see figure 35. In spite of that renovation will costs € 100,- million less in comparison to new estate it will maybe not reach break-even. Unfortunately as a result of the models limited time frame the simulation does not show this point. But by extrapolation of the simulations it can be found. For renovation the break-even point can be found around the year 2054. In spite of the higher investment costs new estate will reach break-even around 2052. This could be easily explained because the level of occupied dwellings will decline by the renovation simulation. In the extension of this it will be doubtful if after renovation break-even will be reached anyway!

New estate is in spite of the higher investment costs on the long term a much better choice in comparison to renovation.

Another important element for this financial conclusion is the construction and renovation time. This will have an effect on the expenses but on the bank loan and the income from rent. If the construction and demolition time could be accelerated it will mean that the inhabitant could move in faster. And this of course will have a positive effect on the monthly and annual income. This finally will have an effect on the bank loan and the payback time. The faster this redevelopment process is been completed the earlier break even can be reached. The earlier this can be reached the earlier profit can be made.

## **6.2 Conclusions sustainable development**

The national government consider sustainability as paramount importance. New and stricter legal regulations will be introduced or are already been introduced. All have one common purpose, making the world a little more sustainable. However this research concluded that by those rules the world definitely will be a little more sustainable, with the emphasis on ‘a little.’

### **6.2.1 Dutch building decree**

An important tool for the national government, in the challenge to a more sustainable future, is the Dutch building decree (Dutch; bouwbesluit). It is applicable on all construction projects as well renovation as well new estate. Over time the legal regulations are tighten up, for as well renovation as well new construction projects. However this research mentioned a difference between the ‘minimum’ requirements for renovation and new estate. For new estate those ‘minimum’ requirements are much ‘higher’ in comparison to new estate. In some cases the ‘minimum’ requirements are even not applicable on renovation projects.

Does the Dutch building decree not just stimulate renovation projects, in spite of the much more sustainable new construction projects?

This research concludes that as a result of this difference only new estate ‘really’ contributes to a more sustainable future. Further concludes this research that as a result of the ‘lower’ ‘minimum’ requirements for renovation, renovation can/ will be seen as a possibility to avoid the much higher and stricter requirements for new estate.

### 6.2.2 Energy label

The energy label shows the energetic quality of a house, compared to a reference house. But this research has showed that the reliability of this label is doubtful. In spite of that it will only give a prediction of the annual energy consumption. It will also not take critical elements in consideration in the right way e.g. the heat resistance of thermal insulation. The heat resistance of a dwelling for example will only be categorized by poor, moderate, and good. But when is good, good, or when is bad, bad? This is of course very fuzzy. In line of this concludes this research that the configuration of the energy label should be changed to make sense. But now it does not!

### 6.2.3 New WWS

Making the energy label part of the WWS scoring should stimulate or ‘force’ housing corporations towards a more sustainable future. But it does not!

As a result of the integrated energy labels a maximum of 40 points for the energetic quality could be obtained for apartments. In comparison to the ‘old’ existing scoring system (maximum 26) this means a difference of maximum 14 points. But this research has also showed that the monthly rent depends on many different factors, e.g. floor space, which impact is much greater than anything else, see appendix 2.

The maximum monthly rental price, which is determined by the national government is € 652,52. This equals 141 WWS scoring points. In other words tenants within the social housing sector do not have to pay more than € 652,52 or 141 point, in spite of the ‘real’ WWS scoring.

But what will be the maximum floor space for new estate by taking the maximum of 141 points into account. With use of reverse calculation the maximum floor space is determined, based on the reference dwelling, see appendix 2. The results are showed in figure 36.

Floor space	Basic dwelling scoring*	Energetic scoring		WWS scoring
49	100	‘old’ WWS	12	112
49	100	Label E (new WWS)	5	105
49	100	Label C (upgrade)	15	115
49	100	Label A (renovation)	32	132
49	100	Label A++ (new)	40	140
100 (new estate)	151	Label A++ (new)	40	191
51 (new estate)	101	Label A++ (new)	40	141 (maximum)
59 (new estate)	100	Label A (new)	32	141 (maximum)
64 (new estate)	100	‘old’ WWS	26	141 (maximum)

\*Scoring excludes the energetic quality

Figure 36; Determination of the maximum floor space, based on the WWS scoring

The purpose of the new WWS is to stimulate and encourage sustainable development. But in spite of this, it does not encourage or stimulate sustainable development at all.

This research concluded that towards a more sustainable future the floor space is a decisive factor and not the energetic quality. A floor space of already 100 square metres is required for families. But based on figure 36 could be concluded that housing corporations never would built those houses within this segment. This for the simple reason that tenants in the social housing sector will not pay more than is determined by the national government. Housing corporations will not build houses which have a market value of e.g. € 893, 24 (191 points) while they get a rent of just € 652,52 per month. This means a loss of € 240, 72 per month per dwelling! In this case this means an annual loss of more than € 1 million.

Towards a more sustainable future the new WWS scoring system should not be introduced before is it adjusted. Integration the energy label in the WWS is a short term sustainable perspective. But it is far from sustainable for the future. Building for the future has to be encouraged and not counterworked. In line with the main conclusion of this research could be concluded that a more sustainable future begins with meeting the requirements of today and not of the past.

#### **6.2.4 National support (90 percent rule):**

As consequence of this income rule housing corporations could not rent dwelling to those which have a combined annual income of more than € 33.614,- per year. This will of course have an effect on the potential new inhabitants and the liveability of the neighbourhood.

This research concluded that the 90 percent rule, also know as the € 33.614,- income rule, will definitely have some influence. Housing corporations fear that as a result of this policy the liveability of the neighbourhood will start to decline. This research however concluded that as a result of the change in lifestyle (floor space demand) those 'low' income families also will move towards bigger houses. And this policy stimulates this by reducing the waiting list for social, by excluding those who do have an income of more than € 33.614,-. In other words the chance on a newer/ bigger dwelling will only increase for 'low' income households by excluding the 'high' income.

In fact this 90 percent income rule will stimulate 'low' income household because their chance for a newer and or bigger dwelling will only increase. Based on the System Dynamics model and the case study could be concluded that the effect of this policy will not really stimulate a bad society mix. In spite of this it maybe only accelerates the single households to move to those areas.

Of course this policy will have an effect on the liveability of the neighbourhood but it is out of the scope and research area to research to conclude this.



## 7 DISCUSSION

Some conditions and or conclusion of this research will be discussed within this chapter.

### 7.1 Renovation

- Within the research the renovation simulation contains only some energetic and technical measurements. The existing floor space will not change within this simulation. A possibility which is not been simulated and mentioned is the combination of two dwellings, with a floor space of 50 square metres each, to one dwelling. A study done by (Andeweg and de Jonge) has showed that this is possible and useful. In the neighbourhood Sloterveer Noord Oost this is also possible because it consist of comparable buildings. In this research this scenario is not be taken into account because from a social perspective this is not advisable. There is already been a housing shortage in Amsterdam, by combining two dwelling to one this will only reinforce this.

Financially this is also not advisable because combining of two dwellings will not automatically result in rental price which is twice as high.

### 7.2 Housing stock

- To make the System Dynamics model not too complicate some concessions are been done. The neighbourhood, Sloterveer Noord Oost, is owned by different housing corporations and private property owners. Within this research and in the model it is been stated that the whole area is in hand by one housing corporation, *De Alliantie*. Also the differentiation between the different houses and their quality are not been taken into account. In spite of this one reference house of De Alliantie is been used in order to make model complete.



## **8 RECOMMENDATIONS AND FURTHER RESEARCH:**

First part of this chapter will give some recommendations with regards to the use of system dynamics within the area of urban (re-)development and decision making. Second part will give some recommendations to housing corporation *De Alliantie* with regard to the redevelopment process in Amsterdam Slotermeer Noord Oost.

### **8.1 Recommendations:**

During this research I have experienced a lot with the system dynamics principle and the simulation software Vensim. From my point of view this was an ideal methodology to see and discover the relation between the different systems/ aspects variable and how they influencing each other. The biggest advantage of system dynamics is that it makes it possible to make simulation of certain decision over time and see the effect of it.

Self I have struggled a lot with the simulation program Vensim, it is far from easy and unfortunately there is no clear user manual or tutorial which explains the program.

After all I would recommend this methodology to those whom solve real life problems in a complex environment.

#### ***8.1.1 Housing corporation De Alliantie:***

Redevelopment strategy Slotermeer Noord Oost

As already concluded is new estate the best option for this area, but when to start? According to the new WWS housing corporation should upgrade their existing housing by at least two energy label steps, or to label B. This should be realized before 2020. In this light all the old buildings should be demolished before 2020.

With use of the sub-system 'construction/ renovation time' the exact date of start can be calculated. This will depend on the demolition and construction speed, see appendix 5.

If *De Alliantie* decides to maintain their existing housing stock after 2020, then the energy label needs to be upgraded by two energy label steps. This can easily be achieved by replacing the 'old' central heating boiler (CV-Ketel) for a new one, a HR (High Efficiency), see appendix 3.

#### ***8.1.2 Organization***

Housing corporation *De Alliantie* should consider implementing a research department within their organization. The purpose of this department will be 'measuring' the differences between the supply and the demand, and 'prediction' the future. This input will support the organization by making better strategic and more sustainable decisions for the long term, in spite of the short term.

## **8.2 Further research:**

Within this paragraph some suggestions will be given to make the whole puzzle complete. This is just one piece of the jigsaw puzzle.

- This research mentioned only the relation between a bad social mixture and the move-out percentage. This aspect will be of great importance on the liveability within the neighbourhood. Implementing this social aspect within the SD model will make the model more complete and more realistic.
- Within the existing model the energetic and technical quality are modelled very 'summary'. By expanding the model on this aspect it will on one hand make the model more reliable, while it on the other hand will increase the possibilities of the model. The model is now limited to the early post-war buildings only, by expanding the capacity on this aspect the model can also be used for other types of dwellings and buildings.

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## **APPENDIX 1: WWS SCORING SYSTEM**

Appendix refers to the paragraphs:

- 3.4.2 (WWS WoningWaarderingsStelsel)
- 4.2 Energetic/ technical quality
- 5.3.3 Legislation and regulation

This appendix includes the scoring systems, as well the existing which is been used today, as well the new one which will be introduced soon.



## APPENDIX 2: REFERENCE DWELLING (WWS SCORING)

This appendix refers to paragraph:

- 5.2 Supply existing housing stock
- 6.2.3 New WWS

The monthly rent will be determined with use of the scoring system. This appendix includes the scoring point of the reference dwelling which is been used within this research.

Scoring element	value	Points 'old' WWS	Points new WWS
Living	18,7m <sup>2</sup>		
Kitchen	5,9m <sup>2</sup>		
Bedroom 1	12,4m <sup>2</sup>		
Bedroom 2	8,5 m <sup>2</sup>		
Bathroom	3,5m <sup>2</sup>		
Total surface:	<b>49m<sup>2</sup></b>	<b>49,0</b>	<b>49,0</b>
Storeroom	4,2m <sup>2</sup>		
Attic	7,5m <sup>2</sup>		
<b>Total surface remaining not living surface</b>	<b>12,0m<sup>2</sup></b>	<b>9,0</b>	<b>9,0</b>
Heated rooms	5	10,0	10,0
Heated remaining spaces		1,0	1,0
Private central heating boiler (Dutch; cv ketel) CR-ketel		3,0	
Private combination heating warm water boiler		1,0	
Double glazing	9,0m <sup>2</sup>	3,6	
Floor insulation	0,5	0,5	
Roof insulation	0,5	0,5	
Façade insulation	1,8	1,8	
Energy label E			5
Length kitchen-sink unit (1 to 2 metres)		4	4
Toilet		3	3
Washbowl		1	1
Douche		4	4
Balcony , 1 metre wide			
Apartment, second floor, no elevator		1	1
Neighbourhood		17,5	17,5
<b>Total:</b>		<b>110</b>	<b>105</b>



## APPENDIX 3: ENERGY LABEL UPGRADE

This appendix refers to the paragraphs:

- 4.2 Energetic/ technical quality
- 6.2.3 New WWS
- 8.1.1 Housing corporation *De Alliantie*

After the new WWS is introduced Housing Corporation needs to upgrade their existing housing stock by at least two energy label step or to label B. In this case the energy label needs to be upgraded from label E to label C.

The following figure shows the current situation of the reference dwelling, and the new situation. Just the replacement of the existing central heating boiler (Dutch cv ketel) is already enough to achieve this!

Kenmerken	Huidige situatie van uw woning	Welke maatregelen wilt u nog treffen?	Maatregelen maximale energiebesparing
gevelisolatie	Geen	Geen	Goed
dakisolatie	Niet van toepassing	Niet van toepassing	Niet van toepassing
vloerisolatie	Niet van toepassing	Niet van toepassing	Niet van toepassing
ramen leefruimtes	Dubbel glas	Dubbel glas	HR++ glas
ramen slaapruidtes	Dubbel glas	Dubbel glas	HR++ glas
installatie	CR-combi	HR-combi	HR-combi+zonneboiler
ventilatie	Natuurlijk	Natuurlijk	Natuurlijk
PV-cellen (15 m2)	Nee	Nee	Ja
	Beginwaarden	Bewaar Pakket 1	Totaaloverzicht
<i>Let op: onderstaande resultaten zijn een indicatie. De werkelijke waarden kunnen voor uw woning afwijken. <a href="#">Meer informatie.</a></i>			
	Huidige situatie van uw woning	Resultaten van de hierboven geselecteerde maatregelen	Maatregelen maximale energiebesparing
Uw maandelijkse energiekosten gaan omlaag met		€ 17	€ 62
Financieringskosten maatregelen energiebesparing per maand		€ 7	€ 104
Uw maandelijkse voordeel is		€ 10	€ [-42]
De totale investering bedraagt		€ 3.114	€ 22.692
Daarvan wordt geïnvesteerd in energiebesparing		€ 1.173	€ 18.516
Energie label			
Comfort	★★★★★	★★★★★	★★★★★

Figure; Source; [www.energiebesparingsverkenner.nl](http://www.energiebesparingsverkenner.nl)



# APPENDIX 4: DEMAND STABILIZATION

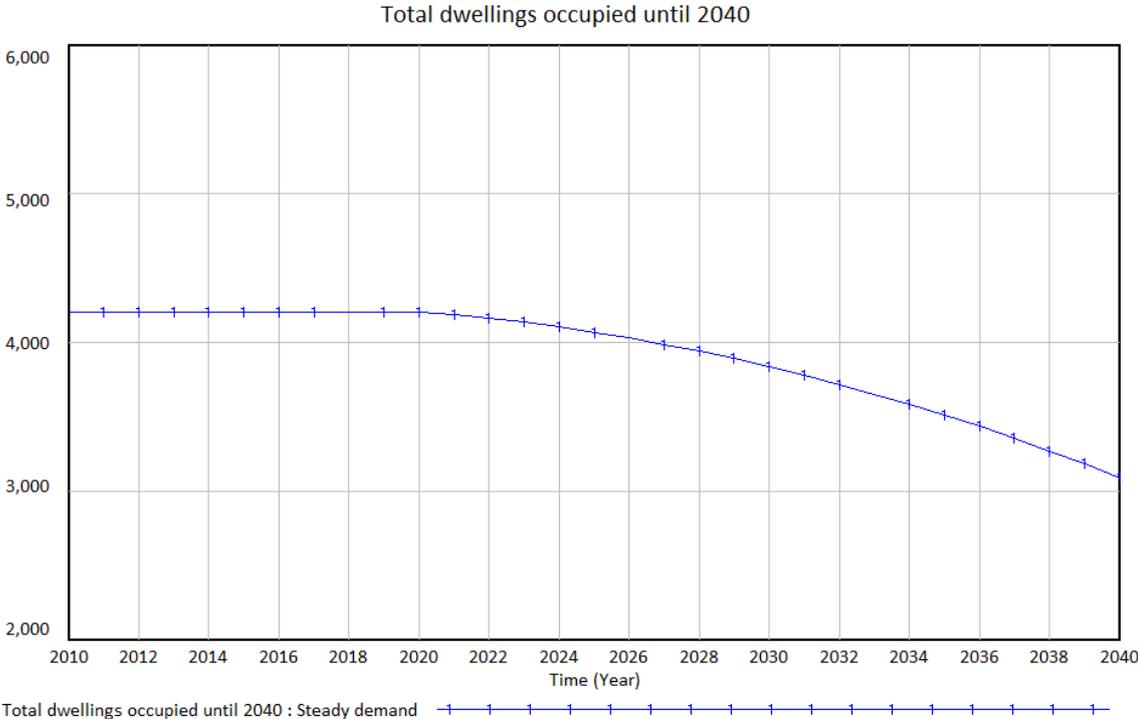
This appendix refers to the paragraph:

- 6.1.1 Social development

The following figure shows that even if the floor space demand will stabilize on the level of today even then number of occupied dwelling will start to decline. The demand of today is set on 100 square metres for family households and 50 square metres for one person households.

By 2040 the number of occupied dwellings will be declined by 1110 dwellings. This means that by 2040, 3090 dwellings will be occupied.

In spite of the stabilizing demand the supply is still not in line with the demand of families. Families will leave and the inflow of new one person households is not enough to fill up all the empty dwellings.









**APPENDIX 6: SUMMARY RENOVATE OR NEW ESTATE**