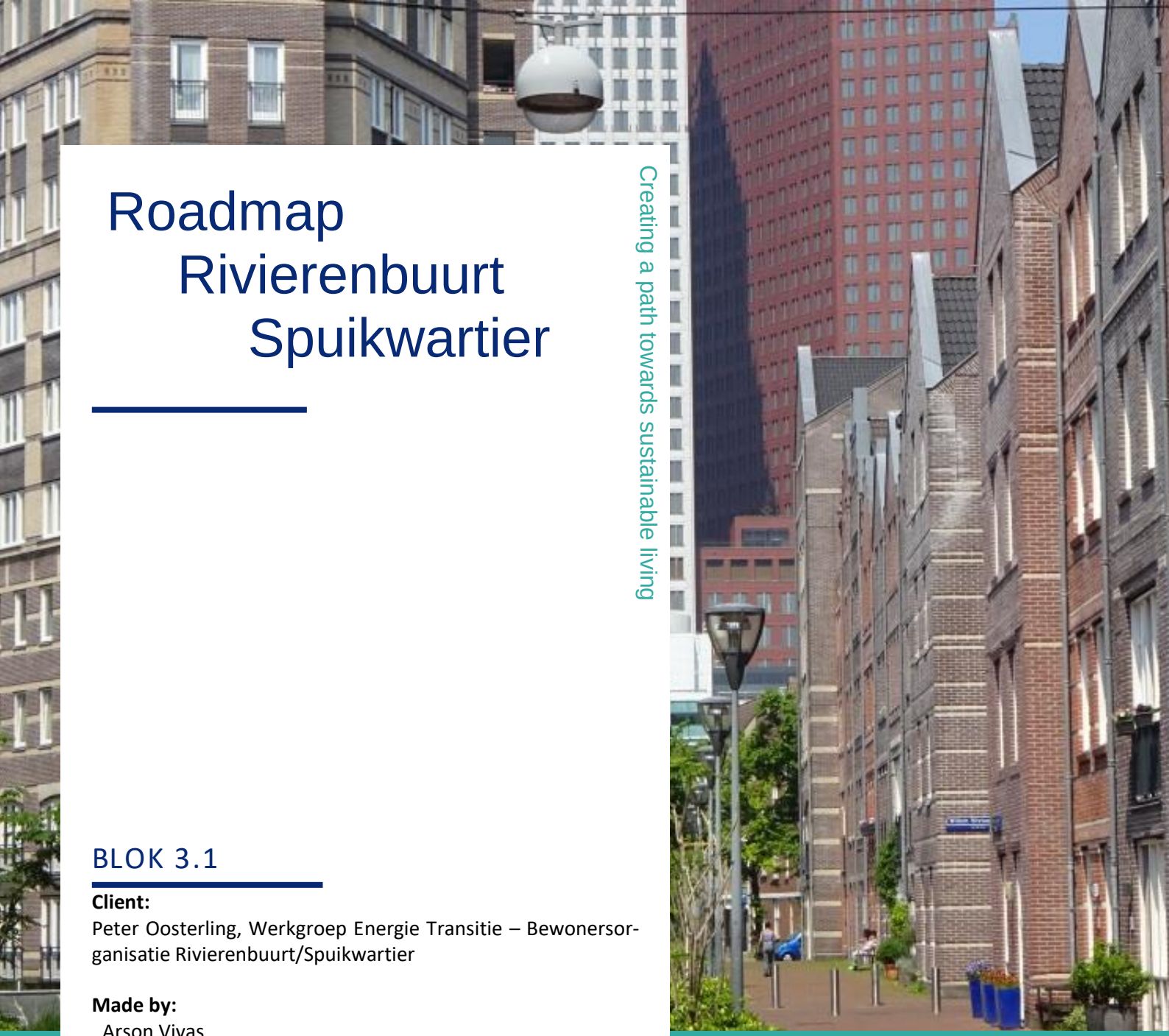
Roadmap Rivierenbuurt | Spuikwartier

Creating a path towards sustainable living



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Creating a path towards sustainable living

BLOK 3.1

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THE HAGUE UNIVERSITY OF APPLIED SCIENCES

Preface

This report is the outcome of an assignment for The Hague University of Applied Sciences for the study program of Spatial Development and Climate & Management. This project took place over the course of eight weeks and has as aim to design a plan to phase out natural gas out of given neighbourhood. In our case this was the Rivierenbuurt/Spuikwartier.

Every neighbourhood has their own unique challenges, but most of them had one problem in commons common is poorly insulated dwellings. However one request was specific for Rivierenbuurt/Spuikwartier which was to develop communication plan to involve the residents of Rivierenbuurt/Spuikwartier.

Reading this report will give the reader more insight on how it possible to phase out natural gas out of the Rivierenbuurt. The report looks at how to phase out gas out of Rivierenbuurt/Spuikwartier and what options are possible to replace the functions gas has in the neighbourhood. The report not only tackles techniques that are possible, but also finance, laws and regulations stakeholders.

The project was divided in four phases which were Preliminary research, transition scenarios, transition design and the final roadmap. In the first phase, the preliminary research, a research on the neighbourhood was done to have more insight on the strengths, weaknesses, threats and opportunities of Rivierenbuurt/Spuikwartier, The second phase, the transition scenarios, includes various different possibilities that were tested according to Multi Criteria Analysis. The third phase, The transition design, was intended serve as final proposal for regarding the phasing out of the gas out of Rivierenbuurt/Spuikwartier. And the last phase, which is the roadmap, is the final design for Rivierenbuurt/Spuikwartier.

Team Energy Transition Rivierenbuurt/Spuikwartier,
2019, October 30th
The Hague

Summary

De Werkgroep Energietransitie van de Bewonersorganisatie Rivierenbuurt/Spuikwartier wilt draagvlak onder de bewoners Rivierenbuurt/Spuikwartier creëren ten aanzien van de energie transitie. Er is daarbij gevraagd een plan te ontwikkelen die rekening houdt met de grote diversiteit van de buurt. Daarbij wilt de werkgroep een lijst hebben van de mogelijke maatregelen om de energietransitie binnen de Rivierenbuurt/Spuikwartier te realiseren. Tot slot ziet de werkgroep de realisatie van de energietransitie gecombineerd worden met een verhoging van de leefbaarheid in de omgeving.

Om een beeld te krijgen van de diversiteit en de technische mogelijkheden in de buurt is er eerst een onderzoek uitgevoerd. Dit onderzoek heeft zich met name gefocust op de interne en externe waardes van de buurt. De interne analyse is gefocust op de buurt zelf. Hierbij komt onder anderen de diversiteit van inwoners, woningbezit en het bouwjaar aan bod. Hieruit is gebleken dat de diversiteit niet enkel onder de inwoners te vinden is, maar bij alle facetten van binnen de wijk. Het externe onderzoek heeft zich met name gefocust op stakeholders, technische maatregelen, wet- en regelgeving en financiën. Elke onderwerp is uitgebreid onderzocht en overzichtelijk gemaakt.

Voor de ontwikkeling van een plan voor de realisatie van de energietransitie in de buurt, zijn er meerdere stappen genomen. Eerst is er door elke betrokken expert binnen dit project een scenario geschreven. Deze scenario's sluiten aan bij de kennis van de expert, het uitgevoerde onderzoek en de vragen van de opdrachtgever. Uit deze scenario's zal er aan de hand van een Multi Criteria Analyse één scenario naar voren komen die het meest geschikt is als basismodel voor het uiteindelijke planvoorstel. Het uiteindelijke gekozen basismodel is vervolgens verbeterd en heeft geleidt tot een concept versie voor het uiteindelijke planvoorstel.

De concept versie is uitgewerkt tot een definitief plan ten aanzien van de realisatie van de energie transitie voor de Rivierenbuurt/Spuikwartier. Het plan bestaat uit drie verschillende fases met een totale duur van 10 jaar.

De eerste fase is ontwikkeld om bewustzijn en draagvlak te creëren onder de bewoners en zal twee jaar duren. Hierbij worden en workshops en sessies georganiseerd om kennis te verspreiden. Ook biedt de eerste fase ruimte om contacten te leggen en voorbereidingen te treffen voor fase twee en drie.

De tweede fase is ontwikkeld om betrokkenen partijen met elkaar in contact te brengen en zal vier jaar duren. Niet alle woningen zijn in het bezit van de bewoners. Ook bijvoorbeeld wooncorporaties en verhuurders bezitten panden. Daarbij kan een pand in het bezit zijn van meerdere eigenaren. Installaties die kunnen zorgen voor gasloze woningen worden geleverd door bedrijven en subsidies kunnen aangevraagd worden bij de gemeente. Doordat al deze partijen een bijdrage in de energie transitie leveren, worden deze met elkaar in contact gebracht om kleine energie projecten op te zetten per woonblok. Daarbij worden de huidige panden beter geïsoleerd om de energievraag van bewoners naar beneden te brengen. De duurzame renovatie van gevels zorgt meteen ook voor een nieuwe en frissere uitstraling in de gehele buurt. Dit draagt bij aan een verhoging van de leefbaarheid in de omgeving.

De derde fase is ontwikkeld om de kleine energie projecten per woonblok tot een realisatie te brengen en zal vier jaar duren. Alle partijen zijn met elkaar in overleg gegaan voor een aantal jaar. Hieruit zijn afspraken en plannen naar voren gekomen die tot een realisatie gebracht kunnen worden. En omdat er per woonblok is gekeken naar oplossingen is er een collectief plan ontwikkeld door in te zetten op de participatie van de burger. Hierdoor is het een bottom-up initiatief en is er een plan op maat gemaakt.

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1 – Introduction

With the current developments in climate change, the search for sustainable energy plays a major role. At this moment, the most energy is produced by the use of fossil fuels. However, fossil fuels have many disadvantages. For this reason, the world is busy transitioning to sustainable and renewable energy sources. This is called *Energy Transition*.

The Trias Energetica is a strategy to tackle the energy transition by providing energy saving measures. The strategy consists of three different steps.

- Step one: Reduce the energy consumption
- Step two: use renewable energy sources.
- Step three: Use fossil energy sources as efficiently as possible.

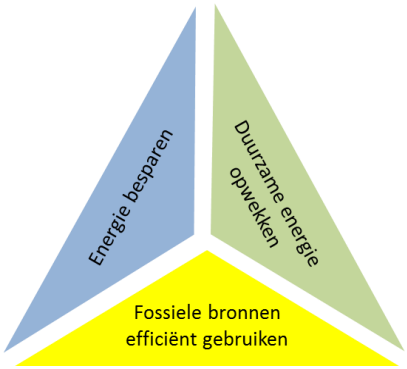


Figure 1: Trias Energetica

Step one is about architectural measures to reduce the energy consumption. For example, by insulate the building. Step two is about the use of renewable energy sources instead of use the energy from fossil energy sources. Examples for renewable energy sources are the sun or the wind. Step three is the last step in the Trias Energetica. When everything is done to get about energy reduction and getting energy from renewable sources, the rest of the energy can be taken from the fossil energy sources. Its needs to be assured that the installations and lighting work as efficient as possible. (Schrooten & Schrooten, 2019)

1.1 The reason

The municipality of The Hague wants a plan for the energy transition designed for every neighbourhood by 2021. This energy transition plan also applies to the neighbourhood Rivierenbuurt/Spuikwartier. The Rivierenbuurt/ Spuikwartier Energy Transition Workgroup wants to create support among the residents of the neighbourhood on the basis of a bottom-up initiative. The intention is that the residents will be activated and will participate in this transition in the future. All this raises the final question: *"How does the Energy Transition Workgroup create a support base among residents and homeowners of the Rivierenbuurt/Spuikwartier with regard to the energy transition? "*


Figure 2: Project area, Rivierenbuurt / Spuikwartier

1.2 The assignment

The municipality of The Hague has been working on the issue of the energy transition for some time. But not only the municipality but also neighbourhoods themselves are working on this transition. The Rivierenbuurt/Spuikwartier residents organization has set up a working group that is aimed at motivating residents to be part of this energy transition. The client would like to see a communication plan developed to get the residents going. But the question has also arisen of investigating the opportunities and possibilities within the neighbourhood for the various neighbourhoods.

The main objective for the Energy Transition working group is currently: Getting the residents along. To achieve this goal the derivative goal is promoting awareness amongst resident. Therefore a clear and good communication plan has to be designed. Into account must be taken of a large diversity in accommodation (age, quality and property), households (background), knowledge and level of interest, as well as the partial disposal of corporation ownership.

There is also an insufficient insight into the characteristics of the whole neighbourhood. Before thinking of solutions, a good quantification of the neighbourhoods is needed. Also, an overview of alternative sources, possibilities and opportunities for energy and/or heat solutions for the neighbourhood is needed.

It is also necessary that the liveability of the neighbourhood is made transparent by the use of the Liveability Effect Report (LER) instrument of the municipality of Den Haag. There is a great need to have the situation characteristics registered for each building, whereby separate non-linked systems must be avoided.

1.3 The approach

This project focuses on creating support among the residents of the Rivierenbuurt and the Spuikwartier with regard to the energy transition. It also takes into account which possible measures can be implemented in the project area and how liveability can be improved. Four steps were taken for the realization of this energy transition project. The full effect of the process can be found in **Chapter 2**.

Part A: Preliminary research

In the preliminary research of the project, the research is divided into two segments. The first part is a neighbourhood analysis that should map the internal strengths and weaknesses of the project area. Research has been done based on the client's request (**§1.2**). The second part of the research consists of a DESTEP-analysis that maps the external opportunities and threats of the project area.
The data collected from the two analyses is combined in a SWOT-analysis. The SWOT-analysis serves as a conclusion of the collected data. On the basis of the SWOT-analysis it becomes clear what needs to be focused on when designing the energy transition in the project area.

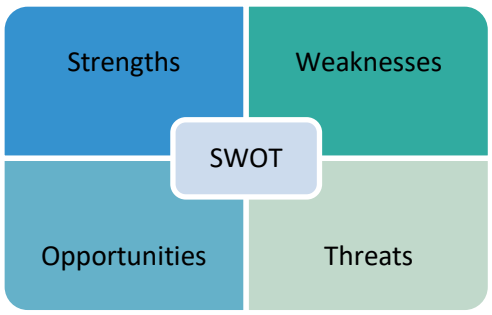


Figure 3: SWOT

Part B: Transition scenarios

For the transition design, three steps are taken that lead to a definitive and appropriate design for the Rivierenbuurt/Spuikwartier. The first step is the writing of multiple scenarios by the team members working on the project. Each expert writes a scenario that matches the expertise of the relevant expert.
The second step is to test the scenarios against a Multi Criteria Analysis (MCA). By using this method, one scenario, tested against the predefined criteria, will emerge with the highest score. The chosen scenario is then used as a basic scenario to improve on, this is step three. The other scenarios are used as inspiration for improvement. This will ultimately lead to the final transition design.

Table 1: Rating table MCA

Rating Table			
Criteria	Measuring unit	Weighting factor	Cost/ Benefit (C/B)
Communication	%	10,00	C
Environment	%	3,00	C
Social	%	4,00	B
Finance	%	6,00	B
Technical	%	7,00	B
Transition	%	9,00	B
Policy and law	%	1,00	B

Part C, Transition design

One scenario has been designed from the Transition scenarios that serves as a basic model for the elaboration of the final transition design. The final transition design is the final plan proposal for the client's question regarding the energy transition.

Part D, Roadmap

The definitive transition design with regard to the energy transition in the Rivierenbuurt/Spuikwartier will be visualized on the basis of a roadmap. The roadmap must serve as a clear overview for the client.

1.4 Reading guide

The report is divided into the four parts as described in the approach (§1.3). To this end, chapter two will first go into more detail about the process that has led to the production of this report.

Part A contains seven chapters that describe the preliminary investigation. Chapter three is the internal neighbourhood analysis that has been carried out. This chapter deals with data about the Rivierenbuurt and the Spuikwartier. Chapters four to nine describe the different steps of the DESTEP-analysis. Starting with the Demographic of The Hague, followed by Ecology, Stakeholders, Law and regulations, Technology and finally Finance. Part A is then concluded with a conclusion in the form of a SWOT-analysis in chapter ten.

Part B contains three chapters that describe the path to the final scenario, starting with chapter eleven. Chapter eleven briefly describes the written scenarios for the project. Chapter twelve concerns the Multi Criteria Analysis that was performed to test the scenarios. Part B is then closed with chapter thirteen in which a short variant of the final scenario is described.

Part C also contains three chapters that further explain the three phases of the final scenario. All phases deal with communication, concerning actors and possible measures with regard to the energy transition. Chapter fourteen discusses the first phase of the final scenario. Chapter fifteen then discusses the second phase of the final scenario. Finally, part C concludes chapter sixteen that deals with the third and final phase of the final scenario.

Part D contains the visualized pathway of the transition design as a roadmap.

2 – Process explanation

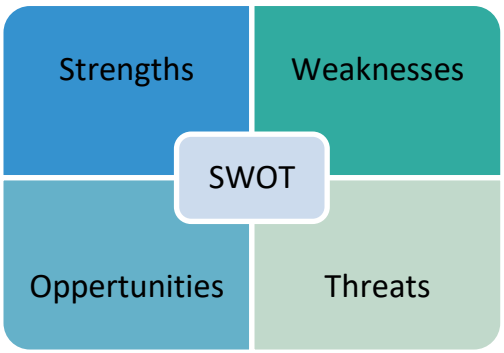
This chapter deals with the process that led to the realization of the end result, namely the roadmap.

The first part of the research concerns an internal neighbourhood analysis and focuses on statistical and analytical data from the project area. Because the residents of the project area are a big part of the target groups, research will been done into the demographical, financial and political data of the residents. It also addressed the business community within the neighbourhood, especially among small businesses. Small businesses are often located in residential buildings which could make them part of a VvE (Vereniging van Eigenaren) in a building. Research will also been done into the properties within the project area in order to be able to develop a customized strategy. Research is also being done into the urban design of the buildings in the in area. This with the underlying reason to map different construction years and styles. These topics are in line with the client's request (**§1.2**).

The second part of the preliminary research consists of collecting data the outside influences on the project area in the form of a DESTEP-analysis. The DESTEP-analysis is used to analyse the external values and influences on the project area. With this, the opportunities and threats for the project area can be mapped and determined. The demographic section is about demographic data from The Hague. The economic component concerns the possible costs and subsidies that come with this contract. The socio-cultural aspect is the stakeholders involved who will be involved with this project. The technological component concerns the possible sustainable measures. Ecology deals with the climate of The Hague. Finally, the political part will deal with the rules and legislation.

Figure 4: DESTEP-analysis

The internal strengths and weaknesses emerge from the neighbourhood analysis. The external opportunities and threats emerge from the DESTEP-analysis. From the analyses performed, a conclusion is drawn that is reflected in a SWOT-analysis.
SWOT stands for: Strengths, Weaknesses, Opportunities and Threats. The SWOT-analysis is a tool to clearly and easily display the large amount of information from the internal and external analysis. A SWOT-analysis provides insight into the environment in which activities must be carried out. These activities are therefore easier to understand and control. The interpretation of the SWOT-analysis is in line with the client's request.



From the SWOT-analysis, a scenario is written by each team member that is also in line with the expert knowledge of each team member. The various experts are concerned with: policy and law, technology, finance and stakeholders/communication. This ensures a diversity but also specialization between the written scenarios.

The written scenarios are then tested against a Multi Criterion Analysis (MCA). An MCA is an evaluation method for making a rational choice between the various scenarios on the basis of a score assigned to multiple differentiation criteria. The criteria are specifically defined in advance, for the assessment of the scenarios. On the basis of the predetermined definition it can be determined which score can be assigned per scenario per criteria. The value of a score can still differentiate by the value percentage that is given to a certain criterion. The criteria that are established for MCA are based on:

- The client's request;
- The knowledge within the expert team members;
- The results of the SWOT analysis.

After the criteria have been determined, the scenarios are checked against the MCA. Every scenario is tested against every criteria. The scenario with the final highest score will be used as the basic model for the final transition design. The basic model will be adjusted before the full elaboration. These adjustments are aimed at increasing the lower scores of the basic model. The other scenarios are used as a source of inspiration for these adjustments. The reason for this is because the scenarios are written to the know knowledge of the specific experts.

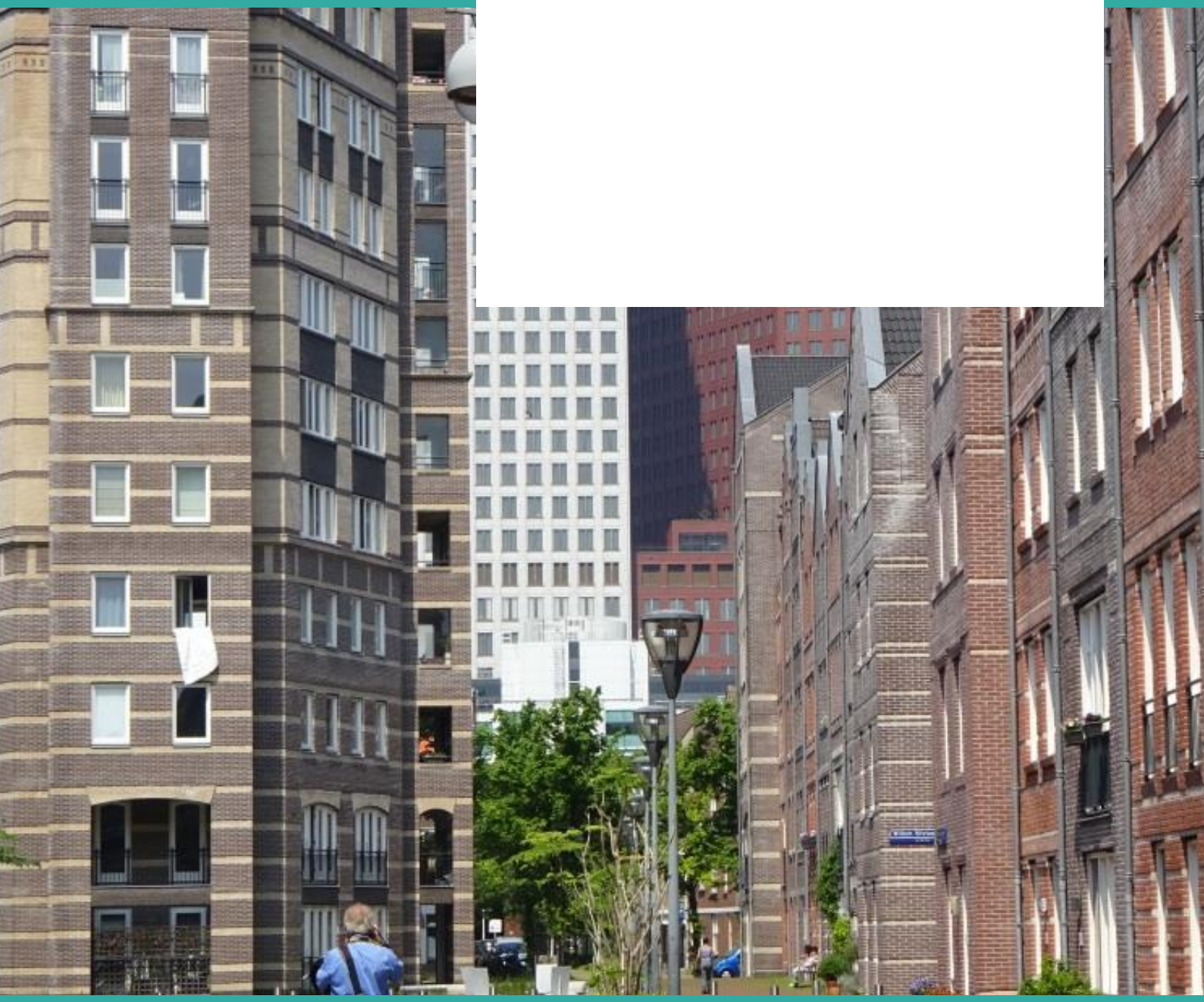
Table 2: Rating table MCA

Rating Table			
Criteria	Measuring unit	Weighting factor	Cost/ Benefit (C/B)
Communication	%	10,00	C
Environment	%	3,00	C
Social	%	4,00	B
Finance	%	6,00	B
Technical	%	7,00	B
Transition	%	9,00	B
Policy and law	%	1,00	B

After the adjustments to the basic model, a short variant of the final transition design is written in the form of a scenario. This variant is then tested against the MCA. If all scores are higher than the previously obtained score of the basic model, with the exception of the criteria that have already reached the maximum score, the final variant will be worked out. If scores remain the same or decrease, the final variant will be adjusted again until it meets the condition.

For the elaboration of the final transition design, the request of the client as described in **§ 1.2** is taken into account. This means that the transition design is written with the first priority being creating support among the residents of the Rivierenbuurt/Spuikwartier with regard to the energy transition. In addition, the transition design must contain information about the application of multiple sustainable measures that can be implemented in the area. The proposed measures must be able to be implemented in the area and thus be a realistic possibility for the neighbourhood. Finally, there will also be a strategy that focuses on increasing the quality of life in the neighbourhood.

PART A:
NEIGHBOURHOOD ANALYSIS

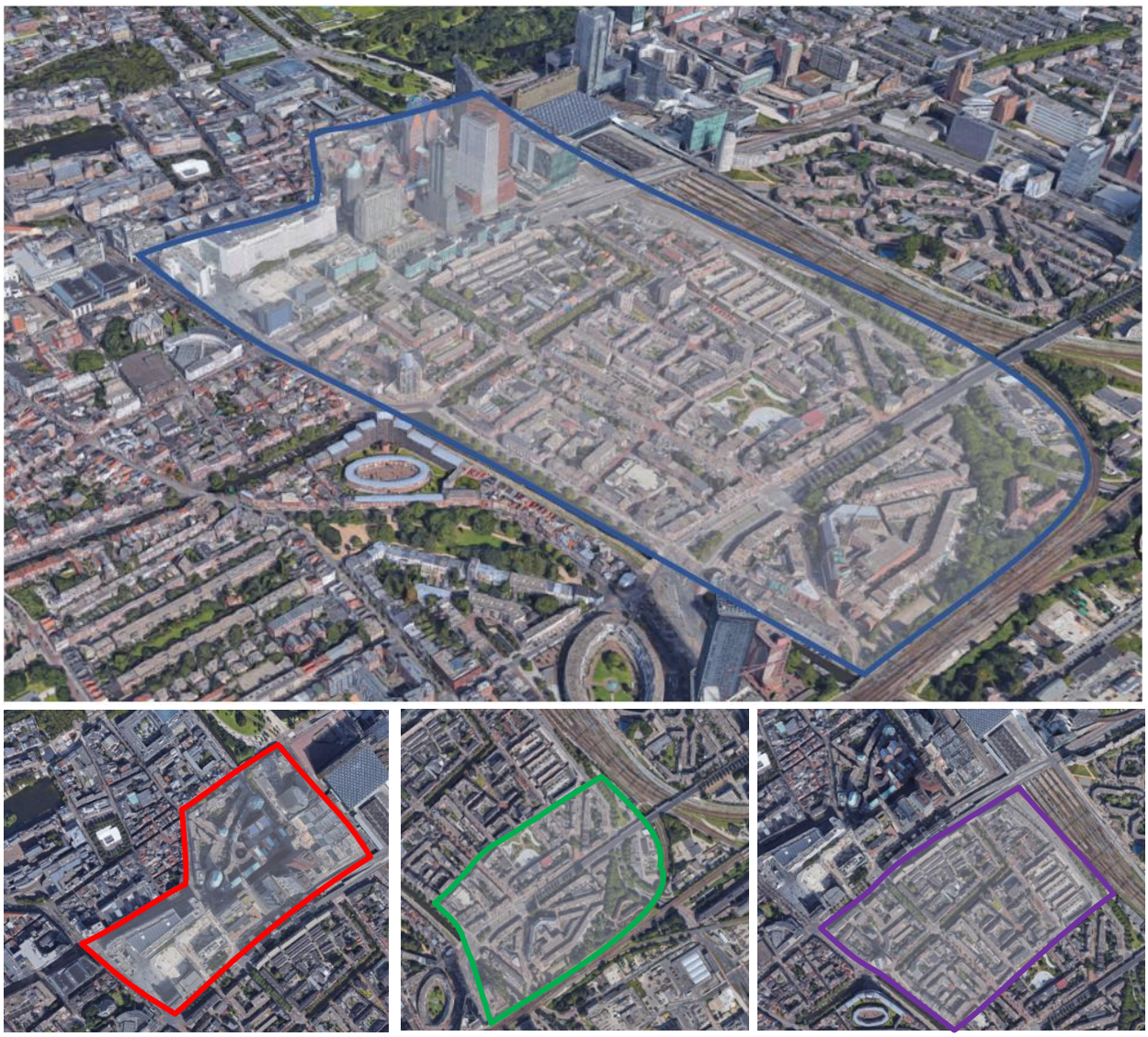


3 – Neighbourhood analysis

The neighbourhood analysis examines the substantive information about the project area. The entire project area consists of three neighbourhoods (**Figure 5**): Spuikwartier, Rivierenbuurt-Noord and Rivierenbuurt-Zuid. For example, different neighbourhoods may contain different target groups or years of construction. For this reason, the project area is also analysed in the three different neighbourhoods and not as one large project area. In this way, more diversity can be considered, and a tailor-made plan can be developed per neighbourhood.

The project area is located in the Central Innovation District, an area between the three stations (The Hague Central, Hollands Spoor and Laan van NOI) and the Binkhorst. The C.I.D is the growth task of the city of The Hague, this means a doubling of homes, workplaces and facilities. (Gemeente Den Haag, 2019) The future developments of this area can make a big difference to the final future of the project area itself.

This chapter provides information about the residents of the neighbourhoods. In addition, there will also be described about the neighbourhood design of the neighbourhoods, energy consumption and home ownership.



Uilenbuurt, Rivierenbuurt-Noord, Riverenbuurt-Zuid.

Figure 5: Map of the project area with the different neighbourhoods that are within the project area. Source: (Google inc., 2019)

3.1 Residents

The residents of the complete defined project area are the target group of this project from the client's point of view. To get a good picture of the entire target group, an analysis has been made per neighbourhood. It should be noted that no interviews or surveys have taken place within the neighbourhoods. The information below is based on statistical data.

3.1.1 Spuikwartier

The neighbourhood Spuikwartier has a population of 2,580 inhabitants with a total of 1,495 households. Of these 1,495 households, around 1.7 people live per household. This means that a large proportion of households consist of one person. The number of single-person households is also higher than the average for the Netherlands. The number of households of a couple without children or a family with children is lower than the Dutch average. (Weetmeer Buurtinformatie, 2019)

Table 3: Residents of Spuikwartier

Aantal inwoners	Aantal huishoudens	Personen per huishouden	Bevolkingsdichtheid (OAD)
2.580	1.495	1,7 pers	5.783
Gemiddeld	Gemiddeld	Onder gemiddelde / Laag	Hoog

The average age in the Spuikwartier is between 25 and 44 years. This group usually consists of starters and what is seen as the "happy singles" group. (Rutte, 2018) The largest ethnic group in the area are Dutch people followed by a Western population group. Population groups with a colonial background or from former guest workers represent around 25%. The last 19% are other non-Western population. (Weetmeer Buurtinformatie, 2019)

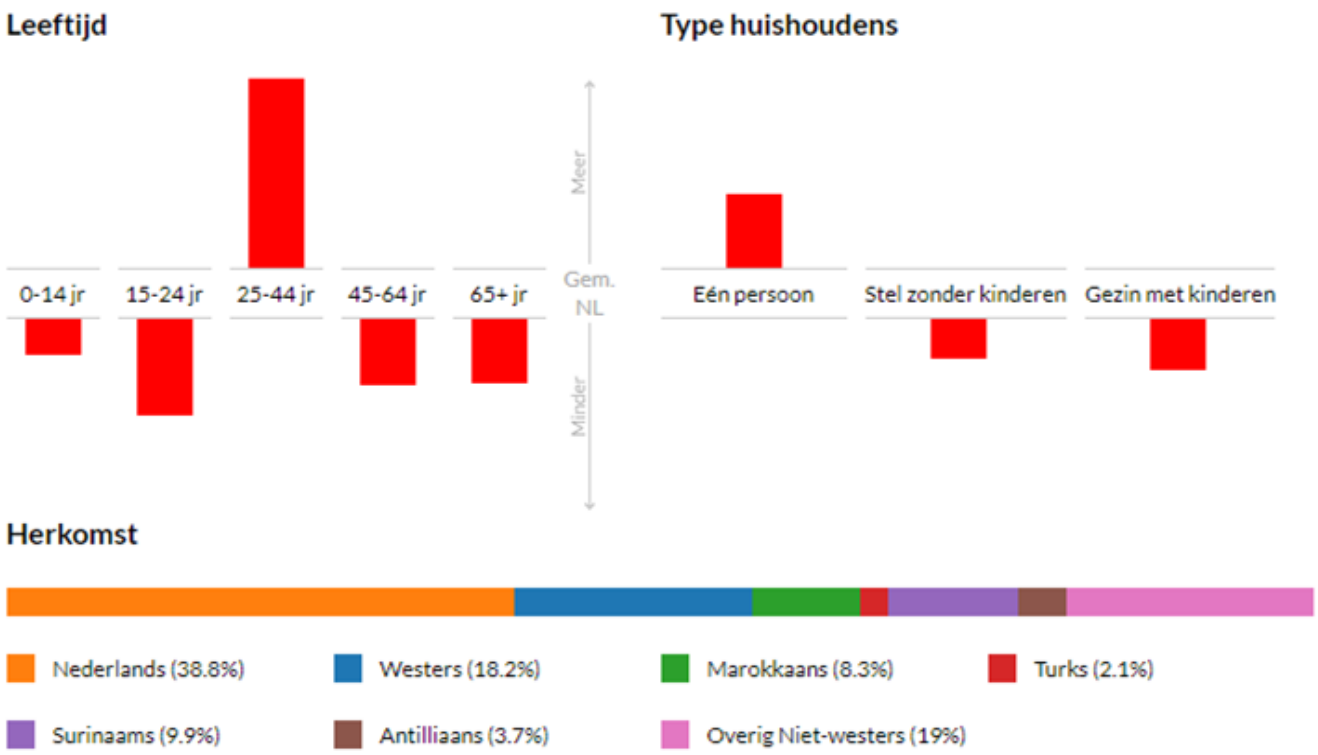


***Figure** 6: Demographic Spuikwartier*

The average income per inhabitant in the Spuikwartier is around € 26,300 per inhabitant. This income is above the Dutch average income. 41% of the inhabitants in the Spuikwartier have a low income and 26% have a high income. This means that 33% of the neighbourhood has an average income per inhabitant. (Weetmeer Buurtinformatie, 2019)

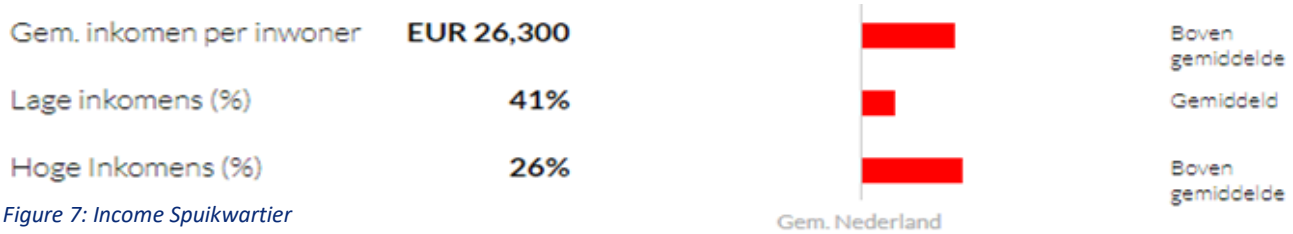


Figure 7: Income Spuikwartier

The political voting behaviour of the Spuikwartier is mainly progressively oriented. The largest political party represented is D66 followed by GroenLinks. Right-winged people are doing less well in the Spuikwartier. (Weetmeer Buurtinformatie, 2019)

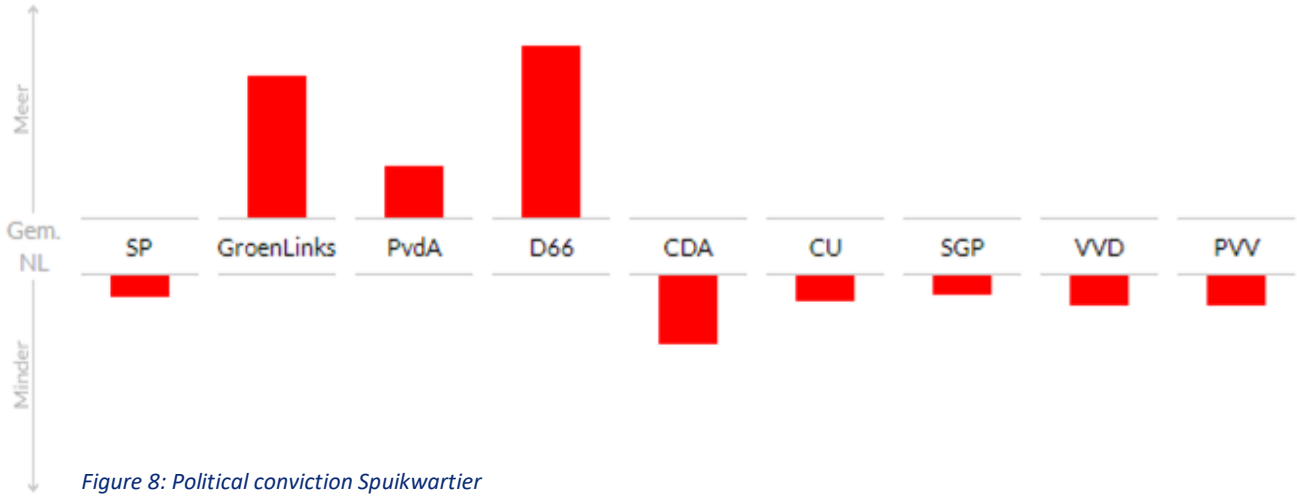


Figure 8: Political conviction Spuikwartier

3.1.2 Rivierenbuurt-Noord

The neighbourhood Rivierenbuurt-Noord has a population of 3,300 inhabitants with a total of 1,885 households. Of these 1,885 households, around 1.7 people live per household. This means that a large proportion of households consist of one person. The number of single-person households is also higher than the average for the Netherlands. The number of households of a couple without children or a family with children is lower than the Dutch average. (Weetmeer Buurtinformatie, 2019)

Table 4: Residents of Rivierenbuurt-Noord

Aantal inwoners	Aantal huishoudens	Personen per huishouden	Bevolkingsdichtheid (OAD)
3.300	1.885	1,7 pers	5.390
Gemiddeld	Boven gemiddelde	Onder gemiddelde / Laag	Hoog

The average age in the Rivierenbuurt-Noord is between 15-24 and 25-44 years. This group usually consists of starters and what is seen as the group "happy singles". Given the high age group between the ages of 15 and 24, it can be assumed that there are also group families with children of adolescent age. The largest ethnic group in the area are Dutch people, followed by a Western population group. Population groups with a colonial background or from former guest workers represent approximately 22.9%. The last 15.3% are other non-Western population. (Weetmeer Buurtinformatie, 2019)

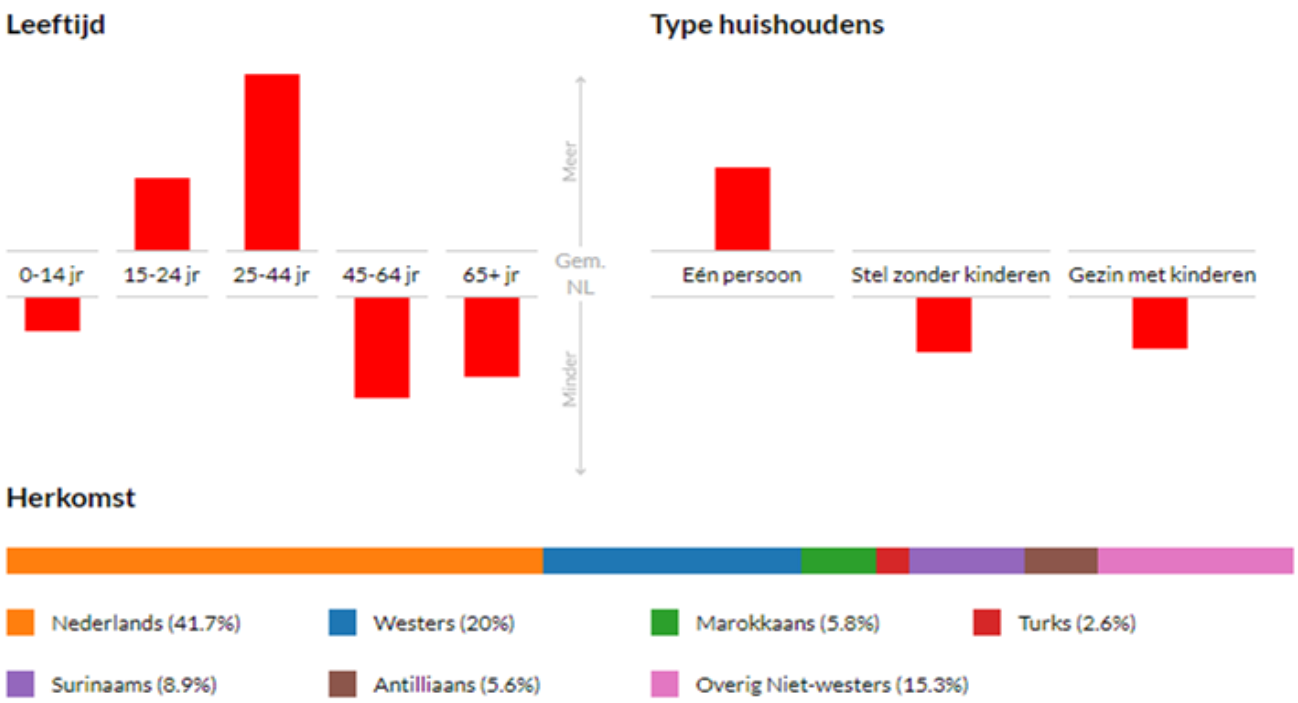


Figure 9: Demographic Rivierenbuurt-Noord

The average income per inhabitant in the Rivierenbuurt-Noord is around € 23,100 per inhabitant. This income roughly corresponds to the Dutch average income. 49% of the inhabitants in the Rivierenbuurt-Noord have a low income. This percentage is high compared to the Dutch average income per neighbourhood per inhabitant. About 20% of the inhabitants of the Rivierenbuurt-Noord have a high income. This means that 31% of the neighbourhood has an average income per inhabitant. (Weetmeer Buurtinformatie, 2019)

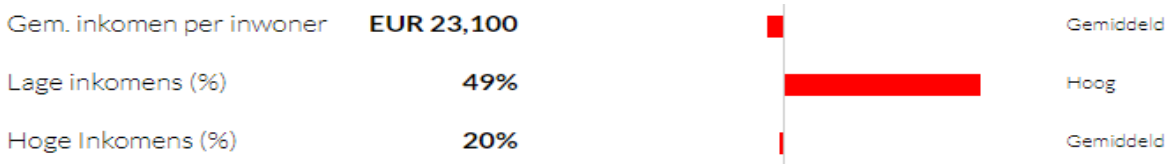


Figure 10: Income Rivierenbuurt-Noord

The political voting behaviour of the Rivierenbuurt-Noord is particularly progressively oriented towards the middle. The largest political party represented is D66 followed by GroenLinks. Right-wing people are doing less well in the Rivierenbuurt-Noord. (Weetmeer Buurtinformatie, 2019) This voting behaviour also strongly overcomes the voting behaviour in the Spuikwartier.

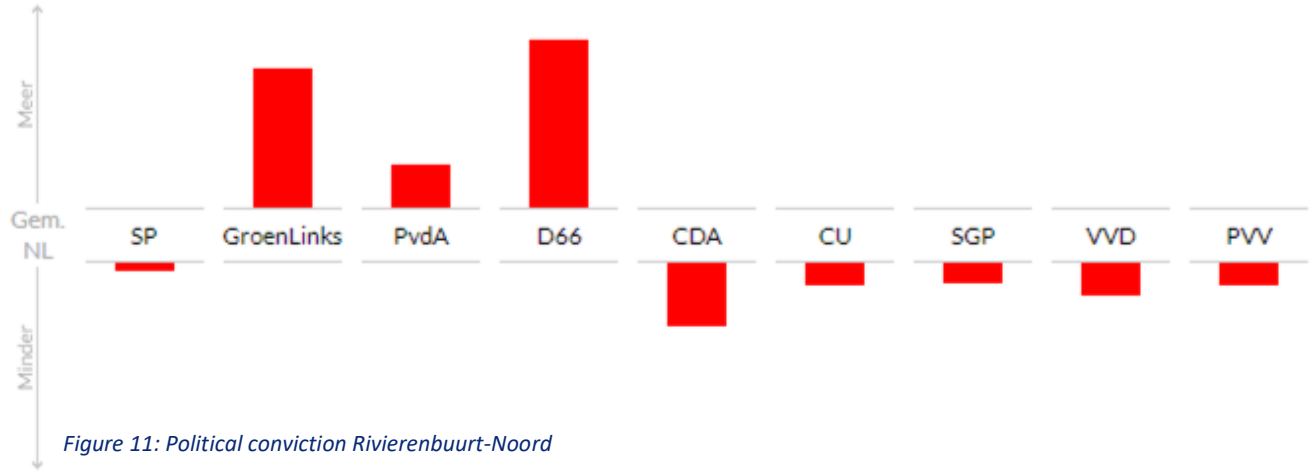


Figure 11: Political conviction Rivierenbuurt-Noord

3.1.3 Rivierenbuurt-Zuid

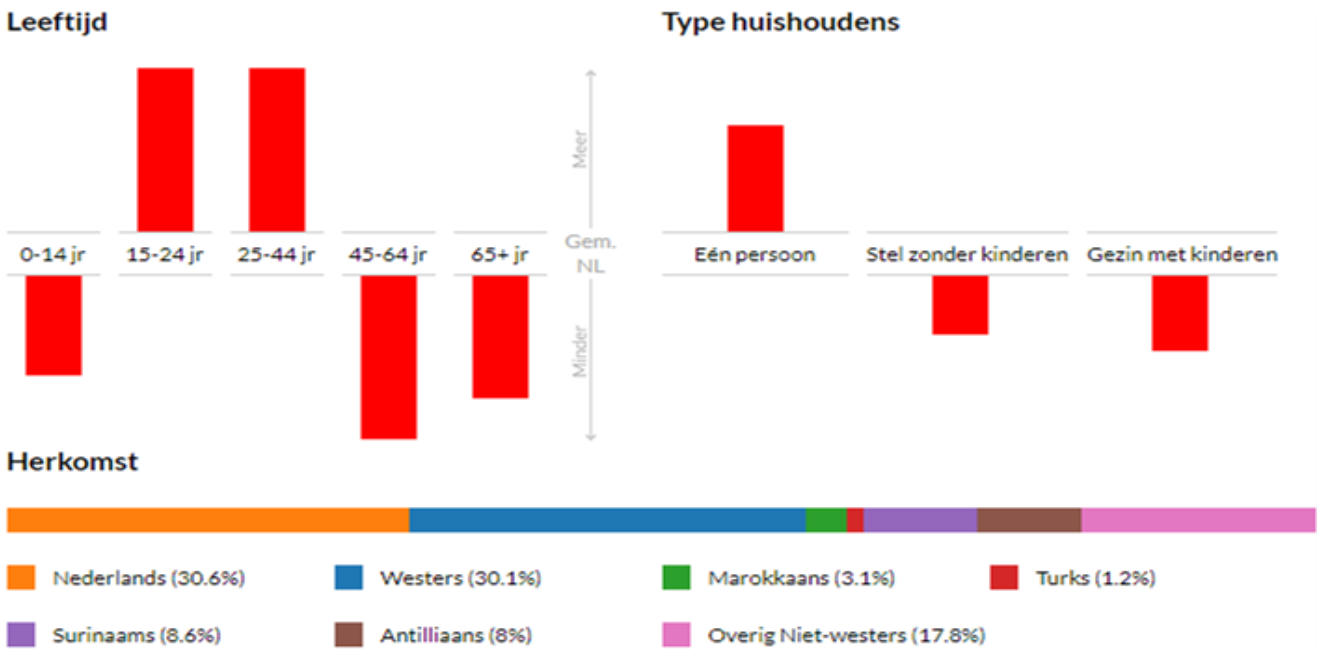
The neighbourhood Rivierenbuurt-Zuid has a population of 815 inhabitants with a total of 570 households. Of these 570 households, around 1.4 people live per household. This means that a large proportion of households consist of one person. The number of single-person households is also higher than the average for the Netherlands. The number of households of a couple without children or a family with children is lower than the Dutch average. (Weetmeer Buurtinformatie, 2019)

Table 5: Residents of Rivierenbuurt-Zuid

Aantal inwoners	Aantal huishoudens	Personen per huishouden	Bevolkingsdichtheid (OAD)
815	570	1,4 pers	5.625
Onder gemiddelde	Onder gemiddelde	Laag	Hoog

The neighbourhood Rivierenbuurt-Zuid has a population of 815 inhabitants with a total of 570 households. Of these 570 households, around 1.4 people live per household. This means that a large proportion of households consist of one person. The number of single-person households is also higher than the average for the Netherlands. The number of households of a couple without children or a family with children is lower than the Dutch average. (Weetmeer Buurtinformatie, 2019)

Figure 12: Demographic Rivierenbuurt -Zuid



The average income per inhabitant in the Rivierenbuurt-Zuid is around € 17,700 per inhabitant. This income is lower than the Dutch average income. 57% of the inhabitants in the Rivierenbuurt-Zuid have a low income. This percentage is very high compared to the Dutch average income per neighbourhood per inhabitant and also compared to the other neighbourhoods. About 8% of the inhabitants of the Rivierenbuurt-Zuid have a high income. This means that 35% of the neighbourhood has an average income per inhabitant. (Weetmeer Buurtinformatie, 2019)

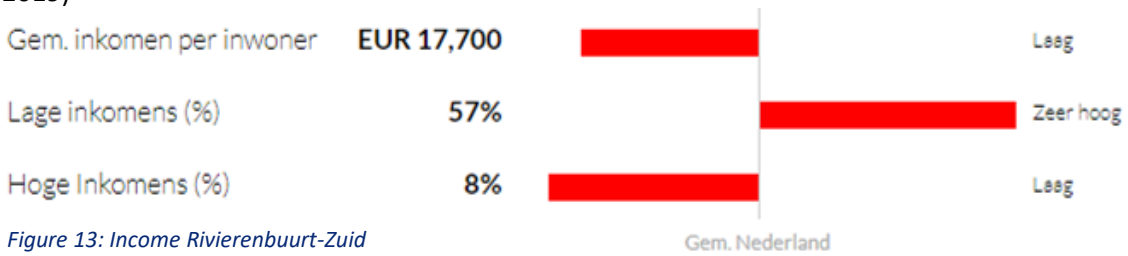


Figure 13: Income Rivierenbuurt-Zuid

The political voting behaviour of the Rivierenbuurt-Zuid is socially progressively oriented. The largest political party represented is GroenLinks followed by D66. Right-wing people are doing less well in the Rivierenbuurt-Zuid. (Weetmeer Buurtinformatie, 2019)

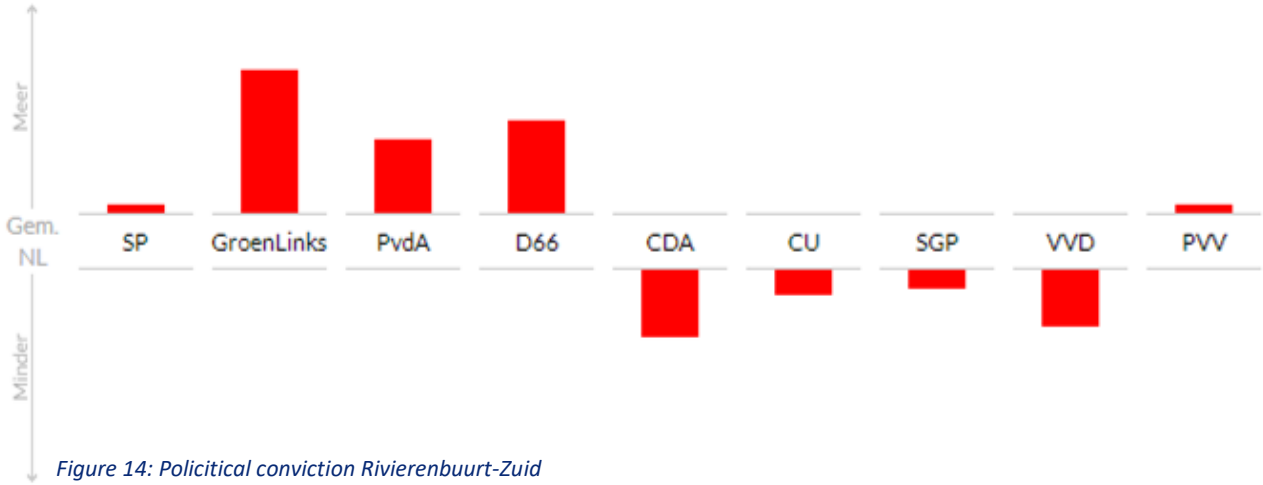
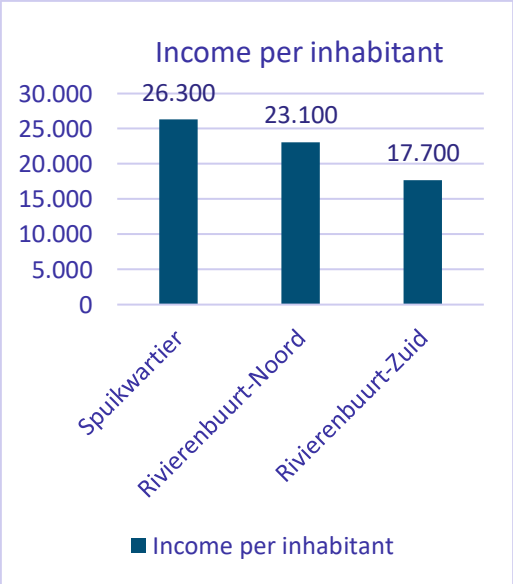


Figure 14: Policitical conviction Rivierenbuurt-Zuid

3.2 Resident analysis

The entire project area consists of single-person households with an average age of 25 to 44 years old. The age group of 25-34 is fairly busy with climate change. They emit the least CO_2 after the age group of 18-24. The age group of 35-44 on average emits the most CO_2 of all ages. In addition, this percentage of age group is the least concerned about climate change. (I&O Research, 2019) If the largest group is between 35 and 44 in terms of age, there is a chance that residents will be less willing to cooperate in a possible energy transition within their neighbourhood or neighbourhood.

There is a big income difference per neighbourhood. The difference in income per inhabitant between the Spuikwartier and Rivierenbuurt-Zuid is almost € 9,000. In addition, the largest group of inhabitants of the entire Rivierenbuurt neighbourhood has a low income. A lower income can mean that people are less willing to make a financial contribution to sustainable measures. Indeed, around 55% of low-income people believe that they cannot afford to live more sustainably financially. (I&O Research, 2019) To develop a plan to encourage residents to participate in making the house more sustainable, this fact must be considered.



Looking at the political convictions of the target group, there is a progressive social conviction throughout the project area. D66 and GroenLinks are the largest parties in the entire project areas. These two parties are known to be actively involved in climate change and to do something about it. This political conviction of the target group can ensure that people are more aware of the changes that can take place regarding climate change and sustainability. This can make it easier for them to come along or be prepared to think along with an action plan for the neighbourhood.

3.3 Small businesses

There are not only homes in the Rivierenbuurt Noord, the Rivierenbuurt Zuid and the Spuikwartier (also called Uilenboom, but also companies and institutions. All these companies and institutions use electricity / gas. It is therefore important to include companies and institutions in the energy transition. In 2018 there were 54.773 companies and institutions throughout the municipality of The Hague. Of these, 580 were in Rivierenbuurt Noord, 122 in Rivierenbuurt Zuid and 441 in Spuikwartier. The total floor space is 366.688 m2 in Rivierenbuurt Noord, 40.335 m2 in Rivierenbuurt Zuid and 542.592 m2 in Spuikwartier (incijfers.nl, 2019).

3.3.1 Floor Space per category

In **Table 6** we see how much square meter of floor space was available for different categories of companies, institutions and facilities per neighborhood. This table shows that most space is used for offices.

Companies and institutions can also be a member of a VVE (Association of Owners). This means that they also participate in decisions about changes to the building. This must be taken into account during the energy transition. Companies have completely different norms and values when it comes to more sustainable changes. According to the Environmental Management Act, companies and institutions are obliged to take measures to save the environment. Companies and institutions that consume 50.000 kWh electricity or 25.000 m3 natural gas per year must comply with the obligation to provide information and must report their energy-saving measures (Rijksdienst voor Ondernemend Nederland, 2019).

***Table** 6: Square meter floor of floor space per neighbourhood (incijfers.nl, 2019)*

Categories	Rivierenbuurt-Noord	Rivierenbuurt-Zuid	Spuikwartier
Offices	246.930 m2	23.483 m2	394.506 m2
Stores	24.851 m2	895 m2	29.675 m2
Businesses	12.368 m2	9.199 m2	2.360 m2
Catering industry	7.259 m2	733 m2	13.603 m2
Hotels and questhouses	7.954 m2	3.357 m2	8.730 m2
Entertainment facilities	0 m2	0 m2	0 m2
Cultural facilities	0 m2	0 m2	22.123 m2
Attractions	0 m2	0 m2	0 m2
Sport facilities	1.569 m2	0 m2	973 m2
Recreational facilities	1.319 m2	200 m2	600 m2
Medical facilities	2.527 m2	0 m2	2.599 m2
Special provisions	0 m2	0 m2	0 m2
Schools	4.766 m2	0 m2	15.616 m2
Churches and prayer roms	290 m2	0 m2	740 m2
Special forms of living	0 m2	0 m2	0 m2
Other categories	56.85 m25	2.468 m2	51.067 m2
Total	366.688 m2	40.335 m2	542.592 m2

In **Figure 15** and **Figure 16** you can see that the number of companies in the Rivierenbuurt Noord and the Rivierenbuurt Zuid continues to increase every year. This means that it is becoming more important to also include companies and institutions in the energy transition for the neighborhoods.

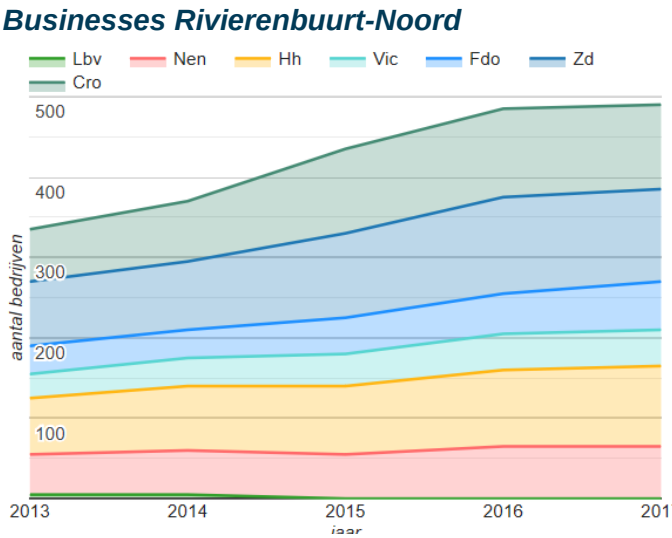


Figure 15: Number of companies per sector per year in Rivierenbuurt Noord (allecijfers.nl, 2017)

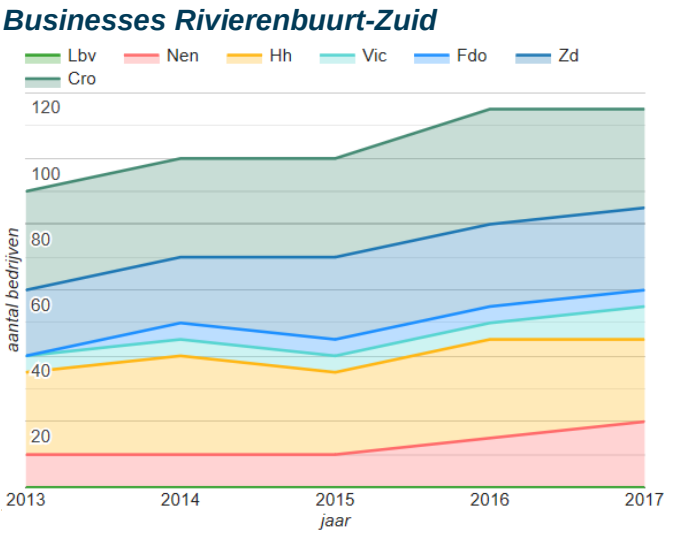


Figure 16: Number of companies per sector per year in Rivierenbuurt Zuid (allecijfers.nl, 2017)

Each sector is indicated with an abbreviation. The meaning of each abbreviation is shown below:

- Lbv: Agriculture, Forestry and Fisheries
- Nen: Industry and Energy
- Hh: Trade and Hospitality
- Vic: Transport Information and Communication
- Fdo: Financial Services and Real Estate
- Zd: Business Services
- Cro: Culture Recreation and Other Services

3.4 Neighbourhood design

The project area contains different buildings from different time periods (**Figure 17**). This variation in buildings and construction years means that different building styles and requirements that were set for the realization of a building in the relevant time must be considered.

The buildings in the Rivierenbuurt-Zuid are mainly buildings in the years 1900 to 1930. A few buildings were built in the period 1850 to 1900 and a single building, in this case a primary school, was realized after 2005. In the Rivierenbuurt-Zuid area, there is mainly revolution construction. These are homes that were built during the industrial revolution to house the workers. However, these houses are not only built by professionals but also by all kinds of ignorant entrepreneurs. At the time, the emphasis was primarily on saving money. The houses are very narrow but quite deep. Most buildings from this period can be divided into a front and back house or an upstairs and downstairs house. Another characteristic phenomenon of this property is the double front door. (van Schijndel, 2016)

Figure 17: Different construction years in the project area (Rijksinstituut voor de Volksgezondheid en Milieu, 2019)

The buildings in the Rivierenbuurt-Noord are more modern. Although part of the buildings in this neighbourhood were built in the period 1900-1930, a large part was built in the period from 1975 or later. This neighbourhood is a post-war portico neighbourhood. The buildings in these types of neighbourhoods no longer followed the streets but were placed separately or perpendicular to the existing infrastructure: strip subdivision. The porch apartments have four to five storeys. In addition, they are placed in an open parcel or in strips. (van Schijndel, 2016)

The most common year of construction in the neighbourhood of Spuikwartier is 1995 or later. Because people increasingly wanted to live in the city, cities started to look for inner-city possibilities for realizing homes. The more central the better. This was done by using the scarce space more economical to increase the liveliness and to strengthen the position of the city. These inner-city developments often concern residential towers with roof terraces. (van Schijndel, 2016)

Houses in the Netherlands are designed at a temperature in winter to a maximum of -15°C and a west wind from the sea. (Alewijnse, 2019) The year of construction of a building is very decisive for the interpretation of energy transition-related possibilities. Newer properties are often better insulated or more energy-efficient, while older properties may lack insulation. This means that less has to be invested in properties of a recent year of construction than for properties with a year of construction at the beginning of the previous century.

The only monumental building that is located in the project area is The New World Campus. The New World Campus is located in the Rivierenbuurt-Zuid. The New World Campus is the place where ground-breaking solutions are found for local and global sustainability issues. Possibly inspiration or information can be taken from the building.

3.5 Energy use

Looking at the energy labels in the project area, a link can be drawn between the year of construction of different buildings and the allocated energy label. For example, it can be seen from **Figure 18** that the buildings in the Rivierenbuurt-Zuid, which for the most part contain old buildings, contain the lowest possible energy rating. The post-war buildings in the Rivierenbuurt-Noord have a better energy label between C and E. In the Spuikwartier it can be seen that the majority of the neighbourhood consists of energy labels A to C.

When the cards of the energy labels (**Figure 18**) and the amount of kg CO_2 emissions (**Figure 19**) are superimposed, an agreement can be seen. The properties with a lower energy rating also emit more CO_2 on average than the properties with a higher energy rating. However, it must also be said that, according to the source used, this reflects the CO_2 emissions of the houses, but that more CO_2 emissions have been observed around large and busy roads than in the neighbourhoods. And so, in areas where no cars are allowed no measurements of CO_2 were observed.

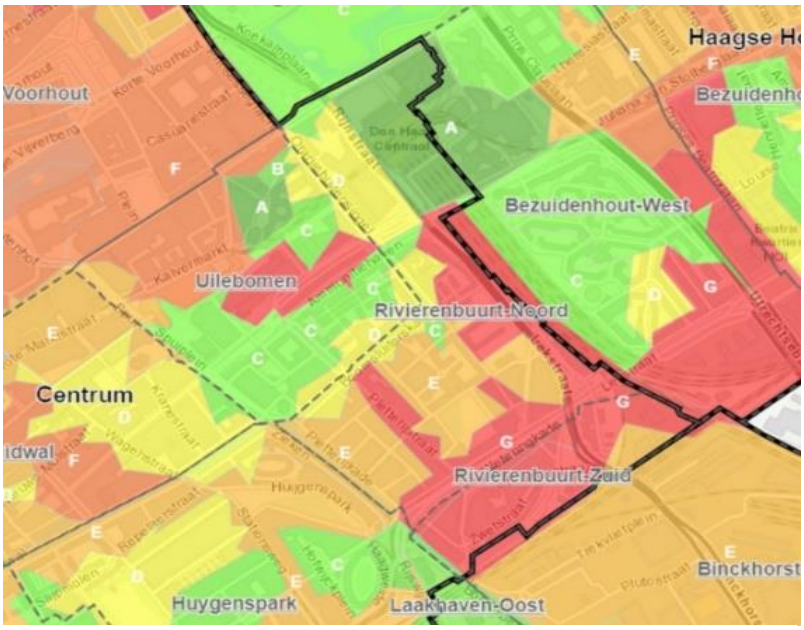


Figure 18: Energy labels in the project area (Rijksinstituut voor de Volksgezondheid en Milieu, 2019)

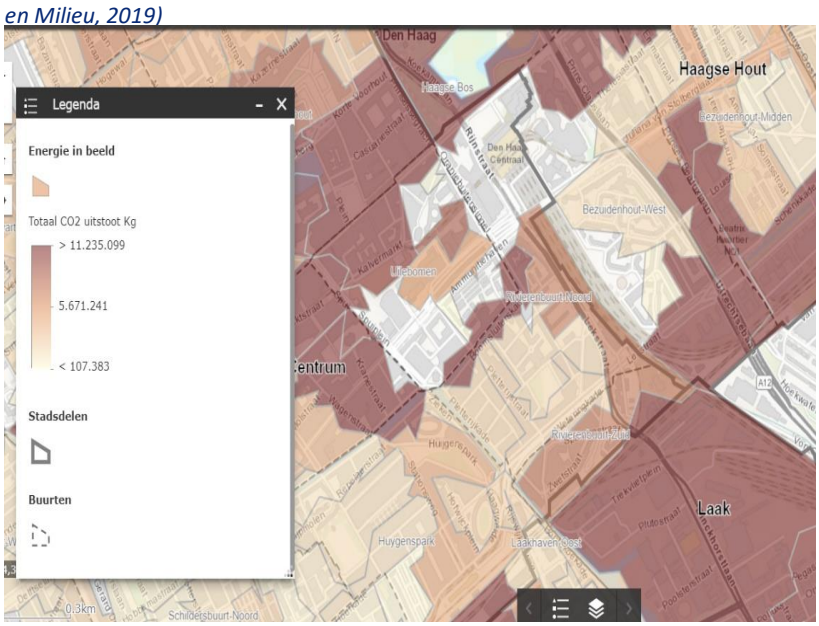


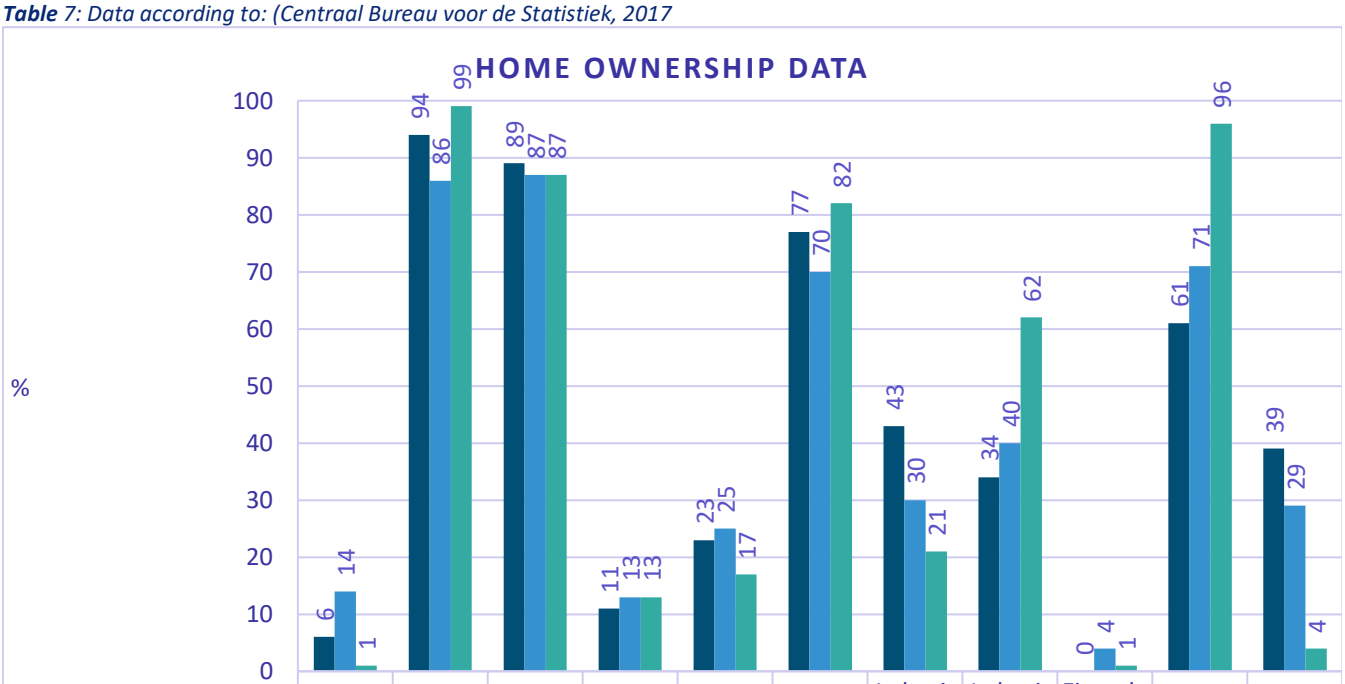
Figure 19: Energy use Datalab Energy transition (Datalab Den Haag, 2019)

3.6 Home ownership

All neighbourhoods have a low percentage of single-family homes (**Table 7**). With 14%, Rivierenbuurt-Noord has the highest percentage of single-family homes. Most buildings in the project area are multi-family homes. This means that in many buildings two or more different families live. This will result in almost every building dealing with a large representation at the Association of Owners.

The total project area contains a total of 4290 homes. Approximately 88% of these 4,290 homes are inhabited. This also means that approximately 12% are uninhabited. However, there is no clear reason why this last 12% is empty.

***Table** 7: Data according to: (Centraal Bureau voor de Statistiek, 2017*



	Eengezinswoning	Meergezinswoning	Bewoond	Onbewoond	Koopwoningen	Huurwoningen totaal	In bezit woningcorporatie	In bezit overige verhuurders	Eigendom onbekend	Bouwjaar voor 2000	Bouwjaar vanaf 2000
Spuikwartier	6	94	89	11	23	77	43	34	0	61	39
Rivierenbuurt-Noord	14	86	87	13	25	70	30	40	4	71	29
Rivierenbuurt-Zuid	1	99	87	13	17	82	21	62	1	96	4

Less than a quarter of the total number of homes is owner-occupied. The percentage of owner-occupied homes in the Spuikwartier is 23%, in the Rivierenbuurt-Noord 25% and in the Rivierenbuurt-Zuid 17%. These homes are therefore occupied by homeowners and are fully responsible for the maintenance of their own home.

The rest of the homes are rental properties. The percentage of rental properties in the Spuikwartier is 77%, in the Rivierenbuurt-Noord 70% and in the Rivierenbuurt-Zuid 82%. These residents are not fully responsible for the home maintenance of a home. However, the tenants also have no full say about the adjustments they can make within a home. External owners such as housing associations and other landlords also have a say in these decisions. However, these external owners must also make a financial contribution in the event of possible maintenance to or in a home. Of the 77% rental properties in the Spuikwartier, 43% of the properties are managed by housing associations. The other 34% is managed by other landlords. In the Rivierenbuurt-Noord, of the 70% rental properties, 30% of the properties are managed by a housing corporation. The other 40% is managed by other landlords. Finally, in Rivierenbuurt-Zuid, 82% rental properties 21% of the properties are managed by housing associations. The other 62% is managed by other landlords. **Figure 20** shows which properties are owned by a housing corporation.

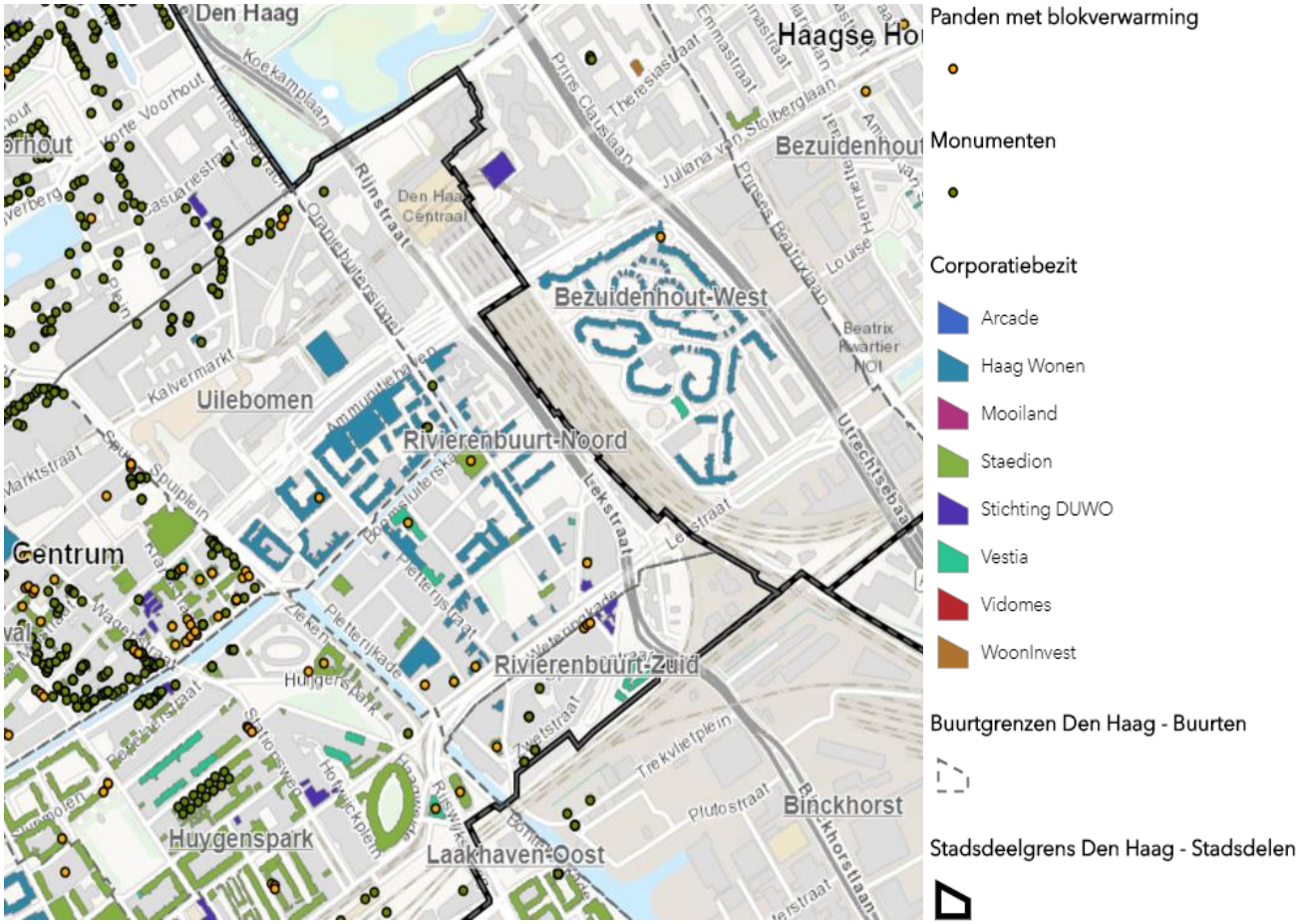


Figure 20: Corporation ownership within the project area (Datalab Den Haag, 2019)

4 – Demography

The Hague is the capital of the province of South Holland and consists of approximately 538.00 inhabitants and the number of inhabitants continues to grow. Since 1995 the number of inhabitants has grown by 21%. (AlleCijfers.nl, 2019)

The plan below shows the number of inhabitants per neighbourhood. The Rivierenbuurt and Spuikwartier are located in the neighbourhood with number 27, which is shown in **Figure 21**. (AlleCijfers.nl, 2019) **Figure 22** shows the number of inhabitants, addresses and cars per km2 in The Netherlands and The Hague.

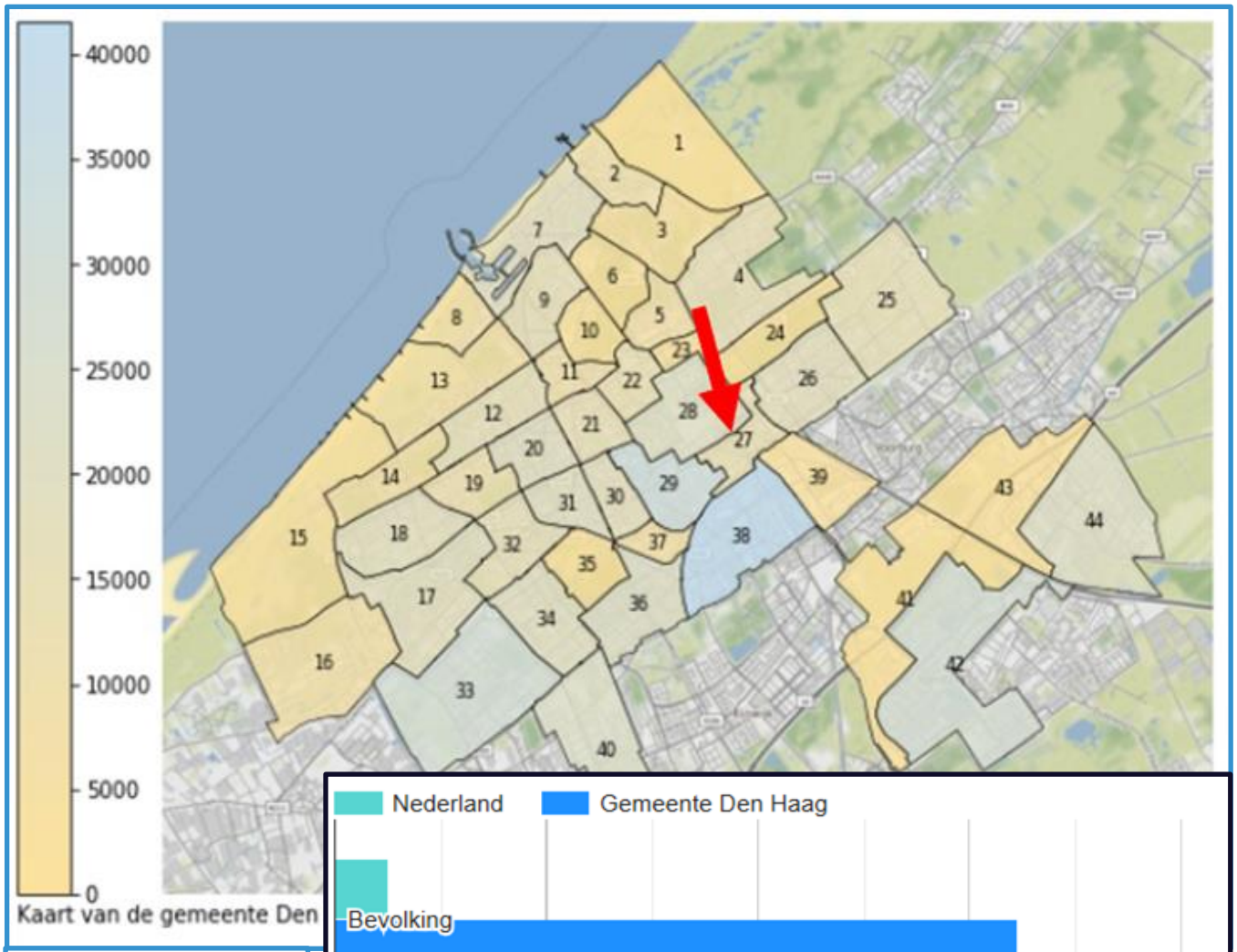


Figure 21: Number of inhabitants per neighbourhood (AlleCijfers.nl, 2019)

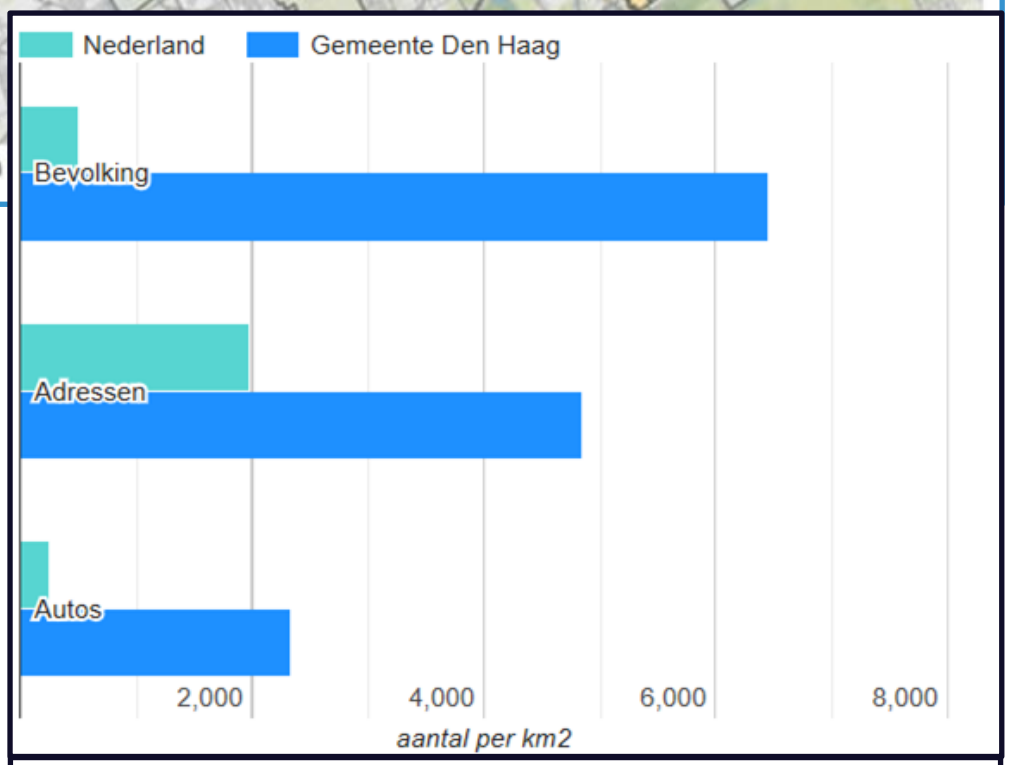


Figure 22: Density of the population, address and passenger cars per Km2 area in The Netherlands and The Hague

Figure 23 shows the number of inhabitants per age category on 1 January 2018. As we see, in The Hague there are mostly people between 25 and 65 years old. The total number of inhabitants consists of 532.561 with 263.975 men and 268.586 women.

Not all residents are form The Netherlands. The Hague consist of many people with different backgrounds. The number of natives and migrants can be seen in this diagram. 46,4% of the residents is native Dutch, 35,6% is non-western migration and 18,1% is western migration. This is shown in **Figure 24**.

The average income of The Hague is 25.600 euros. This is low compared to other municipalities in South Holland. In the graph below, The Hague is indicated by red. The average income of the neighbourhood Spuikwartier is 26.300 euros, the income of the Rivierenbuurt-Noord is 23.100 euros and the income of the Rivierenbuurt-Zuid is 17.700 euros. Only the income of Spuikwartier is above the average of The Hague. Also the neighbourhood Rivierenbuurt-Zuid is far beneath this average. This is visible in **Figure 25**.

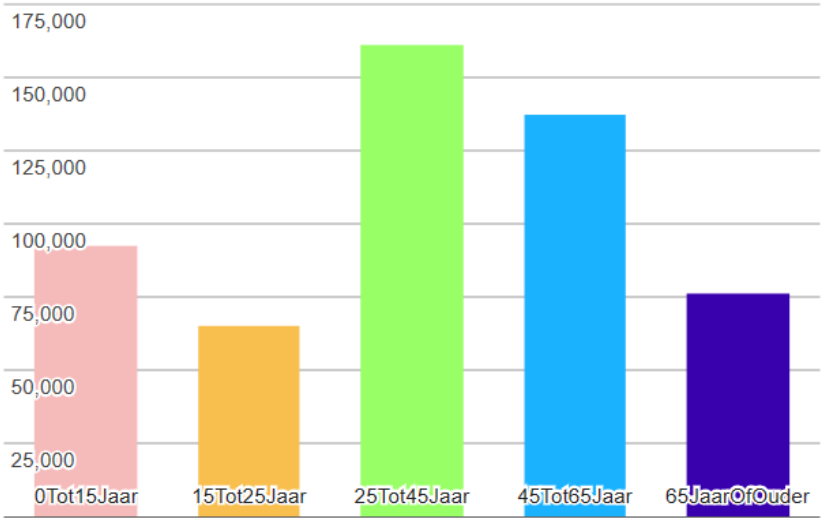


Figure 23: Population, age groups: number and percentage of inhabitants on 1 January 2018 per age category (AlleCijfers.nl, 2019)

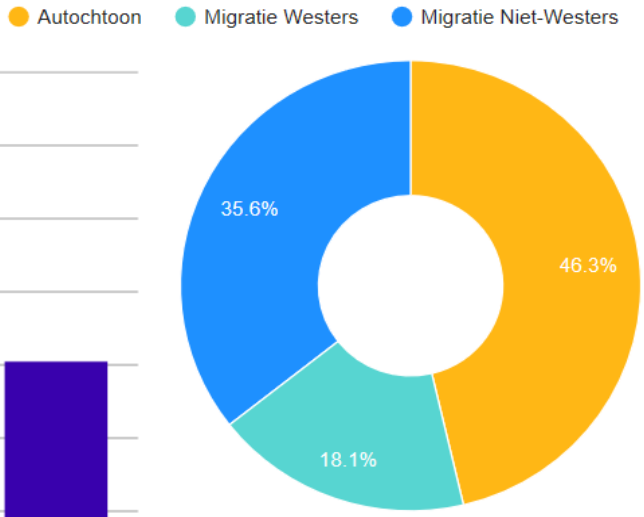


Figure 24: Donut diagram with a distribution of the population in The Hague to native Dutch, migration western and migration non-western (AlleCijfers.nl, 2019)

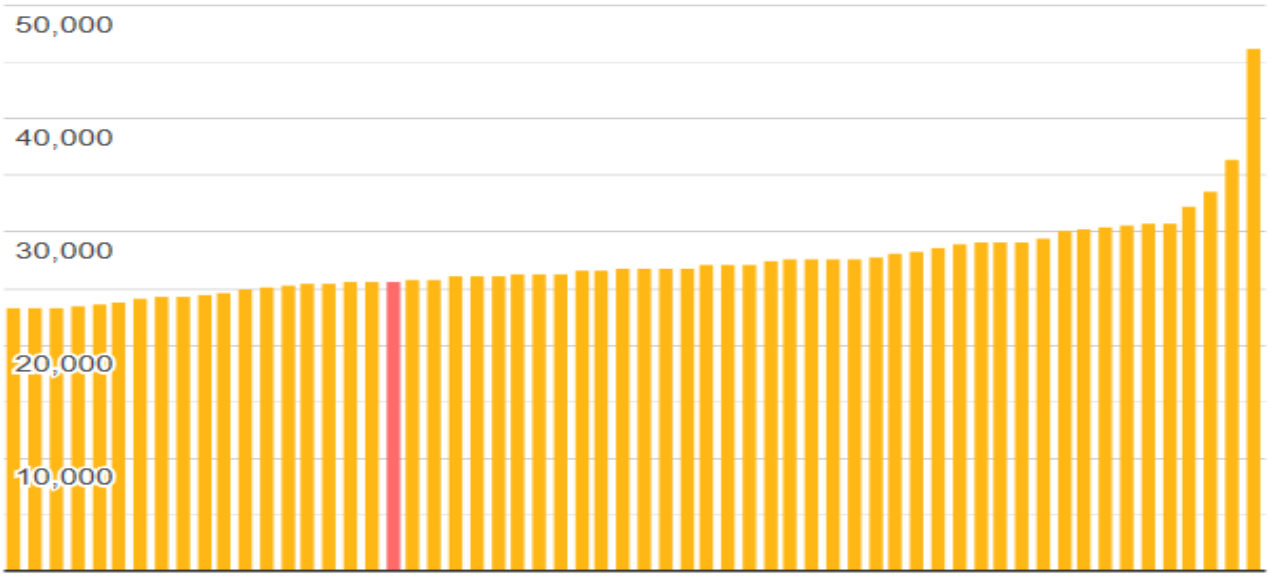


Figure 25: Average income per year for every municipality in South Holland (The Hague is red) (AlleCijfers.nl, 2019)

5 – Ecology

The Hague lies close to the sea, which has a major influence on the climate of the city. The city is dryer and has a higher temperature in comparison with the rest of the Netherlands. This is due to the constant sea breeze which allows the cloud to drift faster and in return ensures there's less rainfall in The Hague.
According to the Köppen-Geiger climate classification, The Hague of a classification of Cfb. This means that The Hague has an oceanic climate with average temperature below 22°C in its warmest months and an average temperature above 0°C. (DenHaag, 2019)
The table two tables below shows the average data and expectancy regarding the climate in The Hague. **Table 8** shows the average high temperature, low temperature, sun hours, rainfall and the average rainy days in The Hague. And **Table 9** shows the Expectancy of warm weather, winter weather, constant rain, cyclones, sunny days and UV-index.

***Table 8**: Average rain, sun and temperature in The Hague (DenHaag, 2019)*

	gemiddelde maximum temperatuur (°C)	gemiddelde minimum temperatuur (°C)	gemiddeld aantal uren zon per dag	gemiddeld aantal dagen neerslag per maand	gemiddeld aantal mm neerslag per maand	gemiddelde water temperatuur (°C)
januari	5	0	2	19	💧💧💧	n.v.t.
februari	5	0	3	12	💧💧	n.v.t.
maart	8	2	4	15	💧💧	n.v.t.
april	12	4	5	13	💧💧	n.v.t.
mei	16	8	7	14	💧💧	n.v.t.
juni	19	10	7	13	💧💧💧	n.v.t.
juli	21	12	6	14	💧💧💧	n.v.t.
augustus	21	12	6	14	💧💧💧	n.v.t.
september	18	10	4	16	💧💧💧	n.v.t.
oktober	14	7	3	17	💧💧💧	n.v.t.
november	9	3	2	18	💧💧💧	n.v.t.
december	6	1	1	19	💧💧💧	n.v.t.

The average temperature year round in The Hague is 9,5°C and the average precipitation is 777mm. April is the driest month of the year with an average of 45 mm of precipitation and October the wettest with an average rainfall of 85 mm (Den Haag, 2019). And as shown in the table January is the coldest month of the year and august the warmest.

***Table** 9: : Expectancy of rain, snow, sun and UV-index (DenHaag, 2019)*

	kans (zeer) weer	op warm	kans winters weer	op	kans langdurige neerslag	op	kans orkanen (cyclonen)	op	zonzekerheid	UV-index
januari	○		🔵🔵🔵		⚫⚫⚫⚫		○		🟠	UV 0-3
februari	○		🔵🔵🔵		⚫⚫⚫⚫		○		🟠	UV 0-3
maart	○		🔵🔵		⚫⚫⚫		○		🟠🟠	UV 0-3
april	🔴		🔵		⚫⚫⚫		○		🟠🟠🟠	UV 3-6
mei	🔴🔴		○		⚫⚫⚫		○		🟠🟠🟠	UV 3-6
juni	🔴🔴		○		⚫⚫		○		🟠🟠🟠	UV 6-8
juli	🔴🔴🔴		○		⚫⚫		○		🟠🟠🟠	UV 6-8
augustus	🔴🔴🔴		○		⚫⚫		○		🟠🟠🟠	UV 3-6
september	🔴🔴		○		⚫⚫⚫		○		🟠🟠	UV 3-6
oktober	🔴		🔵		⚫⚫⚫⚫		○		🟠🟠	UV 0-3
november	○		🔵🔵		⚫⚫⚫⚫		○		🟠	UV 0-3
december	○		🔵🔵🔵		⚫⚫⚫⚫		○		🟠	UV 0-3

6 – Stakeholders

A distinction will be made between internal and external stakeholders concerning the project. This separation has been chosen so that a better picture can be sketched of the location where the stakeholders are located. From this it can be determined whether a certain stakeholder is directly affected by a possible energy transition or not. This factor can influence the importance of a stakeholder.

6.1 Internal Stakeholders

The internal stakeholders concerning the stakeholders within the project area. These stakeholders make direct use of the outside space and change has an effect on the immediate living environment. The exact influences and interests of the various stakeholders are not yet known. For this, interviews must take place to find out.

Residents

The residents of the neighbourhoods Uilenboom, Rivierenbuurt-Noord and Rivierenbuurt-Zuid will most often have to deal with changes in their living environment. In addition, these residents are also the target group for which the client wants to focus on why. In addition, this group will also be the largest group concerning the Association of Property Owners. It is important to take into account the fact that the residents differ per neighbourhood.

Werkgroep Energietransitie

In this case, the Energy Transition working group of the Rivierenbuurt/Spuikwartier Residents' Organization is the direct client of the project. They asked to prepare a communication plan to stimulate energy transition among the residents in the project area.

Small businesses and entrepreneurs

The neighbourhoods have many small businesses and entrepreneurs. Just like the residents, entrepreneurs and shop owners own or rent properties in the neighbourhood. In some cases this also makes them part of the Owners' Association in different buildings.

Bewonersorganisatie Rivierenbuurt Spuikwartier

The residents' organization is a small representation of the residents in the neighbourhood. They are also the ones who work hardest for the neighbourhood. They set up working groups that take action within the neighbourhood. This with the underlying reason to, for example, increase social cohesion or improve the neighbourhood.

Christelijke Basisschool Jan van Nassau

The Christian Primary School (CBS) Jan van Nassau (SCOH) is located In the Rivierenbuurt-Zuid. This primary school is provided with sustainable measures to build the building sustainably.

Ministries

Several branches of different Ministries are located in the project area. Although this specific stakeholder is not part of the target group presented, it is always possible to look at the possibilities and opportunities that the town hall can offer for the energy transition.

City Hall

The town hall is also located in the project area. Although this specific stakeholder is not part of the target group presented, it is always possible to look at the possibilities and opportunities that the town hall can offer for the energy transition.

New World Campus

The New World Campus is located in the project area. This is the only monumental building in the project area. The New World Campus is the place where ground-breaking solutions are found for local and global sustainability issues. Possibly inspiration or information can be taken from the building.

Stadsgewest Haaglanden

The location of the Haaglanden Urban District can be found in the project area. Although this specific stakeholder is not part of the target group presented, it is always possible to look at the possibilities and opportunities that the town hall can offer for the energy transition.

Big companies

The different neighbourhoods also have different larger companies that have a branch.

Nursing homes and day-care centres

There are several care homes in the project area. In the case of a possible sustainable renovation, it is important to take into account the people staying in the homes. There is a possibility that the buildings in question must close temporarily, as a result of which the building is not available for people who need care or for children who need to be cared for

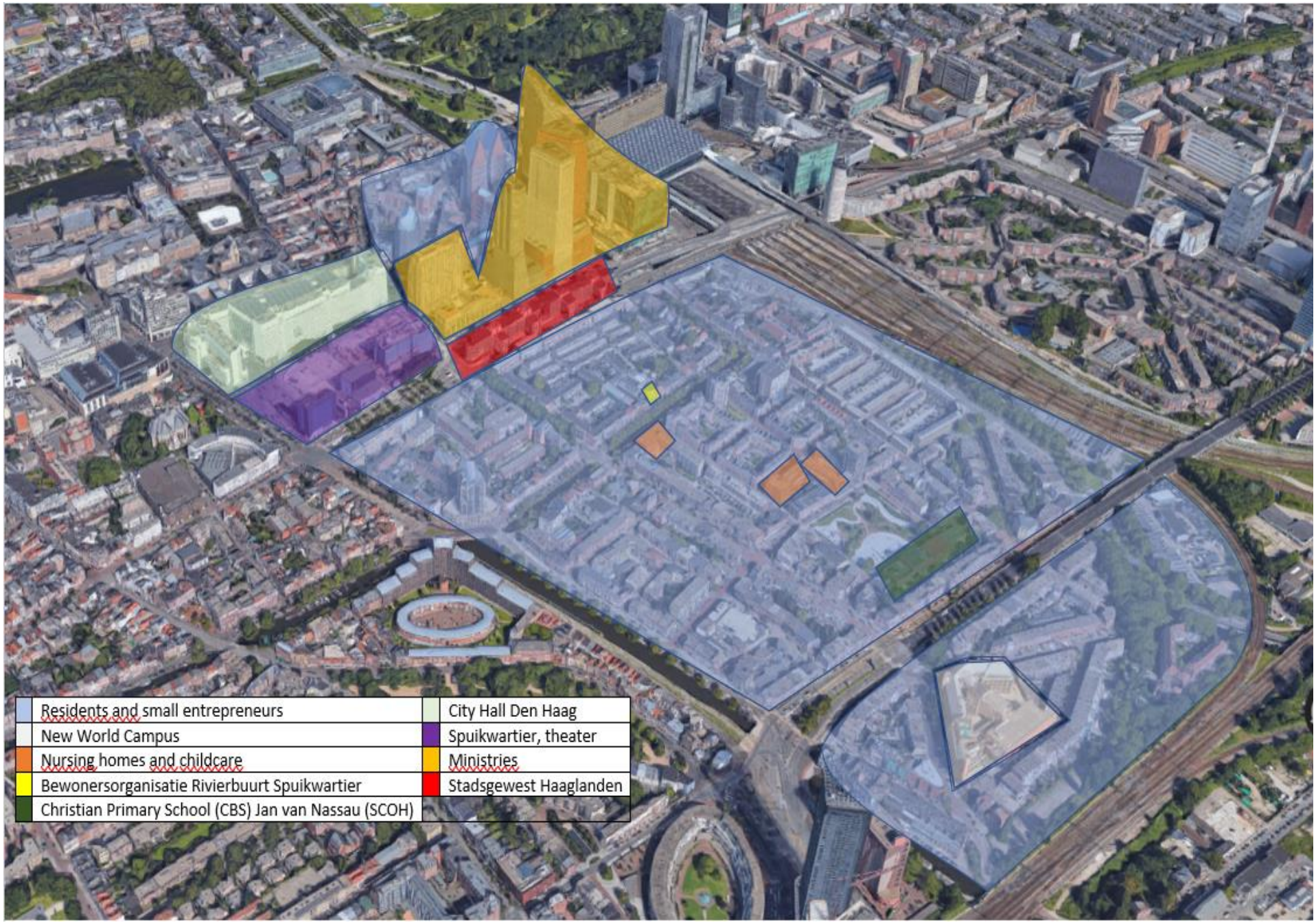


***Figure 24**: Internal stakeholders of the project area (Google.maps)*

6.2 External Stakeholders

The external stakeholders concerning the stakeholders outside the project area. These stakeholders make indirect use of the outside space and change has an indirect effect on their impact on living environment.

Water Authority

The water Authority is a government organizations, just as a central government. It controls the water management in a certain region. There are 21 water Authorities in the Netherlands. The plan area is part of the Delfland water Authority. A water Authority is responsible for water quantity management, water quality management and flood defence care. The Delfland water Authority is an external stakeholder because it must take care of the water management in the plan area, before, during and after the energy transition (Waterschappen, sd)

Municipality Den Haag

The Municipality Den Haag is an important external stakeholder because they have the ambition to be a city without natural gas. They want to be a clean, healthy and liveable city in the future. The city is looking for new ways to cook, shower and keep the houses warm. That's why the city is looking for different ways to make a transition to clean energy. Their goal is to change 25.000 till 30.000 existing houses to clean energy. (Den Haag aardgasvrij, 2019)

Province Zuid-Holland

The province Zuid-Holland has laws about different subsidies within the energy transition. It's important to know what kind of subsidies to make the renovation and the energy transition as affordable as possible. It's an external stakeholder because they don't have anything to do with the plans about the energy transition, they just have to afford the subsidies.

Housing corporations and estate agents

In the Hague there are different housing corporations. They are all involved by the developments in the plan area.

The Rivierenbuurt is a combination of the Spuikwartier, Rivierenbuurt-Noord and Rivierenbuurt - Zuid. In the Spuikwartier are private homes and renting houses. Most of the renting houses are property of the housing corporation Haag Wonen. In the Rivierenbuurt-Noord is 30% of the houses private. The other 70% are property of the housing corporations Haag Wonen, Vestia, Staedion and DUWO. In the Rivierenbuurt-Zuid are the most houses private. Only 30% of all the houses are renting houses. (Den Haag in cijfers, sd)

Housing corporations are external expats because they have to inform their renters about the energy transitions. But they don't have anything to say about the developments in the energy transition. For estate agents is it the same. When they sell a house, they have to inform the buyers about the plans in the plan area about energy transition.

Distributors

A distributor is responsible for the arrival of products at the consumer. Companies like Stedin, which is responsible for the natural gas consumption at houses in the plan area, Eneco, which is responsible for the electricity and the natural gas in the plan area, are important distributors who have to deal with the energy transition in the neighbourhood

Het Rijk

Some of the ministries of the Empire are placed in the Rivierenbuurt. Those are intern stakeholders. The Empire is an external stakeholder because of the laws and rules about energy transition. The Empire made some important laws which are important for the developments in the plan area.

Companies

Companies like energy suppliers, building companies, contractors, are extern stakeholders because they don't have anything to say about the plans which are going to be made for the plan area. But they are involved by the changes in the area.

Consultancy firms

The consultancy firm Overmorgen is a company where we are working for. This company gives consultancies about energy transitions.

Utilities who are responsible for the infrastructure

Because we have to make changes under the ground, it's important to know who are the utilities about infrastructure. For changes to different ways to get energy it's necessary to break the infrastructure. If we want the infrastructure to be fixed after the energy transition it's important to know who is able to do it.

6.3 Stakeholder analysis

The most important stakeholder in both influence and interest are the owners of the dwellings. This group consists of residents, housing corporations and landlords. It is important to make a difference between residents and owners. A resident of a home does not have to be the owner of the home. However, the resident will be affected, since the adjustments are made to the home. For example, a resident of a rental home will have to contribute less to the costs because this responsibility lies with the landlord.

Small businesses and entrepreneurs can contribute to creating support for the energy transition. A number of them will also be part of a VvE (Verening van Eigenaren) in a building. This also gives them a considerable influence when it comes to making decisions about sustainability.

Nursing homes and day-care centres are locations where many people rely on. The elderly and children are temporarily housed and cared for in such a location. With a possible renovation, it may mean that all individuals who use this service have to be relocated. This operation takes time and money to arrange. Another temporary shelter must also be found.

The municipality of The Hague is also a major player, according to the force field analysis. The municipality wants to have a plan for every neighbourhood in 2021 for the realization of the energy transition. The municipality also has the money, expertise and workforce to initiate the energy transition in the neighbourhood.

The residents' organization and the energy transition working group will have more influence in the first instance. Because the working group, a branch of the residents' organization, wants to create support among the residents, they will have played an active role during the entire transition. This active role will in particular include organization and social cohesion.

Companies, particularly in the energy and infrastructure sectors, often have the money and the knowledge to make the energy transition a reality. If companies decide not to cooperate on a project like this, the costs for owners will increase considerably.

7 – Policy and law

This chapter will map out which policy and law is important when it comes to the energy transition. This makes a distinction between the different scales of policy. The policy that the municipality of The Hague (local level), South Holland (regional level) and the national government (national level) apply to the energy transition was examined. The European legislation and regulations are also mapped.
All laws and regulations concerning the energy transition are primarily aimed at protecting the environment for the future generation.

7.1 Local (municipality)

The municipality of The Hague has the ''kadernota duurzaamheid''. This agreement a turning point for the development of the city. Here knowledge development and awareness about the energy transition are recorded. But pilot projects also contribute to making the city visible. The municipality of The Hague wants to create a cleaner, greener and more sustainable city together with the residents of the city. With the appointment of this agreement it has been accepted to agree with the following directives:

- To involve the energy transition, climate permanency, surroundings quality, sustainability of mobility and commodity management with the area development;
- The municipality taking the power with drawing up of the urban planning of the head infrastructure energy;
- The principles communication energy transition;
- Using Geo-thermal heating for the warmth network in The Hague conform the principles like named in this nota;
- Starting with energy plans for neighbourhoods in the 'Groene EnergieWijken';- with concrete initiatives like project sustainable roofs; support for the people with a small loan; SDE+ initiatives on company terrain and saving programmes for stores to work on lowing energy usage and sustainable energy generation;
- To manage the needed preparations to directly make the next step when the stocks from Eneco are sold. When this happens de coalition can mediate and speed up the process on the terrain of energy transition and sustainability. This will be implanted in the budget actualisation 2019;
- Keeping to support the resident initiatives on the ground of sustainability and energy transition;
- Using this nota when there are agreement made with parties like subsidies, tenders and prestation agreements;
- At municipal reorganisation of the public space with less pavement then before;
- making the city more compact going hand in hand with the improvement of the quality of the environment;
- Focussing more on space-efficient solutions like walking, biking and public transportation.

(denhaag.raadsinformatie.nl, 2019)

7.2 Regional (provincie)

Within the Netherlands, the province of Zuid-Holland plays a highly relevant role. It is responsible for a quarter of all national energy consumption and one third of all carbon emissions. Taking responsibility for addressing this, the provincial government has developed its own ambitious plan to meet climate change targets: aiming to reduce its CO2 emissions from 44 Mega tonnes (MT) in 2013 to 32MT in 2020 and to only 6 MT by 2050.

For the Province Zuid-Holland, energy transition will bring significant challenges as households, businesses and whole industrial areas move away from fossil fuels. Meanwhile, innovation in energy transition will bring opportunities, and potentially environmental, economic and social benefits.

Zuid-Holland stimulates the use of sustainable energy sources, such as wind and water. The objective is to generate 14% of the province's total energy consumption from renewable sources in 2020. Building on this, the province of Zuid-Holland is one of the initiators of the Heat-Cold Zuid-Holland alliance (Warmte-Koude Zuid-Holland), in which 25 parties - local governments, power companies, companies, banks and grid managers - jointly work on exploiting the geothermal and residual heat from the port area. Zuid-Holland is a region that lends itself perfectly

to the installation of a heat grid system. The demand for heat is great, not only in the cities, but also in the glass-house horticulture sector. The supply of residual heat and the geothermal potential in this region is also large. An initial global exploration shows that the implementation of the heat grid will generate significant reductions in the emissions of NOX and CO2 . In The Netherlands, Zuid-Holland is leading in the work on the transition from using natural gas to using renewable and industrial residual heat (circular heating system). Regional heat grids already exist elsewhere in Europe, but the approach adopted in Zuid-Holland is, in some respects, exceptional, even for the EU:

- The circular heating system is a public-private cooperation;
- The circular heating system aims to promote an open heat grid and heat market with a large number of heat suppliers and takers.
- The heat roundabout will facilitate the development of innovative applications, for example, very deep geothermal energy, energy storage and heat cascades.

It is important to join the discussions at EU level regarding the desired structure of the circular heat system as an open grid. Europe also offers sufficient opportunities to finance what we should do concerning our energy supply. It is one of the central objectives within 'Opportunities for West' (Kansen voor West), which is working on a revolving fund for energy. Other programmes such as Horizon2020 and the European Investment Bank are relevant to the financing of our task as well. The 21e 'Conference of the Parties (COP21)' takes place in Paris from 30 November to 11 December 2015. During COP21, agreements will be made regarding a new legally binding protocol ('Paris Agreement'). The EU aims for an emission reduction of 40% in 2030 compared to 1990, and shall endeavour to ensure that the protocol contains a long-term ambition of a maximum rise in temperature of 2 degrees. The EU also intends to make binding agreements on climate adaptation and financing. The agreements to be made in Paris constitute the framework for the proposed legislation to be brought up by the European Commission in 2016, to put the Intended Nationally Determined Contribution (INDC) ambitions into effect.
(Marco van Steekelenburg, 2018) (Regio Rotterdam Den Haag, 11 september 2018)

7.3 The Netherlands (National)

The Netherlands want to reduce its CO2- emissions with 95%. On the 12 of December at the climate accord 195 countries came to this agreement. In this climate accord there were made goals like to restrain the heating of the earth to less than two degrees Celcius and to reach balance between the emissions and capture of greenhouse gasses. Therefore we have to be careful using less energy and making the transition from fossil fuel to sustainable energy sources. The national energy agenda from the government, released in December 2016, gives the energy transition an extra boost. In the agreement stands the following: The Netherlands have to be gas free in 2050, this because of the climate accord but also to be self-dependent to reduce the import of fossil fuel from foreign countries and to reduce the production of gas in Groningen to zero. Municipalities are deemed to take control in making the Netherlands gas free from the built environment. Because the induce of big sustainable energy has a big environmental impact and the developments of heating network urge a central strategy, there is management needed on each scale to come to the solutions in the process of the energy transition. The leading subjects form the climate accord are the five sectors:

- Mobility
- Electricity
- Buildings
- Industry
- Agriculture & land

The sectors 'Electricity' and 'Buildings' are the most important sector if u think about energy transition. The other sectors do have an influence on the energy transition, but this influence is to a lesser extent. They do belong to the five most important sectors of climate agreement (Rijksoverheid Nederland, 2019).

Mobility

- All new passenger cars to be emission-free by 2030
- Incentives for electric vehicles through several taxation measures, including in support of the used car market; 1.8 million charging points by 2030
- Modal shift from car to bicycle / public transport
- Smart solutions will enable logistics to organise more efficient and sustainable transport

Electricity

- Phasing out coal-fired electricity generation by 2025/2030, first plant to be closed by 2020
- Accelerating offshore wind power, also growth of onshore wind and solar energy;
- Subsidies for additional renewable energy capacity (wind and solar) until 2025; estimated 70% renewable share in electricity production by 2030
- Introduction of a minimum CO2 price for electricity production

Buildings

- Enhancing the energy efficiency of 1,5 million homes and 1 million utility buildings.
- New buildings will no longer be heated with natural gas; existing buildings need to be improved to enable fossil-free heating as well.
- Municipalities take the lead in a local, participative approach, to make housing emission free, neighbourhood by neighbourhood.
- Energy tax system improved with stronger incentives for energy efficiency and CO2-reduction.

Industry

- Introduction of a targeted carbon levy, starting at €30 per ton in 2021 and rises to €125-150 per ton in 2030, including the ETS price, on every ton emitted exceeding a fixed reduction path
- Subsidy scheme for renewable energy (SDE) and CO2-reducing options in industry, such as CC(U)S
- Funding for innovation aimed at hydrogen and other sustainable fuels

Agriculture & land use

- Sustainable heating in greenhouse horticulture
- Reducing methane emissions from livestock through improved processing of manure
- Carbon storage in soil and vegetation through pilot programmes for climate-friendly land use
- Incentives for climate-friendly food consumption and reducing food waste.

7.4 European Union (Europe)

The European Union mainly sets guidelines that the members of the EU must adhere to. At the end of 2015, the Paris 2020-2050 Climate Agreement was delivered in Paris. As the name suggests, the agreement will enter into force from 2020, provided that 55 countries have ratified more than 55% of the world's total emissions. All forms of CO2 emissions will have to be phased out by 2050 so that global warming can be limited(Framework Convention on Climate Change, 2015. The climate agreement is an international agreement in which 195 countries participate.

The five main aims of the EU's Climate Agreement are (Ecovat, 2018):

- Compared to the pre-industrial era, the average temperature on earth should not rise more than 2 degrees Celsius. the aim is to achieve a maximum increase of 1.5 degrees Celsius.
- All parties involved will do their best to
- reduce greenhouse gas and harmful emissions as quickly as possible. The Paris Climate Agreement takes into account differences between countries.
- All 195 countries will measure their objectives once every five years against the current scientific knowledge about climate change. They will adjust their objectives where necessary.
- All negative effects of climate change must be tackled and require urgent action. The amount of greenhouse gases must be reduced.
- However, food production must not be compromised.
- All parties must contribute financially to reducing the amount of greenhouse gases and conduct research into climate-proof developments.
- Poorer countries may have difficulty achieving climate goals. Poorer countries can therefore draw on a fund that is filled by richer countries. However, this is not a binding agreement.
- The agreement also establishes a link with the prominent role of actors other than countries. Think of business, citizens, financial institutions and local authorities. They played an important and stimulating role during the negotiations for the Paris 2020-2050 climate agreement.
- The Paris Climate Agreement is binding. All 195 countries undertake to comply. However, the objectives or plans of countries and the amounts for the climate fund are not binding.

(Framework Convention on Climate Change, 2015) (Beltrame F., 2019)

8 – Technology

As mentioned before, the Rivierenbuurt wants to transition to a scenario where they use as little gas as possible. However, the municipality The Hague wants the Rivierenbuurt to use no gas at all. In this chapter different options for gas replacement will be discussed. All of these different options will contribute to achieving the goal, which is to create a neighborhood that doesn't use gas to sustain the day to day life of its citizens.

8.1 Energy reducing measures

Before any gas alternative measures are taken, it is important to reduce the use of energy of the houses within the Rivierenbuurt. First, the houses could be made into smart buildings. Smart buildings are buildings with self-regulation energy technology. Motion sensors for lighting and a thermostat that automatically adjusts the heat are examples of this. Reducing the use of energy is the first step in the trias energetics.

For ultimate sustainability it also is important to reduce the loss of heat as much as possible. To do this, all the houses need good insulation. This way the heat stays inside of the house, which means the house will be warmer for longer and there is less energy needed to maintain a comfortable temperature in the house. Insulation can be applied in many different ways: between a (new) frontage and the wall, under the roof, insulating glass in the window frames and under the floor. To choose the best option for insulation, the houses need to be investigated further to determine the specific circumstances.

8.2 Technological options for gas replacement

8.2.1 All electric

Without the use of any natural gas, people need to find other ways to cook their food and heat their house. The use of electricity could be a good alternative for gas that is used for cooking and heating. The energy for the electricity will be sustainably sourced from solar panels. With this combination the houses can (partly) provide their own energy.

Solar panels are panels that make electricity out of sunlight. Mostly, a solar panel is made out of lots of combined solar cells. Every solar panel has around 60 to 96 solar cells. Solar panels can be used for around 25 years, which means they have a long lifespan. However, there are some risks and disadvantages when someone chooses to use solar panels to provide their energy. Solar panels must be able to endure different kind of weather conditions: high temperatures, low temperatures, wind, rain, snow, hail. Also, dirt from birds and from the weather (leaves, branches etc.) should easily glide of the solar panels. Another factor to think about, is that the solar panels need to be placed towards the south. The south has the most hours of sun during the day, and the sun is strongest here. That way the solar panels work most efficient.

Figure 25: Solar panels (cortesocial.co)

If there are any houses in the area that don't have a roof that faces the south, or if there are residents that don't want solar panels on their property, a sun field could be a solution. A sun field is a big area where lots of solar panels are placed. If there are enough solar panels on the sun field, they can provide energy for the entire neighborhood (Milieucentraal, 2019).

To determine if homes in the neighborhood can be made into all-electric dwellings, further investigation into the current energy network is necessary. In theory any home could be made all-electric, provided it is sufficiently insulated (Greenhome, 2019).

8.2.2 Windmills

A sustainable way to generate energy, is to use windmills. A windmill consists of three compartments: a rotating rotor with rotor blades, a gondola and a mast. When the wind is blowing hard enough, the rotor blades will start to move. The movement of the blades will drive the gears in the gondola. These gears will take care of the drive for the electricity generator. The rotor blades are secured at the end of the mast, which is very high up. That way the rotor blades can catch the most wind possible. Because the windmills are so high, they are not inconvenienced by the houses, trees and other obstacles that are low on the ground. To make sure the windmill can always catch wind, the gondola is equipped with control technology that can determine the direction of the wind and can move the windmill into that direction (Windcentrale, 2019).

The drawback of windmills is that they need a lot of space. Looking at the Rivierenbuurt and its surroundings, windmills probably won't be an option to provide energy. There is no big open space nearby, except for the Malieveld. However, the Malieveld is an area that is protected as a cityscape and is managed by Staatsbosbeheer. Also, it is used to hosts events (Den Haag, 2019). This means the Malieveld isn't an option, which makes the use of windmills as good as impossible.

Figure 26: Windmills (Meteo, 2019)

8.2.3 District heating

District heating works through a heat network. The (residual) heat is generated at a large central location. This heat is a waste product that can be reused on another location. A large number of homes and small businesses can use this heat to be supplied with hot water. Heat networks can be a good solution in many places in the Netherlands to stop the use of gas and provide them with sustainable energy. It is estimated that about half of the Netherlands can be connected to a district heating network before 2050. To be able to use district heating, no technical installation or a boiler is needed. This be practically any house is suitable to use district heating (kijk, voel, beleef, 2019).

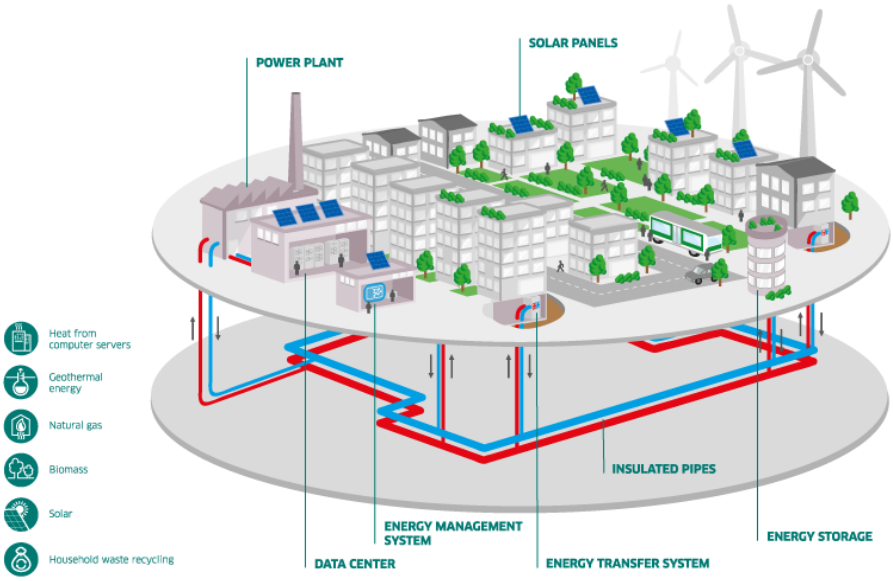


Figure 27: District heating (Engie, 2019)

A disadvantage of district heating is that it should be certain that the product is being delivered. The taker is dependent of the giver for the residual heat. Besides, there need to be strict rules to make sure there won't be any excessive heat production as a residual product. This is not very sustainable (NRC, 2017).

8.2.4 Biomass

By burning any form of bios mass, like wood, compost, vegetable oil and manure, energy will arise. Before the biomass can be burned, it is mostly necessary to gasify or to ferment the biomass into a biofuel. By using biomass as a fuel, the use of fossil fuels will reduce which will have a positive effect on the climate burden. In addition, biomass is an inexhaustible source. This is in contrast to the fossil fuels that are becoming increasingly scarce.

There are also disadvantages to using biomass as a fuel. Sustainability and environmental friendliness are difficult factors to measure. This is due to the wide variety of biomass and the amount that can be used. There is a lot of discussion about biomass and for what it specifically can be used, because there is not enough biomass to replace all fossil fuels (Milieucentraal, 2019).

8.2.5 Aqua thermal

Aqua thermal can be extracted from three different types of water. Aqua energy can be extracted from surface water (TEO), wastewater (TEA) and drinking water (TED).

With TEO, the heat is extracted from the surface water. For example, this surface water can be from rivers or ponds. This water is then sent to homes or buildings via the heat network. On location this water can be used by a heat exchanger or be stored in the soil for later use. When the water is used, it will again be transported to the source.

When talking about TEA, thermal energy from wastewater is considered. In this process heat is extracted from water that comes from discharging wastewater into the surface water. This often occurs with sewage pumping stations and wastewater treatment plants. Here large water flows come together, and the water flows continuously. This water also has a constant temperature, making it a reliable heat source.
TED stands for thermal energy from drinking water. A lot of heat is added when cooling drinking water that can be useful for heating homes and buildings. This results into two usable products: chilled drinking water and heat that can be used for heating.

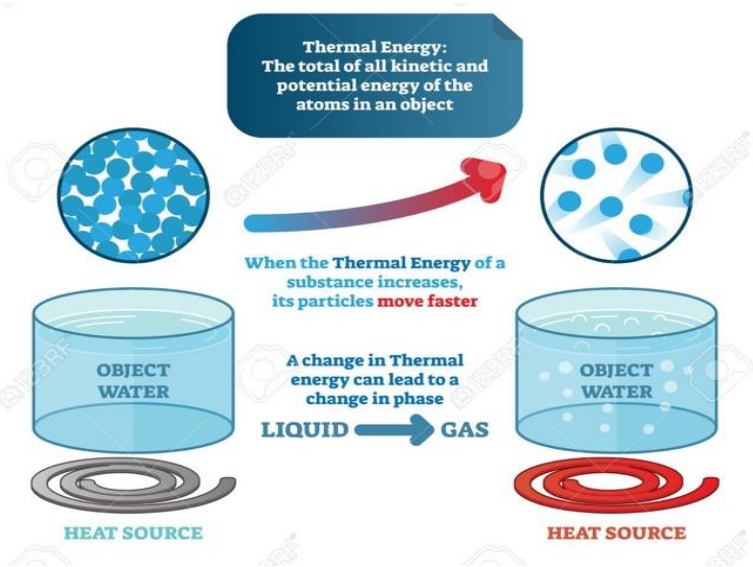


Figure 28: Thermal energy (VectorMine, 2018)

From an analysis by CE Delft about surface water in built environment and the quantity of heat it contains, it was clear that TEO in theory can meet 40 percent of the heat demand in urban areas. With TEA and TED, this is 15 and 1.5 percent.
A disadvantage of aqua thermal is the fact that water must be close by for efficient and effective use. The maximum distance that can be bridged from water source to the location of use is about five kilometers. The greater the distance, the greater the heat loss and the higher are the costs. Another complication is the infrastructure. There must be enough room to hinder water transport as little as possible.

Aqua thermal is currently still a fairly expensive technology and is only suitable for low temperature heating. This ensures that it will only be effective for energy-friendly houses and buildings. Good insulation is a requirement. For this reason, the use of aqua thermal is primarily aimed at new-build houses (Schepers & Kruit, 2018).

8.2.6 Air source heat pumps

Similar to a refrigerator, air source heat pumps extracts heat from the outside air to warm-up the air inside a home or the water, even when the temperatures is below the freezing point.

There are two kinds of air source heat pumps, air-to-air heat pump and air to water heat pump. Air-to-air heat pump works by extracting heat from the outside in to a fluid and sending in to a compressor. The compressor then raises the temperature of the fluid, which then goes to inside the house. While inside the house, the heat is transferred in the form of convection by a fan to warm up the house. The liquid then goes outside and the cycle is repeated. Even though a fan is used, which consumes electricity, there is no need for a constant supply of any kind of fuel. Air-to-water pumps starts of similar to air-to-air pumps by extracting heat from the outside and going to a compressor. The difference is that after the compressor the liquid passes through an heat exchanger, which heats up the water. Air-to-water pumps is suitable for house with an underfloor heating system of large radiators.

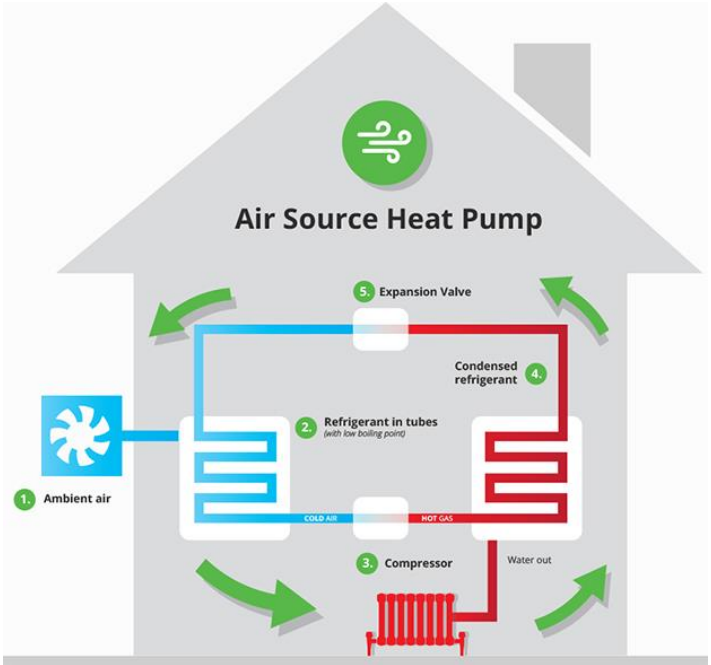


Figure 29: Air sources heat pump (eco-smarthomes, 2019)

The benefits of air source heat pumps are: Lower gas bills or no gas bills at all, lower CO_2 emissions, low maintenances easier to install then ground source heat pumps.

Things to take into consideration when using air source heat pumps are: Space outside of the house, insulation, fuel that is replaced and installation. Air source heat pumps requires enough space outside of the house for placement and ventilation. It also requires that a house is well insulated, because it operates on lower temperatures than conventional heating systems. Also the installation may be cheaper if it's taken in to account in to new developments. Lastly, the system will pay for itself when replacing certain fuels. (Trust, 2019).

8.2.7 Geothermal

Another sustainable method to obtain energy for either warming up a house or produce electricity is geothermal. Geothermal relies on the warmth the ground that is usually a constant temperature at specific level but is warmer the deeper the drill goes into the ground. Geothermal can be used in three ways: direct geothermal energy, geothermal heat pump and geothermal power-plant.

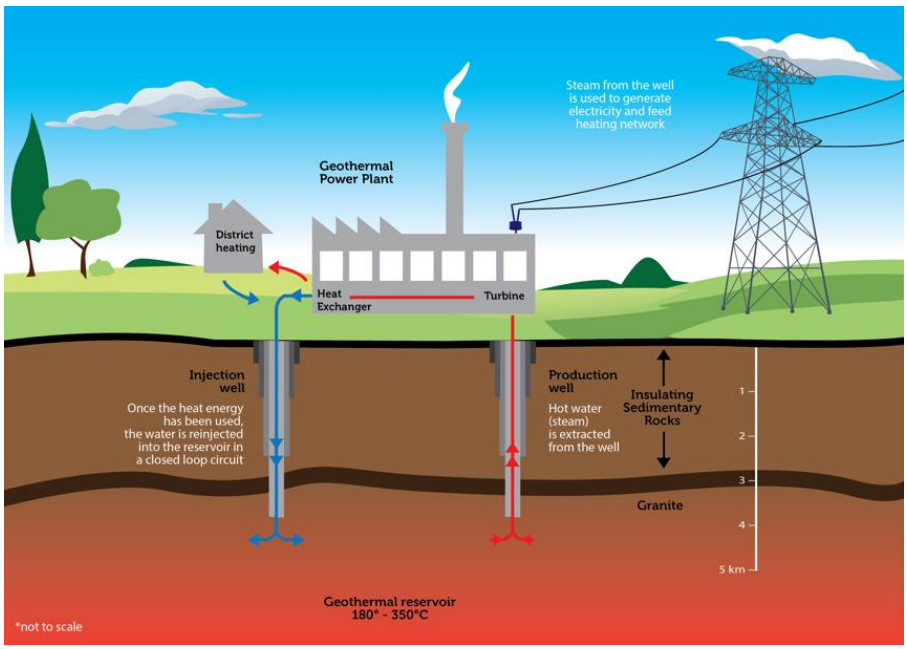


Figure 30 : Geothermal (vallourec, 2019)

Direct geothermal energy can be applied in areas where there's a water reservoir in the earth. This water can be directly pumped to buildings in the neighborhood to warm them up. In this case a heat exchanger is used to transfer the warmth to the buildings. The water is later returned to the reservoir to be reheated and used again.

At just a few meters in the ground the temperature there is usually 10 to 15°C and similar to air source heat pump, a geothermal heat pump can be used to extract heat from ground. Instead of using air to extract heat from the

ground. In this a piped is drill down in to the ground with a coolant fluid inside the pipe. Geothermal also makes use of a compressor, heat exchanger and a fan to warm up the house.

The last way geothermal energy is used is to produce energy is by building a geothermal power plant. Geothermal powerplants use steam to power turbines that produce electricity. There are three types of geothermal power plants which are dry steam plants, flash steam plants and binary cycle plants. All three types of geothermal plants makes use of a water reservoir that is in the ground. In a dry steam plant, steam is collected from the reservoir and used directly to spin the turbines in order to produce electricity. Flash steam plants uses water that between 148 to 371°C, a portion of water turns to steam as it reaches the earth's surface. This steam is than used to power the turbines that produces electricity. The steam later condenses back to water and is returned to the reservoir. The last types of powerplant is the binary cycle plants. In this case water steam is not used directly to spin the turbines, but another substance with a lower boiling point than water is used to spin the turbines. Although the water is not used directly, it is used to heat up the other substance through a heat exchanger. When the substances turns into steam it sends it to spin the turbines.
The advantages of geothermal energy is that it's reliant on fossil fuel, which makes it cleaner and cheaper. As mentioned before, Geothermal energy is cleaner because it produces a fraction of CO_2 that fossil fuel produces and by products sulfur gases are drastically reduced. It is also cheaper because it eliminates the transportation of foreign fuel to the location of production. (Watson, 2019)

9 – Finance

Last but not least, the chapter Finance. The costs and benefits of energy-saving measures can sometimes play a decisive role in the option for cleaner energy. This chapter not only discusses costs and revenues, but also the possible subsidies.

9.1 Subsidies

If there is a desire to apply any energy saving measures to a house, the residents of that house are eligible for energy subsidies. These subsidies are implemented by the government to stimulate energy transition for houses. The government wants to lose the use of natural gas and wants to switch to cleaner energy sources. An example of an energy saving measure is replacing a gas boiler for a heat pump, solar water heater or biomass boiler (Rijksoverheid, 2019).

Houseowners can ask for a subsidy from 2 September 2019 to 1 January 2021 for insulation measures. The maximum amount of money residents can receive is 15.000 euros per house (Rijksdienst voor Ondernemend Nederland, 2019). The government also made 100 million euros available for sustainable heat subsidies from 1 January 2019. The amount of money a resident receives depends on the type of device and the energy performance. For a subsidy, the device has to be purchased and installed first before a request for a subsidy can be made. To qualify for a subsidy, there have to be at least 2 energy saving measures in the house and the measures are executed by a construction company after 15 August 2019. Every house can only get one subsidy (Eigenhuis, 2019).

In the year 2020 there is a new subsidy scheme for owners of solar panels who return energy to the grid. The old energy meter is decreasing when energy is returned to the grid, but the new energy meter registered both use and deliver energy. The used electricity is subtracted from the delivered energy. The residents receive a compensation from their energy supplier and subsidy from the government for the energy that is left over. The compensation of the energy supplier is the electricity price including the energy tax and VAT (sales tax). The subsidies are only given on the delivered energy. It is not possible to get a subsidy for the energy that is used or stored in a battery. But there is still an advantage, because no taxes need to be paid for this energy (Business Insider Nederland, 2018). The amount of money the residents receive for each type of energy measure is given in the subsection 'Costs & Revenue'.

9.1.1 Regional

The residents can apply subsidies for energy-saving measures at the municipality. Not only residents, but also entrepreneurs can apply for these subsidies. The Hague has various subsidy schemes and funds that can help make a building more sustainable. For example, the SEEH (Subsidieregeling Energiebesparing Eigen Huis), which is a subsidy for homeowners and Owners Associations. The municipality of The Hague also gives a maximum of 5000 euros for neighbourhood projects that are working on sustainable alternatives. (Den Haag, 2019) Unfortunately, subsidies can only be requested from next year, because the budget for 2019 has already been used up. (Duurzaam Den Haag, 2019)

9.1.2 National

The government also wants to stimulate innovations that link sustainability and economic growth. These subsidies are called energy-innovation subsidies and are available for entrepreneurs, scientists and knowledge institutions which are part of the Top Sector Energy. The subsidies in this sector are part of the National EZ Subsidy Regulations. The projects that qualify for a subsidy are combinations of industrial research, experimental development, demonstration and fundamental research. For projects and research in the field of energy innovations, the Top Sector Energy offers around 130 million euros in subsidies every year. (Rijksdienst voor Ondernemend Nederland, 2019)

9.1.3 European

The European Union has a number of programs in the field of sustainable development. The most important program for the environment is the European program LIFE (2014-2020). This program is focusing on stopping biodiversity loss and restore ecosystems. The Private Financing for Energy Efficiency (PF4EE) can provide loans to private parties for energy-efficient initiatives. PF4EE is a part of the program LIFE. The Natural Capital Financing Facility (NCFF) is also a program of LIFE and is financing projects that aim at nature conservation. (Europa Nu, 2019)

The European Union also has financing facilities for the energy and infrastructure area. Connecting Europe Facility is a financing facility. The European Commission wants to invest at least 29.3 billion euros between 2014 and 2020 for better European transport, digital network and energy. The project will continue after 2020 and maybe with an increasement of 47%. Another facility program is the NER300-Program. This is one of the largest financing programs of its kind in the world and it is intended for the stimulation of environmentally friendly technologies.

ELENA is an European Subsidy with which regional and local authorities can develop a project plan for a large investment (above 50 million euros) in the climate and sustainable energy field. Other funds provided by the European Union are for example the European Energy Efficiency Fund (EEEF) and the European Fund for Strategic Investments (EFSI) which consists of 300 million euros. (Europa Nu, 2019)

9.2 Costs & Revenue

In this chapter mentions the costs and savings of various energy saving measures. The chapter is subdivided into the subchapters: Insulation, Boilers & Heat pumps, Solar water heaters and Solar panels. With each improvement option, the possible subsidy which may be entitled, is also noted.

9.2.1 Insulation

The revenue is calculated with use of a natural gas boiler and an energy price of 77 cent per m3. The type of house influences the amount of energy that is lost. That's why every type of house has different amounts of costs (**Table 10**).

Table 10: Costs Insulation

Improvement option	Type of home	Costs (Euros)	Revenue (Euros per year)	Subsidy (Euros/m2)
Facade insulation	Townhouse	800	250	25
	Corner house	2.100	650	25
	Detached house	3.100	950	25
Floor insulation	Townhouse	1.400	190	7
	Corner house	1.600	220	7
	Detached house	2.800	380	7
Roof insulation	Row house	4.100	600	20
	Corner house	4.700	700	20
	Detached house	8.400	1.300	20
Insulating glass instead of single glass window	Row house	3.100	120	35
	Corner house	3.500	140	35
	Detached house	4.500	180	35
Insulating glass instead of double glass	Row house	3.100	120	35
	Corner house	3.500	140	35
	Detached house	4.700	180	35

Sources: (Rijskoverheid, 2019; Rijksoverheid, 2019; Rijksdienst voor Ondernemend Nederland, 2019; Rijksoverheid, 2019; Rijksoverheid, 2019; Rijksoverheid, 2019)

9.2.2 Boilers & Heat pumps

The biomass boiler burns wood ships, logs or wood pallets (pressed pellets) and costs 6.000 euros or more (**Table 11**). In some cases, a suitable flue gas outlet needs to be installed, which could cost 2000 euros. The costs and revenues are calculated with 77 cents per m3 gas and 33 cents per kg wood pallets. (Rijksoverheid, 2019) The hybrid heat pump and ventilation heat pump have to be used in combination with a natural gas boiler. The costs in the table do not include the required natural gas boiler. If a hybrid heat pump or ventilation heat pump is purchased, which is more durable, the subsidy can increase by 300 euros. The costs and revenues for the heat pumps are calculated with 77 cents per m3 gas and 22 cents per kWh. (Rijksoverheid, 2019)

Table 11: Costs boilers and heat pumps

Improvement option	Costs (Euros)	Revenue (Euros per year)	Subsidy (Euros)
Biomass boiler	From 6.000	305-420	
Hybrid heat pump 5kW	3.600-4.600	220	From 1.500
Ventilation heat pump	2.500-4.700	170	From 1.350
Heat pump air	6.500-16.500	380	1.300-2.500
Heat pump floor	8.500-22.000	550	2.650-3.400

9.2.3 Solar water heater

The costs and revenues for the heat pumps are calculated with 77 cents per m3 gas (**Table 12**). (Rijksoverheid, 2019)

Table 12: Costs solar water heaters

Improvement option	Costs (Euros)	Revenue (Euros per year)	Subsidy (Euros)
Solar water heater (3,5 m2)	3.300	140	1.100
Solar water heater (5,0 m2)	4.300	180	1.300

9.2.4 Solar panels

The costs above are including inverter, installation and VAT. The revenue is calculated with a power price of 22 cents per kWh. Installing solar panels has another advantage. The already paid VAT of the solar panels can be reclaimed (**Table 13**) (Rijksoverheid, 2019).

Table 13: Costs solar panels

Improvement option	Type of home	Costs (Euros)	Revenue (Euros per year)
Solar panels	Row house (10 panels)	4.700	600
	Corner house (10 panels)	4.700	600
	Detached house (18 panels)	7.600	1.050

As mentioned earlier in this chapter, the use of more sustainable measures has a major advantage in terms of costs, because costs are saved on the long term. But this can cause problems on the long term, because it needs an investment and a lot of people don't have that money. This can cause problems, because the people that live in the Rivierenbuurt aren't rich. They don't have a lot money and it is questionable whether they want to spend this on more sustainable alternatives.

10 – SWOT-analysis

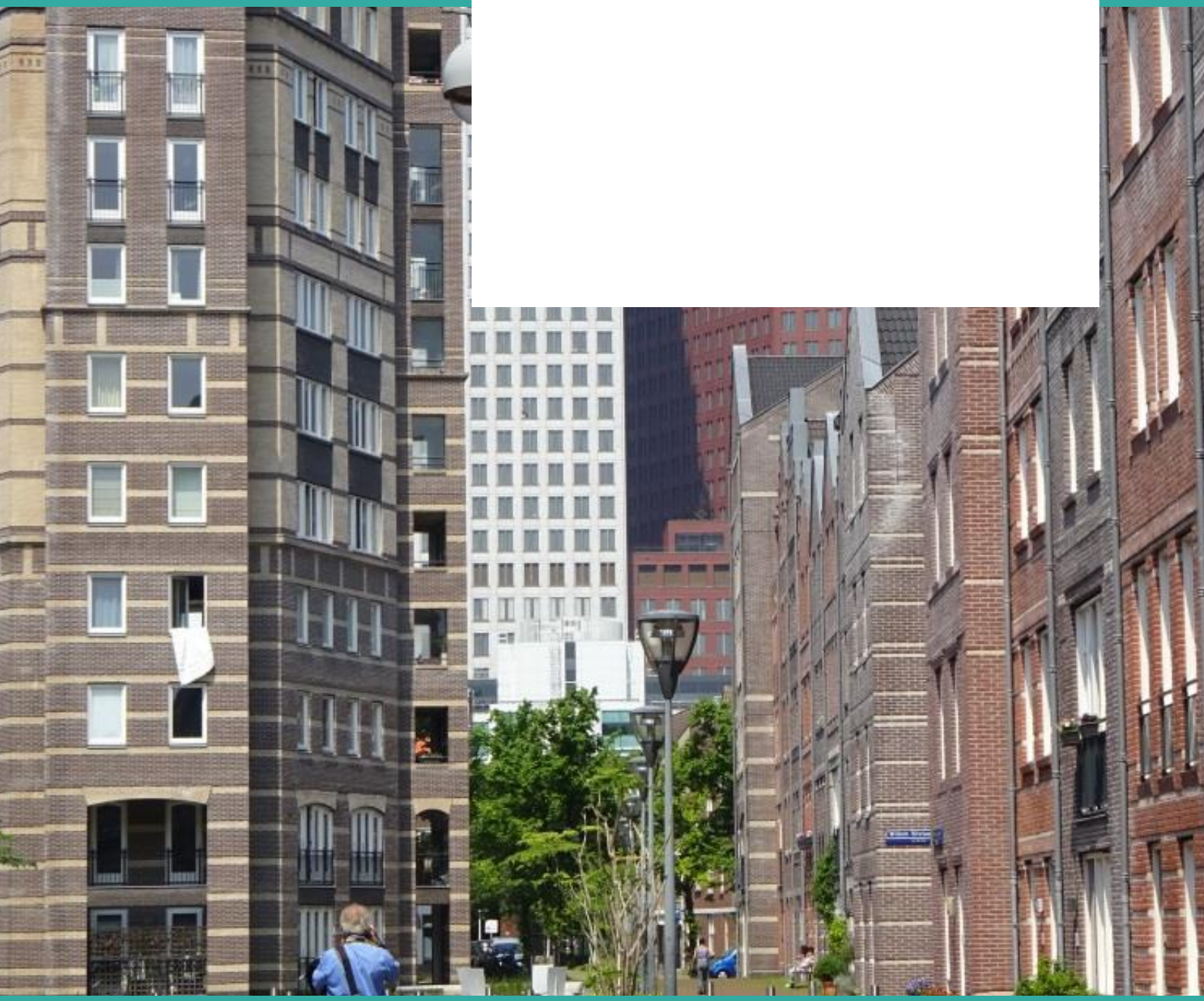
The project area has various internal strengths and weaknesses. For example, the neighbourhood has a very committed residents' organization that works hard for the neighbourhood. There are also several bottom-up initiatives in the neighbourhood to help the neighbourhood. However, the neighbourhood also has several weaknesses. The demography within the neighbourhood is enormously diverse. And although that is a strength, it makes a weakness for the energy transition. Within the project area there is a lower average income compared to the average income of the Netherlands. The percentage of low literate people in the project area is also high. Another weakness is the different construction years of the houses. Due to the different construction years, homes are isolated or not or suitable for sustainable measures.

In addition to the internal values, the project also has external opportunities and threats. An energy transition is encouraged from the various control bodies. The various government bodies also offer subsidies and foundations to support residents with sustainable adaptations to homes. The municipality of The Hague specifically encourages bottom-up initiatives when it comes to the energy transition. The municipality is willing to support these initiatives where necessary. Finally, the project area is in the CID, an area in the centre of The Hague that will be developed. However, threats are that the project area is in a densely populated urban area. This makes it harder or impossible to gain energy close to the project area. If energy needs to be imported, this will always have to be done from outside the city. Various parties such as companies will also be involved in the energy transition. It may be that companies see no reason to invest in the energy transition because they prefer to put the money elsewhere. A final threat could be the costs of sustainable measures. Due to high costs, residents with a low income are unable to make a financial contribution.

***Table** 14: SWOT-analysis*

Strength	**Weakness**
• The initiative is bottom-up • Involved residents' organization • Progressive political point of view	• The inhabitants have a low income compared to the average income of the Netherlands. • Low literacy • Homes have been built in different periods, so homes should be drastically adjusted.
Opportunities	**Threats**
• From the municipal, provincial and national politics there is a strong stimulation for the realization for the energy transition. • Grants and foundations have been made available. • Development of the CID. • The municipality of The Hague is willing to support bottom-up initiatives where necessary.	• Urban area ensures that no large-scale measures can be implemented close to home. • Companies see no reason to invest in the energy transition of the neighbourhoods. • The investments are too expensive

PART B: TRANSITION SCENARIOS



11 – Transition scenarios

Every team member has written a scenario within their well respected field of expertise. This chapter contains a summary of all the scenarios that are written. The six scenarios can be found in their completion in Appendix 1.

11.1 Scenarios

11.1.1 Summary scenario Manon

The buildings in the different areas of the Rivierenbuurt were all built in different points in time. The newest homes of the Rivierenbuurt are located in the Spuikwartier and probably have pretty good insulation. However, insulation back then is not what is it nowadays. Therefore, the insulation in the homes need to be upgraded to make sure they lose as little warmth as possible. The buildings that are older (in the Rivierenbuurt-Noord and Rivierenbuurt-Zuid) need insulation as well, and right now they probably have no insulation or very little. The floors of all the buildings need to be insulated to a RC-value of 6. The roofs need to have an RC-value of 10. The facade of the homes need to have a RC-value of 4,5. With existing homes it is difficult and expensive to achieve this. This is why cavity wall insulation is a good option. Extra insulation on the in- or outside of the wall can always be added when desired.

To make the energy use of the residents the Rivierenbuurt more sustainable, a variety of options can be applied. The most suitable option for all of the areas of the neighborhood is a combination of solar panels, a solar water heater and air source heat pumps. By using solar panels, the energy they create can be used for cooking and other use of electricity. Besides solar panels, a solar water heater will also be installed. This solar water heater makes sure there is enough warm water in the residency to shower etc. Also, an air source heat pump will be installed. This heat pump will keep the residency at a nice temperature: warm in the winter and cool in the summer.

11.1.2 Summary scenario Maybritt

The Rivierenbuurt / Spuikwartier consist about three different neighbourhoods with different functions and a different investment capacity. To make the neighbourhood gasless it's very important to look at the different areas in the neighbourhood. Specially look to how much money the area can invest in energy transition. It's important that the three different areas get information specifically for their houses and what they can do to become more gasless in the future.

11.1.3 Summary scenario Bente

The Rivierenbuurt can be divided into three different neighbourhoods, namely Rivierenbuurt Noord, Rivierenbuurt Zuid and Uilebomen. This neighbourhood is all tackled in a different way. The houses in the Rivierenbuurt Noord mainly have an energy label between C and E. The houses in the Rivierenbuurt Zuid mainly have an energy label G. The first thing that needs to be done is that the houses must be better insulated. The Rivierenbuurt Noord and Zuid will also be able to use District Heating. The houses in the still needs to be isolated, but this will have to be done less drastically than in the other neighbourhoods. In order to also be able to generate electricity sustainably in the homes of the Uilebomen, heat pumps will be generated in the homes.

11.1.4 Summary scenario Melissa

Because the Rivierenbuurt is poor, a small measure has been chosen that reduces the CO_2 emissions of the houses. Because switching to a heat pump that runs entirely on electricity can quickly cost around 10,000 euros, a water boiler has been chosen. It has also been decided to use solar panels for heating the solar boiler and for supplying electricity to the home. The costs for a water boiler with subsidy is 2.200 euros. The costs for 6 solar panels are 2.650 euros. It is also important to insulate the houses, because it is more difficult to save energy without a well-insulated house. If we want to make the residents of the neighborhood more enthusiastic about these changes, it is important that we show that the measures actually deliver benefits.

11.1.5 Summary scenario Thom

Different things are tackled in different neighbourhoods over different periods. The Rivierenbuurt-Zuid will initially focus on sessions and workshops to spread information about energy transition. During these workshops, houses are isolated in the Rivierenbuurt-Noord to make the houses there more sustainable. Workshops and sessions will then also start in the Rivierenbuurt-Noord. A SmartGrid will then be installed in the Spuikwartier. After the installations, small energy projects were started among residents during the sessions and workshops to realize gas-free homes for existing buildings.

11.1.6 Summary scenario Jonathan

There are three different areas in the Rivierenbuurt: Rivierenbuurt-Noord, Rivierenbuurt-Zuid and Uilenboom. Between these areas is a difference in characteristics. This means that there every area needs a own plan adapted to its characteristics. The Rivierenbuurt-Zuid and Rivierenbuurt-Noord need better insulation while the Uilenboom already had reasonable isolation. The homes in the Rivierenbuurt-Zuid and Rivierenbuurt-Noord are going to bed insulated while the Uilenboom's insulation is fine for now.

The measures that are going to be taken are solar panels on the roofs of the buildings, a heat, pump for the heating the homes, air source heat pump for the ventilation of the homes, solar water heater for the usage of warm water, half-open callosity, green roofs and realizing parks and playing grounds. Next to this measures there will be a greener outlook implemented.

12 – Multi Criteria Analysis

The MCA is a Multi Criteria Analysis. The goal of this analysis is to analyse different scenario's, based on what the client wants in the project area. The different scenario's get different names. So it's easy to find them back in the analysis. The written scenario's for this document are recovered in appendix 1.
After the scenarios have a description. The different criteria get a rating. Which one is the most important and which is less important for this plan area?

12.1 MCA Criteria

12.1.1 Communication:

- Transmission of information: From the very first moment, the parties involved are well informed and involved in the developments concerning the energy transition in the planning area. Communication is the most important aspect as this is the start of the energy transition.

12.1.2 Environment:

- Appearance: The measures shall not restrict the appearance of the surrounding area. For residents, the appearance of the neighbourhood is important, which ensures the quality of life. Appearance can be ruined by large measures or buildings that are realized, so the appearance of the neighbourhood must be taken into account.
- Liveability: The measures may not limit the liveability of the plan area, the liveability remains the same or will be improved. In the neighbourhood, quality of life is a characteristic aspect. The quality of life determines whether people want to live in the neighbourhood, so the quality of life will have to be the same or better.

12.1.3 Social:

- Taking diversity into account: The application of measures takes into account the demographics of the project area. In each project area there is always diversity, the term diversity can be taken widely and there are many ways in which this can be interpreted.
- Civic participation: Residents must be given the opportunity to participate in the energy transition in their homes. Citizens are very important in the energy transition and there will be a lot of communication with the citizens, so this is an important point.
- Cooperation between parties: The various parties, such as citizens, governments and businesses, are working together towards a common goal for the realisation of the energy transition. In a cooperation it is a requirement that each party has a say and that there is communication between parties. This is one of the most important points in the MCA

12.1.4 Finance:

- Payback period: The payback period for each measure is a maximum of 10 to 15 years. The payback period is important when starting a project. It is necessary to make a profit so that the costs that the project provides are useful.
- Budget proof: Taking into account different incomes. The costs of the measures are related to it. Costs are divided fairly between the different parties.
- Investment costs: No unexpected additional costs. Don't pay for gold taps. The investment costs need to be looked at carefully. At the start of the project, the investment costs are important because the project must be profitable. It is also important that all stakeholders agree on what measures are needed and how much money can be put into the project.

12.1.5 Technical:

- Local power generation: The energy is generated locally. Local energy generation is currently a measure that is often applied in sustainability projects. Local energy sources ensure that the user does not incur excessive costs and that the entire neighbourhood or district is free of the gas.
- Energy saving: The measures limit the amount of energy needed in the new situation. Saving energy can be done by means of insulation or sustainable measures that reduce energy consumption. Saving energy is good for the residents themselves financially and for the government/municipality for the energy transition.
- Maintenance-friendly: The measures applied in the new situation last for a long time and require little maintenance. The use of materials is currently a problem if something breaks down, people buy it new and cheaply. Maintenance-friendly materials last a long time, which results in less use of materials.
- Low gas: The measures applied in the new situation are gas-free. By 2050, all homes will have to be gas-free, so this is a requirement for future projects. Low-gas solutions consist of collective and individual solutions. Many types of measures are available, and the solutions that can be applied vary from one neighbourhood to another.

12.1.6 Transition:

- Out of the box: The transition in the neighbourhood is out of the box and inspiring for future projects. The scenario that has a solution that is original and not applied by others will end higher.
- Future-proof: The measures that are taken can still be adapted in the future. The application of measures must be done carefully so that it is possible to respond further to the measures currently being taken. As a result, the measures have not been applied in vain and the investment has been useful, which means that the value of the measures has not been lost either.
- Bottom-up: The measures are accessible to the residents. Bottom-up ensures that the project is done from the point of view of the residents so that there is no opposition in the project.

12.1.7 Policy and law:

- Laws and regulations: The measures applied comply with the various laws and regulations on energy transition. The project must always take account of laws and regulations, otherwise the project cannot be realised. For example, the Buildings Decree 2012 should be taken into account.
- It motivates or stimulates the municipality to provide people that could help the Rivierenbuurt/ Spuikwartier with regard to the energy transition.

12.2 Rating the scenario's

There are six scenario's, every person in our project group made one. In the MCA the scenarios are named by the abbreviation of the name from the group member. This abbreviation is used in the rating table, result table and the graph.

Table 15: MCA Descriptions scenario

Description scenario	Abbreviation
Manon	MA
Maybritt	MY
Bente	BE
Melissa	ME
Thom	TH
Jonathan	JO

In **Chapter 11.1** there are six different scenario's described. In this chapter the criteria get a rating between 1 or 10. Mark 1 is less important and mark 10 is very important for this plan area. We gave the rating to the criteria by first describing all the criteria with the whole group. Then we all took a vote based on our knowledge of the first hand in D1 what rating each criteria should get. After everybody gave their opinion we appointed the average of the chosen rating, that's how the ratings were appointed. This is the short description of every criteria and their rating (**Table 16**):

Table 16: MCA Criteria

Communication	10	In the energy transition, the resistance of the residents must first be lowered so that measures can be taken without problems.
Environment	3	The environment is not a characteristic we focus on, it is more a side issue. In any case, no major measures will be taken that can be seen here, so we don't have to pay too much attention to them.
Social	4	The residents and parties participating in the project have to be taken into consideration when making plans.
Finance	6	In order to finance the project and ultimately make it profitable, it is important to look at the finances
Technical	7	The technical possibilities for furthering the energy transition will be examined.
Transition	9	Transition is forward-looking here we focus on the intention to make the neighbourhood resistant to future problems.
Policy and law	1	For the project in the area there will be hardly any rules or laws discussed.

In **Table 17** the scenarios have been linked and weighed to all the criteria. The way we did this is by reading one person's scenario and then the other groupmates discussed what rating each scenario should get per criteria. In the rating table it's shown what rating each scenario gets for every specific criteria. The results of the rating table are shown in the results table.

Table 17: MCA Rating

Rating Table									
Criteria	Measuring unit	Weighting factor	Cost/ Benefit (C/B)	MA	MY	BE	ME	TH	JO
Communication	%	10,00	C	1,00	5,00	1,00	1,00	5,00	1,00
Environment	%	3,00	C	1,00	1,00	1,00	1,00	5,00	5,00
Social	%	4,00	B	1,00	3,00	1,00	3,00	3,00	3,00
Finance	%	6,00	B	5,00	3,00	5,00	5,00	3,00	1,00
Technical	%	7,00	B	5,00	3,00	5,00	3,00	5,00	3,00
Transition	%	9,00	B	5,00	3,00	5,00	5,00	5,00	5,00
Policy and law	%	1,00	B	1,00	1,00	1,00	1,00	1,00	1,00

In **Table 18** the total score of the scenario's is shown. The table shows that the scenario of Thom has the highest score of all tables. The table is a calculation of the weighing factor and the given number to the criteria per scenario. This leads to different scores per person, to get the best scenario all the results have been added up so the best scenario is shown. **Figure 31** gives an good view on who has the best score.

Table 18: MCA results

Results **Table**						
Criteria	MA	MY	BE	ME	TH	JO
Communication	0,10	0,50	0,10	0,10	0,50	0,10
Environment	0,03	0,03	0,03	0,03	0,15	0,15
Social	0,04	0,12	0,04	0,12	0,12	0,12
Finance	0,30	0,18	0,30	0,30	0,18	0,06
Technical	0,35	0,21	0,35	0,21	0,35	0,21
Transition	0,45	0,27	0,45	0,45	0,45	0,45
Policy and law	0,01	0,01	0,01	0,01	0,01	0,01
Totaal	1,28	1,32	1,28	1,22	1,76	1,10

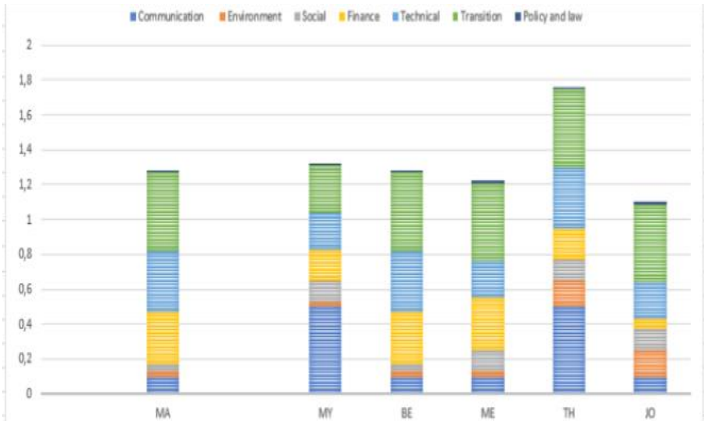


Figure 31: Results per scenario

12.3 Conclusion

The conclusion of the MCA is that Thom has written the best scenario. His scenario has the highest score on the different criteria. But the scenario of Thom could be better. So after a discussion, there is decided that Thom his scenario is the basic for the plan about the energy transition in the Rivierenbuurt.
The scenario is a combination of all the scenario's there are made. The best items from the different scenarios are put together to one big scenario. This final scenario is written in **Chapter 13**. An explanation of the scenario will be find in the next chapters.

13 – Scenario Rivierenbuurt

The scenario written by Thom had the highest scores according to the MCA (**§12.2**). The chosen scenario will be used as a base model for the final energy transition design. The base model also did not get the maximum score. So it is not a perfect scenario. That is why there also needs to be improved upon the scenario. For the improvements, other scenarios will be used by looking at what the best points were from the other scenarios. The concept final scenario will be a multi scenario based idea to meet the request.

13.1 Concept scenario

The Rivierenbuurt can be divided into three different neighbourhoods: Rivierenbuurt-Noord, Rivierenbuurt Zuid and Spuikwartier. As **Part A: Neighbourhood analysis** has shown, the differences between these three neighbourhoods are large. The residents of the Spuikwartier have in general more to spend than the residents of the Rivierenbuurt-Noord and -Zuid. Also the dwellings are younger in the Spuikwartier and are therefore better insulated. But the residents in the Spuikwartier also have more money to make the houses more sustainable. The residents of the Rivierenbuurt-Noord and -Zuid have older and lesser insulated homes. They also have less money less to spend.

Especially the residents from the Rivierenbuurt-Noord and the Rivierenbuurt-Zuid have in general not much to spend. The urgency for making the houses more sustainable may therefore not be every homeowners biggest priority. In addition, it may also be that residents would like to contribute to the energy transition, but do not know where they should start.

Workshop evenings will be organized for the residents of the Rivierenbuurt. During these evenings the residents will be informed about the options, but the residents can also share their own ideas here.

The transition will be divided into three phases with different workshops, sessions and measures. This allows residents to enter at the level that suits their situation. During this evening, small solutions are proposed, residents can come up with ideas themselves and residents can come into contact with their neighbourhood residents to make collective plans for making the houses more sustainable.

13.1.1 Phase 1 (2 years)

During the workshop evenings of the first phase, an explanation is mainly given about the energy transition in general. For example, the residents receive information about small adjustments that can be made in their own home. This includes, for example, draft strips, heating insulation or the replacement of halogen lamps for LED lighting. The residents of Rivierenbuurt-Noord and -Zuid in particular have fewer isolated houses and with small changes the residents can see that they can already save quite a bit of energy and money.

These two years also gives the Workgroup Energy Transition the opportunity to contact, inform and invite the municipality of The Hague, companies, housing corporations, governments and other possibly involved parties. This serves as an preparation for the second phase.

13.1.2 Phase 2 (4 years)

During the workshop evenings of the second phase, it is explained which next steps residents and other homeowners could take in the energy transition. The first phase gives the residents a better insight into the fact that small adjustments to the insulation of their house can save money. By becoming aware of the small adjustments the goal is to make the residents more open and aware of larger adjustments in their home.

The larger adjustments that could be made to homes are, for example, the installation of double glazing, wall insulation, roof insulation and floor insulation. For each housing block, the residents and other homeowners will be looked at for insulation options. This will lead to increased citizen participation. Citizens will be part of their own project to start a collective initiative

Because these adjustments require more money and are dependent on external parties, companies, banks, organizations and governments will also be involved in these workshops. Information about the role of these external parties in the energy transition will be treated as well as information about subsidies and other financial support will be presented during workshops. The municipality of The Hague delivers a of several process manager(s) to get the different parties work together.

Insulation measures can also lead to changes in the outdoor space. A number of the houses are very small, so interior wall insulation is not desirable. That is why we will also look at which changes fit well within the street scene or which lead to an improvement of the living environment.

13.1.3 Phase 3 (4 years)

During the workshop evenings of the third phase, the most major adjustments in addition to energy transition are proposed. When almost all homes are well insulated, the last step to possibly completely remove homes from the gas can be looked at. In addition, companies, banks, organizations and governments are again involved in these workshops. Because owners of the same housing block together with external parties have thought about the possible adjustments that could be made to go low or even without gas.

For example, residents can purchase heat pumps in consultation with them, or they can consider a heat-cold system with the entire neighbourhood. Solar panels could also be purchased collectively with the neighbourhood. The most important of these is that support is created among residents and that they work together.

What makes the workshop evenings more attractive for the residents is that during the evenings, experts come by to whom all questions can be asked without obligation. Discount coupons will also be made available for induction pans, for example, which makes gasless cooking more attractive. But also, coupons for paint when replacing the frames of a house by installing double glazing.

13.2 Multi Criteria Analysis

The concept for the final scenario has also been tested against the Multi Criteria Analysis (MCA) that was prepared in advance. This with the underlying reason that the final scenario meets all predefined criteria (**Chapter 2**).

Communication

Just as in the basic model, the concept achieved the maximum score for the *Communication* criteria. However, the communication method has improved compared to the basic model. Now there is more phased communication with all parties involved and everyone is better informed.

Environment

As in the basic model, the concept achieved the maximum score for the criteria *Environment*. However, the interpretation of these criteria has changed compared to the basic model. This focuses more on improving the quality of life by making use of facade renovation.

Social

For the *Social* criteria, the concept scored higher than the previously determined basic model. The involvement between parties is encouraged in the concept. In doing so, greater account is taken of the diversity within the neighbourhoods.

Finance

For the *Finance* criteria, the concept scored higher than the previously established basic model. This way, more account is taken of differences in assets per owner. The concept has also been drawn up in a more budget-proof manner, taking more account of a changing market in the field of energy transition.

Technical

For the *Technical* criteria, the concept, just like in the basic model, achieved the maximum score. However, the interpretation of this is completely different compared to the basic model. Instead of a large collective solution, there is now more focus on technical solutions on a smaller scale. Greater account has also been taken of the applicability of technical measures.

Transition

For the criteria *Transition*, the concept, just like in the basic model, achieved the maximum score. The difference, however, is that in the concept a phased transition path has been drawn up with more detail.

Policy and Law

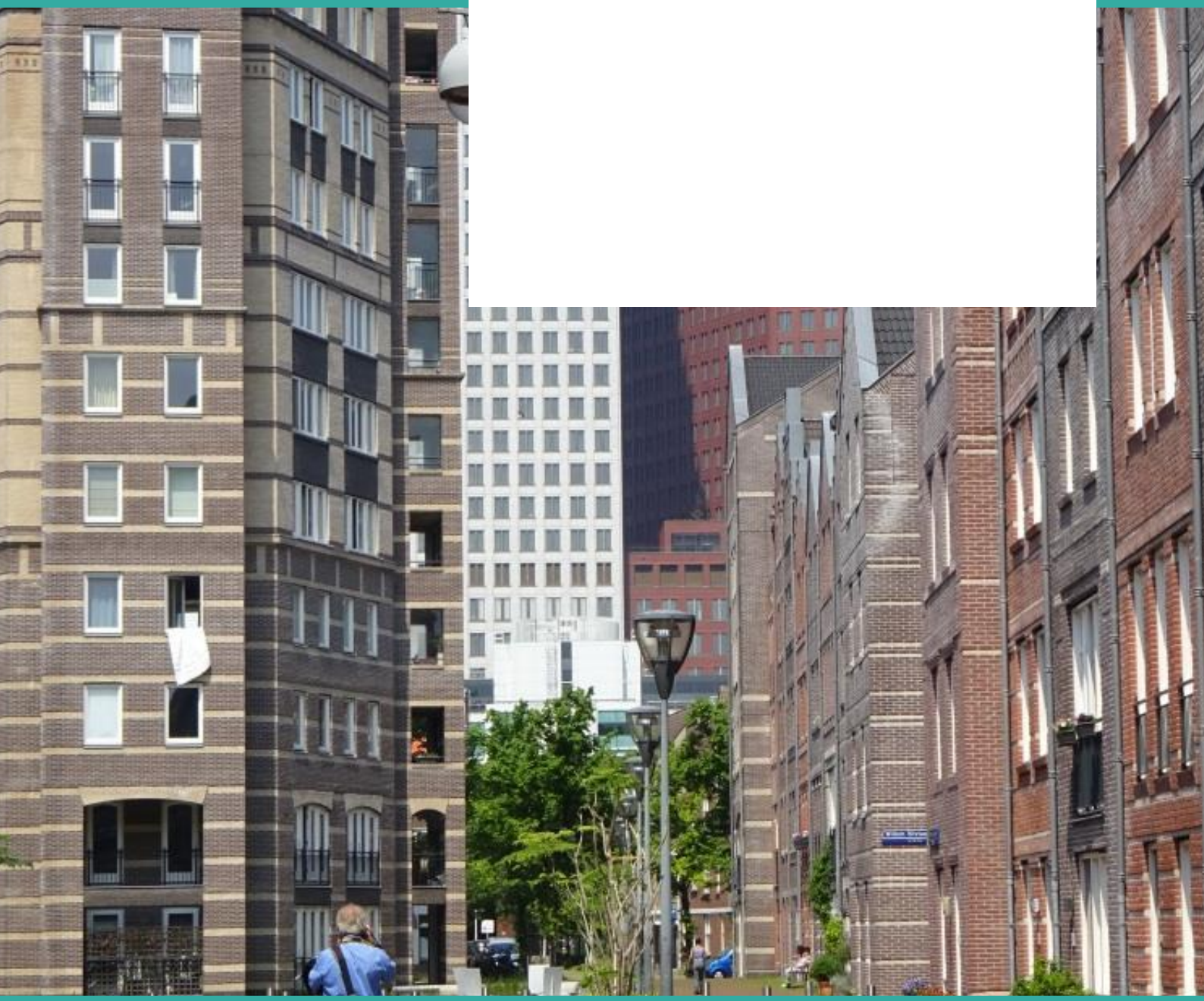
For the *Policy and Law* criteria, the concept scored higher than the previously established basic model. In this way, the concept takes more account of the involvement of the municipality of The Hague.

Description scenario	Abbreviation
Thom	TH
Final concept	FC

Table 19: MCA results final scenario

Rating Table						
Criteria	**Measuring unit**	**Weighting factor**	**Cost/ Benefit (C/B)**	**TH**	**FC**	**FC**
Communication	%	10,00	C	0,50	5,00	0,50
Environment	%	3,00	C	0,15	5,00	0.15
Social	%	4,00	B	0,12	5,00	0,20
Finance	%	6,00	B	0,18	5,00	0,30
Technical	%	7,00	B	0,35	5,00	0,35
Transition	%	9,00	B	0,45	5,00	0,45
Policy and law	%	1,00	B	0,01	3,00	0,03
				1,76	**Total**	**1,98**

PART C:
TRANSITION DESIGN



14 – Phase one: Informing and activating

The first phase will be focused on informing and activating the neighbourhoods and its inhabitants. The duration of the first phase will last two years (December 2019 - December 2021) and will be carried out per neighbourhood. By the end of 2021, it should be clear to all of The Hague how the municipality wants to do and organize the energy transition per neighbourhood. To include the diversity of the neighbourhood it is not considered feasible to come up with one specific plan. For this reason, there will be no concrete plan by the end of 2021 that can provide precise figures and data. However, before that time the entire elaboration for phase two and possibly even three can be set in motion and started. (Oosterling, 2019)

14.1 Communication

14.1.1 Strategy

The first phase is all about raising awareness and activating the residents. In addition, this phase must also serve to regulate and set up the multiyear plan. The municipality can be of great help in this initial phase. For example, contact must be made with the business community and other external parties that may be relevant in the future. Communication resources must also be developed and deployed to inform everyone as well as possible.

The intention is to create awareness among the population. But also, to get the participation going. This must be achieved through various workshops. The knowledge that comes with these workshops will go through experts. However, the best thing would be if the residents eventually transferred this knowledge to each other. This should help to further increase participation.

The workshops will first be held for the inhabitants of the Rivierenbuurt-Zuid, then Rivierenbuurt-Noord and finally Spuikwartier. Because the people of the Rivierenbuurt-Zuid have the lowest income they receive the first information about cheap measures. Each neighbourhood will take about 9 months to get most people informed and to participate. The turnout is expected to be low in the beginning but will increase over time. The residents will encourage each other to go through word of mouth communication.

14.1.2 Workshops and sessions

There will be several workshops in the first phase. Most workshops will be scheduled in the evening when most people do not have to go to work. This should lead to a higher turnout.

The first workshop will be focused on sharing and disseminating information about the energy transition in general. This with the reason to provide all residents with the same information. At the end of this workshop every resident has the same knowledge when it comes to the energy transition.

The second workshop will be about living comfort. Here residents receive information about what the energy transition can mean for their own living comfort. Hereby they get an explanation about how living comfort is determined and what is being looked at. They also receive various tools during the workshop that residents can focus on to make their own living comfort.

The third workshop will be about how residents can save energy in their own home through small changes. They receive an explanation about, for example, sustainable lighting or draft strips. With this, residents are made aware of the fact that to save money, small adjustments can make a contribution. The residents are also informed about the upcoming plans for the energy transition in their neighbourhood. It will be advised that residents are well advised to use the given tools in order to be prepared for future costs. Snap hier ook niks van? Geen idee wat ik er van moet maken

14.1.3 Actors

Various actors will be involved during the first phase. The actors that are relevant in the first phase are:

- Residents;
- Homeowners;
- Residents' organization Rivierenbuurt and Spuikwartier (BRS);
- Energy Transition Working Group BRS (W.E.T);
- The municipality of The Hague;
- Experts in the field of energy transition.

The residents of the various neighbourhoods are the target group on which the transition is focused. Ultimately, it is their homes that need to be adapted to realize the energy transition. It is not known to what extent all residents are aware of the energy transition and what it exactly means.

The Rivierenbuurt and Spuikwartier Residents' Organization (BRS) is the best way to inform the neighbourhoods about the workshops. The BRS is a representation and residents in the neighbourhoods and have the most contact with the neighbourhood. The BRS is aware of what is going on within the neighbourhood and knows best how the neighbourhood works.

The Energy Transition working group BRS (W.E.T) is a branch of the BRS that deals with the energy transition within the neighbourhoods. This group, if it will grow, will be the umbrella organization from the BRS to initiate the energy transition in the neighbourhood. They will also be the point of contact for the neighbourhood and they are responsible for bringing in knowledge.

The municipality of The Hague is a party that needs to be involved from the start in the energy transition in the neighbourhoods. In addition, the municipality is the largest party that can offer support in various areas for the W.E.T to initiate the energy transition within the neighbourhoods. (Gemeente Den Haag, 2018)

For the expert in the field of energy transition, various institutions can be called upon. The municipality of The Hague can provide experts, but the W.E.T can also ask the Haagse Hogeschool if they can provide students who can provide information about the energy transition. The most important thing is to make a selection of the experts to get the right knowledge, but also to keep it close to the people.

14.1.4 Communication

As mentioned earlier, the first phase is about informing and activating. Residents in the neighbourhoods must be approached to make them aware of the workshops. The residents can be approached in different ways:

1. Residents can be informed about the workshops on the basis of a letter sent by post. This form of communication will be particularly suitable for an older target group that makes less use of online communication.
2. Residents can also be informed via email. By sending an email to a large group of residents, the message can also be spread in this way.
3. Residents can also be notified by using social media platforms. However, it is wiser to use a social media platform as a reminder than as a direct means of communication.

A final form of communication distribution is on the basis of hard copy means. Think of flyers or information in the neighbourhood newspaper.

14.2 Measures

Phase one is the first part of the energy transition plan that is made for the Rivierenbuurt. The goal of this phase is to introduce the residents to little and affordable measures they can install in their home to save some energy. To inform the residents, they will be invited to workshops and information evenings. In these workshops people will be informed about all the different measures they can use to save energy in their house. These measures will be easy and affordable which makes these measures accessible to all residents with different circumstances. Businesspeople and company owners will also join the workshops to inform the residents about the options there are to make a home sustainable. People from other sustainable neighbourhoods will come and share their experiences with the residents to hopefully inspire and motivate them to become sustainable as well. As a reward, the people who attend the workshops regularly will receive discount coupons that can be handed in when sustainable measures are being purchased. Hopefully these coupons will encourage people to attend the workshops, learn something about sustainable living and motivate them to become sustainable in their home and in their lives.

14.2.1 Door closers

Door closers is an installation that is attached to the door that will close the door automatically. This way there is less time for air to pass through the doorway, which means residents no longer will be bothered by drafts. Also, doors will no longer be open unnecessarily, so the air with the desired warmth will stay in the room it is supposed to be in, no heat or cool will be lost.

Figure 32: Door closer

The price of a door closer is differs from company to company. The cheapest ones are between €30 and €50. The more expensive ones are between €90 and €130 or even higher (**Table 20**). The price of a door closers really depends on the kind of door closer is specifically needed for the particular door (Deurdrangers, sd).

Let's describe an example of what kind of door closers an average household will need. For example, a house needs two advanced door closers for the front door and the back door, and a simple one for the connecting door between the hall and the living room.

Table 20: Costs door closer

Door	Price	Link
Front door	€69,99	(Budgetline deurdranger, sd)
Back door	€69,99	(Budgetline deurdranger, sd)
Connecting door	€21,99	(Geze deurdranger arm, sd)
Total investment.	€161,97	

The investment of this house will be €161,97. Up to 15m^3 gas a year per door can be saved. So, when three door closers are used, 45m^3 gas a year can be saved (Ecosavers deurdranger standaard, sd).

Advantages:

- A door can never be accidently left open, because the door will close automatically.
- There will be less drafts
- Only the desired rooms can be warmed, and no warmth will pass to the other rooms.
- The energy use will be lower, so money on the energy bill can be saved.

Disadvantages:

- There are a lot of different types of door closers, that makes it hard to choose the right one.
- People often don't like in their interior.
- Door closers can be dangerous for children and pets when they play around the door area.

14.2.2 Draft tape or weather strips

Gaps in moving parts of doors and windows can be sealed with a draft tape or weather strips. Draft tape is flexible and self-adhesive. Weather strips are hard profiles of plastic or metal, with or without a brush.

Draft tape

Draft tape is very easy and simple to apply. When applying draft tape, pay attention to the crack width for the correct draft tape. Look at the packaging for the correct size. Cut the draft tape to size and stick the strip on the frame where the door or window falls.

Draft band can be made of silicone rubber, EPDM rubber, EPT rubber, PE, PVC foam or PUR foam. Draft tape made of silicone rubber is very flexible and will last a long time. EPDM rubber and EPT rubber also last a long time but is less flexible. Furthermore, a draft band made of PE can be chosen, or PUR foam or PVC foam that is better for the environment. A disadvantage of PE is that it does not last as long (Milieu centraal, 2019).

Weather strips

The hinge side of a door or window let through draft. When this is the case, weather strips that can bend along are suitable (also called holder profiles or strips). Again, these weather strips are very easy to apply. Cut the strip to size and fix it with nails on the border of the frame and the door or window.

EPDM and EPT rubber profiles have a very long service life but are not suitable for all cracks due to their rigidity (Milieu centraal, 2019). This table gives an indication of the costs for each type of material. All materials are for sale in the hardware store and suitable for outdoors; protect PE rollers against UV radiation with a sealing bar.

Table 21: Costs weather strips

Material	Costs
Weather strips EPDM or EPT rubber profiles	€3 - €7 / 2,1 m
PE belt conveyor	€5 / 10 m
PUR foam band	€5 / 10 m
Draft band PVC foam band	€3 / 10 m

Advantages:

- Draft tape made of silicone rubber is very flexible and will last a long time.
- A draft band made of PE than of PUR foam or PVC foam is environmentally friendly.
- EPDM and EPT rubber profiles have a very long service life.
- They also might catch a lot of dust

Disadvantages:

- PE does not last long.
- Are not suitable for all cracks due to their rigidity.
- The dust they catch is hard to clean.

14.2.3 Led lamps

Another good measure to save energy is to use led lamps. Halogen lamps and light bulbs can be replaced by led lamps. Nowadays there are really natural coloured led lights, so the argument of ugly lights doesn't apply anymore. A led lamp saves 85% more energy than a light bulb. **Figure 33** shows how much money can be saved with the led lamps. (Led lampen, 2019)

Figure 33: The different between lamps

Advantage

- Led lamps last longer than the other lamps.
- The investment will be earned back very easily.
- Led lamps use less energy, so the energy bill will be lower.
- It can be done by the resident; there is no need for an installer to install the led lamps.

Disadvantage

- The investment in led light is bigger than buying a new halogen or light bulb.
- The lamps are sensitive to overheating, which does not improve the lifespan. An LED lamp must be able to properly dissipate its heat.

14.2.4 Radiator foil

Radiator foil is a thin foil. It is placed onto the wall behind the radiator. This makes sure that less warmth is lost through the outer wall that is adjacent to the outside. Radiator foil is very user-friendly and easy to apply.
There are two different kinds of radiator foil: one with foam and one with aluminium. The one with foam is a little thicker, it doesn't fit behind every radiator. That's why there is a radiator foil with only aluminium, this one is thinner and generally fits better (Radiatorfolie, 2019).

Radiator foil with the size of 50cm*0,2cm*600cm costs only €10,49. The costs of this measure depend on how many radiators there are in the house. However, a lot of surface can be insulated with just one role, so the costs will never be sky-high (Radiatorfolie, sd).

Advantages
- It is very cheap.
- It can be applied by the residents.
- Money can easily be saved.
- The rooms will warm up faster.

Disadvantages
- When the foil is wider than the radiator, the foil can be seen, which can look ugly.
- The process of making the foil is not sustainable.

Figure 34: Radiator foil

14.2.5 Water-saving shower head

With a water-saving shower head water, gas and money can be saved. Showering with a water-saving shower head is no different from showering with a normal shower head. The big difference with a water-saving shower head is that there it uses up to 20% less water (Waterbesparende douchekop, 2019).

An average family saves up to 7.400 litters warm water and almost 45m^3 gas a year. This comes down to €45, - a year. The cheapest water-saving shower head costs around €25, -. The most expansive ones are around €150, - (Waterbesparende douchekop, sd).

Advantage
- Saves water, gas and money.
- The investment can be as expensive as desired.
- It's as expensive as a normal shower head.

Disadvantage
- It gives less water than a normal shower head.

14.3 Cost distribution

Phase 1 is mainly about activating and informing the residents. In this phase, small measures will be taken to save energy in homes. Examples of measures are: door closers, draft tape, weather strips, LED lamps, radiator foil and water-saving shower heads. Because these measures are considered affordable, there are no subsidies available for these measures. This means that these energy-saving measures will only be paid by residents and building owners.
What each resident will pay in phase 1 for the measures depends on the house and which measures the resident decides to take. To give an overview of the expected costs for the residents in phase 1, the costs for the energy-saving measures are again shown below. These costs are based on the average home. For example, an average home has 10 radiators, which means that the costs for radiator foil are multiplied by 10 (Viessmann, sd) and an average home has 24 inefficient lamps (Milieucentraal, 2019).

Table 22: Total costs

Measure	Costs (Euros)
Water saving shower head	25
Door closer (front door, back door and connecting door)	161,97
Radiator foil	104,90
Weather strips	71,42
Led lamps	180
Total:	**543,29**

The amount of meter weather strips is difficult to calculate because no average is available. That is why there's calculated with a quantity of 30m. The total number of costs for a resident in phase 1 is therefore 543,29 euros. These costs are not fixed and can be higher or lower because each house is different.

15 – Phase two: Connecting and saving

The second phase will last approximately four years (January 2022 - January 2026) for completion. For this phase it is already clear that houses will be better insulated. One will not escape this change. However, this will be the first step to a house without gas.

15.1 Communication

15.1.1 Strategy

Phase two will be completed differently compared to phase one. In phase two, the focus will be on connecting the parties involved in the energy transition and insulating the homes to save energy.

Homes are often heated by the use of gas. The aim of the municipality to go gasless is to look at how this should be tackled. The first and fastest way to reduce gas demand is by insulating homes. This is because insulating homes means that less heat is lost in the house, which ultimately leads to a lower demand for fuel to heat the home. The first adjustments will be made in the Spuikwartier. The remaining houses that are not yet insulated will be isolated there. The average income of this neighbourhood is also higher, so that people can invest in the shorter term compared to the inhabitants of the Rivierenbuurt. After the Spuikwartier, the Rivierenbuurt-Noord will be tackled with regard to insulation. The Rivierenbuurt will also look at previously sustainably renovated homes and their facades. This with the underlying reason to create urban development agreement but also to increase the liveability of the neighbourhood. (van Schijndel, 2016) Finally, Rivierenbuurt-Zuid will be tackled with regard to insulation. With the received tools from phase one to save energy, residents have saved money on their energy bill. This of course if they have done something with this.

The residents are made part of the project. The intention is that residents per housing block contribute to the entire process. This should lead to the development of a tailor-made plan for residents and stimulates citizen participation. Because awareness was created in the first phase, residents are better informed and have the basic knowledge regarding the energy transition.

Process managers can be supplied from the municipality of The Hague to oversee the project. These people will perform more a guiding role than a guiding role vis-à-vis residents and external parties. The process manager also supports the W.E.T with arranging and organizing the future plans. A process manager is meant to let all parties come into contact with each other. This person can also provide the best insight into the requirements of the municipality and there is knowledge available about the possible subsidies that can be applied for.

The business community will also be involved in the second phase. Companies that are located in the neighbourhood are the first to be included, also because they can be part of the VvE's. Companies such as Eneco, for example, will serve as suppliers of sustainable measures and installations. But organizations such as housing associations and companies that provide mortgages can also contribute in this phase. After all, it is important to trust and create and win with a target group with a lower income or low literacy before the next steps can be taken. In addition, companies would do well to be involved in the process. This ensures that the companies want to enter into a partnership with more certainty. This can also ensure that companies supply people for a fraction of the costs because it can mean new potential customers. (Bink, 2019)

The connection between the parties is to exchange knowledge, ideas and possibilities with each other. Because of this, it feels to the residents that they are involved and can participate in the process themselves. The feeling that nothing is being imposed on the residents should result in the residents going along better and resistance decreasing. Work will start in the Spuikwartier, then the Rivierenbuurt-Noord will be close by and finally Rivierenbuurt-Zuid with regard to the application of insulation. This gives the lower incomes in the Rivierenbuurt-Zuid a little more time to prepare for the costs.

15.1.2 Workshops and sessions

In the second phase there will be fewer workshops to disseminate information and more sessions will be organized to collect information. These sessions and workshops will also be organized per residential block.

The first workshop will be about the dissemination of knowledge about subsidies and insulation of homes. This gives the residents more knowledge about the ongoing changes in their neighbourhood. This workshop will also be used to inform a residential block about the process. There will be an introduction of the assigned process manager from the municipality and companies will also get a chance to introduce themselves.
The first session that will take place will mainly be about connecting residents, government and companies. This form of networking must lead to people and institutions getting to know each other better. In this way it is also possible to better map out what the options are per residential block. Getting to know each other makes it easier for the various parties to work together in the future.

During session two, the various parties explain the possibilities. In this way the residents can indicate which possibilities they see but also what obstacles they see regarding the energy transition. Companies can also tell from their point of view about the possibilities they see. Finally, the representative from the municipality also has the option to share information.
The second workshop will be about sustainable installations. Companies and experts in the field of energy transition share information with the residents about the possibilities in sustainable installations. Advantages and disadvantages are mentioned, costs, savings. The aim is not to make residents experts in the field of sustainable installations, but to inform them more about it.

During the third session, all parties start a conversation. Each party must be given the opportunity to express the ideas. Based on the discussion, parties may possibly come to an agreement for a plan of action. It is important that this discussion is properly conducted and conducted. It is possible that one session is not sufficient for this. Therefore, a possible second session must be taken into account.
For a third workshop, an inventory will be made from all parties of what chances and possibilities for the energy transition to come about. All this data is analysed and combined into a possible plan of action for a residential block.

15.1.3 Actors

Various actors will be involved during the first phase. The actors that are relevant in the first phase are:

- Homeowners:
  - Residents;
  - Housing associations;
  - Tenants;
- Residents' organization Rivierenbuurt and Spuikwartier (BRS);
- Energy Transition Working Group BRS (W.E.T);
- The municipality of The Hague;
- Other government agencies;
  - Province;
  - Rijk;
- Energy companies;
- Contractors
- Experts in the field of energy transition.

In phase two, residents are given a more active role compared to phase one. They are more involved in the design and discussions regarding the energy transition. The BRS and the W.E.T retain the same role compared to the first phase as before. It will always be useful to keep energy transition experts involved during the second phase. This may, based on the expertise of the expert, give possible advice. Residents will have to financial contribute to the insulation of house they live in. They can choose to do it individually or collectively with for instants the VvE.

The municipality of The Hague will provide professional assistance in the form of providing multiple process managers who can guide the process. It is not the task of the municipality to push through a plan. They are responsible for the smooth running of the entire process over the years. The municipality can also contribute financially in the form of subsidies.

Government agencies, other than the municipality of The Hague, can make a financial contribution in the form of subsidies. This can be interesting for both residents and businesses. As a result, owners may have to pay less for sustainable measures and companies can appeal for funds to cover any costs.

Energy companies, such as Eneco, are responsible for the delivery and possibly even installation of the sustainable measures in and around homes. Both insulation and sustainable installations are produced by these companies. The energy companies also ensure that knowledge is disseminated among residents. They are best informed about costs, installation options and savings.

The housing associations can contribute to the financing of possible sustainable adjustments to homes. Especially when they own houses. Not only housing associations but also other organizations that could control the home, such as other landlords or banks, can make possible financial contributions.

Contractors provide the people and knowledge to bring about the changes in the homes. They are used for, for example, the installation of new facades with better insulation or are responsible for installing a heat network if this is desired.

15.1.4 Communication

Because projects will take place per residential block, the information will be distributed to the residents via post. This prevents incorrect messages from being sent to the wrong addresses. The companies, agencies, organizations and other parties are informed by the process manager of the municipality of The Hague or are invited at the invitation of the W.E.T. Furthermore, most communication will take place during the workshops and the organized sessions.

A possible idea is to set up a website with all possible information for residents. This allows them to be kept informed of progress during the project.

15.2 Measures

In the second phase the residents are informed during the workshop evenings about the next steps they can take to make their home more sustainable. In this phase, there will be looked into larger adjustments in the field of insulation. The larger adjustments that could be made to homes are, for example, double glazing, wall insulation, roof insulation and floor insulation. Per housing block, the possible insulation will be examined.

This chapter will describe the advantages and disadvantages of the various measures, the costs and how much can be saved with the different types of isolation. The possible subsidies will also be taken into account. But first, there will be a brief description of the meaning and importance of insulation.

15.2.1 Insulation in general

When insulating a house, material is applied in such a way that heat, cold or sound cannot penetrate or go outside (Woorden.org, sd). The better a house is insulated; the less heat is lost. As a result, less draft and moisture are supplied to the house and floors and walls will also feel less cold. Because less heat is lost, less energy is needed to heat a house. This ensures a lower energy bill and it is of course also better for the environment (Greenhome, 2015). The insulation value is often expressed in U value. The lower the U value, the less heat (in Watts) goes out per m2 and per degree of temperature difference (Verbouwkosten.com, 2019). According to the Bouwbesluit, a new-build construction must comply with a certain RC-value (Resistance Construction). How higher the RC-value, the better the insulating capacity (De Isolatieshop, 2019).

15.2.2 HR ++ glass and triple glass

Buildings that were built before the year 2000 often have double glazing and in some cases single-glazed windows (Milieucentraal, 2019). HR ++ and triple glass insulates much better than regular double glass or single glass. HR ++ is double glass with 2 insulation layers. Triple glass has 3 insulation layers and is also referred to as HR +++ glass.

HR glass means high efficiency (Hoog Rendement) and consists of 2 or 3 glass plates with a space between them (the cavity). The cavity is filled with air or noble gas. There is a coating on the inside of the HR glass which improves the insulation. The coating reflects heat, while allowing light to pass through (Milieucentraal, 2019). There are many advantages for better insulation of the windows. The most important one is the saving of energy. **Table 23** shows how much gas per m^2 of window per different window type can be saved, according to Milieucentraal (Milieucentraal, 2019).

***Table** 23: Saving on gas per type of glass (Milieucentraal, 2019)*

Type of glass (U value)	Saving on gas per m^2 of window every year
Triple glass (0,5-0,9) in new frame*	30 m3
Triple glass (0,5-0,9) in existing frame**	25 m3
HR ++ glass (1,0-1,2)	23 m3
HR+ (1,3-1,6)	21 m3
HR (1,7-2.0)	16 m3
Attached window with coating	16 m3
Double glass	13 m3
Attached window without coating	13 m3
Single glass	-

**Insulating frame (U value 1.3 or lower)*
*** Standard frame (U value 2.4)*

Another important reason to use HR++ glass or triple glass is the revenue. A lot of money can be saved with these measures (**Table 24**):

***Table** 24: Costs and revenue for HR++ glass and triple glass (Milieucentraal, 2019; Milieucentraal, 2019)*

Improvement option	Type of home	Costs (Euros)	Revenue (Euros per year)	Subsidy (Euros / m^2)
HR++ glass instead of single glass window	Row house	3.100	120	35
	Corner house	3.500	140	35
	Detached house	4.500	180	35
HR++ glass instead of double glass	Row house	3.100	120	35
	Corner house	3.500	140	35
	Detached house	4.700	180	35
Triple glass instead of single glass window	Row house	8.400	200	100
	Corner house	9.600	220	100
	Detached house	12.700	290	100
Triple glass instead of double glass	Row house	8.400	200	100
	Corner house	9.600	220	100
	Detached house	12.700	290	100

The revenue is calculated with use of a natural gas boiler and an energy price of 77 cent per m^3. The type of house influences the amount of energy that is lost. That's why every type of house has different amounts of costs. The subsidy for triple glass is 100 euros in combination with insulating frames (Milieucentraal, 2019).

HR++ glass and triple glass also have a few drawbacks. At night and in the morning, condensation may form on the outside of the glass due to the temperature differences. Fortunately this is not dangerous and it will disappear automatically. Another disadvantage is that HR glass can break due to large temperature differences. These breakages are not covered by the warranty. But there are some tips to avoid the breaking of the glass. Don't put any things against the glass like bags or posters and don't hang interior sun protection directly in front of the window. Don't spray cold water if the glass is heated by the sun and make sure the glass does not get half in the sun and half in the shade. It is also very important that the glass is properly applied. This can be seen by the KIWA or KOMO quality mark (Milieucentraal, 2019).

Advantages:

- Less energy is needed to heat the house.
- Money can be saved with this measure, because residents pay less for the heating of their house.

Disadvantages:

- This measure needs an investment.
- Condensation may form on the outside of the glass in the morning.
- HR glass can break due to large temperature differences.

15.2.3 Floor insulation

There are different ways to insulate a floor. The easiest option is to insulate the underside of the floor. Insulating material is applied to the underside of the floor, for example, cork, wood, flax, EPS, foam, thermos pads, glass wool or rock wool. Floor insulation at the underside of the floor is only possible if there is a crawl space that is at least 35 cm high. A minimum of 50 centimeters is required for PUR floor insulation. To prevent the insulation material from becoming moist, a plastic foil can be applied to the bottom of the crawl space.
Other options to insulate the floor are insulating the bottom of the crawl space, applying insultation material between the floor beams, applying insulation to the upside of the floor or installing a brand new floor with insulation (Milieucentraal, 2019).

Insulating the bottom of the crawl space (soil insulation) saves less energy and provides less comfort than the insulation of the underside of the floor, because there is no longer direct contact between the cold air in the crawl space and the floor. With floor insulation 280 m^3 of gas per year and 220 m^3 with soil insulation can be saved for an average corner house with HR boiler. But it is a good option if the crawl space is lower than 35 cm. With this insulation, spheres or pieces of polystyrene (EPS or bio foam pearls or EPS chips) are sprayed into the crawl space (Milieucentraal, 2019) (Milieucentraal, 2019). Not only energy is saved, costs can also be saved with both floor insulation and the soil insulation (**Table 25**):

***Table** 25: Costs and revenue of floor insulation and soil insulation (Milieucentraal, 2019) (Milieucentraal, 2019) (Milieucentraal, 2019)*

Improvement option	Type of home	Costs (Euros)	Revenue (Euros per year)	Subsidy (Euros / m^2)
Floor insulation	Rowhouse	1.400	190	7
	Corner house	1.600	220	7
	Detached house	2.800	380	7
Soil insulation	Corner house	950	170	4

The revenue is calculated with use of a natural gas boiler and an energy price of 77 cent per m^3 and is in comparison with no floor insulation. (Milieucentraal, 2019)

As mentioned before, floor insulation is only possible when there is free space under the floor. This is a disadvantage because not every floor has space beneath it. The required space per insulation material is shown in **Table 26.**

***Table** 26: Thickness required per insulation material (Milieucentraal, 2019)*

Insulation material	Thickness required for Rc = 3,5
Glass wool	11 cm
Rock wool	12 cm
Custard plates	13 cm
Thermos pads	Three rooms
Insulation foil with air cushions	10 cm
EPS plates	13 cm
Resol and polyurethane foam sheets	7 - 8 cm
Expanded cork plates	13 cm
Wood fiber boards	13 cm
Sprayed PUR foam without HFCs	9 cm

If there is no space at all under the floor, insulation material can be applied to the top of the floor. The disadvantage of this is that it reduces the space in the house.

Another disadvantage is the moisture problems that can arise in the crawl space when there is a bad ventilation. Make sure that the insulation material doesn't block the ventilation holes. There must be 4 cm^2 of ventilation openings (grilles) in the outer walls per square meter of wooden floor and 1 cm^2 of ventilation openings per square meter of concrete floor. These holes must be divided over 2 outside walls that face each other (Milieu-centraal, 2019).

Advantages:

- With floor insulation 280 m^3 of gas per year and 220 m^3 with soil insulation for an average corner house with HR boiler can be saved.
- Money can be saved with this measure, because residents pay less for the heating of their house.
- Residents can get a subsidy for floor insulation or soil insulation.

Disadvantages:

- This measure needs an investment.
- Floor insulation is only possible if there is space left under the floor.
- When there is bad ventilation, moisture problems can arise in the crawl space.

15.2.4 Roof insulation

If the roof of a home is not well insulated, a lot of heat will be lost through the roof. Roof insulation ensures a warmer house with a lower energy bill. There are various roofs and functions of an attic. Because of this, there are also various options for installing roof insulation (Milieu centraal, z.d.).

Slanted roof

When the home is over a sloping roof, and the attic is used as a living space, the roof can be insulated by three methods:

- Insulate on the inside of the roof.

Advantage	Insulating can be done without help.
Disadvantage	The insulation material causes a loss of space in the home.
Costs	When the job is outsourced: € 4.700. Material costs, if done without help: € 1.000.
Saving	€700 per year (when RC value is 4). 900 m^3 gas per year (when RC value is 4).

- Place insulation material under the roof tiles.

Advantage	By this way of isolation, the best insulation value is achieved.
Disadvantage	When a home is insulated in this way, it will have to be done by a professional company. It's a big job.
Costs	Costs vary per company but will be between € 40 - € 60 per m^2.
Saving	€700 per year (when RC value is 4). 900 m^3 gas per year (when RC value is 4).

- Close insulation material under the roof tiles.

Advantage	By this way of isolation, achieve the best insulation value can be achieved.
Disadvantage	Delivers little insulation. A lot of debris can also be released during later work on the roof.
Costs	Costs vary per company but will be between € 40 - € 60 per m^2.
Saving	Due to a lower RC value, the saving will also be less.

When the attic is not used as a living space, it can be insulated in another way:

- When the attic can be closed with, for example, a hatch door, it is a good idea to insulate the attic floor.

Advantage	Less material is required than when insulating a sloping roof. It is also possible to insulate the attic floor.
Disadvantage	The insulation material causes a loss of space in the home.
Costs	When the job is outsourced: €1.000. Material costs, if done without help: €450.
Saving	€390 per year (when RC value is 4). 500 m^3 gas per year (when RC value is 4).

- If the attic cannot be closed by a hatch door, the sloping roof is insulated.

Advantage	Insulating can be done without help.
Disadvantage	The insulation material causes a loss of space in the home.
Costs	When the job is outsourced: €2.500. Material costs, if done without help: €1.000.
Saving	€380 per year (when RC value is 4). 500 m^3 gas per year (when RC value is 4).

Flat roof

When a home has a flat roof, this is always a job for a professional company. When residents go to work themselves, the risk is too great for moisture problems. A good time to insulate a flat roof is when the roof needs to be renovated.

- Install insulation boards on top of a flat roof.

Advantage	By this way of isolation, the best insulation value is achieved.
Disadvantage	When a home is insulated in this way, it will have to be done by a professional company.
Costs	When the job is outsourced: €3.300.
Saving	€600 per year (when RC value is 4). 750 m^3 gas per year (when RC value is 4).

- Insulation inside of flat roof

Insulating a home on the inside of a flat roof carries a huge risk. By placing insulation material against the concrete, there is a chance that a lot of moisture will form mold in the roof construction. This allows the roof construction to weaken and collapse. This method of isolation is also strongly discouraged.

- Green roof

A green roof is an ideal solution in both summer and winter. In the summer, a green roof provides cooling and the need for air conditioning is reduced. In the winter, a green roof provides insulation and the heat can escape less from the home. In addition to having a green roof insulating and cooling, a green roof also has a green appearance (Milieu centraal, z.d.).

Advantage	The green roof collects water and can buffer it. Air pollution is partly absorbed, whereby CO_2 is also absorbed.
Disadvantage	Not every roof is suitable for wearing a green roof. Due to the water-storing function, the roof can become very heavy.
Costs	The costs for green roof: €40 - €120 per m^2.
Saving	varies greatly per roof

15.2.5 Facade insulation

A lot of heat will also be lost through the façade. Most of the homes in the Rivierenbuurt were built in the early 1900s. These homes often do not have façade insulation. When the facade will be insulated, this can be done on the inside of the facade, but also on the outside of the facade. Both options have advantages and disadvantages.

Inner wall insulation

When a home is going to be insulated from the inside, this is often done with a wall. This is a wooden skeleton that is placed against the inner wall. Insulation material can be sprayed or put between the skeleton, then drywall can be placed in front of the wall (Milieu centraal, z.d.).

Advantage	This method of isolation is cheaper and can be done more easily without help.
Disadvantage	This causes the wall to come in by an inch or 10. This is a big disadvantage because lot of space is lost. The house must also be completely emptied when insulated from within.
Costs	When the job is outsourced: € 100 per m^2. Material costs, if done without help: € 40 per m^2.
Saving	€ 7.50 per m2 per year (when Rd value is 2.5). 9.5 m^3 gas per m2 per year (when Rd value is 2.5).

Exterior insulation

Insulation material can also be placed on the outside of the home (Milieu centraal, z.d.).

Advantage	The house looks good again. The energy bill is much lower, and the comfort in the home increases.
Disadvantage	It is an expensive measure and the job must always be done by a professional company.
Costs	When the job is outsourced: € 13.000 (with an outer facade of 100m^2).
Saving	€ 850 per year (with an exterior facade of 100m2). 1100 m^3 gas per year (with an exterior facade of 100m2).

15.2.6 Subsidies

If it is planned to insulate the roof, exterior wall, floor or windows, it is advantageous to have two or more measures carried out simultaneously. If this is the case, residents can receive a subsidy of 20 percent, with a maximum amount of € 10,000 (Milieu centraal, z.d.).

15.3 Cost distribution

Phase 2 focuses primarily on the insulation of homes and other buildings in the neighbourhoods. The costs of insulation are a lot higher than the costs in phase 1 and are therefore more difficult to pay for residents. Fortunately, there are also available subsidies for investments in insulation. These subsidies can be obtained from the municipality of The Hague and other government agencies from the government and provinces.
The subsidies and costs themselves can change every year and are therefore not fixed. As a result, the final costs for insulation may differ compared to the costs in a few years. Because phase 2 starts in January 2022, it is therefore not possible to determine the exact subsidies and costs.

In order to have a picture of the possible costs in phase 2, a calculation can be seen below of the costs with and without subsidies based on what it would cost now. The costs are calculated for an average townhouse (Milieucentraal, 2019).

Table 27: Costs insulating measures (Milieucentraal, 2019)

Insulation measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
HR++ glass	3.100	650	2.400
Floor insulation	1.400	840	560
Slanted rood insulation	4.100	1.200	2.900
Inner wall insulation	800	200	600
Total	9.400	2.890	6.460

You can only receive these subsidies if you apply at least 2 of these measures in your home. In the example above (**Table 27**), in which 4 insulation measures are applied, the resident pays 6.460 euros for the insulation of a home and 2.890 euros is paid by the government.

14.3.1 Refund plan

Earlier in this paragraph is describes what the expected costs will be in phases 2 when certain energy-saving measures are purchased. The big question now is how these measures will be financed by the residents. Is a loan connected or is a building-related financing chosen? There are several options on which a resident can pay for the measures. It is also possible to make certain agreements with the energy supplier and to repay the investment in instalments.

***Table** 28: Costs insulating measures (Milieucentraal, 2019)*

Insulation measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
HR++ glass	3.100	650	2.400
Floor insulation	1.400	840	560
Slanted rood insulation	4.100	1.200	2.900
Inner wall insulation	800	200	600
Total	9.400	2.890	6.460

If a resident in phase 2 has to pay 6,460 euros for insulation measures, this can be paid in one go. This is not possible for every household. Certainly not in the Spuikwartier, Rivierenbuurt-Noord and Rivierenbuurt-Zuid, because the incomes are below average (**§3.2**).

***Table** 29: Income per neighbourhood (Weetmeer Buurtinformatie, 2019)*

Neighbourhood	Average income per year	Average income per month
Spuikwartier	26.300	2.191,67
Rivierenbuurt-Noord	23.100	1.925
Rivierenbuurt-Zuid	17.700	1.475

As can be seen in **Table 29** the average incomes are very low and there is a high chance that they need to get a loan. It is recommended to use an energy-saving loan because it has a low interest rate.

***Table** 30: Interest rates for energy saving loan for Owners' Associations (Nationaal Energiebespaarfonds, 2019)*

Total costs	Monthly costs	Duration in months and number of installments	Interest	Total loan costs	Annual costs percentage
€ 65.000,-	€ 421,29	180	2,1%	€75.832,20	2,12%
€ 50,000,-	€ 324,07	180	2,1%	€58.332,60	2,12%
€ 15.000,-	€ 97,22	180	2,1%	€17.499,60	2,12%
€ 15.000,-	€ 136,02	120	1,7%	€16.322,40	1,71%
€ 10.000,-	€ 90,68	120	1,7%	€10.881,60	1,71%
€ 4.999,-	€ 62,52	84	1,4%	€ 5.251,68	1,41%

It is recommended to take out a loan with an interest rate of 1.71% (**Table 30**). As a result, the monthly costs for the coming 10 years will be 54,75 euros, resulting in a total amount of 6460,47 euros.

In short, for phase 2, for example, there can be paid in one go 6460,47 euros, but also in instalments. For example, 10 years each month € 54.75. This loan may of course also be repaid earlier or may be tied to the building with building-related financing. This means that residents do not have to worry that they will still be in debt when they move house.

16 – Phase three: Contributing and heating

The third phase will last a total of four years (January 2026 - January 2030) for completion. During this phase it will be laid down in concrete terms what will happen per residential block to remove it from the gas. This responsibility will not lie on the shoulders of the residents but on the shoulders of the municipality of The Hague.

16.1 Communication

16.1.1 Strategy

The third phase is aimed at removing the homes from the gas or making it 90% poor. After the first phase where residents have gained knowledge about the energy transition and phase two where residents are involved in thinking about the energy transition for their own residential block, it is in phase three that it must be realized.

The residents only get a small role at the beginning. After the final workshop of the second phase, a process plan is drawn up by the process manager. This action plan is the result of cooperation between residents, governments and companies that became involved during the workshops and sessions. Because there are several residential blocks, different process managers will also be active. Through mutual communication, they can better map out the measures that have been taken per residential block. This gives them the opportunity to combine projects and tackle them at the same time.

The action plan will be presented to the parties involved. If the plan is approved, agreements can be made. If the plan is not approved, a revision will take place to make the plan better tailored. The aim is to have the final plan of action completed in the first year of phase three. Once all parties agree with the proposed plan of action, it can be implemented. The process manager will be given the task of project manager and will be responsible for the realization and realization of the proposed feasible project.

16.1.2 Workshops and sessions

In the third phase, only sessions will take place that should lead to a concrete proposal for the action plan in the Rivierenbuurt and Spuikwartier. After these sessions, no further sessions or workshops will take place that are intended to gain or provide information. If residents prefer to have a session take place about the progress of the project, this can always be arranged.

16.1.3 Actors

The actors of the third phase correspond to the second phase (**§15.1.3**). However, the role of the residents will decrease and more will be carried out by the process manager. The process manager is expected to put together a team that must ensure that agreements are reached and that the implementation of the action plan is in the right direction.

16.1.4 Communication

Along the way, residents will be kept informed of the progress behind the scenes. They will also be informed early when there is an adjustment to their home specifically. Agreements with companies, agencies, organizations and other parties will be made through the municipality of The Hague. How the municipality wants to implement this is by their choice.

16.2 Measures

16.2.1 Heat pumps

The most suitable type of heat pumps are ground source heat pumps, because of the constant temperature of the ground. But because the neighbourhood is already developed, it makes it difficult to drill in to the ground. Meaning the best options for the neighbourhood is water- and air heat source pumps. Areas that are close to water should make use of water source heat pumps due to the high efficiency of water source heat (Association European heat pump, 2019). Other areas should make use of air source heat pumps, which is less efficient due to non-constant air temperature.

Mechanics

Heat pump work similar to a fridge, a heat pump 'moves the heat from one place to another to several mechanism. Whether the heat pump either an air source-, water source- or a ground source heat pump, they all have the same mechanism. The only thing that differs is the source from which the heat is extracted from and the to what surrounding it's delivered.

Heat pump works by extracting energy from the environment, through a heat exchanger, in to a fluid called the refrigerant. The refrigerant turns to gas as is extract heat from the environment. The refrigerant is then send to a compressor, which then raises the temperature and the pressure of the gas. The gas moves to heat exchanger to release the energy, this ensures for e decompression and condensation of the gas to liquid. The fluid then goes back to the outside environment and the cycle is repeated

Advantages and disadvantages

For most houses installing a heat pump system replaces the conventional gas boiler, which is used to warm water. This will either lower the gas bill or eliminate it completely, but will increase the electrical bill. The increase of the electric bill is due to the compressor of the heat pump that uses electricity. However, the increase in the electrical bill is compensated by the reduction or the elimination of the gas bill. The efficiency of heat pump is 400%, meaning that out of 1 kW of electricity 4kW of heat is produced. A conventional gas boiler usually has efficiency of 70 – 80% and direct electrical heating has an efficiency of 35 – 45%. (Association European heat pump, 2019)

Advantages

- Lower or elimination of the gas bill: If only gas boiler is replaced it will lower the gas bill and if the gas for cooking is removed it will eliminate the gas bill completely.
- Low maintenance: Filters must be replaced every two to six months and cleaning of the condensate pan and evaporator every two to four years. (EREC Fact Sheet, 2001)
- Subsidies: Municipality will subsidies the purchase of a heat pump.
- Easy installation (only air source): Air to air heat source are fairly easy to install and can be done within a day

Disadvantages

- The downside of acquiring are the purchase price: For instance, a 3kW air to water heat pump will cost approximately cost 3000 – 6000 euros. The prices increases with the power it consumes.
- Electrical bill increases: This is due to the electricity that the compressor and if it's an air-to-air source that system may use fan to blow the warm air inside.
- Improvements on the house: If it's an older house either some type insulation must be done and/or replacing the radiator for bigger ones if and air-to-water heat pump system is used.
- Surrounding may affect the efficiency: The area around Spuikwartier is developing with allot of high rise buildings, which may affect the efficiency of a solar panel

Subsidies

The prices for a heat pump differ for each heat pump depending few variables, however residents can get a subsidy from municipality when purchasing a heat pump. The variables that influence the price are power, source from which the heat is extracted from and the way the heat is delivered. For instance, a 3kW air to water heat pump will cost approximately cost 3000 – 6000 euros. The subsidy for such a heat pump is approximately 1300 euros. The subsidy may increase a bit more on depending on the efficiency of the heat pump. A 5kW air to water heat pump may cost approximately 4000 – 8000 euros. The municipality may subsidies such heat pump with an amount of 1500 euros. The municipality made a list with the amount they will subsidies each heat pump that is sold in The Netherlands. This list is available on the website of Rijksdienst voor Ondernemend (Subsidies warmtepompen, 2019)

16.2.2 Solar panels

Mechanics

Solar panels convert sunlight directly into electricity and do not cause air pollution or greenhouse gases. This makes them one of the cleanest forms of energy. The environment is also taken into account in the production of solar panels. Furthermore, solar panels are quiet and inconspicuous.

Solar panels are panels that produce electricity from sunlight. They usually consist of several solar cells that are all connected to each other. One solar panel is usually about 1 meter wide and 1 meter 60 long. Between 60 and 96 solar cells fit on one solar panel. Solar panels are usually on the roof and have to last a long time. The lifespan of solar panels is 25 years or longer. They have to endure hard with high and low temperatures, wind and rain, snow and ice. They must be able to withstand hail and the dirt from birds and air pollution must wash off by itself. Solar panels work best when they are fully exposed to the sun. The sun's rays are strongest around noon when the sun is in the south. (Wat zijn zonnepanelen?, sd).

Advantages:

- Lower energy bill: Solar panels allow the residents to generate their own electricity. This means that residents no longer have to pay for all their energy from the energy supplier. In the summer, they may be able to provide their own household with 100% self-generated energy. Of course, these profits are at the beginning to recoup the investment. After about 7 to 8 years, the residents can make a profit of 1.000 euros per year with an average family.
- Reduce CO_2 emissions: The energy generated by solar panels is clean energy. No CO_2 is released during generation. This saves 60 kilograms of CO_2 per m^2 of solar panel per year. In this way we can combat the greenhouse effect.
- Higher house value: By investing in solar energy the the value of the home can be increased. By using solar energy, we can stretch the depletion of fossil fuels.
- Balancing: An additional advantage of solar panels is that unused generated electricity can be balanced. It can happen, especially in the summer, that there is more energy generated than is consumed. The unused generated electricity can be returned to the grid, for which the user will receive a refund. Please note that there is a maximum of 3000 kWh connected to it and that the resident will need a meter.
- Long service life: Solar panels have a long lifespan. A resident will benefit from solar panels for at least 25 years. If the payback period for the solar panels is 8 years, there is a 13-year profit!
- Low maintenance required: Solar panels need little maintenance. Most of the dirt on the panels is automatically flushed away. In order to maintain an optimal yield, it is necessary to check the panels once a year for dirt or damage. The house has a higher energy label if the residents have purchased solar panels. After all, the buyer does not have to make this effort and investment anymore and benefits from lower energy costs. To show how much the value of the house is increasing, we give this example: Suppose a resident has invested 3.500 euros in 6 solar panels. The house will then increase by an average of 7.000 euros.
- Subsidy: There are no subsidies for solar panels from the government at the moment, but a resident can get their VAT back from the installation and labour. This 21% 'discount' is a nice bonus! Sometimes there are also regional subsidies or subsidies from the municipality available.
- Sustainable source: Sunrays are always there, even in winter. This source does not run out.

Disadvantages:

- The roof must be suitable: Not every roof is suitable for solar panels. There are a number of requirements that the roof must meet. A minimum of 10 metres of surface area must be available. The panels must be able to face south and the optimal angle would be 36 degrees.
- Less beautiful roof: Not everyone is charmed by a roof full of solar panels. Although it is becoming more and more normal to have solar panels on the roof. Some people think it's something to show off.
- Investment price: The purchase of solar panels is a lot of money in one go. An investment quickly costs a few thousand euros. Of course, this will pay for itself in 7 to 8 years. So, earning back is a long-term process. After the payback period, a profit can be made.
- Generated energy is not enough: The energy generated by solar panels is often not enough to supply the entire household with energy. So, the energy from the grid is still necessary.

- Energy storage in expensive batteries: Instead of returning unused generated energy to the grid, the energy can be stored by the resident. To do this, the residents will need batteries that are quite expensive. Often the prices are already around 1.000 euros.
- Extra group in meter cupboard for more than 3 panels: If a resident buys more than three panels, an extra group must be placed in the meter cupboard. This often costs more than one hundred euros.
- Increase in insurance premium: It is possible that the insurance premium for a home will increase if solar panels are installed. This depends on the insurance company (De voor- en nadelen van Zonnepanelen, 2019)

Price of the measure

The average cost of solar panels is difficult to determine, because there are so many differences in quality and yield. Also, the the question 'what does a solar panel cost on average' can be answered without looking at whether it's one solar panel or a package including inverter and installation. What do solar panels cost us on average? The average NUON price of solar panels, per 10 panels = € 5.353. The costs for solar panels include all necessary materials, complete installation up to and including the group box and technical inspection (Kosten zonnepanelen, 2019)**.**

Subsidies:

Unfortunately, in 2019 it will not be possible for private individuals to apply for a subsidy for solar panels. But the VAT refund that was active in 2018 is still in force in 2019. This means that individuals can claim back the 21% they paid on the entire investment. Officially, it is necessary to be an entrepreneur in order to be able to make an application. In this case, however, the government already charges somebody as an entrepreneur on account of the fact that they supply electricity back to the grid. For a private individual it is actually equal to the amount excluding VAT. This is because only a small part of the VAT on the supply of the solar panels has to be paid. If one wants to qualify for this, they must be registered as a private individual as an entrepreneur. The tax authorities have drawn up a special form for private individuals who want or have already purchased solar panels (subisdie zonnepanelen, 2019).
Private households and business users (including VVEs) who want to generate their own renewable energy can apply for a subsidy from 1.100 euros or more (resultaten, 2019).

Yield of the measure:

The choice of energy supplier is important for the payback period. Especially if there is more power generated on an annual basis than is consumed. Some suppliers offer a much higher amount per kWh of electricity than others. The standing order also differs from one supplier to another. The user pays this regardless of how much is consumed and generated. The less net electricity is drawn from the grid, the more important this standing charge is for the energy bill (terugverdientijd zonnepanelen, 2019). The average payback time for solar panels is 7.5 years. Solar panels are a great way to generate electricity. Solar panels should be place towards the south the maximize the intake of the sun light. Rivierenbuurt is limited by the amount of roof area that can be used for solar panels. And because not everyone has a roof directly above them it is better for dwellings to make use of collective solar panels. In fact, the municipality only gives out subsidies for VvE's that have less than 10 houses. A great thing for the inhabitants of Rivierenbuurt is that they don't need a permit for solar panels, unless the building is considered a monument or protected city view.
The municipality only gives out subsidies for VvE's that have less than 10 houses. A great thing for the inhabitants of Rivierenbuurt is that they don't need a permit for solar panels, unless the building is considered a monument or protected city view.

16.2.3 Ground-coupled heat exchanger

Mechanics

The heat cold storage usually works using two separate sources located separately from each other. Of course, this is a hot and a cold source. During the summer months, the available groundwater is pumped up from the cold source. Via a heat exchanger, this is then used to cool a building. The heated groundwater is then injected into the hot spring. During the winter, this hot water can then be used by making the process go in the opposite direction. Once the heat has been released, it is then pumped back into the cold source. In this way, home owners can save considerably on cooling during the summer, while heating a house during the winter, the house will also require considerably less energy.

Advantages:

- Environmentally friendly, sustainable and low CO_2 emissions;
- No gas connection and therefore independent of energy prices;
- An efficiency that is 5 times higher than that of a central heating boiler;
- Passive cooling capacity to live comfortably even in summer;
- No chimney or roof penetration;
- No odour nuisance or dust from a wood-burning stove;
- No colds due to the use of classic air conditioning.
- Environmentally friendly due to low emissions of CO_2;
- Future-proof and independent of price increases;
- Comfortable living and working in all seasons;
- Increase in the value of the home on the housing market.

(Kosten bronsystemen, 2019)

Disadvantages:

A WKO-system is only profitable if the following conditions are met:

- New construction or can be integrated into the current system (renovation);
- It uses floor heating, hot water and air heating or concrete activation;
- The house has its own ground in which the heat exchanger can be constructed;
- A permit from the municipality for the system (Individuele Warmte-Koude Opslag (WKO), 2019).

Price of the measure:

The costs of a WKO installation are quite high today. Buyers should therefore bear in mind that such a system consists of many different components. Think not only of a storage vessel for hot tap water, but also of a heat pump, one or two closed ground heat exchangers and also a suitable dispensing system must be provided. For an average single-family house, the residents need to take into account that the average cost of between 15.000 and 17.000 euros. When we compare this cost price with a traditional system consisting of a gas boiler and radiators, we see that there is a price difference of about 11.000 euros. On the other hand, the energy costs of a CHP installation are almost negligible. This provides the residents with a very sustainable system that they will enjoy for many years to come. The costs for maintenance are 50 euros per 2 years (Subsidie warmte koude opslag, 2019).

Subsidies:

In addition to a lower energy bill, there are also other financial benefits associated with the use of soil energy. The government encourages investment in sustainable forms of energy, such as soil energy, with various subsidies and schemes. For example, with the Energy Investment Deduction (EIA), entrepreneurs can deduct 41.5% of the investment costs in energy-saving equipment and renewable energy from the taxable profit (WARMTE KOUDE OPSLAG, 2019).

It is also possible to get a green loan for energy saving activities. This is available for amounts between €2500 and €25000. This allows residents to use a lower interest rate because they are green. Think of an interest rate between 3 and 3,5 percent (Subsidie warmte koude opslag, 2019).

Yield of the measure:

The payback period for dwellings is between 12 and 16 years. This is not much given the amount of money that needs to be invested. What's more, there is now a brand-new heating system that can last for many years.

A central heating boiler will last for an average of 15 years. In most cases, a central heating boiler still works, but much less efficiently and the risk of malfunctions increases. A heat pump lasts on average 20 years. In addition, there are pumps that are only replaced after 30 years. By carrying out proper maintenance, the service life can be extended. In addition, Duratherm gives a 25-year guarantee on the sustainable operation of the closed collector system.

Compared to a conservative system, this is €11.000 more expensive. Remember, however, that residents get heat and coolness from nature and that they will use at least half as much energy less. (Subsidieverbouwing, 2019)

16.2.4 District heating

Mechanics

District heating and cooling is a system that distributes heat or cooling to dwellings and other building throughout a network of hot water pipes. The warm water is produced in centralized location and is later distributed through the network. This system has been used for a long time and has developed over the years. The latest developments include the 4th and 5th generation district heating and cooling. These systems operates a low temperature and sometimes use a heat pump to extract heat from the pipeline.
The centralized location can produce warm water in various ways by either geothermal, combustion of biomass or solar panels. The water is send to the network pipes at a temperature of 50°C or lower. The temperature can go as low at 10°C. When the temperature is low a heat pump is used to extract the energy. The water then goes back to the centralized location to be reheated and send back to the network pipelines.

Advantages:

- Bi-directional: The system can function as either heating or cooling trough out the year.
- Negligible thermal losses: The temperature difference between the pipeline and the ground is small if the system is operating at low temperature.
- No need for insulation: Because the temperature difference may be small, it may not be necessary to insulate the pipelines if the operating temperature is low
- Polymeric materials can be used: This is also due to the low operating temperatures

Disadvantages:

- Substations are more expensive: The installation of a water tank is necessary
- Larger pipeline diameter: Due to the small temperature difference in supply and return
- High pumping costs: This depends on the operating temperature. the lower the temperature the higher the viscosity
- Electricity bill increases: Only if a heating pump is needed (Buffa, Cozzine, Baratieri, & Federizzi, 2019).

Yield of measure

The prices of supply may vary depending if the consumer is a small-scale consumer, less than 100 kW, or large-scale consumer, more than 100 kW. The pricing for small scale consumers I regulated under the Dutch Heat Act to avoid monopoly. The price for heat usage consists of a fixed amount, which is (Osman, 2017)euro and the price per gigajoule, which is 24,03 euro. Additional to the usage, there's the cost of the meter which is 24,54. Lastly, there's the connection that must be made to pipeline. This cost 911,78 euro for the first 25 meter and 31,31 euro per meter if the distance is greater than 25 meter.
A study on district heat project in The Netherlands showed that it costs a bit more than 87 million euro. This amount includes Initial investment, re-investment, exploitation, interest payment, loan payments and taxes. The amount of money this project gets in return is around 93,8 million euros and includes onetime connect costs, heat sales and annual service charges. Payback time is 25 years and the profit of this project is about 6,7 million euros (Osman, 2017).

16.3 Cost distribution

In the final phase, the largest measures are discussed, such as heat pumps, solar panels, ground-coupled heat exchangers and district heating. Multiple homes can purchase solar panels and ground-coupled heat exchangers together, but this can also be purchased per home. A heat pump is purchased per building and district heating for an entire neighbourhood.

When a resident installs 10 solar panels on his roof, the costs are for example, 5.353 euros. A 3kW heat pump costs between 3.000-6.000 euros and a 5kW heat pump costs between 4.000-8.000 euros. A subsidy can be requested for a heat pump and VAT can be claimed back for solar panels. The table below shows the cost of purchasing these measures with and without a subsidy or VAT. The costs and the subsidy for the heat pump are an average of a heat pump of 3kW and a heat pump of 5kW.

Table 31: Costs measures solar panels and heat pump

Measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
10 solar panels	5.353	1.124,13	4.288,87
Heat pump	5.500	1.400	4.100
Total	10.853	2.524,13	8.388,87

In the example above (**Table 31**), in which 10 solar panels and a heat pump are applied, the resident pays 8.388,87 euros and the government 2.524 euros. The real costs can be different and depend on the type of house and the subsidy that is available at the time. It is also possible to buy the measures together with the whole neighbourhood. In this way, the costs are lower.

Another example is the use of solar panels in combination with a ground-coupled heat exchanger. The average costs with and without a subsidy for a ground-coupled heat exchanger and solar panels are shown in **Table 32**.

Table 32: Costs measures solar panels and ground-coupled heat exchanger

Measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
10 solar panels	5.353	1.124,13	4.288,87
Ground-coupled heat exchanger	16.000	2.500	13.500
Total	21.353	3.624,13	17.788,87

In the example above (**Table 32**), in which 10 solar panels and a ground-coupled heat exchanger are applied, the resident pays 17.788,87 euros and the government 3.624,13 euros. The costs for the ground-coupled heat exchanger may be lower, because the available subsidy is between 2.500 and 25.000 euros. It is also possible with the Energy Investment Deduction (EIA) to deduct 41,5% of the investment costs from the taxable profit.

The rates for a new heat network will only be set by the ACM in 2020. The costs for installing a heat network often fall under the energy supplier who does this in collaboration with the municipality. The rates for existing heat networks are known. The table below shows the maximum rates for 2018 that have been set by the ACM (Klimaatexpert.com, 2018).

Table 33: Cost components heating network

Cost component	Costs (Euro)
Maximum heating network connection costs within 25 meters	1.037,78
Maximum connection costs heat network more than 25 meters away	1.037,78 + 33,77 per extra meter
Maximum fixed costs per year for standing charge	309,52
Maximum measurement costs per year	25,36
Maximum fixed costs per year delivery set	181,09

Table 33 shows the total costs of a situation where a heat network is available within 25 meters and where the maximum rates apply. These total costs do not include the costs for energy consumption. In the following situation, the total purchase costs for 10 solar panels and a heat network are shown (**Table 34**):

Total costs first year	1.553,75
Annual costs after first year	515,97
Costs after 15 years	8.777,33

Table 34: Costs measures solar panels and heating network

Measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
10 solar panels	5.353	1.124,13	4.288,87
Heating network	1.037,78		1.037,78
Total	6.390,78	1.124,13	5.326,65

The purchase costs in the latter situation are lower than in the previous situations with a heat pump and a ground-coupled heat exchanger. Yet this is not yet possible, because there is no heat network in the Rivierenbuurt-Noord, Rivierenbuurt-Zuid and the Spuikwartier districts yet.

16.3.1 Refund plan

Earlier in this paragraph is describes what the expected costs will be in phases 3 when certain energy-saving measures are purchased. The big question now is how these measures will be financed by the residents. Is a loan connected or is a building-related financing chosen? There are several options on which a resident can pay for the measures. It is also possible to make certain agreements with the energy supplier and to repay the investment in instalments.

Just as in phase 2, the costs for energy-saving measures in phase 3 are also high. In phase 3 measures are purchased such as solar panels, heat pumps or a ground-coupled heat exchanger. There is also the possibility of a heat network, but because the costs for this are not yet known, this will not be discussed further.

Table 35: Costs for 10 solar panels and a heat pump (Rijksoverheid, 2019)

Measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
10 solar panels	5.353	1.124,13	4.288,87
Heat pump	5.500	1.400	4.100
Total	10.853	2.524,13	8.388,87

In the situation above (**Table 35**), the costs in phase 3 can amount to 8.388,87 euros. These costs can be paid in one go, but also in instalments with the energy-saving loan. This amount falls under the same rate with an interest rate of 1.71%. As a result, the monthly costs for the coming 10 years will be 70,68 euros and the total amount will be 8281,46 euros. This amount can be repaid earlier or tied to the property.

Table 36: Costs for 10 solar panels and a ground-coupled heat exchanger (Rijksoverheid, 2019)

Measure	Costs (Euros)	Subsidy (Euros)	Costs with subsidy (Euros)
10 solar panels	5.353	1.124,13	4.288,87
Ground-coupled heat exchanger	16.000	2.500	13.500
Total	21.353	3.624,13	17.788,87

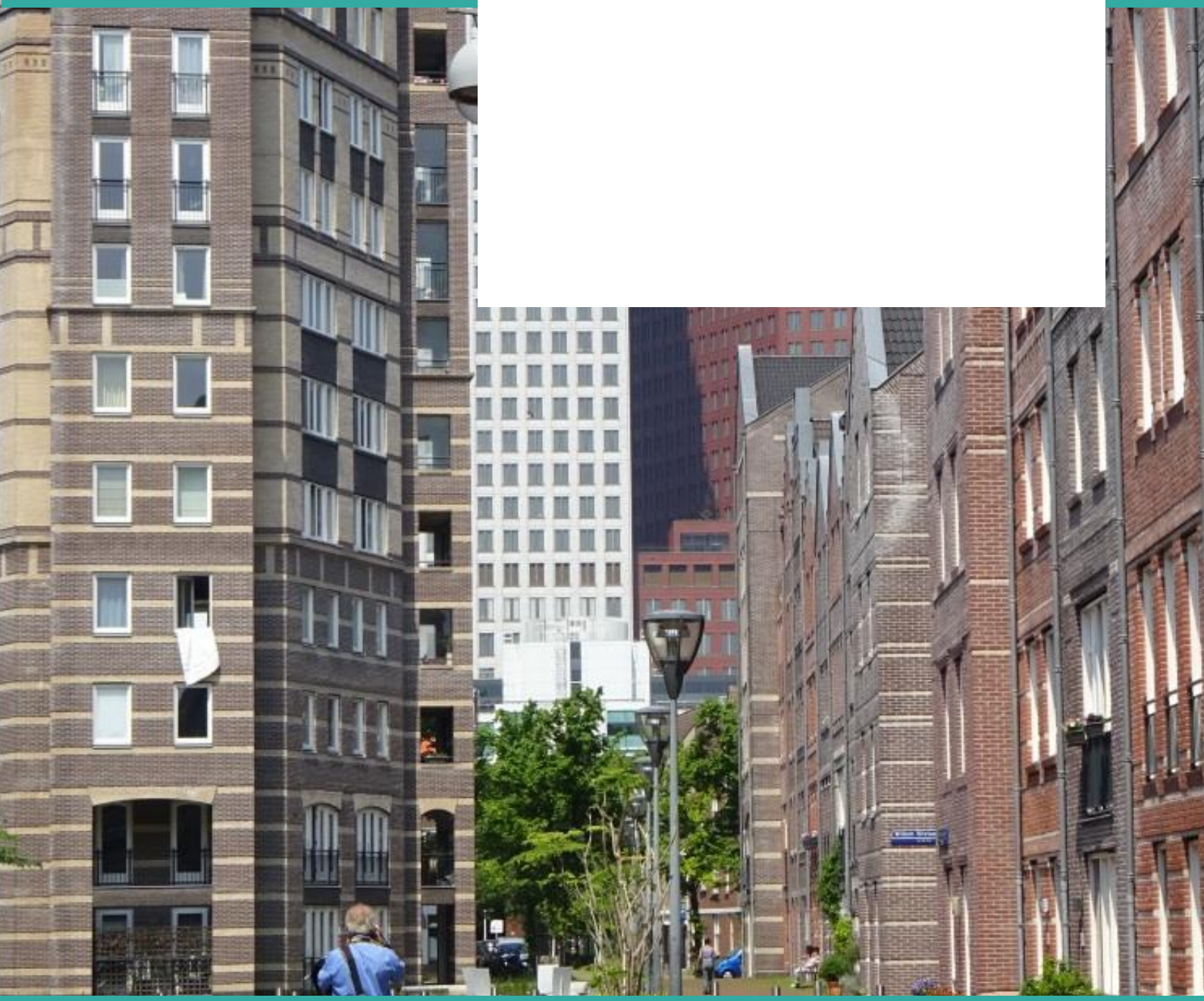
The same story applies to a situation in which a resident purchases 10 solar panels and a ground-coupled heat exchanger (**Table 36**). This investment amount includes an interest rate of 2.12% and a term of 180 months. This makes the monthly costs 100,92 euros and the total costs 18.165,99 euros.
When repayments are made in installments, there is an overlap between phases 2 and 3, because phase 2 only lasts 4 years, while the repayment period is 10 years. This means there is a 6 year overlap, which increases the monthly costs.

On the other hand, the measures also save money. An example is given with the yields of insulation. The data in **Table 37** is from **Chapter 9.2.1**. The costs for the insulation are earned back, because the revenue is higher than the term costs, when, for example, in phase 2, payments are made of 54,75 euros. There is money left over and this can be spent on the energy-saving measures of phase 3.

Table 37: Revenue insulating measures (Rijksoverheid, 2019)

Insulating measure	Revenue (Euros per year)	Revenue (Euros per month)
HR++ glass	120	10
Floor insulation	190	15,83
Slanted rood insulation	600	50
Inner wall insulation	250	20,83
Total	1160	96,67

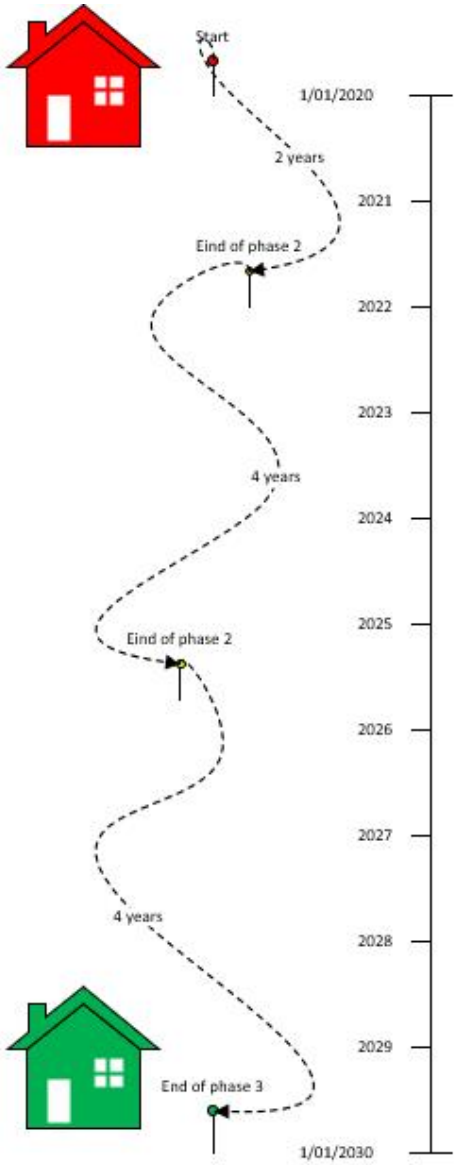
PART D:
ROADMAP



17 – Roadmap

Roadmap – Rivierenbuurt

The Rivierenbuurt is going through an energy transition. From 2020, the residents of the Rivierenbuurt will be made aware through workshops of the adjustments that can be made to the houses. A global planning of this transition can be seen in this roadmap. The transition is divided into three phases. Each phase is a constructive step towards the end result.



PHASE 1

Water saving shower head

- \+ Saves water, gas and money.
- \+ It's as expensive as a normal shower head.
- \- Use less water than a normal shower head.
- € Costs €25
  Saves €45 a year

Radiator foil

- \+ It is cheap.
- \+ The room will warm up faster.
- \- The process of making foil is not sustainable.
- \- You might see it.
- € Costs €10,49 (size 50cm*0,2cm*600cm)
  Saves €30 a year

Door closer

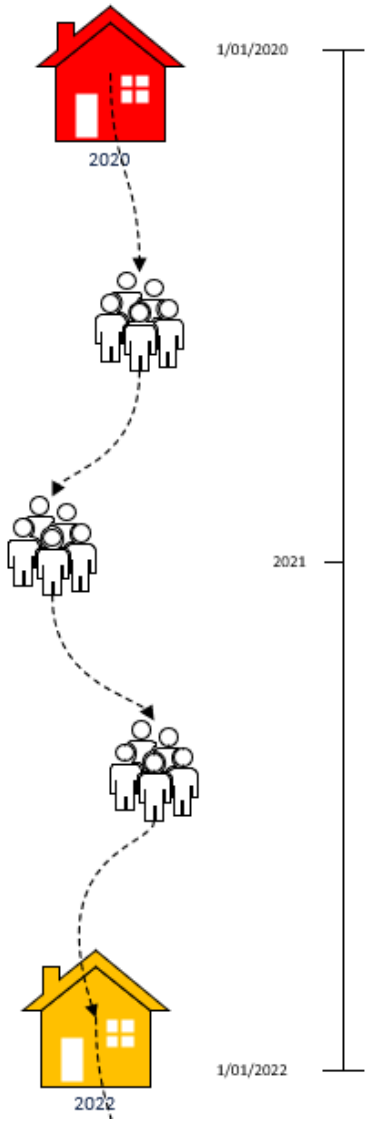
- \+ You can never forget to close the door.
- \+ There will be less draft.
- \- People often don't like the design.
- \- Door closers are dangerous.
- € Outside doors €69,99
  Inside doors €21,99

Weather strips

- \+ Have a very long service life.
- \+ They also might catch a lot of dust.
- \- Are not suitable for all cracks.
- \- They are hard to clean.
- € €3 - €7 per 2,1 meter

Led lamps

- \+ Use less energy.
- \+ The payback time is short.
- \- The lamps are morgen expensive to purchase.
- \- The lamps are sensitive to overheating.
- € Costs €10,49 (size 50cm*0,2cm*600cm)
  Saves €30 a year



Phase 1 and workshops

Phase 1 focuses primarily on the first steps that residents can easily take themselves. This makes them aware of the impact of the changes.
During phase 1, approximately 3 workshops will be scheduled.
- The first workshop will focus on the energy transition in general.
- In the second workshop residents receive information about what the energy transition can mean for their own living comfort.
- The third workshop will be about how residents can save energy in their own home through small changes.

Flat roof insulation

- + Saves money.
- + Saves energy.
- – This is a professional work.
- – Bigger changes on leakage.

€ Around €3,300

Inner wall insulation

- + The method is cheaper.
- + Can be done by yourself.
- – U lose lot of space inside.
- – The houses must be completely emptied.

€ €100 - €40 per m2

Slanted roof insulation

- + Can be done by yourself.
- + Saves energy.
- – Causes a loss of space in the hous
- – Outside insulation is professional work

€ Insulation inside: €40 - €60 per m2
Insulation outside: €450 – 2500 per m2

Exterior insulation

- + The house looks new again
- + Increases the comfort
- – Big investment
- – Job must always be done by a professional

€ €13.000 (for 100m2)

Floor insulation

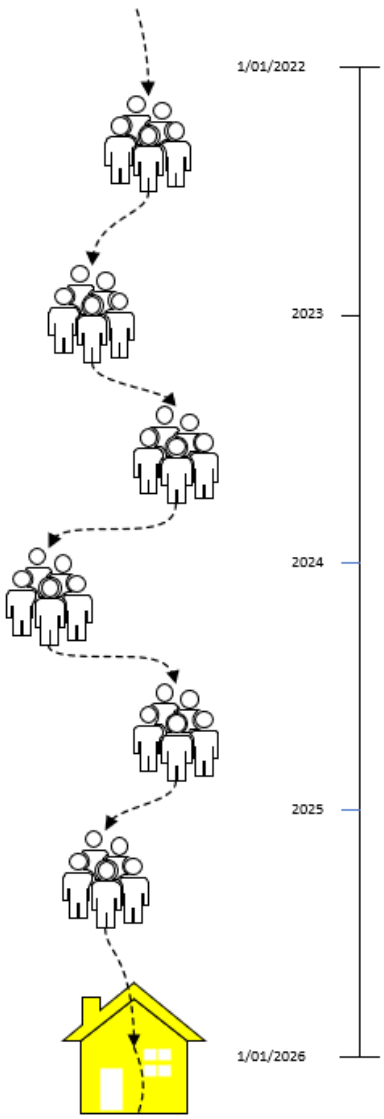
- + Saves energy
- + Saves money
- – Big investment
- – U need space under the floor

€ Floor insulation: €1600
Soil insulation: €950

HR++ and tripple glass

- + Saves energy
- + Saves money
- – Big investment
- – Condensation

€ HR ++ glass: €3.500
Triple glass: €9.600



Phase 2 and workshops

In the second phase here will be fewer workshops to disseminate information and more sessions will be organized to collect information. This phase is about insulation for the house and which option there are.

- The first workshop will be about the subsidies u can get for the insulation of homes.
- The first session that will take place will mainly be about connecting residents and homeowners, government and companies.
- During session two, the various parties explain the possibilities. In this way the residents and homeowners can indicate which possibilities they see but also what obstacles they see regarding the energy transition.
– The second workshop will be about sustainable installations. Companies and experts in the field of energy transition share information with the residents about the possibilities in sustainable installations.
- During the third session, all parties start a conversation. Each party must be given the opportunity to express the ideas.
- For a third workshop, an inventory will be made from all parties of what chances and possibilities for the energy transition to come about. All this data is analysed and combined into a possible plan of action for a residential block.

Solar panels

- + Reduce CO2 emissions
- + Higher value of the house
- – The roof must be suitable
- – Less beautiful roof
- € Average price of solar panels = €5,353 (10 panels)

Heat pump

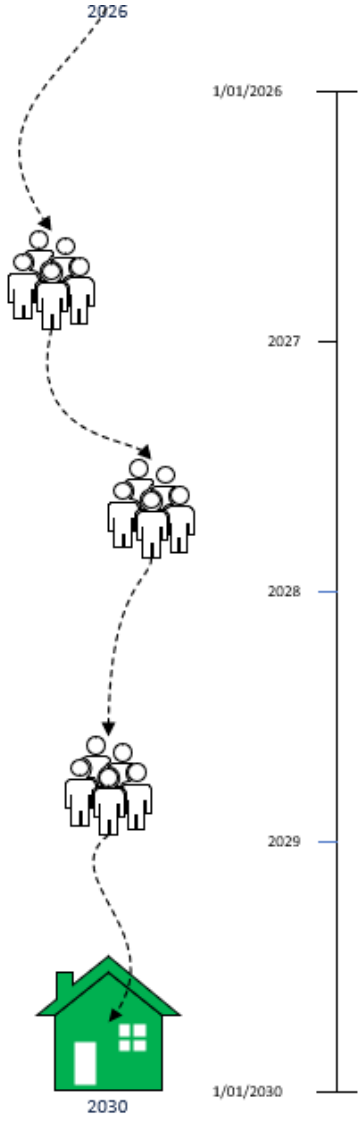
- + Lower gas bill.
- + Lower maintenance.
- – Purchase price
- – Improvements on the house
- € 3kW
  Price: €3000 - €6000
  Subsidy €1300

Ground-coupled heat exchanger

- + Independent of energy price
- + Efficiency 5 times higher than a central heating boiler
- – New construction or intergrated
- – Heat exchanger constructed in houses
- € Average price €15.000 - €17.000

★

- + No insultation needed.
- + Polymeric materials can be used.
- – High pumping costs.
- – Larger pipeline diameter.
- € €87 miljoen



Phase 3 and workshops

In the third phase, only sessions will take place that should lead to a concrete proposal for the action plan in the Rivierenbuurt and Spuikwartier. After these sessions, no further sessions or workshops will take place that are intended to gain or provide information. If residents prefer to have a session take place about the progress of the project, this can always be arranged. The third phase is about big changes, that will cotst more money.

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Appendix 1; Scenarios

Scenario Manon

The Rivierenbuurt consists of three different areas: Spuikwartier, Rivierenbuurt-Noord and Rivierenbuurt-Zuid. Each area has its own characteristics, which means every area needs its own custom-made plan to become energy neutral.

The buildings in the Rivierenbuurt-Zuid are mainly built between 1900 and 1930. A few buildings were built in the period 1850 to 1900 and a single building, in this case a primary school, was realized after 2005.
A big part of the homes within the Rivierenbuurt-Noord were built between 1900 and 1930. Another part of homes are built in 1975 or later. This neighbourhood is a post-war portico neighbourhood. The buildings in these types of neighbourhoods no longer followed the streets but were placed separately or perpendicular to the existing infrastructure: strip subdivision.

Most homes in the Spuikwartier were built around 1995. At this point in time, people wanted to in the city centre, so the city was looking into realising homes within the city centre. Because the homes were built around 1995, they are not that old yet, meaning they probably have good insulation.

The buildings in the different areas of the Rivierenbuurt were all built in different points in time. The newest homes of the Rivierenbuurt are located in the Spuikwartier and probably have pretty good insulation. However, insulation back then is not what is it nowadays. Therefore, the insulation in the homes need to be upgraded to make sure they lose as little warmth as possible. The buildings that are older (in the Rivierenbuurt-Noord and Rivierenbuurt-Zuid) need insulation as well, and right now they probably have no insulation or very little. The floors of all the buildings need to be insulated to a RC-value of 6. The roofs need to have an RC-value of 10. The facade of the homes need to have a RC-value of 4,5. With existing homes it is difficult and expensive to achieve this. This is why cavity wall insulation is a good option. Extra insulation on the in- or outside of the wall can always be added when desired. For the floor and roof insulation sprayed PUR for floor insulation with HFCs as blowing agent and sheep wool should be avoided. These materials are very harmful for the environment. Some better options are rock woll, glass wool, recycled cotton, EPS, biofoam, thermosheets, thermospads made of heat-reflecting foil (Milieucentraal, 2019).

Sustainable alternatives

To make the energy use of the residents the Rivierenbuurt more sustainable, a variety of options can be applied. The most suitable option for all of the areas of the neighbourhood is a combination of solar panels, a solar water heater and air source heat pumps. By using solar panels, the energy they create can be used for cooking and other use of electricity. Besides solar panels, a solar water heater will also be installed. This solar water heater makes sure there is enough warm water in the residency to shower etc. Also, an air source heat pump will be installed. This heat pump will keep the residency at a nice temperature: warm in the winter and cool in the summer. Because the buildings will be very well insulated, an air source heat pump is a great way to ventilate the homes. All of these measures use inexhaustible sources which makes it very sustainable and environmentally friendly.

Scenario Maybritt

The plan area Rivierenbuurt consist of three different neighbourhoods with different functions and a different investment capacity. That makes it impossible to make the same solution for the whole district. In this scenario I show different opportunities for the different neighbourhoods.
To become gasless, for all three neighbourhoods it's important get a view on their energy consumption. It's important to reduce the energy requirement, before expensive measures are being taken. That's why all the inhabitants and employers in the Rivierenbuurt will be informed about how they can reduce the energy consumption. Information forms and brochures will deal with various forms of information. As soon as the inhabitants know more about the energy consumption and how they can reduce it easily, the time will be there to talk about investments in the energy transition.

Spuikwartier

The neighbourhood Spuikwartier is in contrast to the other neighbourhoods a relatively rich neighbourhood. The investments in this neighbourhood can be more expensive than the investments in the other neighbourhoods concerning the energy transition.

The suitable dwellings in the Spuikwartier will get information about solar panels. This is an relatively easy measure to apply in the neighbourhood. As soon as the dwellings will generate to much the energy can be saved in a large battery and can be divided around the other dwellings in the neighbourhood. Today the BTW of the solar panels are deductible. So it's cheaper than it will be in two years.

Another measure in the Spuikwartier is ceramic cooking instead of cooking on gas. Ceramic cooking is on electricity. This will reduce the demand for gas. The residents will get coupons with discounts on the information evenings. The coupons will give some discount on the suitable pans for ceramic cooking. That makes it cheaper to switch to ceramic. The information nights will describe more of this measures, focussed on what will fit on the dwellings in the Spuikwartier.

Rivierenbuurt-Noord

The dwellings in the neighbourhood Rivierenbuurt-Noord has an average income. The investments in this neighbourhood about the energy transition cannot be too expensive, but they don't have to be very cheap.

Just as the dwellings in the Spuikwartier, the suitable dwellings in the Rivierenbuurt-Noord will get information about solar panels. This is an relatively easy measure to apply in the neighbourhood. As soon as the dwellings will generate to much the energy can be saved in a large battery and can be divided around the other dwellings in the neighbourhood. Today the BTW of the solar panels are deductible. So it's cheaper than it will be in two years.

Another same measure in the Rivierenbuurt-Noord is ceramic cooking instead of cooking on gas. Ceramic cooking is on electricity. This will reduce the demand for gas. The residents will get coupons with discounts on the information evenings. The coupons will give some discount on the suitable pans for ceramic cooking. That makes it cheaper to switch to ceramic.

Rivierenbuurt-Zuid

The neighbourhood Rivierenbuurt-Zuid has the lowest income of all three neighbourhoods. With an income €9.000,- lower than the Spuikwartier, can the investments in the Rivierenbuurt-Zuid not be as expensive as they can be in the Spuikwartier. The payback time of the investments has to relatively short. This because the residents are more convinced to do an investment in the energy transition.

Just as the dwellings in the Spuikwartier, the suitable dwellings in the Rivierenbuurt-Zuid will get information about solar panels. This is an relatively easy measure to apply in the neighbourhood. As soon as the dwellings will generate to much the energy can be saved in a large battery and can be divided around the other dwellings in the neighbourhood. Today the BTW of the solar panels are deductible. So it's cheaper than it will be in two years.

Another same measure in the Rivierenbuurt-Zuid is ceramic cooking instead of cooking on gas. Ceramic cooking is on electricity. This will reduce the demand for gas. The residents will get coupons with discounts on the information evenings. The coupons will give some discount on the suitable pans for ceramic cooking. That makes it cheaper to switch to ceramic.

The information nights will describe more of this measures, focussed on what will fit on the dwellings in the Rivierenbuurt-Zuid.

Scenario Bente

The Rivierenbuurt can be divided into three different neighbourhoods, namely Rivierenbuurt Noord, Rivierenbuurt Zuid and Spuikwartier. As preliminary research has shown, the differences between these three neighbourhoods are large. The residents of the Spuikwartier have much more to spend than the residents of the Rivierenbuurt Noord and Zuid. The houses are cheerfully better, but the residents in the Spuikwartier also have more money to make the houses more sustainable. The residents of the Rivierenbuurt Noord and Zuid have less good homes and also less to spend. For this scenario, the three different neighbourhood have been taken into account.

Rivierenbuurt Noord

The houses in this district mainly have an energy label between C and E. A lot of energy is used and that will probably also be due to insufficient insulation. The first thing that needs to be done is that the houses must be better insulated. In addition to better insulation of the house, the houses will also have to be removed from the gas. As a result, more electricity will be used. This electricity will also have to be generated sustainably. Solar panels will be placed on the homes in the Rivierenbuurt Noord, subsidies can be used to finance this.

Rivierenbuurt Zuid

The houses in this district mainly have an energy label G. A lot of energy is used and that will probably also be due to insufficient insulation. The first thing that needs to be done is that the houses must be better insulated. In addition to better insulation of the house, the houses will also have to be removed from the gas. As a result, more electricity will be used. This electricity will also have to be generated sustainably. Solar panels will be placed on the homes in the Rivierenbuurt Zuid, subsidies can be used to finance this.

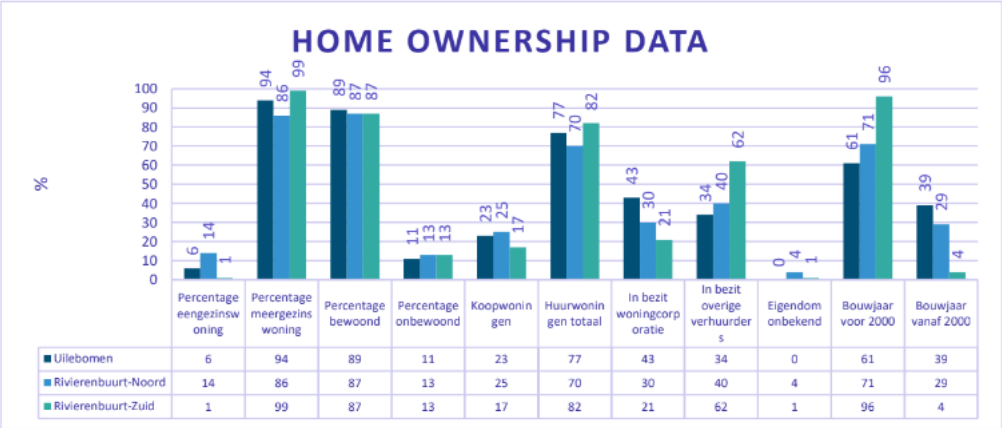
The Rivierenbuurt Noord and Zuid will also be able to use District Heating. In the Spuikwartier there are many offices that deliver a lot of heat in the evening. This could heat the houses in Rivierenbuurt Noord and Zuid.

Spuikwartier

The houses in the Spuikwartier were built a little later and therefore better insulated. Something still needs to be isolated, but this will have to be done less drastically than in the other neighbourhoods. In order to also be able to generate electricity sustainably in the homes of the Spuikwartier, heat pumps will be generated in the homes.

Scenario Melissa

Solar water heat pump with solar panels



	Percentage eengezinswoning	Percentage meergezinswoning	Percentage bewoond	Percentage onbewoond	Koopwoningen	Huurwoningen totaal	In bezit woningcorporatie	In bezit overige verhuurders	Eigendom onbekend	Bouwjaar voor 2000	Bouwjaar vanaf 2000
Uilebomen	6	94	89	11	23	77	43	34	0	61	39
Rivierenbuurt-Noord	14	86	87	13	25	70	30	40	4	71	29
Rivierenbuurt-Zuid	1	99	87	13	17	82	21	62	1	96	4

Figure *SEQ Figure * ARABIC 33: Home owner-* Data according to: (Centraal Bureau voor de Statistiek, 2017)

Most houses in the Rivierenbuurt consist of multi-family homes. We also know that the income in this neighbourhood is below average.

That means that we have to take the available amount of money into account, because not everyone can and wants to invest in a more sustainable energy supply. Nevertheless, an order has been received to reduce CO2 emissions in the neighbourhood and to make the residents enthusiastic about this. Because switching to a heat pump that runs entirely on electricity can quickly cost around 10,000 euros, it is more convenient to take a smaller step first. The use of a solar boiler ensures that an average family of 4 people annually saves 180 m3 of gas and 330 kg of CO2 emissions.

Improvement option	Costs (Euros)	Revenue (Euros per year)	Subsidy (Euros)
Solar water heater (3,5 m2)	3.300	140	1.100

Table *12: Costs and revenue solar water heater (Rijksoverheid, 2019)*

	Costs (one time)	Revenue CO2 (kg per year)	Revenue euros	Required roof area (m2)
6 solar panels	2.650 (after VAT refund 2.200)	600	290	10
Solar water heater (3,5 m2)	3.300 (with subsidy: 2.200	330	120	3,5

Table *13: Costs and revenue solar panels (Rijksoverheid, 2019)*

The costs an revenues for the heat pumps and solar panels are calculated with 77 cents per m3 gas. (Rijksoverheid, 2019)

It is also important to insulate the houses. With insulation we can think of floor insulation, wall insulation, double glazing and roof insulation. Insulation is very important because it ensures that less heat escapes from the house. It is more difficult to save energy without a well-insulated house.

If we want to make the residents of the neighbourhood enthusiastically about these changes, it is important that we show that it actually delivers benefits. What we have to take into account is that there is enough space on the roof for the solar panels and for the storage tank that comes with the solar water heater. (Rijksoverheid, 2019).

Scenario Thom

Three neighbourhoods, three plans, one strategy

With the energy transition we first start in the Rivierenbuurt-Zuid. This neighbourhood is the oldest and the poorest part of the entire project area. These houses are better insulated to reduce gas consumption for heating. This can result in the change of the facade in the neighbourhood. New facades can lead to a new and fresher appearance that has an impact on the quality of life. However, if the facades actually get a different appearance, an agreement must be made about the ownership of the street.
On the basis of subsidies and financial contributions from companies, such as energy companies, housing associations and banks, residents can be expected to keep costs as low as possible.

Following this approach in the neighbourhood, various sessions and workshops are organized with the residents of the Rivierenbuurt-Zuid to discuss a follow-up plan on how they see change ahead. These sessions and workshops will also be used to make residents more aware of the energy transition and to inform them of the reason why this is being done. This way we can work together towards a future-oriented plan for the neighbourhood. In addition, citizens can be part of their own project. One possibility in this is to let residents of a residential block determine together how they see adaptations. The business community and governments will also be involved in the workshops.

Part of the homes in the Rivierenbuurt-Noord have recently been built or renovated. However, this does not apply to all properties. In order to continue the urban development trend throughout the entire neighbourhood, other houses are being built or renovated in the same style.
The residents of the Rivierenbuurt-Noord will also receive workshops and sessions on the energy transition, just like in the Rivierenbuurt-Noord, to share information and work together for a future.

A large heat and cold storage can be realized under the square in front of the school. Heat collectors can be placed under the asphalt roads. This can also be done under the rails (possibly). During the summer months, when the asphalt is hot, the heat can be transported to the large storage. During the winter months, several homes can use the stored heat.

A Smartgrid can be implemented in the Spuikwartier between the ministries and the houses. The offices are in use during the day, making it warmer and more heated inside. Most homes will not be in use during working hours. When people go home again, the ministries will be army. With an exchange of heat between the different buildings, heat can be shared and reused.

After a few years, the residents of the Rivierenbuurt-Zuid will have saved gld because the energy bill has gone down. Through the workshops and session they will also be more aware of the possibilities around the energy transition. As a result, there is a chance that they will be more willing to deposit a little more money to make their home even more economical. This, for example, by jointly investing in the purchase of solar panels. Or purchase a heat pump on the basis of subsidies.

Scenario Jonathan

There are three different areas in the Rivierenbuurt: Rivierenbuurt-Noord, Rivierenbuurt-Zuid and Spuikwartier. Between these areas is a difference in characteristics. This means that there every area needs a own plan adapted to its characteristics.

The buildings In the Rivierenbuurt-Zuid are built build in 1900 to 1930. Only a couple of buildings were built from 1850 to 1900 besides these older buildings there is one building that was realized in 2005. In the Rivierenbuurt-Zuid Noord most of the buildings were built in 1900 to 1930. The other homes are built 1975 or later. The buildings that were built in 1975 or later are post-war. The buildings in these types of neighbourhoods no longer followed the streets but were placed separately or perpendicular to the existing infrastructure: strip subdivision. Most homes in the Spuikwartier were built around 1995. These homes are not so old meaning they are reasonably insulated.

So this means that the Rivierenbuurt-Zuid and Rivierenbuurt-Noord need better insulation while the Spuikwartier already had reasonable isolation. The homes in the Rivierenbuurt-Zuid and Rivierenbuurt-Noord are going to bed insulated while the Spuikwartiers insulation is fine for now.

The whole neighbourhood from the Rivierenbuurt needs a greener outlook. Right now the Rivierenbuurt doesn't attract people because the outlook of the neighbourhood, besides that the current inhabitants don't have a safe feeling. The outlook of the neighbourhood has to change it needs to be greener by realizing parks and playing grounds. The parking spot can have half-open callosity. These green spot also help faster infiltration of heavy rain, what will happen in the near future. On the roofs there will be the adaptation of green roofs this will help heavy rain.

At last the energy generation and heating of the buildings. Right now the buildings are still connected to gas lines. In 2050 the inhabitants can't use gas anymore meaning a change is needed in the energy usage. The energy use needs to be more sustainable therefor new energy sources need to be used. The most suitable energy source's for the Rivierenbuurt are:

- Solar panels on the roofs of the buildings.
- A heat pump for the heating the homes.
- Air source heat pump for the ventilation of the homes.
- Solar water heater for the usage of warm water.