Sustainability enhancement of the new housing estate Boekhorst

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Cover image: Sketch design Nieuw-Boekhorst, Kokon (2016)

PREFACE

In front of you lies the thesis 'Sustainability enhancement of the new housing estate Boekhorst'. In this thesis different sustainable measures for implementation in spatial design are listed and assessed. This thesis is written in completion of the study Civil Engineering at the University of Twente. The research for this thesis is done at RPS, in association with Kokon. From May 2018 till July 2018, I enjoyed being involved with the research and writing of this thesis. During the time spent at RPS, I learnt a lot about the assessment and implementation of sustainability in spatial design.

For this, I would like to thank several people. First of all, I would like to thank my supervisors. Heike Gaasbeek for her help with the framing of the research design, the suggestions on my thesis and for the explanations and discussions about the ambitionwebtool. Mar Kwakkelstein for giving me the opportunity to start on this topic in a great team and for the inspiring ideas he gave. And last, Silu Bhochhibhoya for the answers on my questions and for the fast and useful comments she gave on the proposal and thesis.
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Karly van der Spek
Delft, July 2018

ABSTRACT

Urban developers often struggle with the question on how to implement sustainability in spatial design. They are looking for specific measures that can be implemented. In this thesis sustainable measures are assessed and proposed for implementation in the new housing estate Boekhorst.

The goal of this research is to find achievable measures to implement sustainability in spatial design, with help of the ambitionwebtool. The ambitionwebtool is a model in which different scenarios can be assessed on sustainability. This model contains specific sustainable goals on eight themes: energy, materials, cost and value, space usage, living environment, nature, water and soil. With the help of the sustainable goals, ambitions are set on the themes and requirements are determined.

Based on the research goal, the following research question is composed: *Which measures can be implemented in the spatial design of Boekhorst, so that the sustainable ambitions are met?*

To answer this question, first the ambitions for Boekhorst are inventoried in an interview with the architects of Boekhorst. In this interview three scenarios are created in the ambitionweb: 1) the current sustainability ambitionlevel, 2) the required ambitionlevel and 3) the aimed ambitionlevel. For each theme in the ambitionweb, ambitions and goals are determined.

After the this is done, measures to satisfy these goals and thus these ambitionlevels are looked for in literature and found in interviews. The found measures are assessed in an multi criteria analysis. Based on the multi criteria analysis an overview of the feasibility of measures is given.

The measures that proved to be feasible are coupled to the requirements belonging to the ambitions. This is done in the ambitionwebtool. Here specific goals are set based on the ambitions. The measures that help to meet these goals are coupled to their ambition. The result of this research is a list of measures that can be implemented in the design to meet the set ambitions of scenario 2 and 3.

Per scenario, measures are listed that must be implemented to meet the ambitions belonging to these scenarios. Optional measures are listed per theme in another table. These measures can be implemented when, after follow-up studies, it appears that the proposed measures do not meet the goals in the ambitionwebtool. Following studies can focus on which or how many of the proposed measures are needed to meet the goals.

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TABLE OF ABBREVIATIONS

Abbreviation	Term	Definition
EIA	Environmental Impact Assessment	Assessment of the environmental consequences of a plan.
GWW	Grond- Weg en Waterbouw	The civil engineering industry (ground, road and water construction)
LCC	Life Cycle Costs	Sum of all the occurring costs over the full life span.
MCA	Multi Criteria Analysis	A decision-making tool to compare several options.
MKI	Milieu Kosten Indicator	Environmental Cost Indicator: one value to measure the total environmental costs.
SPI	Sustainability Performance Indicator	Indicators which make sustainability measurable.
WKO	Warmte- en Koude Opslag	Heat and cold storage. A method to store energy in the soil in the form of heat and cold.

TABLE OF TERMINOLOGY

Term	Definition
Ambitionlevel	A score of 1 to 3 on themes in the ambitionweb, based on ambitions. One means low ambitions and three means high ambitions.
Ambitionweb	A figure of a web with several themes belonging to sustainability.

Ambitionwebtool	A model to measure sustainability. This model creates Ambitionwebs for several scenarios, based on project goals.
Asphalt heat	Hot/cold network in which water pipes are implemented in the road and combined to a heating system. The road heats water during summer for heating of buildings and the water coming from buildings cool the road.
Black water	Waste water from the toilet.
Circular building	Reuse of 'waste' materials. So, no waste in generated.
Domotica	Electronic communication between all kinds of electrical applications in the home and living environment.
DuboCalc	Method to calculate the environmental impact of a material or building
Duurzaam bouwen ++	A guideline with regulation on sustainable building.
Free migration	In ecology the movement from species to a different environment.
Grey water	Relatively clean waste water from bathroom, kitchen and washing machines.
Helophyte filter	A sand filter that is generally planted with reeds. The actual treatment of the water is done by bacteria living in the roots.
Materials passport	Registration of materials based on financial value, life span and quality. Gives insight in recycle possibilities.
Geothermic energy	Energy generated and stored in the earth.
Greenlabel	A company that created a method to measure sustainability. They provide assessments and sustainability scores.
Quickscan	A limited and fast research.
Riothermic energy	Hot/cold network with heat from waste water in the sewerage system.
Smart energy floor	Floor that produces energy from movement.
Smart grid	An electricity supply network that uses digital communications technology to detect and react to local changes in usage.
Surface water heating	Hot/cold network in which heat is drawn from surface water.
Sustainability themes	Sustainability factors. The themes belonging to the ambitionweb. These themes can be different per ambitionweb.
Sustainable dimension	The aspects of sustainability: people, planet and profit.
Theme-ambitionweb	The ambitionweb of sub-themes belonging to the themes in the main ambitionweb
Water impact assessment	Maintain insight on issues relating to declining water quality, managing and allocating water, wastewater collection and treatment, and stormwater management
Weight	Importance value. A higher value means a higher importance.

TABLE OF THEME TRANSLATIONS

Theme number	Dutch	English
1	Energie	Energy
1	Energieverbruik tijdens gebruik	Energy consumption during use
1.2	Energieverbruik, productie & werkproces	Energy consumption, production & work process
1.3	Energieverbruik onderhoud	Energy consumption maintenance
1.4	Energieverbruik door gebruik	Energy consumption through
1.5	Energieverbruik door sloop	Energy consumption by demolition
2	Materialen & grondstoffen	Materials & raw materials
2.1	Ontwerp algemeen	Design generally
2.2	Hoeveelheid gebruikt materiaal	Amount of material used
2.3	Herkomst materialen	Origin materials

2.4	Milieu-impact van materialen	Environmental impact of materials
2.5	Afval bij sloop	Waste at demolition
2.6	Hernieuwbare materialen	Renewable materials
3	Kosten & waarde	Cost & value
3.1	Kosten	Costs
3.2	Toekomstige opbrengsten	Future revenues
3.3	Maatschappelijke waarde	Social value
4	Ruimte	Space
4.1	Belevingswaarde	Experiential value
4.2	Gebruikswaarde	Usage value
4.3	Toekomstwaarde	Future value
4.4	Educatieve waarde	Educational value
4.5	Klimaatbestendigheid	Climate resistance
4.6	Aansluiting ontwikkelingsvraag	Connection development demand
4.7	Adaptiviteit/flexibiliteit	Adaptivity / flexibility
4.8	Gebruik bestaand gebied	Use existing area
4.9	Meervoudig ruimtegebruik/multifunctionaliteit	Multiple use of space / multifunctionality
4.10	Robuust mobiliteitssysteem	Robust mobility system
4.11	Efficiënt gebruik infrastructuur	Efficient use of infrastructure
4.12	Bereikbaarheid functies	Accessibility functions
4.13	Adaptief mobiliteitsbeleid	Adaptive mobility policy
5	Leefomgeving	Living environment
5.1	Gezondheid algemeen	Health general
5.2	Hinder tijdens uitvoering	Nuisance during execution
5.3	Veiligheid	Safety
5.4	Demografische samenstelling	Demographic composition
5.5	Sociaal welzijn	Social well-being
5.6	Sociaal draagvlak	Social support
5.7	Vestigingsklimaat bedrijvigheid	Business climate activity
5.8	Vestigingsklimaat bevolking	Business climate for the population
6	Natuur	Nature
6.1	Natuurgebieden	Nature areas
6.2	Landbouwomgeving	Agricultural environment
6.3	Flora & fauna (algemeen)	Flora & fauna (general)
6.4	Verstoring	Disturbance
6.5	Natuurlijk kapitaal	Natural capital
7	Water	Water
7.1	Kwaliteit	Quality
7.2	Waterkwantiteit (wateroverlast, veiligheid)	Water quantity (flooding, safety)
7.3	Waterkwantiteit (droogte, tekorten)	Water quantity (drought, shortages)
8	Bodem	Soil
8.1	Bodemkwaliteit	Soil quality
8.2	Ruimtelijk beslag	Spatial attachment
8.3	Grondverzet	Earthmoving
8.4	Bodemwaarde	Soil value
8.5	Delfstoffen	Minerals
8.6	Water	Water

1 INTRODUCTION

Greenhouse gas emissions are causing global warming. Effects of global warming are extreme temperatures, extreme weather conditions, flooding, melting ice and disturbance of the ecosystem. (Bradford & Pappas, 2017)

To reduce greenhouse gas emissions 195 countries, including the Netherlands, signed the 'Paris Agreement 2020-2050'. The 'Paris Agreement' contains specific requirements for the countries which they have to meet, concerning climate change and global warming. (Framework Convention on Climate Change, 2015) In addition to the 'Paris Agreement', in the Netherlands the 'Green Deal; Duurzaam GWW (Grond, Weg en Waterbouw)' is developed with the ambition to make sustainability in 2020 an integral part of rail, ground, water and road construction projects. 'Duurzaam GWW' contains an approach to determine ambitions and possibilities on different aspects of sustainability and translate them into specific designs. Duurzaam GWW does not describe how and where to make sustainable gains, because each project contains different possibilities and drawbacks for sustainability. (Duurzaam GWW, 2018)

Due to the 'Paris Agreement and Duurzaam GWW the attention and importance for urban sustainability is growing. Urban sustainability is the idea that a city can be organised without excessive reliance on the surrounding countryside and be able to power itself with renewable sources of energy. The aim of this is to create the smallest possible ecological footprint and to produce the lowest quantity of pollution, to efficiently use land, compost used materials, recycle it or convert waste-to-energy and to make the city's overall contribution to climate change minimal. (Siemens, 2018)

A study is done to look at sustainable measures to implement in the design in a new housing estate. This research is done at RPS in collaboration with Kokon.
RPS is an independent consultancy and engineering company for environmental and safety issues, that works from different disciplines on a better living and working environment. RPS is a company located in several countries around the globe, with six offices in the Netherlands. This assignment is done at the department location development and infrastructure in Delft.

Kokon architecture and urban development, is an architectural office in Rotterdam that provides housing plans, urban planning, non-residential construction, care construction and transformation of buildings. They give room for sustainability and implement it in their designs in discussions with their client.

1.1 PROBLEM DEFINITION

Architectural firm Kokon desined a new housing estate called Boekhorst for one of their clients. Boekhorst is going to be located in Voorhout. The precise location can be seen as the cross-marked area in Figure 1.1.

FIGURE 1.1 LOCATION OF BOEKHORST IN VOORHOUT

The design is shown in Figure 1.2. In the design, a lot of nature (green) and water (blue) is already implemented. The orange planes show where buildings can be build; There is a possibility to shift these locations, only the grey planes are already existing buildings that cannot be relocated. The design is approved on the spatial part but is not accepted by their client, because it must be more sustainable. The new housing estate is aimed to be the most sustainable area of the province South-Holland. The problem for this research is a lack of measures in the design to justify the design on the part of sustainability. To justify the spatial design for Boekhorst Kokon consulted RPS.

FIGURE 1.2 SPATIAL DESIGN FOR NEW BUILD AREA BOEKHORST IN VOORHOUT CREATED BY KOKON

1.2 THEORETICAL FRAMEWORK

Sustainability is a broad aspect and it means something different for everyone. In this theoretical framework the general definition of sustainability is given.

Because sustainability is a concept that can be interpreted in a lot of different ways, the general description is given from the Brundtland report (1987): *''Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs''*

This means that beside the financial aspects of projects also a social and environmental aspect must be considered. This is further explained in ''The triple bottom line'' defined by John Elkinton in 1994. In the triple bottom line, the social, environmental and financial aspects are included in the *3P's*:

- *People;* The social pillar of sustainability. This pillar contains the labour involved in a corporation's work, and wider the community where a corporation does business.
- *Planet;* The environmental pillar of sustainability. This pillar focuses on the stimulation of biodiversity and the prevention of global warming.
- *Profit;* The economic pillar of sustainability. This pillar focuses on business plans with profit and cost effects.
  (University of Wisconsin Sustainable Management, 2018)

The goal is to create a balance between these three pillars to reach an optimal situation. Therefore, it is important to address these three pillars in projects.

1.2.1 THE AMBITIONWEB

To make sustainability concrete and measurable Duurzaam GWW developed the ambitionweb as shown in Figure 1.3. The ambitionweb is developed so that at the start of projects an insight can be obtained in what is possible on several aspects in the project. When it is clear from the start where the focus should lie, these aspects can get more attention immediately. During all the time frames in each project can be reflected with the ambitionweb if the ambitions as set are still achievable. This gives focus in projects. In the ambitionweb the ambitions on different sustainable themes are visualized. (Duurzaam GWW, 2018)

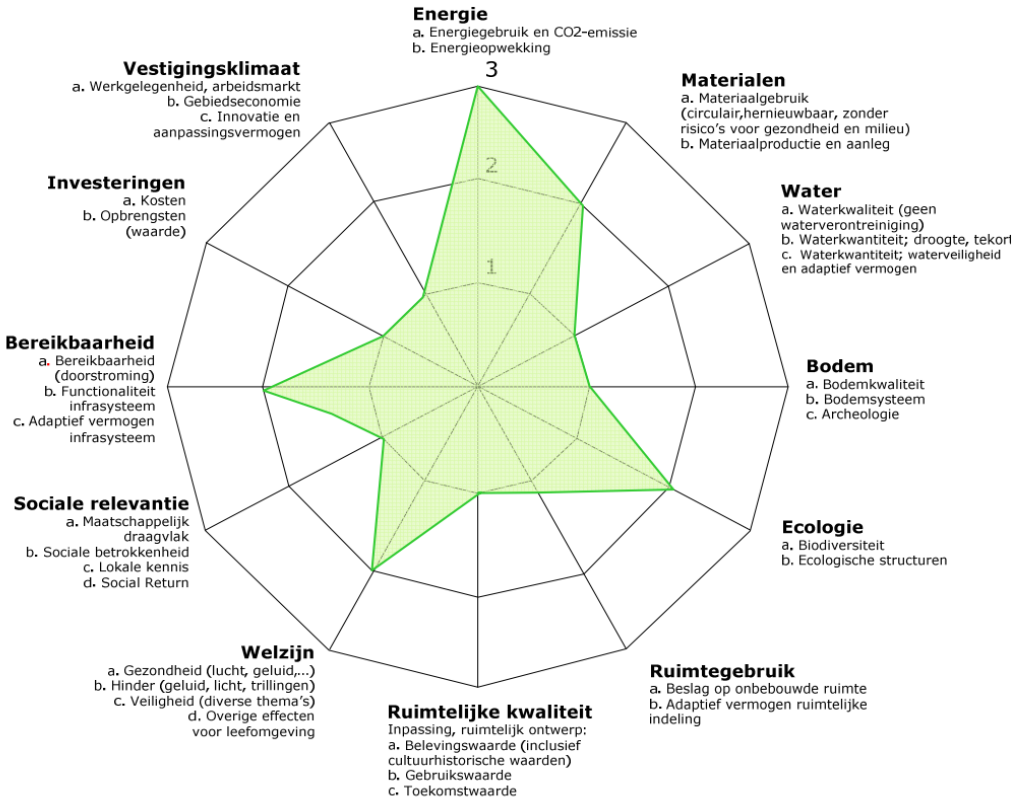

FIGURE 1.3 AMBITIONWEB AS DEVELOPED BY DUURZAAM GWW (2018)

The ambitionweb covers all the pillars within the *3P's (people, planet and profit)* of sustainability, but they are further broken down in several themes. The themes and sub-themes as used by Duurzaam GWW are Shown in Dutch in Figure 1.3 and listed in English in Appendix A.

The ambition web consists of three ambitionlevels as indicated in Figure 1.3. These ambitionlevels show the ambitions on each theme in a project. The meaning of the ambitionlevels is as followed:

1) Insight in the sustainability effects of a theme and thereby achieving a minimum sustainability performance. In any case, this means meeting the existing situation and the legal ambitionlevel.
2) Setting concrete improvement goals to achieve a significant sustainability gain on the theme.
3) Maximum effort to achieve the most possible on a theme. It means that no negative contribution is made or even positive contributions takes place. You can hereby think of the aspects climate neutral, energy neutral, profitable, air cleaning.

Inspired by Duurzaam GWW, RPS advice and Engineering company works with the ambitionweb. They have developed the ambitionwebtool to make the ambitionlevels more measurable. The ambitionwebtool is a model in which goals are defined per sub-theme. When choosing an ambition, the tool makes it possible to determine the goals that must be achieved to reach this ambition. However, since they believe that all the themes of the ambitionwebtool from Duurzaam GWW are too much to discuss in every project, they combined some pillars to one. In the ambitionwebtool of RPS eight fixed themes are established instead of the twelve from Duurzaam GWW. All the twelve themes are included in these eight themes.

The eight themes used in the ambitionwebtool of RPS are:

- Energy
- Materials and raw materials
- Costs and value
- Space
- Living environment
- Nature
- Water
- Soil

(RPS, 2018)

1.3 RESEARCH QUESTIONS

Based on the problem definition and theoretical framework, the research objective is stated as follows:

Find concrete and achievable measures to implement sustainability in the spatial design for Boekhorst with the help of the ambitionwebtool.

From the research objective follows the main research question:

Which measures can be implemented in the spatial design of Boekhorst, so that the sustainable ambitions are met?

To find an answer to this question, the main-question is divided in the following sub-questions:

Sub-question 1:	What are the ambitions for Boekhorst and what are the preconditions on the different sustainability themes in the ambitionweb?
Sub-question 2:	What are achievable sustainable measures that can be implemented in the new housing estate?
Sub-question 3:	At what ambitionlevel in the ambitionwebtool do the measures fit and which measures are thus fitting within the different scenarios for Boekhorst?

1.4 THESIS OUTLINE

Chapter 2 **Research design.** In this chapter the methods used to answer the research questions are described.

Chapter 3 **Ambition and goals for Boekhorst.** In this chapter the ambitions for Boekhorst are inventoried in an ambitionweb.

Chapter 4 **Sustainable measures for Boekhorst.** Measures for Boekhorst are inventoried and assessed in this chapter. An overview of possible sustainable measures for Boekhorst is given.

Chapter 5 **Ambitionwebtool scenarios.** The measures found in chapter 3 are coupled to requirements in the ambitionwebtool. With this coupling scenarios are proposed.

Chapter 6 **Conclusion.** The conclusion is presented in this chapter

Chapter 7 **Discussion.** This chapter discusses the used methods and the outcomes of the research.

Chapter 8 **Recommendations.** This chapter contains recommendations of the research for the companies where this research is done.

2 RESEARCH DESIGN

The methods used in this research are part of a continuous process during projects. The followed process in this research is shown in Figure 2.1.

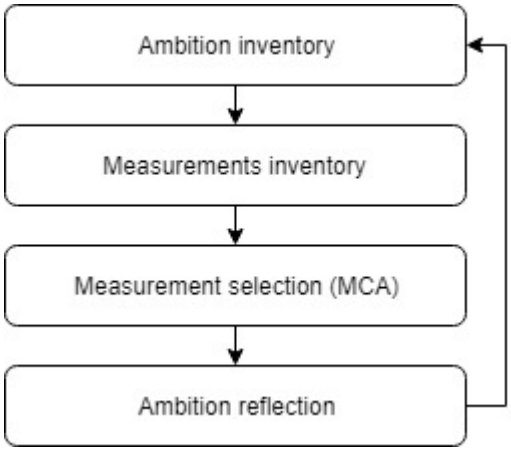

FIGURE 2.1 PROCESS SCHEME

The process consists of the following steps:

1. Ambition inventory: The ambitions are firstly inventoried during an interview.
2. Measure inventory: Measures are looked for and found based on the ambitions as determined in step one.
3. Measure selection: Measures are selected with a multi criteria analysis (MCA). Feasible measures are used in the following step.
4. Ambition reflection: After the selection of measures the measures are coupled to the ambition scenarios as determined in step one. This reflection shows if the ambitions as determined are realistic or not. Ambitions might have to be adjusted which leads to step 1 again.
   Each time the process is followed, measures are selected on more precise criteria and assessments. This can lead to new ambitions and extra needed measures.

By consecutively answering the sub-questions this process is followed and an answer can be given on the main question.

2.1 RESEARCH DESIGN FOR SUB-QUESTION 1

Sub-question 1: What are the ambitions for Boekhorst and what are the preconditions on the different sustainability themes in the ambitionweb?

For the development of Boekhorst it is important that agreement is reached on the goals and ambitions. That is why ambitions for Boekhorst are determined in an interview with the client, Kokon. Goals, interpretations and ideas for each theme in the ambitionweb were discussed. Based on the interview three scenarios are created in the ambitionweb:

Scenario 1: Current sustainability ambitionlevel
Scenario 2: Required ambitionlevel
Scenario 3: Aimed ambitionlevel

In this interview the ambitionwebtool is used with the following themes:

- Energy
- Materials
- Soil and water
- Nature and ecology
- Space
- Living environment
- Investments
- Mobility

Except for mobility all these themes were used in the standard ambitionwebtool at RPS. Mobility is normally implemented under space and living environment. Since the architects mentioned there where quite some possibilities for mobility, this theme was added separately to the ambitionwebtool. For each scenario, ambitionlevels are determined on all the sustainability themes during the interview.

After this is done, the set ambitions are compared with the ambitions of the municipality. The ambitions of Kokon and the municipality are compared to form a normative ambitionlevel, which is shown as the required ambitionlevel. Because the municipality eventually has to approve the design, their considerations must be taken into account as well. The municipal required ambitionlevel is determined based on their vision of 2014: 'Structuurvisie 2030, Gemeente Teylingen Duurzaam Bloeiend!'. The specific ambitions for Boekhorst could be different from the structure vision, however since the project is still in tender for the developers of Boekhorst, an interview with the municipality is impossible. That is why the vision is used. The ambitions of municipality Teylingen and Kokon are explained in a table and visualized in an ambitionweb.

Based on the created scenarios in the interview and with the municipal vision, the general goals, for the ambition themes are determined. These goals specify where to focus on. At the start of the research it was not possible to set quantifiable goals, due to a lack of knowledge. More quantifiable goals are set with the ambitionwebtool.

The improvement needed on each ambitionlevel is shown in a table. This is calculated as follows:

$$Required\ level\ improvemnet = Required\ ambition\ level - Current\ sustainability\ level$$

$$Aimed\ level\ improvement = Aimed\ ambition\ level - Current\ sustainability\ level$$

With the help of the required ambitionlevel improvement and the aimed ambitionlevel improvement a priority ranking is made. This is done by firstly looking at the required ambitionlevel improvement. Based on required ambitionlevel improvement a ranking is made. The theme on which the highest ambitionlevel improvement is needed, is ranked one, the theme with the second highest required ambitionlevel is ranked two and so on. When themes have the same required ambitionlevel improvement they are ranked double. For the double ranked numbers, the is determined which number they receive by use of the aimed ambitionlevel improvement. Of the numbers with the same double ranking, the theme with the highest aimed ambitionlevel improvement is higher in priority ranking and thus receives the lowest of the double numbers. The priority answer is made so, that a targeted measure search can take place to answer sub-question 2

2.2 RESEARCH DESIGN FOR SUB-QUESTION 2

Sub-question 2: What are achievable sustainable measures that can be implemented in the new housing estate?
The integration of house and environment in a sustainable way is done in different steps:

1. To find right measures for Boekhorst, first a lot of general measures are considered to give an overview of measures with their advantages and disadvantages. These measures are found in literature and in open interviews with six sustainability experts. In literature the measures are looked for on theme. Measures with the highest priority ranking (1), got the highest priority in search. Measures mentioned by the experts are also looked up in literature for reference. All the found measures are listed in a table with their advantages, disadvantages and sources.

2. The measures for buildings and environment are separated, because the measures for the houses are to be considered in a later stage in the project. They are not considered in the stage for the spatial design, since the spatial architects cannot influence the houses. Measures for the buildings are given as advice for when the buildings are designed. Only the measures that are of influence for the environment or for both are considered in this research.
3. The achievability of the measures relevant for the new estate is determined with a multi criteria analysis (MCA). This makes clear how profitable or risky measures are. A conclusion is drawn on the possibility to implement each measure in the new housing estate.

2.2.1 MCA METHOD

The MCA is based on a method described by Kamali and Hewage (2015). In this method the MCA consists of three layers. The first layer consists of all the Sustainability evaluation criteria. The second layer consists of the three sustainability dimensions: people (social), planet (environmental) and profit (economic). The third layer consists of the Sustainability performance indicators (SPIs). The layers of which the MCA consists are shown in Figure 2.2. Here all the SPIs are shown.

The SPIs are determined based on research by Kamali and Hewage (2015). On top of the SPIs from Kamali and Hewage (2015) are added in interest of the developers of Boekhorst: heat stress efficiency strategies, alternative transportation, required skills and knowledge and educational value. All the used SPIs belonging to their sustainability dimension are defined in Appendix B.1.

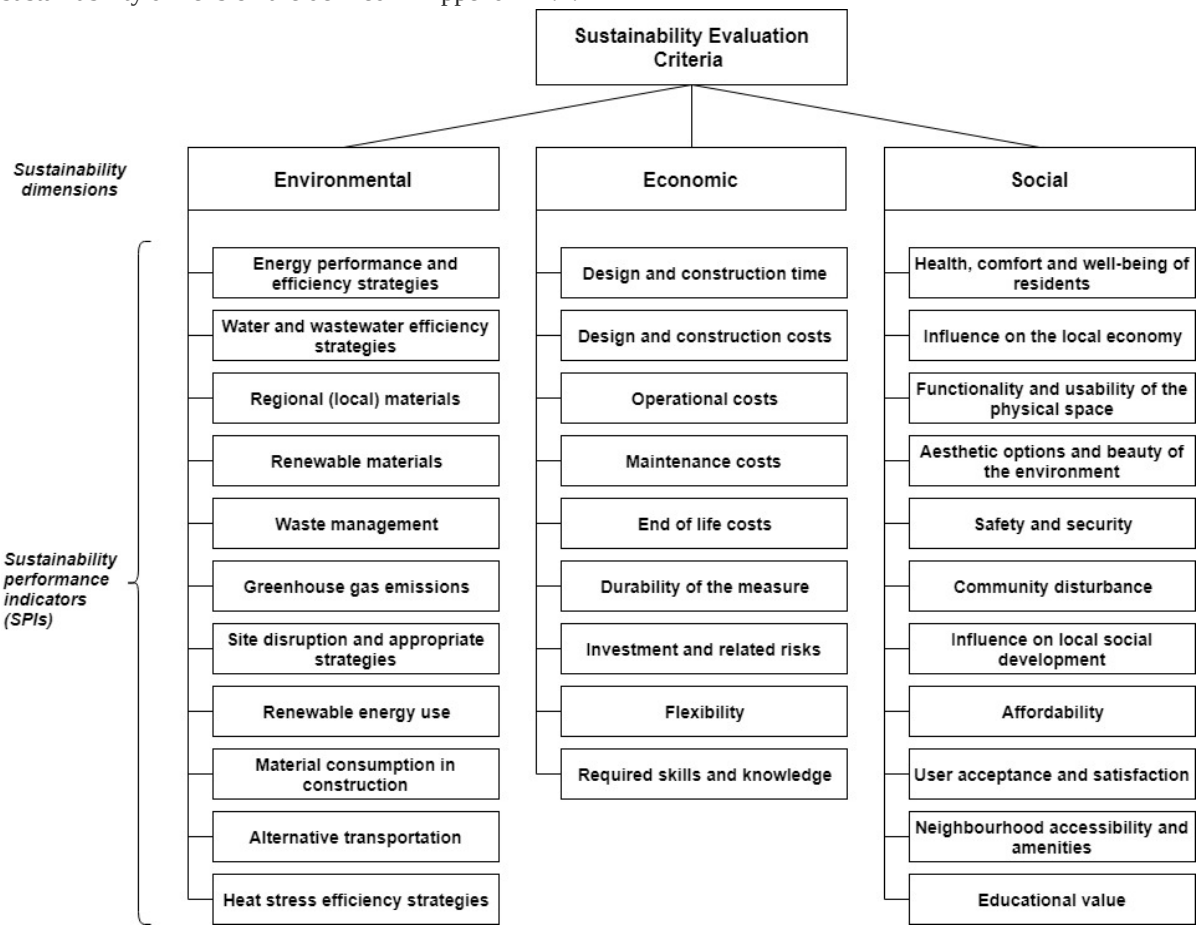

FIGURE 2.2 THE HIERARCHY OF SUSTAINABILITY EVALUATION CRITERIA WITH SUSTAINABILITY PERFORMANCE INDICATORS, BASED ON KAMALI & HEWAGE (2015)

In the MCA several steps are taken:

1. MCA conduction for each sustainable dimension
    1.1. MCA for the environmental dimension
        1.1.1. Environmental sustainability performance indicator (SPI) weight determination
            1.1.1.1. Environmental SPI ranking by experts
            1.1.1.2. Environmental SPI comparison against each other in a matrix
            1.1.1.3. Normalization of environmental SPI comparison matrix
            1.1.1.4. Environmental SPI weight determination
        1.1.2. Scoring the measure on the environmental indicators
        1.1.3. Determining the total environmental score for each measure
    1.2. MCA for the economic dimension
        1.2.1. Economic SPI weight determination
            1.2.1.1. Economic SPI ranking by experts
            1.2.1.2. Economic SPI comparison against each other in a matrix
            1.2.1.3. Normalization of economic SPI matrix
            1.2.1.4. Economic SPI weight determination
        1.2.2. Scoring the measure on the economic indicators
        1.2.3. Determining the total economic score for each measure
    1.3. MCA for the social dimension
        1.3.1. Social SPI weight determination
            1.3.1.1. Social SPI ranking by experts
            1.3.1.2. Social SPI comparison against each other in a matrix
            1.3.1.3. Normalization of social SPI matrix
            1.3.1.4. Social SPI weight determination
        1.3.2. Scoring the measure on the social indicators
        1.3.3. Determining the total social score for each measure
2. Total sustainability evaluation
    2.1. Weight determination of each sustainability dimension by experts
    2.2. Total sustainability determination through combination of the sustainable dimensions

Further explanations and used formulas in the MCA are given in Appendix B.2.

2.3 RESEARCH DESIGN FOR SUB-QUESTION 3

Sub-question 3: At what ambitionlevel in the ambitionwebtool do the measures fit and which measures are thus fitting within the different scenarios for Boekhorst?

This question is answered by coupling the measures from sub-question 2 to goals in the ambitionwebtool.

To get an idea of how the ambitionwebtool works, a piece of the ambitionwebtool is shown in Figure 2.3. In the utmost left column goals on sub-themes belonging to each theme are given. These goals transcend each other. The first goal is easy to achieve, but how higher the ambitionlevel, how harder the goals are to achieve. The ambitionwebtool in this research is used as developed at July 5, 2018.

For each scenario is determined which goals have to be achieved. The requirements that must be achieved in each scenario are determined, firstly based on the ambitionwebtool created by answering sub-question 1 and on what seems realistic for Boekhorst. After this assessment, is reviewed with Kokon if these ambitionlevels and goals fit their wishes and ambitions or if changes must be made.

To each goal used in the scenarios, the belonging measures from sub-question 2 are added. These are added in the utmost right column as seen in Figure 2.3. The added measures are the measures that help to achieve the mentioned requirement. Sometimes several measures are mentioned with their MCA score. In that case the developers of Boekhorst can choose which requirements to use.

The measures are coupled to the goals they influence, based on their advantages and disadvantages determined in sub-question 2. When no measures are fitting to a goal in the ambitionwebtool, recommendations for measures to satisfy the goals and thus the ambitions are given.

AMBITIEWEBTOOL 1.0 ○ Gebouw ◐ Gebied RPS

OVERZICHT | ENERGIE | MATERIALEN | KOSTEN | RUIMTE | LEEFOMGEVING | NATUUR/MILIEU | WATER | BODEM

1 | ENERGIE GEBIED

MAATREGELEN	Current ambition level 1,5	Required ambition level 2,0	Aimed ambition level 3,0	max 3 ptn	opmerkingen
Thema introductie					
Energie heeft betrekking op CO2-reductie en toepassing van duurzame alternatieven.					
				↓WEGING ↓	
1.1 Energieverbruik tijdens gebruik	**1,0**	**2,0**	**3,0**	**20**	
Energieverbruik tijdens gebruik	Let op: maar één antwoord mogelijk				
Er is geen berekening gedaan van de CO_2-uitstoot van het ontwerp in de gebruiksfase in een Life Cycle Assessmenttool.	x			1,0	no measures needed
Er is een berekening gedaan van de CO_2-uitstoot van het ontwerp in de gebruiksfase aan de hand van DuboCalc of een vergelijkbare Life Cycle Assessmenttool.. Er wordt een schatting gemaakt van de levensduur en zo de gemiddelde CO2-uitstoot per jaar bepaald.				1,5	
Er is een berekening gedaan van de gemiddelde CO_2-uitstoot/jaar van het ontwerp gemaakt aan de hand van DuboCalc of een vergelijkbare Life Cycle Assessmenttool. Er wordt een reductie gerealiseerd van ten minste 30% per jaar in vergelijking met de referentiesituatie.		x		2,0	2. CO2 emissions calculation with Dubocalc or a comparable program (1.4)
Er is een berekening gedaan van de CO_2-uitstoot/jaar van het ontwerp gemaakt aan de hand van DuboCalc of een vergelijkbare Life Cycle Assessmenttool. Er wordt een reductie gerealiseerd van ten minste 60% per tijdseenheid in vergelijking met de referentiesituatie.				2,5	
Er is een berekening gedaan van de CO_2-uitstoot van het ontwerp gemaakt aan de hand van DuboCalc of een vergelijkbare Life Cycle Assessmenttool. Hieruit moet blijken dat het ontwerp CO_2-neutraal of opwekkend is.			x	3,0	2. CO2 emissions calculation with Dubocalc or a comparable program (1.4)
1.2 Energieverbruik productie & werkproces	**1,0**	**2,0**	**2,5**	**20**	
Productie componenten	Let op: maar één antwoord mogelijk				
Er is geen inventarisatie gemaakt van de CO_2-uitstoot gedurende de productie zoals beschreven in de CO_2-prestatieladder.	x			1,0	no measures needed
Er wordt een inventarisatie gemaakt van de CO_2-uitstoot gedurende de productie zoals beschreven bij de CO_2-prestatieladder en er wordt een reductie van 30% nagestreefd.		x	x	2,0	2. CO2 emissions calculation with Dubocalc or a comparable program (1.4), 3. CO2 emission mapping of maintenance work, work process and waste processing. (1.2)
Er wordt een inventarisatie gemaakt van de CO2-uitstoot gedurende de productie zoals beschreven bij de CO2-prestatieladder en er wordt een reductie van 50% nagestreefd.				3,0	2. CO2 emissions calculation with Dubocalc or a comparable program (1.4), 3. CO2 emission mapping of maintenance work, work process and waste processing. (1.2)
Aanlevering componenten	Let op: maar één antwoord mogelijk				

FIGURE 2.3 A VIEW ON THE AMBITIONWEBTOOL

3 AMBITIONS AND GOALS FOR BOEKHORST

To determine which sustainability themes, require extra focus in this project the ambitions are determined with help of the ambitionweb. By doing this sub-question 1 is answered:

Sub-question 1: What are the ambitions for Boekhorst and what are the preconditions on the different sustainability themes in the ambitionweb?

3.1 AMBITIONS FOR BOEKHORST

The ambitions for Boekhorst are explained on each theme in Table 3.1. This table shows the ambitionlevel on the sustainability themes, as determined in the interview with Kokon, for the scenarios: 1) Current sustainability ambitionlevel, 2) Required sustainability ambitionlevel and 3) Aimed sustainability ambitionlevel. In the column 'What does this mean?' is explained what it means to meet the determined ambitionlevel. In the column motivation is explained why the determined ambitionlevel is chosen.

For the Required ambitionlevel, the municipal vision is also considered. The differences in ambitionlevel of Kokon and the municipality are mentioned in the utmost left column. The highest ambitionlevel is used as normative. In Appendix C. the comparison of the ambitions of Kokon and the municipality is further explained. Here separate ambitionwebs, for Kokon in Figure B.1 and for the municipality in Figure B.2, are shown and compared in Figure B.3.

TABLE 3.1 AMBITIONS FOR BOEKHORST

Theme	Current sustainability ambitionlevel	What does this mean?	Motivation	Aimed ambitionlevel	What does this mean?	Motivation	Required ambitionlevel	What does this mean?	Motivation
Energy	1	Insight into the most important energy flows of the project during its entire lifetime. In any case not worse, preferably small improvement.	Energy is not considered in the current plan.	3	Measurable and verifiable targets with which the most feasible in the field of energy reduction is achieved. Energy neutral and/or energy providing.	Ambitionlevel 3 makes it possible to meet the requirements of Greenlabel. Collaboration with Hooghkamer is possible. Clean energy production should take place as much as possible.	2,5	Insight into the most important energy flows of the project during its entire lifetime. Measurable verifiable targets for improvement. Relevant energy saving.	According to Kokon the contractors ambitionlevel is not higher than 2. It is not known if plus-on-the-meter building is feasible. However, the municipal ambitionlevel is 2,5, because municipality Teylingen has the vision to use "Duurzaam bouwen ++" (in English "sustainable building ++") in new build projects. They also want to stimulate geothermic energy and WKO (hot/cold transmission) by use of the deep underground.

Materials	1	Insight into the most important materials flows and types.	Materials are not considered in the current plan.	3	Goals to achieve "most feasible" on sustainable material use.	The ambition is to receive a greenlabel score of A+. Greenlabel pays a lot of attention to materials.	2	Measurable and verifiable targets for sustainable material use. Relevant improvement.	Kokon mentioned the ambition on materials is dependent on municipal requirements, which are still unknown. Demountable building is not possible according to Kokon. They mention that the developers ambition is larger than the municipal ambition. There should at least be label A+ according to Kokon. Opposite to Kokon municipality Teylingen wants demountable building for Boekhorst. They both strive for ambitionlevel 2 on materials.
Investments	1	Cost savings in the long term. Insight into life cycle costs (LCC), attention to management and conscious design. Compared to the reference situation, the LCC and maintenance costs are slightly lower.	Investments are not considered in the current plan. There is not a budget yet. There is nothing done with a payback period. The management is done by municipality. They look at cost-saving.	2,5	The client explicitly weighs long-term costs instead of only on investment costs. Insight into the economic aspects in the long term. Investments should be balanced with social-economic benefits.	According to Kokon, the municipality wants the investments balanced with the benefits on nature, ecological, social and economic aspects.	2	The client explicitly weighs long-term costs (LCC) instead of only on investment costs. Insight into the economic aspects in the long term.	Kokon mentioned that the municipality wants the investments balanced with the benefits on nature, ecological, social and economic aspects. This is not important for them yet. Ambitionlevel 2 is given. The municipalities ambition on investments is 1, since the municipality wants investments to be as low as possible and investments and future cost management are not included in their vision. They only mention that investments take place in main shopping areas to attract people and that shops should not be located in Boekhorst, but in the centre of Voorhout.

Space	2	Insight into the effects on the use of space (land take) Insight into the effects on the spatial quality and environment (impairment of cultural historical value). Establish objectives that limit the negative effects on the use of space and quality as much as possible. Robust and future-proof design. Opportunities in the environment are identified. Changes in the environment are identified.	Flexible use of space is included. Development trajectory is still changeable. The new estate can be build up in parts when financing is less. Good road access to other cities. Targeting cycling within Voorhout. No waste of space, so that green can be given back. There is an ecological zone where possible. Changes can still be made based on sustainable measures. Soil raising is planned to take place, but this could be prevented.	3	Project is reasonably possible without negative effects on space and any negative effects are (fully) compensated or improved Project considers the environment around the project area. Opportunities in the environment are used.	An ecological zone is implemented and a green walking park can be implemented. Possibilities for fast access to other cities are provided. Cycling and walking in Boekhorst and Voorhout are stimulated. Only soil raising is planned to happen and should be prevented for ambitionlevel 3.	2	Insight into the effects on the use of space (land take) Insight into the effects on the spatial quality and environment (impairment of cultural historical value). Establish objectives that limit the negative effects on the use of space and quality as much as possible. Robust and future-proof design. Opportunities in the environment are identified. Changes in the environment are identified.	Kokon assigned ambitionlevel 2 for space. There will be an ecological zone, a green walking park and good access to other cities is provided. Cycling and walking in Boekhorst and Voorhout are stimulated. Only soil raising should be prevented. The municipality wants recreation close to home. Urban area's and outer areas need to be separated. Agricultural scale expansion and widening are facilitated in zoning plans. In doing so, explicit attention is paid to maintaining and strengthening landscape and environmental qualities. This makes that space has ambitionlevel 2 according to the municipality as well.

Living environment	2	Insight into the most important effects from project on people and environment (health, safety, nuisance, visual aspects social). Measurable and verifiable objectives to minimize and, where possible, improve negative effects on people and the living environment. Relevant improvement and opportunities for added value.	Car traffic is limited. Social cohesion is stimulated in smaller neighbourhoods. Community formation is stimulated. Opportunities for work-living possibilities still have to be assessed, but distances from supermarkets are alright. Building low is hard because of the water, that is why levelling up is needed.	3	Circuits closed, negative effects on nature fully compensated. Objectives with which most achievable in this area is achieved.	Car traffic is limited. Social cohesion is stimulated in neighbourhoods. Community formation is stimulated. Opportunities for work-living possibilities still have to be checked, but distances from supermarkets are alright. Building low is hard, that is why levelling up is needed.	2,5	Circuits closed, negative effects on nature fully compensated. Objectives with which most achievable in this area is achieved.	Kokon has ambitionlevel 2,5 on living environment, because car traffic is limited. Social cohesion is stimulated in neighbourhoods. Community formation is stimulated. Opportunities for work-living possibilities still have to be checked, but distances from supermarkets are alright. Building low is hard, that is why levelling up is needed. There might be a possibility to build below water ambitionlevel. Stimulation of diversity needs to take place. The municipalities ambitionlevel on living environment is 2. The attention goes to improvement of the touristic recreational infrastructure and to make it sustainable. They want to facilitate good sport facilities, by firstly improving the existing ones and expand when they are not satisfying enough. They want to stimulate small recreation areas. New buildings are possible if the spatial quality and other specific values on site are maintained, improved or compensated.
Nature and Ecology	2,5	Closed cycles, negative effects on nature fully compensated. Objectives with which practically the	There is a sound barrier/contour around the road and an ecological zone is created. The specifics about the	3	Circuits closed, negative effects on nature fully compensated. Objectives with which most achievable in	All the effects on nature should be compensated and biodiversity is stimulated in the ecological	3	Circuits closed, negative effects on nature fully compensated. Objectives with which most achievable in	Kokon mentions ambitionlevel 3 as the required ambitionlevel, because all the effects on nature should be compensated and biodiversity is stimulated in the ecological zone. Emissions should be as low as possible.

		most achievable in this area is achieved.	ecological zone are unknown		this area is achieved.	zone. Emissions should be as low as possible.		this area is achieved.	The municipalities ambitionlevel on this theme is 1,5. They want to preserve nature and maintain the current biodiversity. Nature should be coupled to the surroundings. Flowery roadsides are considered and small-scale natural values, like parks are stimulated in the urban area.
Soil and Water	1,5	Maintaining effects on soil quality (preventing soil pollution) and the soil system. Prevent soil and water pollution as much as possible and to maintain the soil structure, clean up contamination and implement climate adaptation.	Storage capacity already included. The plan is said to limit the contamination, but this is not done yet. Water carries the current plan.	3	Cycles are closed, project is executed without (if possible) negative consequences on soil and water, otherwise negative effects are fully compensated. There is even improvement where possible. Objective measurably and verifiably determined with which most feasible in the field of soil is achieved.	Water carries the current plan. Water can be stored. There should not be negative effects on water. Soil should be clean.	2	Effects on soil quality (preventing soil contamination) and maintaining the soil system. Verifiable targets to prevent soil and water pollution as much as possible and to maintain the soil structure, clean up contamination and implement climate adaptation.	Kokon's ambitionlevel on soil and water is 2. Contamination should be limited and water can be stored according to Kokon. The municipal ambitionlevel on soil and water is 1,5. According to the municipality water storage is not needed, because it is arranged elsewhere. Hardening is compensated with water storage and contributions to a sustainable water system should take place.

Mobility	2	Cycling and walking are encouraged. Good connection to public transport and car sharing options. Encourage electric driving.	Car use in the area is limited. Walking and cycling are stimulated. The station is very accessible.	3	Stimulation of sustainable development and innovation within mobility. Mobility is combined with other aspects, such as energy. Integration of mobility is involved in the big picture (electric car charging by infrastructure)	Car use in the area is limited. Walking and cycling are stimulated. The station is very accessible. Car sharing should be assessed. Possibilities for electric driving and car sharing have to be examined.	2.5	Stimulation of sustainable development and innovation within mobility. Mobility is combined with other aspects, such as energy.	Kokon wants to stimulate electric care use in the area and stimulate walking and cycling. The station is very accessible. Possibilities for electric driving and car sharing have to be examined. They mention that the required ambitionlevel on mobility should be 2.5. The municipality has ambitionlevel 2 on mobility. They want improved and reliable accessibility, greater liveability and higher road safety, especially through better flow-through for the car, bicycle and bus. They strive to double the use of public transport and realise enough bike parking at stations and bus stops. Optimal safe and fast bike routes between centres in the municipality have to be provided. Enough unpaid parking areas should be available. Electric cars and sailing are stimulated.

3.2 INITIAL DEVELOPMENT GOALS FOR BOEKHORST

Based on the minimum ambitionlevel on the sustainability themes as the guideline for this project, the ambitions for Boekhorst are summarized in goals as formulated below:

Energy: Clean energy production must take place to make the neighbourhood energy-neutral.

Materials: Greenlabel must at least be A+

Soil and water: Contamination has to be limited, flooding is prevented.

Nature and Ecology: Negative effects on nature are compensated and emissions have to be as low as possible.

Space: Green walking space has to be added. Cycling and walking are stimulated by offering save cycling paths and sidewalks

Living environment: Community formation is stimulated. Opportunities for a work-living environment should be used.

Investments: Investments have to be balanced with the benefits on nature, ecological, social and economic aspects.

Mobility: Emissions are limited by restriction of car use and stimulation of cycling and walking in Voorhout.

3.2.1 NEEDED IMPROVEMENT

The ambitionlevels as described in Table 3.1 are visualized in Figure 3.1. Here, the ambitionlevel on each theme for the scenarios 1) current sustainability ambitionlevel, 2) the required ambitionlevel and 3) the aimed ambitionlevel is shown. It becomes clear that all the themes are very important, but investments is less important than the other themes, since its aimed ambitionlevel is 2,5 instead of 3. On the theme nature and ecology, the maximum sustainable goals are to be reached. This theme has ambitionlevel 3 on the required and aimed ambitionlevel. After nature and ecology, living environment, mobility and energy are the most important with a required ambitionlevel of 2,5 and then come materials, space, soil and water and investments on ambitionlevel 2.

For the required ambitionlevel the highest ambition level of the comparison of Kokon and municipality is used. The separate ambitionswebs of Kokon and municipality are shown in Appendix C.

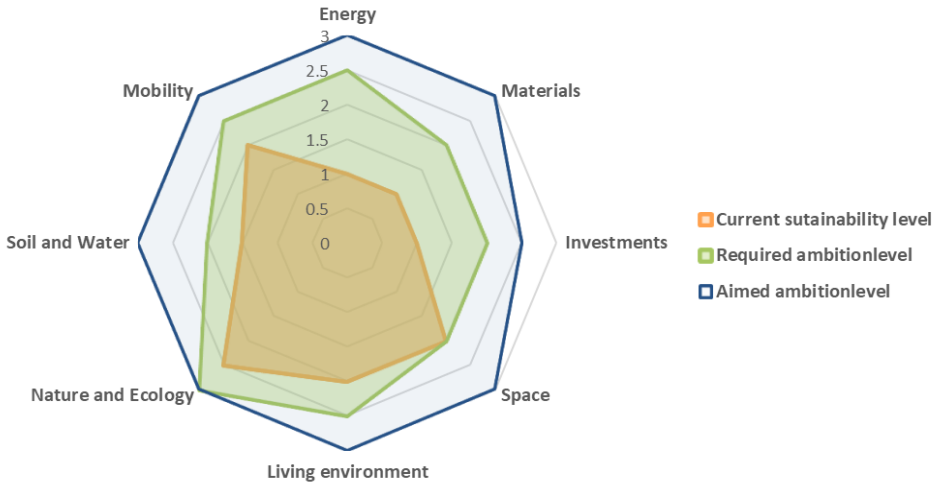

FIGURE 3.1 AMBITIONWEB FOR BOEKHORST

Based on these ambitionlevels, the needed improvement to reach the required ambition and aimed ambitions is shown in Table 3.2.

TABLE 3.2 NEEDED AMBITION LEVEL IMPROVEMENT

Theme	Current sustainability level	Required ambitionlevel	Required ambitionlevel improvement	Aimed ambitionlevel	Aimed ambitionlevel improvement
Energy	1	2,5	1,5	3	2
Materials	1	2	1	3	2
Investments	1	2	1	2,5	1,5
Space	2	2	0	3	1
Living environment	2	2,5	0,5	3	1
Nature and ecology	2,5	3	0,5	3	0,5
Soil and water	1,5	2	0.5	3	1,5
Mobility	2	2,5	0,5	3	1

With the needed ambitionlevel improvement in Table 3.2 a priority ranking on which themes to focus on can be made. This is done by first looking at the required ambitionlevel improvement.

By looking at the aimed ambitionlevel improvement in combination with the first priority as described in the methodology, the priority of the themes is:

1. Energy
2. Materials
3. Investments
4. Space
5. Soil and water
6. Living environment and Mobility
7. Nature and ecology

This ranking shows that energy needs the most improvement to reach the ambitions and nature and ecology needs the least improvement.

4 SUSTAINABLE MEASURES FOR BOEKHORST

In this chapter sustainable measures are found and assessed to answer sub-question 2:

Sub-question 2: What are achievable sustainable measures that can be implemented in the new housing estate?

4.1 MEASURE INVENTORY AND ASSESSMENT

The measures considered in this research are shown in Table 4.2. Measures that seemed not feasible where not considered. This where electricity storage in a battery and hydrogen usage instead of gas. Two interviewees mentioned that a neighbourhood battery is way too costly, and one of them also mentioned that it is even damaging for the environment when produced. For hydrogen as replacement of gas was mentioned that this should happen on large scale. At the moment it still too far in the initial phase, which means there is too little knowledge, too much inefficiency and it is too costly.

The measures that are assessed are sorted based on their MCA score in Table 4.2. The conduction of the MCA score can be seen in Appendix E. The MCA score is to be interpreted as in Table 4.1.

TABLE 4.1 MCA SCORE INTERPRETATION

Measure total sustainability score	Interpretation
2 ≤ sustainability score ≤ 3	Very advantageous, these measures should be implemented
1 ≤ sustainability score < 2	Expected to be advantageous, however effects of these measures should be reconsidered.
0 ≤ sustainability score < 1	Possibly advantageous, however the effects of these measures are very unsure and further feasibility studies must be done.
-3 ≤ sustainability score < 0	Disadvantageous, these measures are not expected to be feasible and are not further considered.

TABLE 4.2 MEASURES SORTED ON MCA SCORE

Number	Measure	MCA Score	Advantage	Disadvantage	Source
37	Green gardens without (much) pavement	2	• Easy drainage possible • Cheap construction and maintenance • Stimulate biodiversity	• Maintenance needed • Unstable garden furniture	• Operatie Steenbreek (2018) • Woonderij Eos (2018)
86	Daylight accessible	2	• Feeling of comfort • Less energy needed	• Limits design options and placings	• RPS (2018)
23	Life cycle analysis (LCA)	1,9	• Helps planning • Effects of change in strategy can be shown	• LCA is not always right. Materials may not reach a next stage of life	• RPS (2018) • LaMarco (2018)
24	Waste management plan	1,9	• Known who is responsible	• Time consuming • Sustainable	• Rebri (2018) • RPS (2018)

			• Clear targets for recyclable materials • Easy progress check possible • Known where products go when demolished	waste management may develop over time	
33	Verge cuttings recycling	1,8	• Betters the soil • Can be fed to animals • Cheap reusable options	• Still being researched	• Rijkswaterstaat (2018) • Spijker et al. (2013)
44	Environmental Impact Assessment (EIA) with water and soil as subject of protection	1,8	• Impact on water and soil known • Opportunity to change project and limit risks	• Limited effects known: not the whole picture is considered • Links are not always known	• Huber (2012) • International Institude for Environment and Development (2018)
45	Green area prioritization in urban planning	1,8	• Stimulate biodiversity • Feeling of comfort	• Not enough available space for other needs	• Huber (2012)
97	Adequate and uniform lighting conditions	1,7	• Visibility on pathways • Immediately adjacent spaces • Less biodiversity disturbance	• Planning needed	• International well building institute (2017)
26	New objects made from cut down trees	1,6	• No waste of valued trees	• Skills needed nearby	• Greenlabel(2018)
15	Smart Grid	1,5	• Optimal energy use • Accurately monitoring and managing of energy use by checking smart-meters • Real-time pricing possible • Improving production and distribution of clean energy by sending back to the grid	• Privacy and security risk by providing real-time data	• U.S. Department of Energy (2013) • Wichmann (2014)
16	Domotica systems	1,5	• Automatic energy saving • Only needed energy use	• Danger of hacking	• One Smart Control (2018) • QwikSense (2018)

			• Insight in energy use		
20	Materials passport	1,5	• Insight in the life cycle and total worth of materials • planning for reuse	• Time consuming	• Madaster (2017) • Voorn (2018)
21	Material loss chart of production	1,5	• Insight in material loss and costs and benefits	• Time consuming • May change over time	• RPS (2018)
30	Roadway of reinforced grass or water-permeable paving (half open paving)	1,5	• Facilitate water infiltration • Cheap construction and maintenance • Easy maintenance • Green appearance	• More maintenance needed • More risk of damage by heavy transport • People with walking sticks, heels, strollers and wheelchairs can get stuck	• Van der Burg (2018) • De Vree (2018) • NL Greenlabel (2018)
35	Water impact assessment	1,5	• Opportunity to learn from previous experience • Long-term effects known	• Limited effects known: not the whole picture is considered • Links are not always known	• Huber (2012) • International Institude for Environment and Development (2018)
54	Adoption green	1,5	• Responsible residents • Stimulate health	• Prevent lacking maintenance	• RPS (2018)
91	Communal gardens for food production	1,5	• Stimulate healthy nutrition • Educate residents about food production • Provide social contact	• Space needed	• International well building institute (2017)
2	CO2 emissions calculation with Dubocalc	1,4	• Environmental Cost Indicator Value (MKI value) known	• Insight in processes needed • Time consuming and thus costly	• RPS (2018)
8	Windows on the south side of buildings with trees in front of them	1,4	• Sun during winter, so that less heating is needed.	• Warmer during summer. A solution for this are trees that lose their leaves during winter	• Vereniging Aardehuis (2018) • Blavier (2015)
71	Flexible building	1,4	• Question-based adaption possible • Future proof design	• Different scenarios need to be considered	• Rijkswaterstaat (2018) • Kokon (2018(

			• No waste of space • Less costs during usage phase	• Waste management needed	
34	Water resource investigation (with a water-resource evaluation matrix)	1,4	• Insight in the effects of urban planning on water • Possibility of plan changing	• Time consuming • Data needs to be available	• Schneider, Rickert & Spieker (1973)
51	Management scheme for the maintaining of the diversity of urban nature	1,4	• Maintaining and stimulation of biodiversity and nature • Responsibility known	• Time consuming	• Niemelä (1999)
70	Design based on the environment	1,4	• Opportunities for shared energy and other sustainable options are used • Residential area fits and uses the climate • Feeling of comfort	• Area knowledge needed • Collaboration with many stakeholders	• Rijkswaterstaat (2018) • Giovagnorio & Chiri (2016)
74	Small private garden, large community garden	1,4	• Less garden space needed per person • Large garden provides comfort • Less maintenance • Less trips taken • Guaranteed water infiltration possible with unpaved parts	• Less privacy • Organization needed • Dependent neighbours on maintenance • Vandalism needs to be prevented	• Van der Burg (2018) • De Kersentuin (2018) • Nancy (2013) • MuConsult (2000)
75	Flexible building (for example demountable)	1,4	• Less waste and maintenance • Fits municipal vision • Easy construction • Reusable • Construction costs are estimated more accurate • Possible to eliminate air gaps, so less heating and cooling is needed • Quality is easier achieved, by tools available in production site • Easy adding or removing of	• Not necessarily cheaper than conventional construction • Transport and position placing can be difficult • Limits specific design options • Time and planning needed to consider different options	• Van der Burg (2018) • Gemeente Teylingen (2018) • Boyne (2014) • Rijkswaterstaat (2018) • Van der Burg (2018)

			building parts, so that space can be optimally used • Future-proof design • Less costs during usage phase		
84	Heat and cold warning mechanism and strategy plan to react	1,4	• React to weather and prepare • Facilitate health provision	• Mechanism needed	• International well building institute (2017)
85	Different function options in the environment	1,4	• Future-proof design • Less costs during usage phase	• Limits specific design options • Time and planning needed to consider different options	• Rijkswaterstaat (2018) • Van der Burg (2018)
74	Small private garden, large community garden	1,4	• Less garden space needed per person • Privacy available	• Less comfort	• Less garden space needed per person
4	Efficient use of building tools/construction machines: switch them of when they are not needed	1,3	• Cost efficient • Minimize damaging emissions	• Planning time	• McClung-Logan (2015)
38	Existing water enlargement	1,3	• Prevention of flooding by water storage • Water recreation possible: relaxation	• Space occupied by water • Operation costs	• Gemeente Teylingen (2018)
41	Water extraction area to capture clean rain water from roofs, Street water is guided away from the extraction area to wade's to infiltrate in the soil	1,3	• Optimal use of water • Prevent sewerage nuisance • Possibility to use rain water in homes (for example toilet flushing)	• More feasible if cleaning works are nearby	• Eva-Lanxmeer (2018)
42	Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc,	1,3	• Aesthetic green • High efficiency • Clean water	• Space needed (3 à 4 cubic meter per person)	• Wetlantec (2018) • Vereniging Aardehuis (2018) • Kilian Water (2018) • Eva-Lanxmeer (2018)
90	Virtual meeting place to organise activities in neighbourhood and	1,3	• Stimulate social cohesion • Very cheap	• Risk it is not used	• De Kersentuin (2018)

	community house (internet and app)				
93	Pet-friendly environment	1,3	• Stimulates pet ownership. • Pet ownership has a positive influence on mental and emotional well-being • Stimulate physical activity	• Space needed	• International well building institute (2017)
1	Feasibility study into renewable energy	1,2	• Insight in options, benefits and drawbacks of renewable energy sources	• Time consuming	• RPS (2018)
3	CO2 emission mapping of maintenance work, work process and waste processing,	1,2	• Insight into emissions and processes	• Insight in processes needed • Time consuming and thus costly	• RPS (2018)
17	Led lighting/ lights with integrated solar panels and battery	1,2	• Energy efficient • Long life-time	• Colour limitations • Sensible to temperature	• Greenlabel (2018)
28	Shared sheds containing shared tools that people need occasionally	1,2	• Optimal use of space • Less objects produced • More usage of objects and less waste • Cost saving	• Walking to the shed, possibly through rain	• Van der Burg (2018) • Vereniging de Buitenkans (2018)
47	Demolition practice plan	1,2	• Prevent contaminated soil • Relatively easy demolition, because of material knowledge and planning	• Upfront time investment needed • Plan should be updated, during usage phase, when new options arise	• Environmental Protection Agency (2011)
65	Streetscape greenery	1,2	• Aesthetically appealing • Stimulate health • Stimulate biodiversity	• Maintenance needed	• International well building institute (2017)
100	LCC for the planning, construction, usage and demolition phase,	1,2	• Costs and benefits during life time are known • Benefits during life time can be very different than in construction	• Estimations can be wrong • Assumptions are made	• Rijkswaterstaat (2018) • Aaron (2014)

6	Prioritization of walking and cycling in the design instead of car usage	1,1	• Stimulate health by motivating physical activity • Reduce car emissions	• Longer travel time by car	• International well building institute (2017)
18	Multipurpose charging stations with led lighting	1,1	• Multifunctional use of sustainable resources • Low amount of energy loss	• Space needed	• Greenlabel(2018)
22	Material origin substantiation	1,1	• Insight in material loss, costs and benefits • Production costs known, transportation costs known	• Time consuming • May lead to choice in easy trackable materials that are not the most sustainable	• RPS (2018)
31	Narrow walking strip in baked bricks	1,1	• Facilitate water infiltration • Use of raw material, no toxic substances • Short transport • Reusable • Warm appearance	• Depending on the size it can be hard for strollers to pass	• NL Greenlabel (2018) • De Jong (2018
43	Water storage for rain water to use in black (toilet) water systems	1,1	• Optimal use of water • Prevent water flooding	• Water storage needed	• De Hobbitstee (2018)
64	Hedge with various native species	1,1	• Stimulate biodiversity • Green comfortable appearance	• Maintenance needed	• NL Greenlabel (2018)
81	Sharing bikes	1,1	• Stimulate health by motivating physical activity • Reduce car emissions	• Enough bikes needed to meet question in peak hours • Planning needed for usage • Maintenance needed	• International well building institute (2017)
104	Room for co-creation with inhabitants	1,1	• Stakeholder involvement causes a higher rate of approval • Reduced development costs • Continuous improvement • Lots of ideas to distract from	• Choice and distinction in contradictory ideas must be made	• O'Hern & Rindfleisch (2008) • RPS (2018)

5	fuel/energy-efficient construction and machinery	1	• Cost efficient • Minimize damaging emissions	• Machinery needs to be available nearby	• McClung-Logan (2015) • Younis & Fahmy (2018)
9	Asphalt heat	1	• Heat from homes saves energy • Less energy needed • Less road maintenance needed, through road heating during winter and cooling during summer. • Earned back in +/-10years	• Investment costs	• Agentschap NL (2010) • RVO (2017)
25	Circular building materials	1	• No waste generation • Optimal use of materials • Less emissions	• Extended material analysis needed	• Van der Burg (2018) • Hellinga (2018)
36	Groundwater level analyzation	1	• Knowledge for options to use groundwater • Insight in building risks	• Right instruments needed	• RPS (2018)
40	Separate sewer for grey and black water	1	• Prevent sewer overload	• Underground space needed • Costs	• RPS (2018)
46	Reduction areas for soil consumption (soil sealing)	1	• Optimal distribution of space possible	• Crowded housing space • Change needed based on population density	• Huber (2012)
55	Garden layout support for residents	1	• Provide water infiltration • Stimulate health • Happy residents • Aesthetically appealing	• Time consuming • Conflicting interests in design	• RPS (2018)
57	Waste bins integrated in the design to reduce waste damage	1	• Reduce waste • Keep the are clean and comfortable	• Aesthetic design needed	• RPS (2018)
61	Green and blue dry and wet spots realization	1	• Diverse nature • Provide recreation	• Space needed	• NL Greenlabel (2018) • De Kersentuin (2018)
62	Reed edge in water	1	• Stimulate biodiversity • Reduce CO2 • Work as	• Slowly flowing water may attracts mosquitoes • Slow flowing	• Rijkswaterstaat (2018) • Duel (1990)

			helophyte filter and clean water	water may smell • Obstacles for boat traffic, thus reduce of recreation	
63	Pond for water capture with open space to relax	1	• Create relaxation • Create recreation • Biodiversity stimulation	• Investment costs • Place needed	• Eva-Lanxmeer (2018) • Boogaard, Jeurink & Gels (2006)
66	Nature-friendly banks	1	• Open character • Long grasses • Water depths		• RPS (2018)
69	Flora and fauna in relation to target species	1	• Stimulate biodiversity	• Limited choice in flora and fauna	• RPS (2018)
82	Aesthetic signs for easy way finding and to stimulate waking	1	• Easy wayfinding • Stimulate walking and thus health • Inform and stimulate available facilities	• Aesthetically appealing signs needed	• International well building institute (2017)
83	Background noise map	1	• Insight into sound levels and thus comfort	• Time consuming • Noise can change over time • Hard to estimate based on surroundings	• RPS (2018) • Kaliski & Cowan (2007)
101	Measures for which subsidy is given	1	• Less costs for sustainability	• Subsidy application must be done on time	• Gaasbeek (2018) • Gemeente Teylingen (2014)
14	Sun-/PV-panels	0,9	• Sun is always available; It's a renewable energy source • Electricity bills are reduced • Can be used for electricity and heating • Low maintenance costs	• Higher investment costs • Weather dependent • Energy storage is expensive • Enough space needed to place the panels • Toxics material used in production and transportation of solar panels	• Van der Burg (2018) • GreenMatch (2014)
53	Compost plants	0,9	• No transportation costs of waste • Clean the soil • Prevent erosion • Degrade chemicals	• Effort required • Only works with good weather	• NL Greenlabel (2018) • RPS (2018) • Dray (2017)

56	Maintenance plan to promote ecological quality	0,9	• Aesthetically greenery • Stimulate health	• Cost	• RPS (2018)
60	Greenery diversity with native trees, shrubs, perennials and seeds	0,9	• Stimulate economy • Stimulate biodiversity • Low transportation emissions	• Limited plant choice	• NL Greenlabel (2018)
52	Noise nuisance prevention	0,9	• Prevent animals from fleeing • Comfort for residents	• Planning and controlling costs time	• Chesire West and Chester (2018)
77	Fast cycling lanes to promote cycling to the centre of Voorhout	0,9	• Stimulate health by motivating physical activity • Reduce car emissions	• Dependent on surrounding space	• International well building institute (2017)
29	Smart led lighting to show half hardened parking spots	0,8	• Visible where to park in the dark • Optimal use of lighting • Feeling of safety and comfort	• Energy connection needed	• NL Greenlabel (2018)
48	Quickscan: Inventory the current flora & fauna	0,8	• Insights on current flora and fauna • Change possible to estimate	• Time needed	• RPS (2018)
59	Plant species that increase biodiversity and better the living environment	0,8	• Stimulate biodiversity • Comfortable living	• Maintenance needed	• RPS (2018) • NL Greenlabel (2018)
67	Free migration stimulation	0,8	• Lifting barriers • Connection zones inside and outside the area	• Space needed	• RPS (2018)
68	Bee strips	0,8	• Stimulate biodiversity	• Limited choice in flora and fauna	• RPS (2018)
87	Suitable trails for rollators, wheelchairs and mobility scooters	0,8	• Stimulate equity	• Investment costs needed • More paving needed and thus less water infiltration	• RPS (2018)
92	Activity spaces	0,8	• Stimulate physical activity and thus health • Provide a meeting place	• Space needed	• International well building institute (2017)

102	Budget to prevent harm on area interests	0,8	• Insight in where money goes • Plan ahead • Less financial worries	• Unexpected surprises are hard to consider • Might under- or overcompensate • Time needed to create budgets	• Rijkswaterstaat (2018) • Simond (2018)
32	Mineral Olivine to absorb CO2	0,7	• CO2 extraction from the air • Possibility to buy CO2 cleaning certificate	• Waste generation • Debatable effect	• NL Greenlabel (2018) • Greensand (2018)
50	Agricultural backgrounds with natural values inventory	0,7	• Changes and risks known	• Information needed	• RPS (2018)
58	Variation in landscape	0,7	• Stimulation of biodiversity • Interesting landscape attracts recreation	• Needs to be aesthetically appealing for comfort	• Rijkswaterstaat (2018)
78	Bicycle parking spots	0,7	• Stimulate health by motivating physical activity • Reduce car emissions	• Space needed	• International well building institute (2017)
94	Outdoor playing and sport places	0,7	• Stimulate health by exercising • Stimulate social cohesion	• Space needed	• International well building institute (2017)
95	Sound barrier around road	0,7	• Comfort for Residents • Natural materials used	• Rising construction costs	• Jense (2018)
103	Educational value through visible sustainable measures	0,7	• Involvement of local residents • Insight in the importance and possibilities of sustainable design	• Measures need to be aesthetically appealing or made fit into the environment • Residents should not be disturbed (but inspired)	• RPS (2018) • Oomen, Van der Linden, Van Haalen & Hulsen (2011)
10	Riothermic energy: extract heat from waste water in the sewerage system	0,6	• Renewable infinite energy source • Earned back in +/- 15 years • High efficiency • Subsidy possible • Lower water temperature in	• Technical space with heat pump needed • 30-meter riothermic tube needed • Still in pilot phase in the Netherlands	• Marsaki (2018) • Stowa (2018 • Boswinkel, Palsma & Sukkar (2018) • DTI (2018) • Straver (2016) • Wielders & Scholten (2016)

			sewerage system is better for the pipes	• 0,5 million euro construction costs	
19	Smart Energy Floor	0,6	• Energy from movement and sun energy • Fitting in play garden • Interactive	• Cost • Maintenance needed	• Veranu (2018)
49	Ecological target type determined	0,6	• Targeted design possible		• RPS (2018)
72	Reduced parking norm	0,6	• More usable space • Less cars, thus less damaging trips • Possible in combinations with sharing cars	• Increase of construction costs with 10% • Overcrowded parking's in Voorhout • Legislation for parking norms must be met	• Van der Burg (2018) • Anderson, Braun Thörn, Gomér & Mandell (2015)
79	Access to public transport	0,6	• Stimulate walking to and from public transport, and thus health • Reduce damaging emissions	• Communication with transport company needed: administrative and time costs	• International well building institute (2017)
96	Public toilet available, possibly in community Centre	0,6	• Stimulate biodiversity	• Limited choice in flora and fauna	• RPS (2018)
99	Long term budget and look at the long-term investments	0,6	• Costs and benefits during life time are known • Benefits during life time can be very different than in construction	• Estimations can be wrong • Assumptions are made	• Gaasbeek (2018) • Aaron (2014)
7	Pipe length reduction of heating and ventilation systems	0,5	• Reduce energy loss • Reduce material needed	• Costs for movement of obstacles	• Kennis Centrum Duurzaam bouwen (2018)
11	Surface water heating	0,5	• Clean heating • ‘Warm’ water always available • Works with low water temperature • Financial valuable with more than 50 buildings and very valuable with more than 100 building • Colder water:	• Limited by low temperature • Requirements water pump to prevent freezing • Filters needed to prevent waist in the pumps • Maintenance needed • Risk for ecology impact	• Van der Burg (2018) • Kodi (2018) • Kleiwegt, van Opstall & Budding (2017) • Deltares (2011) • de Ruijter (2012)

			•Less algae blooms, which causes more oxygen in the water and thus better ecological circumstances.	• Earned back in 25-30 year • Investment costs: +/- 250 EUR/KWth	
73	(Electric) Car sharing (in collaboration with companies)	0,5	• Efficient car use • Less parking space needed • Avoid second cars for households • Cars can be electric, at least fuel-efficient	• Enough cars needed to meet question in peak hours • Electric cars need loading time • It may stimulate car use for people that normally do not drive • Less costs for insurance, depreciation and maintenance • Planning needed for usage	• Van der Burg (2018) • De Kersentuin (2018) • Profita (2015)
76	Safe intersections	0,5	• Less usage of space • Feeling of comfort • Predictable road usage • Prevent unintended road use	• Investment costs • Safety check consumes time • Regulations	• Rijkswaterstaat (2018) • Wegman(1998)
88	Community gardens	0,5	• Less garden space needed per person • Large garden provides comfort • Less maintenance • Less trips taken • Guaranteed water infiltration possible with unpaved parts	• Less privacy • Organization needed • Dependent neighbours on maintenance • Vandalism needs to be prevented	• Van der Burg (2018) • De Kersentuin (2018) • Nancy (2013) • MuConsult (2000)
89	Community centre as a central meeting place and to organise activities, such as cooking, community eating, tv watching, yoga, drama class, a drink, etc,	0,5	• Social cohesion • Enough room to organise parties or sports • Less heating needed • Less material and stuff needed	• Investment costs • Land take	• Vereniging de Buitenkans (2018) • Van der Burg (2018)
105	Recyclable products	0,5	• Recycling minimizes pollution	• Capital costs • Recycling costs energy	• RPS (2018) • Rinkesh (2018) • Josephson (2018)

			• Reduce extraction of raw materials: conserve natural resources • Less waste • Reduction of energy consumption in processing of raw materials	• Recycled products are not always durable or recyclable	
80	Shared working space	0,4	• Work outside home • Less distractions • Less travelled kilometres • Flexible work option • Social cohesion • Less travel costs	• Distractions available • Competition possible • May close after work hours • Space needed in the neighbourhood	• Van der Burg (2018) • Harris (2017)
12	Geothermal heating	0,3	• Environmental friendly • Geothermal reservoirs are renewable, because they are naturally replenished • Heating and cooling possible • Comfortable heating • Flexible home layout • No costs fluctuations, stable electricity prices (Stable costs: 4.267.656 €/MWth, Production Costs: 0.041 €/kWh th) • Soil offers possibilities in Voorhout • Energy generation: 7.000 MWh /MWe	• High investment costs • Adapted heating for existing homes needed • Risk of soil freckling • Managing of reservoirs needed	• Van der Burg (2018) • Gemeente Rijswijk (2017) • Maehlum (2018) • Wielders & Scholten (2016)
98	Art	0,3	• Stimulate well-being • Provide happiness • Possibly provide education	• Space needed	• International well building institute (2017)

13	Compressed air for underground heat storage	0,1	• Clean heating and cooling • Half the costs of competing battery technologies • More capacity than batteries	• Strong soil needed • High investment costs • Efficiency (after development max 70%)	• Van der Burg (2018) • Patel (2017) • Trouw (2014)

For 104 measures the MCA score, advantages, disadvantages and source are shown. All the measures have a positive score in the MCA. This was to be expected, because all the considered measures are meant to be sustainable. Measures that scored high on several SPIs and sustainable dimensions received the highest score and measures that scored low on one SPI received the lowest score. In Table 4.3. is seen that most measures, 63, have a score that is expected to be advantages, then 39 measures are possibly advantageous and only 2 measures are very advantageous.

TABLE 4.3 DIVISION OF MEASURES PER MCA SCORE

Measure total sustainability score	Interpretation	Number
2 ≤ sustainability score ≤ 3	Very advantageous, these measures should be implemented	2
1 ≤ sustainability score < 2	Expected to be advantageous, however effects of these measures should be reconsidered.	63
0 ≤ sustainability score < 1	Possibly advantageous, however the effects of these measures are very unsure and further feasibility studies must be done.	39
-3 ≤ sustainability score < 0	Disadvantageous, these measures are not expected to be feasible and are not further considered.	0

Green gardens and accessible daylight received a score of 2. This is because green gardens do not only influence the water infiltration, but also the material usage and flora and fauna in a positive way. The only negativity is that maintenance in the garden is needed. Accessible daylight does not have large drawbacks, but it is relatively easy to take into account, it saves electricity and it stimulates well-being and health.

Geothermal heating, art and compressed air for heat storage score 0.3 or lower in the MCA. For geothermal heating and compressed air this is, because there is little known about it and sources were contradictive. Art scored low, because it only influences the well-being of some-people that like the art, but on other aspects it has non or even a negative effect.

Measures for the buildings to combine with the environment are listed in Table 4.2. Measures that are relevant for building design, but irrelevant for the spatial design are listed in Table D.1 in Appendix D. These measures are not further considered during this research, because they are not relevant for the architects of the area. They are given as advice for consideration in the design process of the buildings.

5 AMBITIONWEBTOOL SCENARIOS

This chapter provides the recommended measures coupled to ambitions, to give an answer to sub-question 3:

Sub-question 3: At what ambitionlevel in the ambitionwebtool do the measures fit and which measures are thus fitting within the different scenarios for Boekhorst??

5.1 AMBITION REFLECTION

The ambitions as created chapter 3 are reflected and reconsidered in the ambitionwebtool at the same time with the coupling of the feasible measures from chapter 4. With the use of the ambitionwebtool is examined if the ambitions as determined in chapter 3 are achievable and if it is possible to connect measures to the ambitionlevel.

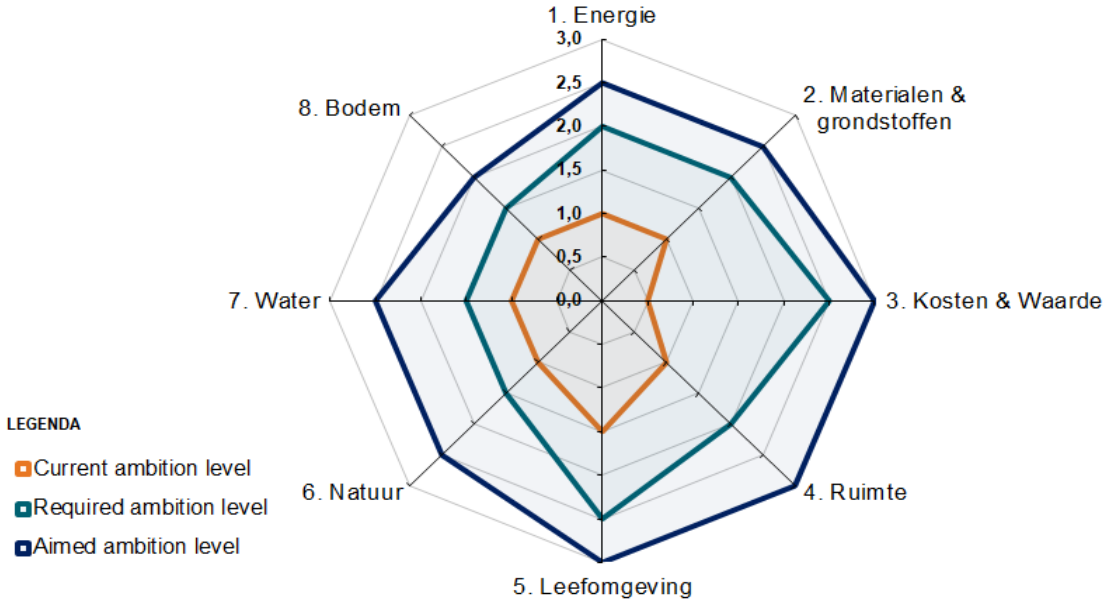

FIGURE 5.1 RESULT OF THE AMBITIONWEBTOOL FOR BOEKHORST

The new version of the ambitionweb for Boekhorst is visualized in Figure 5.1. All the goals per scenario are too extensive too list, but paragraph 5.1.1 discusses each sustainability theme, with the sub-themes to which the requirements belong. The ambitionwebtool shows the themes written in Dutch as can be seen in Figure 5.1. To make the figures from the ambitionwebtool understandable for English readers, the translation of all the themes is given in the 'table of theme translations'. The themes can be looked up based on their number.

5.1.1 AMBITIONS FOR EACH SUSTAINABILITY THEME

All the earlier mentioned themes in the ambitionweb have sub-themes. In the ambitionwebtool the ambition-ambitionlevels for each sub-theme as mentioned are visualized in a theme-ambitionweb. For example, energy is a theme shown in Figure 5.1. The ambitionlevel for energy is determined based on several sub themes shown in Figure 5.2. One sub-theme here is for example 1.1. Energy consumption during use. For all the three scenarios in the ambitionweb is determined which ambitionlevel must met on the sub-themes. With these sub-themes the overall ambitionlevel is determined. Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5, Figure 5.6, Figure 5.7, Figure 5.8 and Figure 5.9 all use the legend from Figure 5.1.

ENERGY

In Figure 5.2, is visible that for scenario 2 all the sub-themes should be focused on evenly. Energy consumption by usage is what is already focused on most, because here the current ambitionlevel is 1,5 instead of 1. This is also what the aimed ambitionlevel scenario focuses on most, together with energy consumption during usage and energy consumption by maintenance. Energy consumption by production and demolition is also important, but this is focussed on less.

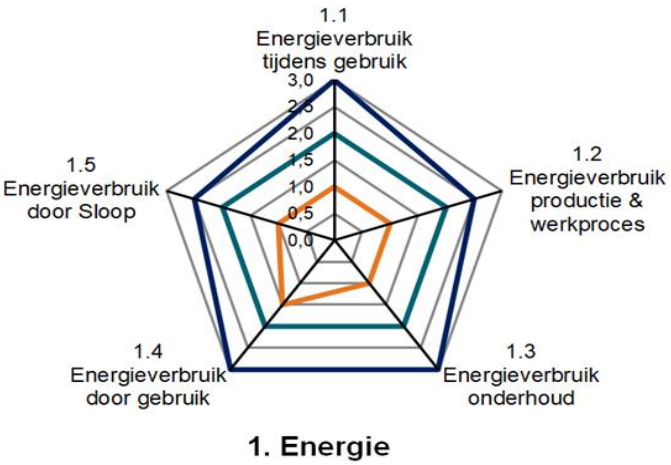

FIGURE 5.2 ENERGY AMBITIONWEB FOR BOEKHORST

FIGURE 5.3 MATERIALS AND RAW MATERIALS AMBITIONWEB FOR BOEKHORST

COSTS AND VALUE

The ambitionweb for costs and value is shown in Figure 5.4. For the theme costs and value, the social value is seen as very important for Boekhorst. The social value must be as high as possible in the required and aimed ambitionlevels, social value must reach ambitionlevel 3. For the future required revenues, the value is 2,5. This means that adaptions are easy to make in the design. Costs are important, so assessment must be made to see where improvements are possible.

MATERIALS AND RAW MATERIALS

The ambitionweb for materials is shown in Figure 5.3. For materials the general design, materials origin and waste by demolition are most important. The amount of material and environmental impact of materials are also important, but a little less than the earlier mentioned sub-themes. Renewable materials are focussed on less for Boekhorst, since the developers of Boekhorst want to work with materials they know and there are less opportunities for renewable materials on the scale of the urban estate.

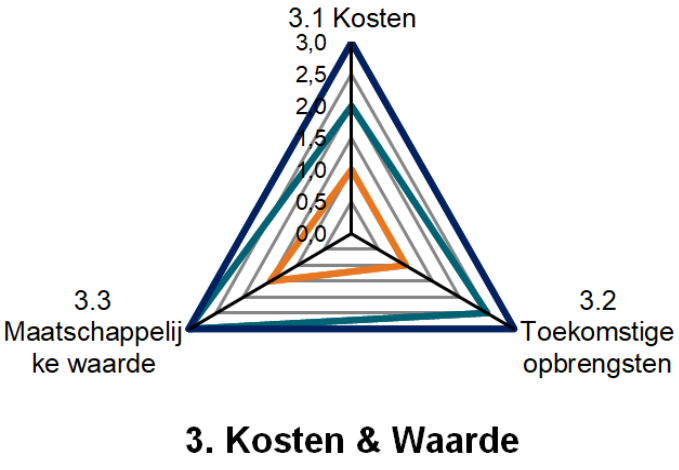

FIGURE 5.4 COSTS AND VALUE AMBITIONWEB FOR BOEKHORST

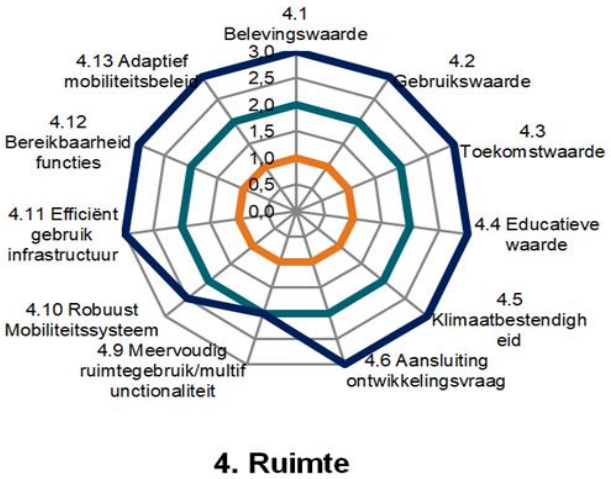

FIGURE 5.5 SPACE AMBITIONWEB FOR BOEKHORST

SPACE

Space is an extensive theme, with a lot of sub-themes. In Figure 5.5 is visible that the required ambitionlevel on all the sub-themes is 2. On most sub-themes the aimed ambitionlevel is 3. However, on multiple use of space / multifunctionality and the robustness of the mobility system the score is lower. The robustness of the mobility system does not have a score of 3, because there is room for new mobility inventions such as shared cars. Inventions like these, provide an uncertainty in the predictability of the mobility system.

LIVING ENVIRONMENT

The sub-themes of living environment have scores that lie very far apart as can be seen in Figure 5.6. Health general does not have a score of 3, because the area becomes less healthy than the current situation. Nuisance during the execution is hard to prevent. For the safety, are already a lot of measures implemented, such as enough lighting, visibility of spaces and traffic safety. Social health is required in ambition scenarios 2 and 3. Social health is stimulated by shared places in the environment and activity spaces. Business climate activity is less important for Boekhorst and not really considered, although the area is possibly made attractive by shared working spaces and recreation possibilities in the environment. The ambitionwebtool focuses on the ability to reach work and this is not something that is focussed on in this project.

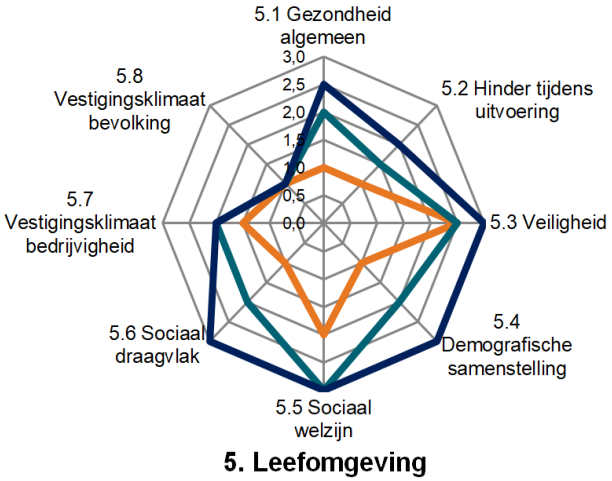

FIGURE 5.6 LIVING ENVIRONMENT AMBITIONWEB FOR BOEKHORST

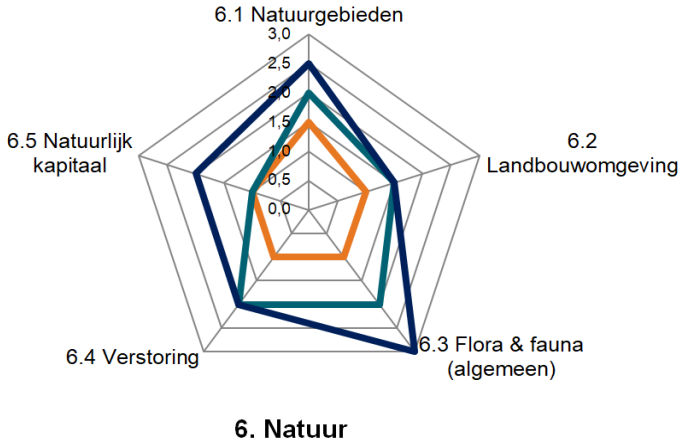

FIGURE 5.7 NATURE AMBITIONWEB FOR BOEKHORST

NATURE

The ambitionwebtool for nature is shown in Figure 5.7. For nature is in the current plan mostly focussed on nature areas. This is seen as important, but since a new build are is build current nature is disturbed and changed. Only compensation and stimulation can take place. Agricultural environment is not really considered in this project, but a score of 1,5 is given because flora and fauna are added for compensation to reduce negative agricultural effects. Total nuisance of nature cannot be totally prevented since it is a residential estate, but nuisance is prevented as much as possible. That is why a score of 2,0 is given in scenario 2 and 3. Flora and fauna (general) has a required score of 2,0 because nature fragmentation is prevented as much as possible and a lot of migration through water can happen. When the right flora and fauna is chosen and connected a score of 3 can be reached.

WATER

The ambitionweb for water is shown in Figure 5.8. For water, the quantity (flooding, safety) is already focussed on, so that ambitionlevel 2,0 is already reached in scenario 1. This is done with the plan to raise the area and with the provided room for water. There are even more possibilities to store water than what is already done. and safety is needed. That is why the required ambition is even higher than the current ambition. Water quality should be focused on more in both scenarios and water quantity against drought and shortages should be considered more as well.

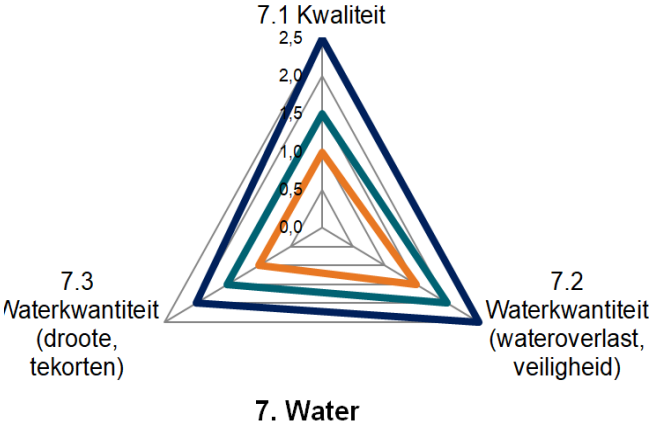

FIGURE 5.8 WATER AMBITIONWEB FOR BOEKHORST

SOIL

The ambitionweb for soil is shown in Figure 5.9. On the theme soil spatial attachment, earthmoving and soil value are already considered, because fragmentation is prevented, soil is raised and natural capital is considered. However, an even higher focus should be on spatial attachment, since the underground space should be used as optimal as possible to give room for WKO systems, cables and pipes. Earthmoving should be considered more as well, so that safety is guaranteed.

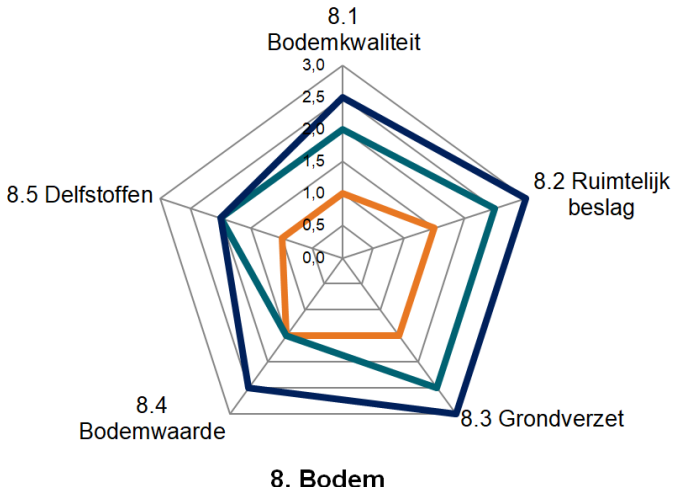

FIGURE 5.9 SOIL AMBITIONWEB FOR BOEKHORST

5.1.2 AMBITION CHANGE FOR EACH SCENARIO

Different ambitions are created based on interview in chapter 1 than with the ambitionwebtool. A comparison with the ambitionweb created in chapter 3, Figure 3.1 , is made with the ambitionweb created in the ambitionwebtool, Figure 5.1.

Scenario 1 current ambitionlevel:

TABLE 5.1 COMPARISON AMBITIONLEVELS INTERVIEW AND AMBITIONWEBTOOL SCENARIO 1

Initial ambitionweb theme	**Energy**	**Materials**	**Investments**	**Space**	**Living environment**	**Nature and ecology**	**Soil and water**		**Mobility**
Ambitionweb theme ambitionweb tool	**Energy**	**Materials and raw materials**	**Cost and value**	**Space**	**Living environment**	**Nature**	**Water**	**Soil**	
Interview score	1	1	1	2	2	2,5	1,5		2
Ambitionwebtool score	1	1	1 (0,5)	1,5	1	1	1	1	-

In the ambitionwebtool is determined which requirements are met already and thus which ambitionlevels are met. Ambitionlevel 1 is the minimum ambitionlevel that must be reached. Lower ambitionlevels cannot be chosen. This means that when ambitionlevel one is not reached in the current design of Boekhorst, the current ambitionlevel is nonetheless placed at ambitionlevel 1. Ambitionlevel 0 is not possible to fill in. In Figure 5.1 the ambitionlevel for cost and value is placed at 0,5. However this is because of a wrong script in the ambitionwebtool. The ambitionlevel for cost and value must be 1,0.

When the ambitions, determined in chapter 3, are assessed in the ambitionwebtool, the ambitionlevels change as shown in Table 5.1. The ambitionlevels of energy, materials and raw materials, costs and value and space are the same as in chapter 3. The ambitions for soil, water and living environment dropped 0,5 in ambitionlevel. This is because there are plans, but very little specific goals on the part of sustainability. The ambitionlevel for space dropped 1,0 in ambitionlevel, because the ecological zone is not further developed than the allocated space. Overall the current ambitionlevel is lower than first thought. This means that there are lots of possibilities to improve the current plan.

Scenario 2 Required ambitionlevel:

TABLE 5.2 COMPARISON AMBITIONLEVELS INTERVIEW AND AMBITIONWEBTOOL SCENARIO 2

Initial ambitionweb theme	**Energy**	**Materials**	**Investments**	**Space**	**Living environment**	**Nature and ecology**	**Soil and water**		**Mobility**
Ambitionweb theme ambitionweb tool	**Energy**	**Materials and raw materials**	**Cost and value**	**Space**	**Living environment**	**Nature**	**Water**	**Soil**	
Initial score	2,5	2	2	2	2,5	3	2		2,5
Ambitionwebtool score	2	2	2,5	2	2,5	1,5	1,5	1,5	-

The change in ambitions for the required ambitionlevel is shown in Table 5.2. For the required ambitionlevel, the ambitions for energy, materials, space and living environment stayed the same as in chapter 1. The ambitionlevel of costs and value rose with 0,5 points, from 2,0 to 2,5. This is because in the ambitionwebtool, educational value is a part of costs and value. This was not considered in the first ambitionweb. Boekhorst provides lots of possibilities for educational values from measures.

The ambitionlevel of nature dropped from 3,0 to 1,5. This is a significant drop of 1,5 in ambitionlevel. This is because Boekhorst is a newly developed estate, meaning that previous nature on the place where Boekhorst is build disappears and nuisance is created. Although nature is considered, compared to the old situation nuisance cannot be prevented.

Soil and water dropped 0,5 in ambitionlevel from 2,0 to 1,5. This because the prevention of soil and water pollution is not considered in this stage of the project yet.

Scenario 3 Aimed ambitionlevel:

TABLE 5.3 COMPARISON AMBITIONLEVELS INTERVIEW AND AMBITIONWEBTOOL SCENARIO 3

Initial ambitionweb theme	**Energy**	**Materials**	**Investments**	**Space**	**Living environment**	**Nature and ecology**	**Soil and water**		**Mobility**
Ambitionweb theme ambitionweb tool	**Energy**	**Materials and raw materials**	**Cost and value**	**Space**	**Living environment**	**Nature**	**Water**	**Soil**	
Initial score	3	3	2,5	3	3	3	3		3
Ambitionwebtool score	2,5	2,5	3	3	3	2,5	2,5	2	-

Table 5.3 shows the change in aimed ambitionlevel when the ambitionwebtool is used. The high ambitionlevel 3,0 set in chapter 3, proves to be possible for space and living environment. It turns out that also an ambitionlevel 3,0 is possible on costs and value. At first ambitionlevel 2,5 was aimed on this theme, but since ambitionlevel 3,0 seems quite easily achievable in the ambitionwebtool the new ambitionlevel for costs and value is set at 3,0.

The aimed ambitionlevel dropped with 0,5 in ambitionlevel from 3,0 to 2,5 for energy, materials and raw materials, nature and water. This is because it is unachievable to guarantee how all the measures work out in the future. Since future developments cannot be guaranteed, the ambitionlevels are set at 2,5 instead of 3,0.

For soil the ambitionlevel dropped 1 ambitionlevel from 3,0 to 2,0. This is because aspects as salinization and soil impoverishment are hard to predict and prevent.

5.2 AMBITION SCENARIOS

The specific goals for Boekhorst are fixed in the ambitionwebtool. The measures from chapter 4, are in the ambitionwebtool coupled to the goal belonging to the ambitionlevels. In this way it can be seen which measures help to meet the goals. Appendix F. shows for each measure the number of the sub-themes on which it has an influence.

Table 5.4 shows the measures that need to be implemented in scenario 2 and scenario 3 to meet the ambitions. Table 5.5 shows measures that are recommended to implement when the measures in Table 5.4 are not satisfying on the requirements in the model

In Table 5.4 can be seen that all the measures in scenario 2 are also recommended in scenario 3. This is, because scenario 3 is an surpassing scenario of scenario 2. The most goals to meet are surpassing as well. In scenario in scenario 2 for example, 40% of CO2 emissions are to be reduced and in scenario 3, 60% CO2 emissions are to be reduced. These requirements can be met with the same measures. However, when a reduction of 60% is needed, more measures are needed to implement than when a reduction of 40% is needed. Further research is needed to see if the goals are indeed satisfied with the proposed measures.

When the proposed measures are not satisfying, measures from Table 5.5 are needed. Table 5.5 shows several measures from which a choice can be made, these themes are classified on the themes they influence most. On space and living environment the measures often influence both, that is why these measures are listed together. WKO-systems are shown separately in Table 5.5 and some are shown in Table 5.4, because a study on which WKO systems are the best to implement in Boekhorst is needed, although a WKO-system is recommended.

In the ambitionwebtool, not all the goals could be met with the proposed measures. To get an insight in what needs to be done to meet all the goals,

Table 5.6 provides a list of recommendations. The recommendations in this list should be taken into account to meet the set ambitionlevels.

TABLE 5.4 MEASURES TO IMPLEMENT IN BOEKHORST FOR THE SCENARIOS

Scenario 2	Scenario 3
37. Green gardens without (much) pavement (2.0)	37. Green gardens without (much) pavement (2.0)
86. Daylight accessible (2.0)	86. Daylight accessible (2.0)
24. Waste management plan (1.9)	24. Waste management plan (1.9)
33. Verge cuttings recycling (1.8)	33. Verge cuttings recycling (1.8)
44. Environmental Impact Assessment (EIA) with water and soil as subject of protection (1.8)	44. Environmental Impact Assessment (EIA) with water and soil as subject of protection (1.8)
45. Green area prioritization in urban planning (1.8)	45. Green area prioritization in urban planning (1.8)
97. Adequate and uniform lighting conditions (1.7)	97. Adequate and uniform lighting conditions (1.7)
27. New objects made from cut down trees (1.6)	27. New objects made from cut down trees (1.6)
8. Windows on the south side of buildings with trees in front of them (1.4)	8. Windows on the south side of buildings with trees in front of them (1.4)
15. Smart Grid (1.5)	15. Smart Grid (1.5)
16. Domotica systems (1.5)	16. Domotica systems (1.5)
20. Materials passport (1.5)	20. Materials passport (1.5)
21. Material loss chart of production (1.5)	21. Material loss chart of production (1.5)
23. Life Cycle Analysis (LCA) (1.5)	23. Life Cycle Analysis (LCA) (1.5)
35. Water impact assessment (1.5)	35. Water impact assessment (1.5)
2. CO2 emissions calculation with DuboCalc or a comparable program (1.4)	2. CO2 emissions calculation with DuboCalc or a comparable program (1.4)
34. Water resource investigation (with a water-resource evaluation matrix) (1.4)	34. Water resource investigation (with a water-resource evaluation matrix) (1.4)
70. Design based on the environment (1.4)	70. Design based on the environment (1.4)
71. Flexible design plan to build question based, so that space can be used different in the future (1.4)	71. Flexible design plan to build question based, so that space can be used different in the future (1.4)
85. Different function options in the environment (1.4)	85. Different function options in the environment (1.4)
51. Management scheme for the maintaining of the diversity of urban nature (1.4)	51. Management scheme for the maintaining of the diversity of urban nature (1.4)
4. Efficient use of building tools/construction machines: switch them of when they are not needed (1.3)	4. Efficient use of building tools/construction machines: switch them of when they are not needed (1.3)
1. Feasibility study into renewable energy (1.2)	1. Feasibility study into renewable energy (1.2)
3. CO2 emission mapping of maintenance work, work process and waste processing (1.2)	3. CO2 emission mapping of maintenance work, work process and waste processing (1.2)
17. Led lighting/ lights with integrated solar panels and battery (1.2)	17. Led lighting/ lights with integrated solar panels and battery (1.2)
47. Demolition practice plan (1.2)	47. Demolition practice plan (1.2)
65. Streetscape greenery (1.2)	65. Streetscape greenery (1.2)
26. Stimulate walking (1.2)	26. Stimulate walking (1.2)
100. LCC for the planning, construction, usage and demolition phase (1.2)	100. LCC for the planning, construction, usage and demolition phase (1.2)
6. Prioritization of walking and cycling in the design instead of car usage (1.1)	6. Prioritization of walking and cycling in the design instead of car usage (1.1)
18. Multipurpose charging stations (with LED lighting) (1.1)	18. Multipurpose charging stations (with LED lighting) (1.1)

22. Material origin substantiation (1.1) 25. Circular building materials (1.0) 36. Groundwater ambitionlevel analyzation (1.0) 57. Waste bins (1.0) 61. Green and blue dry and wet spots realization (1.0) 69. Flora and fauna in relation to target species (1.0) 83. Background noise map (1.0) 101. measures for which subsidy is given (1.0) 14. Sun-/PV-panels (0.9) 52. Noise nuisance prevention (0.9) 60. Greenery diversity with native trees, shrubs, perennials and seeds (0.9) 56. Maintenance plan to promote ecological quality (0.9) 48. Quickscan: Inventory the current flora & fauna (0.8) 59. Plant species that increase biodiversity and better the living environment (0.8) 67. Free migration stimulation (0.8) 87. Suitable trails for rollators, wheelchairs and mobility scooters (0.8) 92. Activity spaces (0.8) 50. Agricultural backgrounds with natural values inventory (0.7) 103. Educational value through visible sustainable measures (0.7) 49. Ecological target type determined (0.6) 99. Long term budget and look at the long-term investments (0.6) 76. Safe intersections (0.5) 105. Recyclable products (0.5)	22. Material origin substantiation (1.1) 25. Circular building materials (1.0) 36. Groundwater ambitionlevel analyzation (1.0) 57. Waste bins (1.0) 61. Green and blue dry and wet spots realization (1.0) 69. Flora and fauna in relation to target species (1.0) 83. Background noise map (1.0) 101. measures for which subsidy is given (1.0) 14. Sun-/PV-panels (0.9) 52. Noise nuisance prevention (0.9) 60. Greenery diversity with native trees, shrubs, perennials and seeds (0.9) 56. Maintenance plan to promote ecological quality (0.9) 48. Quickscan: Inventory the current flora & fauna (0.8) 59. Plant species that increase biodiversity and better the living environment (0.8) 67. Free migration stimulation (0.8) 87. Suitable trails for rollators, wheelchairs and mobility scooters (0.8) 92. Activity spaces (0.8) 50. Agricultural backgrounds with natural values inventory (0.7) 103. Educational value through visible sustainable measures (0.7) 49. Ecological target type determined (0.6) 99. Long term budget and look at the long-term investments (0.6) 76. Safe intersections (0.5) 105. Recyclable products (0.5) 41. Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wades to infiltrate in the soil (1.3) 90. Virtual meeting place (1.3) 93. Pet-friendly environment (1.3) 43. Water storage for rain water to use in black (toilet) water systems (1.1) 64. Hedge with various native species (1.1) 104. Room for co-creation with inhabitants (1.1) 40. Separate sewer for grey and black water (1.0) 66. Nature friendly banks (1.0) 77. Fast cycling lanes to promote cycling to the centre of Voorhout (0.9) 58. Variation in landscape (0.7) 94. Outdoor playing and sport places (0.7) 95. Sound barrier around road (0.7) 73. Electric car sharing hub (0.5)

TABLE 5.5 MEASURES FOR WHEN THE PROVIDED MEASURES DO NOT SATISFY THE GOALS

Concerning	Scenario 2	Scenario 3
Theme Water	30. Roadway of reinforced grass or water-permeable paving (half open paving) (1.5) 91. Communal gardens for food production (1.5) 74. Small private garden, large community garden (1.4) 84. Heat and cold warning mechanism and strategy plan to react (1.4) 41. Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wades to infiltrate in the soil (1.3) 38. Existing water enlargement (1.3) 42. Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc. (1.3) 31. Narrow walking strip in baked bricks (1.1) 43. Water storage for rain water to use in black (toilet) water systems (1.1) 40. Separate sewer for grey and black water (1.0) 55. Garden layout support for residents (1.0) 63. Pond for water capture with open space to relax (1.0)	30. Roadway of reinforced grass or water-permeable paving (half open paving) (1.5) 84. Heat and cold warning mechanism and strategy plan to react (1.4) 38. Existing water enlargement (1.3) 42. Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc. (1.3) 31. Narrow walking strip in baked bricks (1.1) 55. Garden layout support for residents (1.0) 63. Pond for water capture with open space to relax (1.0)
Soil	46. Reduction areas for soil consumption (soil sealing) (1.0)	46. Reduction areas for soil consumption (soil sealing) (1.0)
Themes Living environment and Space	88. Community gardens (1.7) 91. Communal gardens for food production (1.5) 93. Pet-friendly environment (1.3) 28. Shared sheds containing tools that people need occasionally (1.2) 77. Fast cycling lanes to promote cycling to the centre of Voorhout (0.9) 94. Outdoor playing and sport places (0.7) 95. Sound barrier around road (0.7) 79. Access to public transport (0.6) 89. Community centre as a central meeting place and to organise activities (0.5) 80. Shared working space (0.4) 19. Smart Energy Floor (0.6)	91. Communal gardens for food production (1.5) 74. Small private garden, large community garden (1.4) 28. Shared sheds containing tools that people need occasionally (1.2) 19. Smart Energy Floor (0.6) 96. Public toilet (0.6) 89. Community centre as a central meeting place and to organise activities (0.5) 80. Shared working space (0.4)
Theme Nature	54. Adoption green (1.5) 64. Hedge with various native species (1.1) 62. Reed edge in water (1.0) 66. Nature friendly banks (1.0) 53. Compost plants (0.9) 68. Bee strips (0.8)	54. Adoption green (1.5) 62. Reed edge in water (1.0) 53. Compost plants (0.9) 68. Bee strips (0.8)

Theme Energy	18. Multipurpose charging stations with LED lighting (1.1) 4.Fuel/energy-efficient construction and machinery (1.0) 7. Pipe length reduction of heating and ventilation systems (0.5)	75. Demountable building (1.4) 81. Sharing bikes (1.1) 82. Aesthetic signs (1.0) 29. Smart led lighting to show half hardened parking spots (0.8) 78. Bicycle parking spots (0.7) 72. Reduced parking norm (0.6) 79. Access to public transport (0.6) 7. Pipe length reduction of heating and ventilation systems (0.5)
WKO	8. Asphalt heating (1.0) 10. Riothermia: extract heat from waste water in the sewerage system (0.6) 11. Surface water heating (0.5) 12. Geothermal heating (0.3)	9. Asphalt heating (1.0) 10. Riothermia: extract heat from waste water in the sewerage system (0.6) 11. Surface water heating (0.5) 12. Geothermal heating (0.3)

TABLE 5.6 RECOMMENDED MEASURES TO MEET THE AMBITIONS

Recommendations for scenario 2 and scenario 3
Energy
• Implement measures to reduce CO2 during production, delivery and work process (RPS, 2018)
• Instead of DuboCalc SimaPro can be used for an LCA (Voorn, 2018)
• Less to- and back- trips (Movares, 2016)
• Buy materials as close as possible (Movares, 2016)
• Lower friction resistance in roads (Movares, 2016)
• Waste processing/Material re-usage as close as possible (RPS, 2018)
• Calculate the expected energy consumption, so expectations can be made about the needed generation of energy (RPS, 2018)
Materials
• Inventory of materials is needed to create a waste management plan (RPS, 2018)
Cost and value
• Visible measures are needed for eduction in material, biodiversity, energy and in recreational space (RPS, 2018)
Space
• Assess the experiential value of the area (RPS, 2018)
• Implement measures that have a positive effect on the experiential value (RPS, 2018)
• Assess the use value of the area (RPS, 2018)
• Implement measures that have a positive effect on the use value (RPS, 2018)
• Assess the future value of the area (RPS, 2018)
• Implement measures that have a positive effect on the future value. (RPS, 2018)
• Assess the current use value of the area (RPS, 2018)
• Asses the changes to use space effectively (RPS, 2018)
• Asses the accessibility with surrounding area's (RPS, 2018)
• Asses travel the reliability and predictability of the mobility system (RPS, 2018)
• Assess the effects of infrastructure (RPS, 2018)
• Assess the connectivity and accessibility of the most important facilities (RPS, 2018)
• Assess the future mobility developments for at least 25 years. (RPS, 2018)
Living environment
• Asses the effects of the project on air quality in the plan area (RPS, 2018)
• Greenery to capture particulate matter (PM) (Kokon, 2018)
• Assess the ambient radiation and any radiation effects of the project (RPS, 2018)

- Assess the current background noise (RPS, 2018)
- Assess the future background nois (RPS, 2018)
- Assess heat stress (RPS, 2018)
- Assess soil quality and safety (RPS, 2018)
- Carry out soil research (milieu centraal , 2018)
- Rinse the soil by soil remediation (milieu centraal , 2018)
- Map out current propulsion possibilities of non-drivers and cyclists (RPS, 2018)
- Create a maintenance plan for cycling- and walking paths (RPS, 2018)
- Implement recreational facilities for elderly and disabled (RPS, 2018)
- Assess the vibration effects of the project (RPS, 2018)
- Monitor risk locations of vibration effects (RPS, 2018)
- Assess light disturbance of the project (RPS, 2018)
- Prevent traffic disturbance during the construction phase (RPS, 2018)
- Provide measures for roadblock and detour when needed (RPS, 2018)
- Reduce whirling dust (RPS, 2018)
- Take preventive measures to prevent flooding during the construction phase (RPS, 2018)
- Assess if social safety is provided enough (RPS, 2018)
- Look at possibilities for green gulfs in traffic (Crow, 2018)
- Assess and reduce environmental risks (RPS, 2018)
- Communicate environmental risks with the residents (RPS, 2018)
- Keep the environmental risks within the legal norms (RPS, 2018)
- Assess the demographic formation of the area (RPS, 2018)
- Assess the social well-being in the area (RPS, 2018)
- Assess the social support for the project (RPS, 2018)

Nature

- Insights in estates own threated, protected flora and fauna (RPS, 2018)
- Provide nature and ecological compensating measures during construction (RPS, 2018)
- Inventory the needed area maintenance (RPS, 2018)
- Assess how human usage has a negative impact on the areas nature and ecology. (RPS, 2018)
- Maintain insights in the natural capital (RPS, 2018)

Water

- Water quality is assessed.
- Provide groundwater quality, so that the water is at least suitable as process water. (RPS, 2018)
- Assess the soil water quality. (RPS, 2018)
- Possibly provide soil and water rinsing. (RPS, 2018)
- Assess the salinization of the area. (RPS, 2018)
- Asses the ecological water quality. (RPS, 2018)
- Implement measures to improve the ecological water quality. (RPS, 2018)
- Assess the diffuse contamination. (RPS, 2018)
- Assess the 'point contamination' of the area (RPS, 2018)
- Assess the water ground ambitionlevel. (RPS, 2018)
- Assess shelter possibilities and exits in case of flooding. (RPS, 2018)
- Assess the total drainage system of the area. (RPS, 2018)
- Assess the infiltration ability of the soil (k-value). (RPS, 2018)
- Assess freshwater supply. (RPS, 2018)
- Assess the moisture content of the soil and the project effects on possible desiccation. (RPS, 2018)
- Regulate the groundwater ambitionlevel. (RPS, 2018)

Soil

- Make the chemical soil quality transparent by use of the risk toolbox. (RPS, 2018)
- Limit environmental risks, by limiting bad soil quality. (RPS, 2018)
- Assess the microbiological soil quality. (RPS, 2018)
- Assess physical properties and concentrations of minerals / nutrients in the soil. (RPS, 2018)

- Assess the erosion possibility of the soil. (RPS, 2018)
- Assess the amount of nutrients and the ability of the soil to retain them (risk of impoverishment). (RPS, 2018)
- Assess the soil density and the effects of the project on soil density. (RPS, 2018)
- Assess the physical power on the soil. (RPS, 2018)
- Assess the diffuse contamination. (RPS, 2018)
- Assess the soil subsidence risk. (RPS, 2018)
- Limit soil subsidence. (RPS, 2018)
- Limit soil contaminations (RPS, 2018)
- Assess the underground infrastructure. (RPS, 2018)
- Assess the possibilities for hot/cold networks. (RPS, 2018)
- Align the soil so that hot/cold networks are possible. (RPS, 2018)
- Assess the environmental fragmentation. (RPS, 2018)
- Assess the effects of earthmoving on biodiversity. (RPS, 2018)
- Assess flawed explosives in the soil. (RPS, 2018)
- Limit the risks of flawed explosives to a minimum. (RPS, 2018)
- Assess the transport movement by earthmoving. (RPS, 2018)
- Assess the important landscape forms or natural variation in geology, typical of the area. (RPS, 2018)
- Assess the archaeological and cultural-historical soil value. (RPS, 2018)
- Assess the effects of delving on the geological values of the area. (RPS, 2018)

Recommendations only for scenario 3

Costs and value

- Co-creation with start-ups is recommended (RPS, 2018)

Space

- Historical research soil contamination (milieu centraal , 2018)
- Create a traffic plan that takes into account issues such as peak movements, efficiency and local residents. (RPS, 2018)

Nature

- Habitat/ecological conditions connect flawlessly to local, protected and endangered flora and fauna. (RPS, 2018)

Water

- Provide groundwater quality, so that the water is suitable as drinking water. (RPS, 2018)
- Block shifting of water pollution from the plan area to the outside. (RPS, 2018)
- Provide flexible water ambitionlevel management. (RPS, 2018)
- Implement at least one measure to prevent salinization (RPS, 2018)
- Provide an emergency plan, so that everyone can leave the area safe in case of flooding. (RPS, 2018)
- Regulate the groundwater ambitionlevel so that it is always round its optimum. (RPS, 2018)

Soil

- Limit soil contamination to 50% below the norms.
- Take future changes into account when designing the underground infrastructure. (RPS, 2018)

6 CONCLUSION

In this research an answer is sought to the question: 'Which measures can be implemented in the spatial design of Boekhorst, so that the sustainable ambitions are met?'

To find the right measures for Boekhorst first the ambitions are determined in an interview. In this interview the current plan was assessed as scenario 1: current sustainability ambitionlevel. Apart from the assessment the ambitions for Boekhorst are set. A required ambitionlevel is created in scenario 2 and an aimed ambitionlevel is created in scenario 3. It became clear that the aimed ambitions were very high. Boekhorst is aimed to be as sustainable as possible. Therefore, the aimed ambitionlevel is as high as possible and the required ambitionlevels are also high, but lower than the aimed ambitionlevel.

After the ambitions are determined measures fitting the ambitions are proposed. With a multi-criteria analysis is found how feasible these measures are. 2 measures are to be implemented. For 63 measures, expected to be advantageous further research is recommended before implementation and for and 39 possibly advantageous measures, further research is needed.

Based on their score the measures are coupled to the ambition scenarios in the ambitionwebtool. With a reflection of ambitions in the ambitionwebtool became clear that on specific aspects the ambitions changed. The actual ambitions for Boekhorst are lower than first thought. This is because, some goals in the ambitionwebtool cannot be met.

With the coupling of measures to the ambitions requirements, ambition scenarios became measure scenarios as well. The measure scenarios as shown in Table 5.4 and Table 5.5 and Table 5.6 are the result of this research. The measures listed in Table 5.4 must be implemented to meet the set ambitions. For the measures in Table 5.5 further research is needed to see if they are desired and the recommendations in Table 5.6 have to be considered to meet the ambitions for Boekhorst.

7 DISCUSSION

This research used several methods. Firstly, interviews are done to gather measures. The outcomes of these interviews are validated with literature research. All the measures found have several sources, which makes most of the advantages and disadvantages in the measure list reliable. However, sometimes sources gave different information. In the cases where sources did not match, it concerned measures that are little implemented. Since these measures are little implemented, little information is available. This gives uncertainty in advantages and disadvantages. This uncertainty is mentioned in the column disadvantages in Table 4.2.

After the measures are found a multi-criteria analysis is conducted on the measures. The measures that had an uncertainty in their advantages and disadvantages got a lower score on the SPI 'required skills and knowledge' since little knowledge is available.

The multi-criteria is used to roughly select measures on their sustainability influence. The expected outcome was that all the measures would be sustainable, which was the case. The selection with a multi criteria is very rough, because scores of measures on indicators are sometimes given with little information. For example, when it is only known that measures will need maintenance, but it is not known how much the maintenance costs or over how many years maintenance needs to be done. In the MCA a lot of assumptions are made. The MCA would be more precise when a performance matrix with the same indicators and measures is made. In the performance matrix would be mentioned how the measures score in the indicators, exact costs will be mentioned here for example and then scores are added based on the performance measures on an indicator (Department for Communities and Local Government, 2009).This method would be more precise, but also a lot more time consuming. Because of time constraints the decision is made to not make a performance matrix in this stage of the project. A decision matrix can be used for the assessment of scenarios when the developers of Boekhorst make choices on which measures to implement.

For the weight determination of the SPIs in the multi-criteria analysis, six experts are asked to rank the criteria. Based on these rankings the indicators are compared. It could be that when different experts were asked to give a ranking, different weights would be determined. This could be solved by asking more experts, so that one expert more or less does not change the SPI ranking. However, for Boekhorst there are only few experts, which makes it hard to determine the weights in a more reliable way.

Another option than ranking the SPIs would be, to let experts give scores from 0 to 3 or over another scale, based on importance. This may have caused another difference in SPI weights. However, it cannot be said which method is better.

In the measures that use a hot and cold network, were specifically a lot of uncertainties and contradictory literature. Therefore, a separate study to the feasibility of the different hot and cold networks is recommended.

In this study the ambitionwebtool is used for the first time to assess spatial designs. Because of this a lot of defects in the ambitionwebtool are noticed. First of all, some requirements used for the assessment of scenarios are vague. For example, to reach ambitionlevel 2 the requirement is '' Measures that have a significant positive influence on the usage value in the area are taken.'' And to reach ambitionlevel 3 the requirement to meet is ''Measures that have the highest possible positive influence on the usage value in the area are taken.''. Since it is unknown where the margin lies between a significant positive influence and the highest possible influence it is hard to determine which measures to place where.

Several debatable requirements should be reassessed in the ambitionwebtool. To reach ambitionlevel 2 on the sub-theme experiential value, the requirement is ''50% of the defined measures are taken'' and when for the accomplishment of ambitionlevel 3 the requirement is '' 100% of the defined measures are taken''. It is unclear what the defined measures are. Sometimes it might even be better to only implement 50% of the measures when these already accomplish all the wanted effects. In that case the other 50% would be unnecessary and thus costly. Like these, a lot of requirements also have a large difference in percentages that have to be reached between different ambitionlevels.

Secondly, the ambitionlevels coupled to requirements are not always right. Sometimes there were missing requirements at ambitionlevel 3, which made it only possible to reach ambitionlevel 2 on certain themes. This has an influence on the ambitionlevel of the sub-theme and it can also influence the ambitionlevel on the main theme in the ambitionweb. Another problem for the determination of ambitionlevels is that on some sub-themes the ambitionlevels are determined by a sum of several requirements. These requirements form a score of 3 together. In some cases, there were only two requirements that did not belong to ambitionlevel3, but when they are both satisfied, ambitionlevel 3 is reached anyway.
In the ambitionweb it is required that ambitionlevel 1 must always be reached. Therefore, even when no requirements are satisfied, ambitionlevel one is reached. An exception to this is when the ambitionlevel is determined by the sum of several requirements. In these cases, an ambitionlevel of 0 is possible. This is also why cost and value got a score of 0,5 in the current sustainability ambitionlevel scenario.

For the assessment of the current sustainability scenario it was a problem that ambitionlevel 1 must always be reached. This was, because in the ambitionwebtool it was filled in that requirements at ambitionlevel 1 where met, while they were not met. In this way it cannot become clear on which themes the legal level is not met yet. This also leads to the third defect of the ambitionwebtool, which is that sometimes to reach ambitionlevel 1 nothing needed to be done and sometimes, to reach ambitionlevel 1, measures that go beyond legal standards had to be taken. Since level 1 must always be reached, level 1 should not contain requirements that exceed the legislation.

Apart from ambitionlevel 1, sometimes ambitionlevel 3 is unrealistic. One requirement for example mentions that all the material used in the project is fully renewable. Requirements like these are at the moment of writing unrealistic for a whole residential estate. But not only requirements like these are unrealistic. Sometimes ambitionlevel 3 contains requirements that mention that an improvement of the current situation has to be made. This is not possible for new housing estates, for example in nuisance.

A fourth default of the ambitionweb is that the same requirements are placed in one theme under the different sub-themes. This makes that these double mentioned requirements have a large influence on the main theme they belong to. This is because the score they help to reach on the sub-themes form the score on the main theme together with other sub-themes. This does not have to be a problem, if these requirements indeed have a large influence on all these sub-themes. Since this may mean that they are very important, but when they are only of small importance on the sub-themes their large effects are a problem.

Another point to mention is that not for all the set goals of the ambitionwebtool measures are found and assessed. This is, because measures are first looked for and then assessed in the ambitionwebtool. A wrong method order is followed in this research. When the ambitionwebtool would have been available from the start, the goals to meet the measures could have been determined before measures were looked for. In this case measures would have been found for all the goals in the model and the recommendations would not be needed.

To sum it up uncertainties in this research exist, due to assumptions and a disputable model and when a likewise research is conducted, it is recommended to use the ambitionwebtool immediately after an interview with the client. In that way a more target search for measures can take place from the start.

8 RECOMMENDATIONS

This study provided a lot of measures the developers of Boekhorst may consider. The developers are recommended to look at the ambitionwebtool to see the goals combined to measures. When the MCA scores of measures is seen, in combination with the number of requirements the measure helps to meet, extra measures can be chosen based on what they would like to implement and promote the area with.

In the used model, the ambitionwebtool, is room for a lot of improvement. RPS is first of all recommended to make all the goals measurable. Secondly, the reliability can be improved when in between ambitionlevels, for example ambitionlevel 2,5, are added on goals with a large difference in scores. Thirdly, the goals should be made even and realistic. This means that ambitionlevel 1 should not be more than the legal requirements and ambitionlevel 3 should be possible to accomplish, although hard. Lastly, it would be convenient for the assessment of current plans to add a level of 0 to the ambitionwebtool for when legal requirements are not me.

At RPS, the ambitionwebtool is being further developed. The ambitionwebtool is being put in a web application instead of Excel. In this web application the measures can be added as advice or information on how the requirements belonging to the ambitionlevels can be met. In this web application it can help to give weights to requirements instead of sub-themes. In this way the influence of double requirements in a theme can be limited.

During the time of this research at RPS percentages in the ambitionwebtool were changed based on estimations of what is realistic. This was done on estimations by sustainability experts working on the ambitionwebtool. To get more certainty on the specifics of the requirements it is recommended to assess the goals of each theme with experts who have specific knowledge about the separate themes. They can give an advice on which measures and belonging percentages are realistic to meet per ambitionlevel.

When all these changes are made in the ambitionwebtool, the ambitionwebtool would be a good tool to use for the assessment of spatial designs.

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APPENDIX A. AMBITION THEMES OF DUURZAAM GWW

The ambitionweb as developed by Duurzaam GWW contains 12 themes with sub-themes:

1) Energy
   a) Energy use and CO2 emissions
   b) Energy production
2) Materials
   a) Use of materials (circular, renewable, without risks for health and the environment)
   b) Material production and construction
3) Water
   a) Water quality (no water pollution)
   b) Water quantity; drought, shortages
   c) Water quantity; water safety and adaptive ability
4) Soil
   a) Soil quality
   b) Soil system
   c) Archeology
5) Ecology
   a) Biodiversity
   b) Ecological structures
6) Space use
   a) Fittings on unbuilt space
   b) Adaptive power spatial layout
7) Spatial quality
   Integration, spatial design:
   a) Experience value (including cultural-historical values)
   b) Usage value
   c) Future value
8) Well-being
   a) Health (air, sound, ...)
   b) Nuisance (noise, light, vibrations)
   c) Safety (various themes)
   d) Other effects for living environment
9) Social relevance
   a) Public support
   b) Social involvement
   c) Local knowledge
   d) Social return
10) Accessibility
   a) Accessibility (throughflow)
   b) Infrasystem functionality
   c) Adaptive power infrasystem
11) Investments
   a) Costs
   b) Yields (value)
   c) Business climate
   d) Employment, labour market
   e) Area economy

APPENDIX B. CLARIFICATION RESEARCH DESIGN

APPENDIX B.1. SUSTAINABLE PERFORMANCE INDICATOR DEFINITIONS

TABLE B.1 ENVIRONMENTAL SPI DEFINITION BASED ON KAMALI & HEWAGE (2015)

Environmental Sustainability Performance Indicator	Description
Energy performance and efficiency strategies	Energy monitoring, minimizing space for heating/cooling, integrating daylight to reduce the need for electrical lighting, among others.
Water and wastewater efficiency strategies	Reducing the potable water consumption by reuse and recycling systems, water monitoring, among others.
Regional (local) materials	Using building materials and products which are extracted, processed and manufactured within the region.
Renewable materials	Using renewable materials to reduce the use and depletion of finite raw and non-renewable materials.
Waste management	Strategies for diverting waste from disposal in landfills and incineration facilities(Reuse, Recycling, etc.).
Greenhouse gas emissions	The amount of greenhouse gas emissions leading to global warming, ozone depletion, etc.
Site disruption and appropriate strategies	Promoting natural biodiversity (e.g., providing adequate open space, planning for storm water management, avoiding blocking fresh air or sunlight or natural waterways for adjacent developments, and so forth.
Renewable energy use	Reducing the negative impacts of non-renewable energy consumption by using renewable energy sources (e.g., solar).
Material consumption in construction	The amount of any product or natural resource used during the design and construction phase of the building.
Alternative transportation	Availability of public transportation access, cycling facilities, among others.
Heat stress efficiency strategies	Heat monitoring, provision of greenery for cooling, minimize dark surfaces that heat up.

TABLE B.2 ECONOMIC SPI DEFINITION BASED ON KAMALI & HEWAGE (2015)

Economic Sustainability Performance Indicator	Description
Design and construction time	Total duration of the measure design and construction (e.g., planning, manufacturing, installation, finishing, etc.)
Design and construction costs	Pre-construction and construction costs (e.g., coordination, drawings, materials, workforce, transportation, defect/damage to the product before final completion, etc.)

Operational costs	Costs of the measure operation during the usage phase.
Maintenance costs	Costs of repair and maintenance of the measure during the usage phase.
End of life costs	Costs of dismantling and waste treatment (recycling, disposal, etc.)
Durability of the measure	Specify durable and low-maintenance building materials and assemblies in order to have a measure with a long usable life leading to economic benefits.
Investment and related risks	The speed of return on loans or other investments and the associated risks.
Flexibility	Compatibility of the product and adaptability to accommodate substantial changes in the future at a lower cost (e.g., using fastening systems that allow for easy disassembly).
Required skills and knowledge	Ways of handling the management functions and procedures that are conducted during the design and construction of the measure.

TABLE B.3 SOCIAL SPI DEFINITION BASED ON KAMALI & HEWAGE (2015)

Social Sustainability Performance Indicator	Description
Health, comfort and well-being of residents	Health, comfort and well-being of the end users in the usage face of the spatial design (e.g., preventing air pollution)
Influence on the local economy	Influence on the region of construction (e.g., job market employment, workforce stability etc.)
Functionality and usability of the physical space	Usability of the physical space for engineering systems as well as future occupants (e.g., physical spans, openings, etc.)
Aesthetic options and beauty of the environment	Containing design features intended for human delight, spirit and place appropriate to its function, internal and external beauty and visual appearance.
Safety and security	Providing adequate measures and equipment that promote low risk, safe and secure use of the environment (e.g., fire/seismic resistance).
Community disturbance	Impacts of the construction activities on residents and surrounding local communities (e.g., construction noise and dust, traffic congestion, etc.)
Influence on local social development	Influence on culture, interaction of people and development of new local communities
Affordability	Ability to purchase the measure.
User acceptance and satisfaction	The ambitionlevel of residents and user satisfaction when interacting with the measure.
Neighbourhood accessibility and amenities	Proximity to local facilities (e.g., recreational centres, parks, etc.)
Educational value	Visibility and clarity in effects, so that residents and visitors of the neighbourhood see the effect of the sustainable measure.

APPENDIX B.2 MCA METHOD CLARIFICATION

APPENDIX B.2.1. SPI WEIGHT DETERMINATION

For each sustainability dimension (environmental, economic and social) in the MCA the same steps are taken.

SPI weight determination is done with the following steps:

1. Ranking of SPIs by experts

   This ranking is determined with the help of six experts who are involved in the development of Boekhorst. The experts ranked the SPIs based on their importance.
   After experts ranked the SPIs the average score of each SPI is determined.

$$Average\ score = \frac{\sum_{i=SPI\ score\ given\ by\ expert\ 1}^{n=number\ of\ consulted\ experts}(score\ given\ by\ expert_i)}{n}$$

   Because each sustainability dimension has a different number of SPIs, and thus a ranking reaching higher or lower, the SPI importance is converted from 0 to 1 with the following formula:

$$SPI\ importance_i = \frac{Average\ score_i}{Sum\ Average\ score}$$

2. Comparison of SPIs against each other in a matrix.

   This is done in a table with the SPIs in a matrix plotted against each other. In this matrix the Importance score of the upper SPI in the horizontal row is divided with the importance score of the left SPI in the vertical row.

3. Normalization of the SPI comparison matrix

   The SPI comparison matrix is normalized by use of the matrix of step 2. The matrix of step 2 is normalized by dividing the number in each box with the sum of the numbers in the vertical row of the SPI comparison matrix made at step 2.

4. SPI weight determination

   The weight for each SPI is determined by taking the sum of all the normalized numbers in the horizontal column next to the each SPI. Then this sum is divided by the number of SPIs.

$$Weight\ SPI = \frac{\sum_{i=normalized\ \ SPI\ comparison\ 1}^{n=number\ of\ SPIs}(normalized\ number_i)}{n}$$

APPENDIX B.2.2. SCORING THE MEASURES

In a table the measures are listed in the vertical row, with the SPIs in the horizontal row. Based on the measures advantages and disadvantages a score from -3 to 3 is given for the effect of the measure on the SPI. -3 means that the measure has a very negative effect on the indicator, 3 means that the measure has a very positive effect on the indicator. The meaning of each score from -3 to 3 is displayed in Figure B.1.

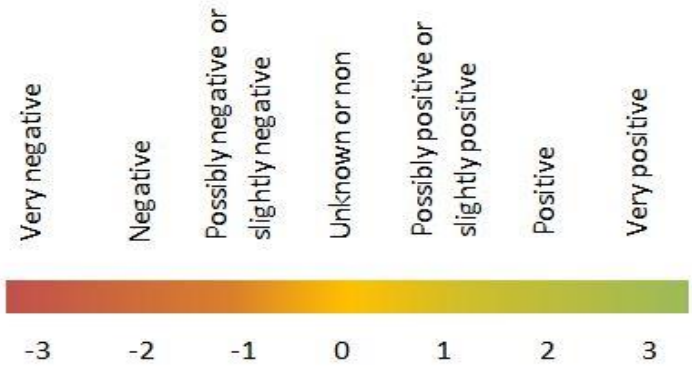

FIGURE B.1 EFFECT OF MEASURE ON THE INDICATOR

APPENDIX B.2.3. SUSTAINABLE DIMENSION WEIGHT DETERMINATION

The weights of the sustainable dimensions are determined by consulting the same experts as for the weight determination of the SPIs. This time the experts are asked to divide the sustainable dimensions in percentages, based on importance for Boekhorst in the initiation phase of the project, so that a total of 100% is created. The experts are asked to divide the sustainable dimensions in percentages, because this gives a more accurate score than a division in ranking. Since there are only three sustainable dimensions assessed a division in percentages is not as hard and time consuming, as it would be with dividing the SPIs.

$$Average\ score = \frac{\sum_{i=Sustainable\ dimension\ \%\ given\ by\ expert\ 1}^{n=number\ of\ consulted\ experts}(\%\ by\ expert_i)}{n}$$

The sustainable dimension importance and in this case the weight is converted from 0 to 1 with the following formula:

$$Dimension\ weight_i = \frac{Average\ score_i}{Sum\ Average\ score}$$

APPENDIX B.2.4. SUSTAINABILITY DIMENSION SCORE

For each sustainability dimension, the score is determined by adding the multiplication of each measures score on each SPI with the SPI weight:

$$Total\ sustainability\ dimension\ score = \sum_{i=1}^{n=3}(SPI\ score_i * SPI\ weight_i)$$

The outcomes of the total sustainability score can lie between -3 and 3.

APPENDIX B.2.5. MEASURES TOTAL SUSTAINABILITY SCORE

The total sustainability score is determined by adding the multiplication of each measures score on each sustainable dimension with the sustainable dimensions weight:

$$Total\ sustainability\ score = \sum_{i=1}^{n=3}(sustainability\ dimension\ score_i * sustainability\ dimension\ weight_i)$$

The outcomes of the total sustainability score can lie between -3 and 3.

APPENDIX C. AMBITION COMPARISON FOR KOKON AND MUNICIPALITY

Based on table 3.1 in chapter 3 the ambitionweb of Kokon is formed in Figure C.1. In this ambitionweb the current sustainability level and the aimed ambitionlevel are the same as in Figure 3.1. Only the required ambition has a lower ambitionlevel of 0,5 on the theme energy. Because only the required ambition level is different only this level is explained.

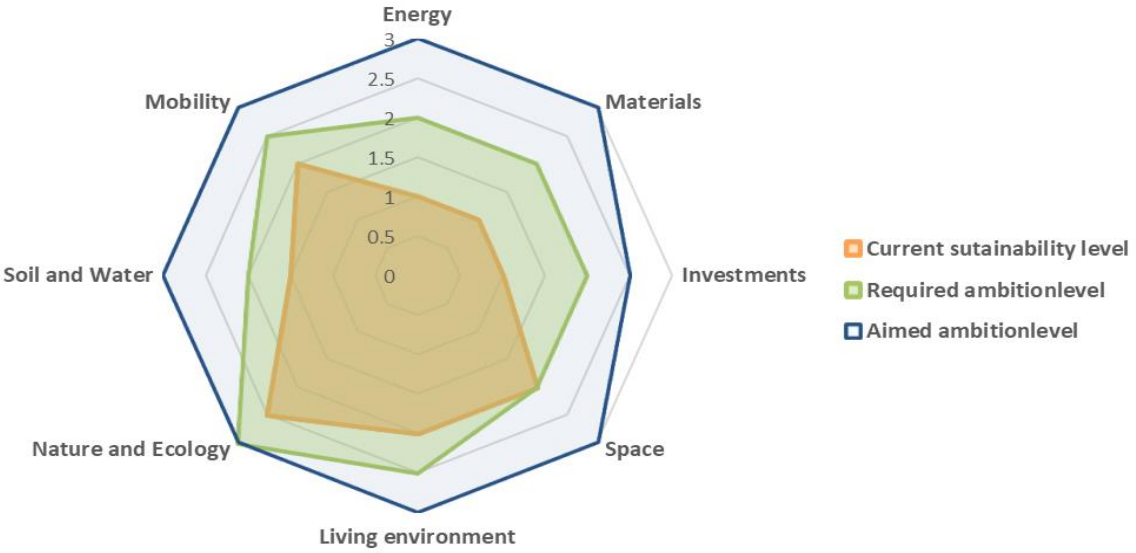

FIGURE C.1 AMBITIONLEVELS OF KOKON

For Kokon Nature and Ecology is the most important with a score of 3. Living environment and mobility are next with an ambitionlevel of 2,5, then come energy, materials, investments, space and soil and water with a minimum ambitionlevel of 2.

The ambitionlevel of municipality Teylingen is described in the column required ambition level in Table 3.1. Their ambitions on the themes are visualized in Figure C.2. The municipality has the heighest ambition on energy with an ambition of 2,5. This is because they aspire geothermic energy. On the themes materials, space, living environment and mobility the municipality has an ambitionlevel of 2. Next the municipality has an ambition of 1,5 on the theme soil and water. The municipality has the least ambitions on the theme investments. There they have an ambitionlevel of 1.

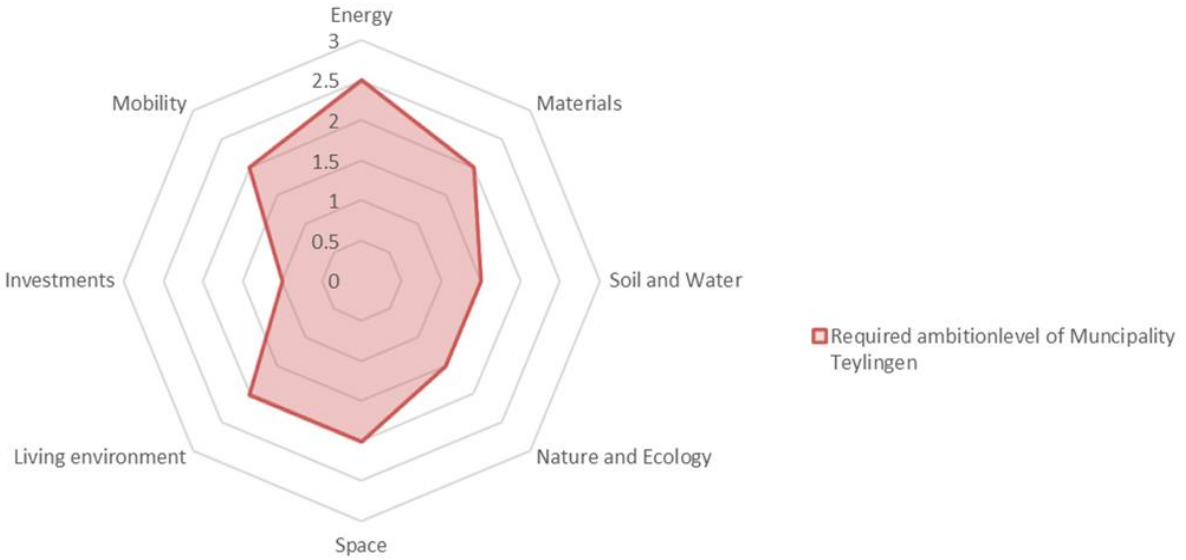

FIGURE C.2 AMBITIONS OF MUNICIPALITY TEYLINGEN

Figure C.3 shows both the required ambitions of Kokon and municipality Teylingen. On the themes energy, materials and space both the ambition of Kokon and the municipality are the same. However, on the theme soil and water the ambition of the municipality Teylingen is higher than the ambition of Kokon. When proposing measures on the part of soil and water, the advice is based on the ambition of the municipality. On the themes nature and ecology, living environment, investments and mobility the ambition of Kokon is higher than the ambition of the municipality. To make sure both Kokon and municipality Teylingen are satisfied with the spatial design and plans for Boekhorst, all the outer ambitionlevels are considered normative. The normative ambitionlevels are shown in Table C.1.The required ambitionlevel, and thus the normative ambitionlevel, based on the ambitions of Kokon and the municipality is shown in Figure C.4.

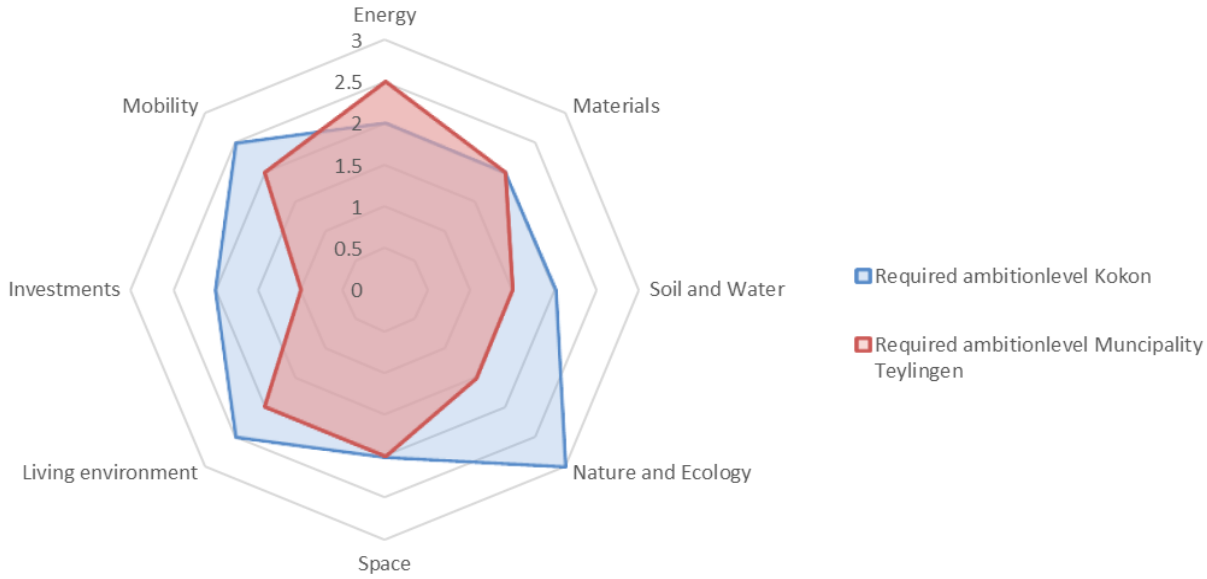

FIGURE C.3 REQUIRED AMBITIONS OF KOKON AND MUNICIPALITY TEYLINGEN

TABLE C.1 NORMATIVE AMBITOINLEVEL BASED ON KOKON AND MUNICIPALITY TEYLINGEN

Ambition theme	Ambitionlevelto meet
Energy	2,5
Materials	2
Investments	2
Space	2
Living environment	2,5
Nature and Ecology	3
Soil and water	2
Mobility	2,5

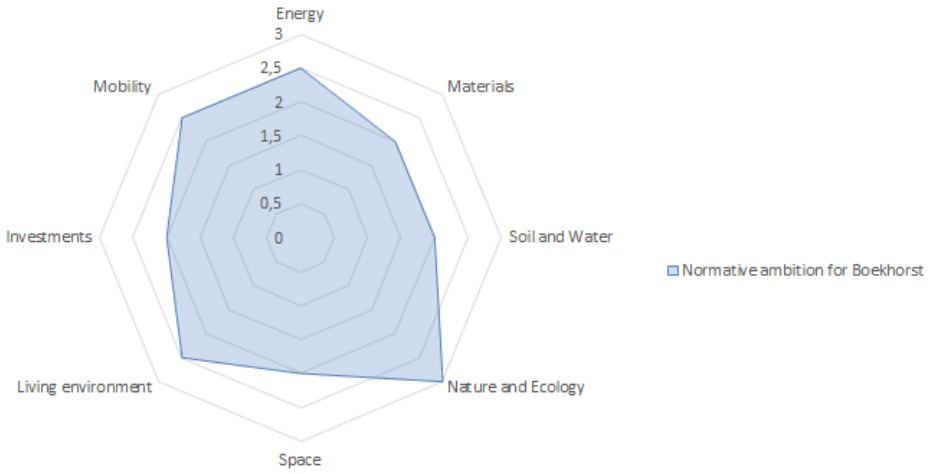

FIGURE C.4 NORMATIVE AMBITION FOR BOEKHORST

APPENDIX D. MEASURES FOR CONSIDERATION IN BUILDINGS

TABLE D.1 SUSTAINABLE MEASURES TO IMPLEMENT WITHIN BUILDINGS

Measure	Advantages	Disadvantages	Source
Tiles from old PET bottles	• Prevent waste • Less energy needed in production and demolition • Warm marble look	• Only available in 3 colours • Production costs unknown • Recently developed (in 2017), so long-term effects unknown • Low capacity production	• New Marble (2018) • Cobouw (2017)
Translucent concrete that provides support and insulation	• Provide strength • Less heating needed • Aesthetic	• Cannot be made on site • High production costs	• zospeum (2018) • Do ityourself (2018) • Zielinska & Ciesielski (2017)
Wall of rammed earth	• Easily identifiable appearance • Natural and plentiful resource • Low carbon emissions associated with manipulating, delivering and building with material • Material reusable when building is demolished • Due to high moisture mass, the humidity of the building is well regulated	• Issues have arisen about its durability, particularly during extreme weather conditions • Other construction materials are needed to help stabilise a structure made out of rammed earth • Not a popular construction technique in the EU, therefore may be	• Vereniging Aardehuis (2018) • Walsh (2012)

	• Good at regulating internal temperature of buildings • Airtight construction is possible	unstable in certain EU conditions • Unable to be fully insulated without additional materials (i.e polystyrene insulation) • Only certain types of soil can be used in construction of this type • Construction labour can be expensive due to quality regulations • Longer construction process	
Sun boiler	• Use the free energy of the sun to heat your water • Lower monthly electric (or gas) utility bills • Great for climates that receive a lot of sunshine • Federal tax credits help lower upfront cost, and there are often local incentives that also help offset part of the initial investment • Investment costs earned back in 10-15 years	• Tank takes up more space than tankless units • Higher up front cost for equipment & installation • May not have as great of performance in climates that do not receive a lot of sunshine • Tank can produce a significant amount of heat, so its location will need to be planned accordingly • More equipment = more maintenance	• Vereniging de Buitenkans (2018) • Greenne (2018) • Laminack (2011)
Boiler with air heat pump	• Prevention of legionella • Lower running costs • Less maintenance than combustion heating • Safer than combustion heating • Reduce carbon emissions • Provide cooling • Long life span	• Investment costs • Knowledge needed for instalment • Damaging fluids needed • Less efficient with cold weather	• Gemeente Rijswijk (2018) • Greenmatch (2014) • Van der Burg (2018)
Energy Paint that changes colour based on temperature: white in the summer to repel sun energy and black in the winter to absorb sun energy	• Less heating and ventilation needed • Maintenance costs	• Changeable colours (only 2) • Darkness during winter	• Voorma (2016) • Mortimer (2018)

Shower heat recovery (warmetterugwinning = WTW)	• Less heating from boiler required	• Special pipe investment needed	Gemeente Rijswijk (2017)
WTW+ in windows frames	• Financing available • Easy instalment • Less heating required • Comfortable climate	• Investment costs	• Rijksdienst voor Ondernemend Nederland (2010) • Installatieprofs (2015)
Infra-red heating in less used places in house	• Less energy needed • Fast heating	• Strategic placing needed, because of focused heating	• Milieu Centraal (2018)
Wall and ground heating	• Comfortable heating • Evenly distributed heating	• Longer warm up time	• Vereniging de Buitenkans (2018) • OVO Energy (2018)
High efficient insulation	• Less heating needed, thus emission reduction • Eliminate inner condensation in walls and prevent mould • Improvement of acoustic properties	• Investment costs dependent on the choice of insulation material	• Van der Burg (2018) • Azkorra et al. (2015)

APPENDIX E.1. MCA CONDUCTION FOR THE ENVIRONMENTAL DIMENSION

APPENDIX E.1.1. ENVIRONMENTAL SPI WEIGHT DETERMINATION

TABLE E.1 ENVIRONMENTAL SPI IMPORTANCE SCORE

	Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**		**Average score**	**SPI importance = Average score / Sum average score**
Environmental category (1-11)									
Energy performance and efficiency strategies	2,5	1	2	2	3	3		2,3	**0,034091**
Water and wastewater efficiency strategies	5	3	4	6,5	3	4		4,3	**0,064394**
Regional (local) materials	10	7	11	11	7,5	7		8,9	**0,135101**
Renewable materials	8	4	8	6,5	7,5	6		6,7	**0,10101**
Waste management	9	9	10	8,5	7,5	8		8,7	**0,131313**
Greenhouse gas emissions	6,5	8	1	4,5	10,5	1		5,3	**0,079545**
Site disruption and appropriate strategies	1	6	5	2	3	9		4,3	**0,065657**
Renewable energy use	2,5	2	3	2	3	2		2,4	**0,036616**
Material consumption in Construction	11	10	9	4,5	3	10		7,9	**0,119949**
Alternative transportation	4	11	6	10	10,5	5		7,8	**0,117424**
Heat stress efficiency strategies	6,5	5	7	8,5	7,5	11		7,6	**0,114899**
Sum								66,0	**1**

TABLE E.2 ENVIRONMENTAL SPI IMPORTANCE COMPARISON

	Energy performance and efficiency strategies	**Water and wastewater efficiency strategies**	**Regional (local) materials**	**Renewable materials**	**Waste management**	**Greenhouse gas emissions**	**Site disruption and appropriate strategies**	**Renewable energy use**	**Material consumption in Construction**	**Alternative transportation**	**Heat stress efficiency strategies**
Energy performance and efficiency strategies	1	1,888 8889	3,962 963	2,962 963	3,851 852	2,333 333	1,925 926	1,074 074	3,518 519	3,444 444	3,370 37
Water and wastewater efficiency strategies	0,529 412	1	2,098 039	1,568 627	2,039 216	1,235 294	1,019 608	0,568 627	1,862 745	1,823 529	1,784 314
Regional (local) materials	0,252 336	0,476 6355	1	0,747 664	0,971 963	0,588 785	0,485 981	0,271 028	0,887 85	0,869 159	0,850 467
Renewable materials	0,337 5	0,637 5	1,337 5	1	1,3	0,787 5	0,65	0,362 5	1,187 5	1,162 5	1,137 5
Waste management	0,259 615	0,490 3846	1,028 846	0,769 231	1	0,605 769	0,5	0,278 846	0,913 462	0,894 231	0,875
Greenhouse gas emissions	0,428 571	0,809 5238	1,698 413	1,269 841	1,650 794	1	0,825 397	0,460 317	1,507 937	1,476 19	1,444 444
Site disruption and appropriate strategies	0,519 231	0,980 7692	2,057 692	1,538 462	2	1,211 538	1	0,557 692	1,826 923	1,788 462	198
Renewable energy use	0,931 034	1,758 6207	3,689 655	2,758 621	3,586 207	2,172 414	1,793 103	1	3,275 862	3,206 897	3,137 931
Material consumption in Construction	0,284 211	0,536 8421	1,126 316	0,842 105	1,094 737	0,663 158	0,547 368	0,305 263	1	0,978 947	0,957 895
Alternative transportation	0,290 323	0,548 3871	1,150 538	0,860 215	1,118 28	0,677 419	0,559 14	0,311 828	1,021 505	1	0,978 495
Heat stress efficiency strategies	0,296 703	0,560 4396	1,175 824	0,879 121	1,142 857	0,692 308	0,005 051	0,318 681	1,043 956	1,021 978	1
Sum	5,128 937	9,687 9915	20,32 579	15,19 685	19,75 59	11,96 752	9,311 574	5,508 858	18,04 626	17,66 634	213,5 364

TABLE E.3 NORMALIZED TABLE ENVIRONMENTAL SPI IMPORTANCE COMPARISON

	Energy performance and efficiency strategies	Water and wastewater efficiency strategies	Regional (local) materials	Renewable materials	Waste management	Greenhouse gas emissions	Site disruption and appropriate strategies	Renewable energy use	Material consumption in Construction	Alternative transportation	Heat stress efficiency strategies	Weight environmental SPI
Energy performance and efficiency strategies	0,194 972	0,194 9722	0,194 972	0,194 972	0,194 972	0,194 972	0,206 831	0,194 972	0,194 972	0,194 972	0,015 784	**0,179 76**
Water and wastewater efficiency strategies	0,103 221	0,103 2206	0,103 221	0,103 221	0,103 221	0,103 221	0,109 499	0,103 221	0,103 221	0,103 221	0,008 356016	**0,095 167**
Regional (local) materials	0,049 199	0,049 1986	0,049 199	0,049 199	0,049 199	0,049 199	0,052 191	0,049 199	0,049 199	0,049 199	0,003 983	**0,045 36**
Renewable materials	0,065 803	0,065 8031	0,065 803	0,065 803	0,065 803	0,065 803	0,069 806	0,065 803	0,065 803	0,065 803	0,005 327	**0,060 669**
Waste management	0,050 618	0,050 6178	0,050 618	0,050 618	0,050 618	0,050 618	0,053 697	0,050 618	0,050 618	0,050 618	0,004 098	**0,046 669**
Greenhouse gas emissions	0,083 56	0,083 5595	0,083 56	0,083 56	0,083 56	0,083 56	0,088 642	0,083 56	0,083 56	0,083 56	0,006 764	**0,077 04**
Site disruption and appropriate strategies	0,101 236	0,101 2356	0,101 236	0,101 236	0,101 236	0,101 236	0,107 393	0,101 236	0,101 236	0,101 236	0,927 242	**0,176 887**
Renewable energy use	0,181 526	0,181 5258	0,181 526	0,181 526	0,181 526	0,181 526	0,192 567	0,181 526	0,181 526	0,181 526	0,014 695	**0,167 363**
Material consumption in Construction	0,055 413	0,055 4131	0,055 413	0,055 413	0,055 413	0,055 413	0,058 784	0,055 413	0,055 413	0,055 413	0,004 486	**0,051 09**
Alternative transportation	0,056 605	0,056 6048	0,056 605	0,056 605	0,056 605	0,056 605	0,060 048	0,056 605	0,056 605	0,056 605	0,004 582	**0,052 189**
Heat stress efficiency strategies	0,057 849	0,057 8489	0,057 849	0,057 849	0,057 849	0,057 849	0,000 542	0,057 849	0,057 849	0,057 849	0,004 683	**0,047 806**
Sum	1	1	1	1	1	1	1	1	1	1	1	1

APPENDIX E.1.2. ENVIRONMENTAL MEASURE MCA SCORE

TABLE E.4 MCA FOR THE ENVIRONMENTAL DIMENSION

Indicator	Energy performance and efficiency strategies	Water and wastewater efficiency strategies	Regional (local) materials	Renewable materials	Waste management	Greenhouse gas emissions	Site disruption and appropriate strategies	Renewable energy use	Material consumption in Construction	Alternative transportation	Heat stress efficiency strategies	Environmental score
Weight	**0,18**	**0,10**	**0,05**	**0,06**	**0,05**	**0,08**	**0,18**	**0,17**	**0,05**	**0,05**	**0,05**	
Measure												
1. Energy												
Insights												
Feasibility study into renewable energy	2	0	0	0	0	3	0	3	0	0	0	**1,09**
CO2 emissions calculation with DuboCalc or a comparable program	2	0	3	3	3	3	0	1	2	1	0	**1,37**
CO2 emission mapping of maintenance work, work process and waste processing.	1	0	1	1	3	3	0	1	1	1	0	**0,93**
Management												
Efficient use of building tools/construction machines: switch them of when they are not needed	3	0	0	0	0	3	2	0	0	0	0	**1,12**
fuel/energy-efficient construction and machinery	2	0	0	0	0	3	0	2	0	0	0	**0,93**
Design												
Prioritization of walking and cycling in the design instead of car usage	0	0	0	0	0	3	0	0	0	3	0	**0,39**
Pipe length reduction of heating and ventilation systems	3	0	0	0	0	1	0	0	3	0	0	**0,77**
Windows on the south side of buildings with trees in front of them	3	0	0	0	0	3	0	0	0	0	1	**0,82**
Hot/cold networks:												
Asphalt heat	3	0	0	0	0	3	1	3	-1	0	1	**1,45**
Riothermia: extract heat from waste water in the sewerage system	2	2	0	-1	1	2	1	2	-1	0	0	**1,15**
Surface water heating	2	2	0	0	0	2	-1	2	1	0	1	**0,96**
Geothermal heating	3	1	0	-1	0	3	0	2	-2	0	0	**1,04**

Compressed air for underground heat storage	3	-1	0	0	0	3	0	2	-1	0	0	**0,96**
Sun-/PV-panels	3	-1	0	-1	0	3	0	2	-1	0	0	**0,90**
Smart Grid	3	0	0	0	1	3	2	2	0	0	0	**1,51**
Domotica systems	3	0	0	-1	0	3	2	0	0	1	0	**1,12**
Led lighting/ lights with integrated solar panels and battery	3	0	-1	-3	0	3	1	0	-1	1	0	**0,72**
Multipurpose charging stations with LED lighting	3	0	-1	-3	0	2	1	0	-1	2	0	**0,70**
Smart Energy Floor	1	-1	-1	-3	0	0	0	2	-1	1	0	**0,19**
2. Materials												
Insights												
Materials passport	2	0	3	3	2	2	0	0	2	0	0	**1,03**
Material loss chart of production	1	0	1	2	3	0	0	0	2	0	0	**0,59**
Material origin substantiation	0	0	3	1	0	1	0	0	0	1	0	**0,33**
Life cycle analysis (LCA)	2	0	2	3	2	2	0	1	2	1	0	**1,20**
Management												
Waste management plan	2	1	0	2	3	0	1	0	2	0	0	**1,00**
Circular building materials	1	0	0	3	3	1	0	0	2	0	0	**0,68**
Design												
Flexible building	0	0	0	0	2	0	2	0	0	0	1	**0,49**
New objects made from cut down trees	0	0	3	3	3	1	1	0	3	0	0	**0,87**
Shared sheds containing shared tools that people need occasionally	1	0	0	0	3	0	0	0	2	0	0	**0,42**
Smart led lighting to show half hardened parking spots	0	1	0	0	0	0	1	0	0	0	0	**0,27**
Roadway of reinforced grass or water-permeable paving (half open paving)	0	3	0	0	0	0	2	0	2	0	2	**0,84**
Narrow walking strip in baked bricks	0	2	2	1	0	-1	2	0	0	2	1	**0,77**
Mineral Olivine to absorb CO2	0	0	-2	-1	0	3	0	0	0	0	1	**0,13**
Verge cuttings recycling	0	0	3	3	2	0	1	0	0	0	1	**0,64**
3. Water												
Insights												
Water resource investigation (with a water-resource evaluation matrix)	0	3	0	0	0	0	3	0	0	0	1	**0,86**
Impact assessment	0	3	1	0	0	1	3	0	0	0	1	**0,99**
Groundwater ambitionlevel analyzation	0	3	0	0	0	0	2	0	0	0	0	**0,64**
Design												

Roadway of reinforced grass or water-permeable paving (half open paving)	0	3	0	0	0	0	2	0	2	0	2	**0,84**
Green gardens without (much) pavement	0	3	1	3	2	0	3	0	3	0	3	**1,43**
Existing water enlargement	0	3	0	0	0	0	3	0	-1	1	1	**0,87**
Pond for water capture with open space to relax	0	3	0	0	0	1	3	0	-1	0	2	**0,94**
Separate sewer for grey and black water	0	3	0	0	3	0	2	0	-1	0	1	**0,78**
Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wade's to infiltrate in the soil	0	3	0	0	1	0	3	0	-1	0	1	**0,86**
Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc.	1	3	2	3	2	1	2	0	-1	0	2	**1,31**
Water storage for rain water to use in black (toilet) water systems	2	3	0	0	0	1	1	0	-1	0	0	**0,85**
4. Soil												
Insights												
Environmental Impact Assessment (EIA) with water and soil as subject of protection	0	3	0	0	2	2	1	0	2	0	2	**0,91**
Management												
Green area prioritization in urban planning	0	0	2	3	0	2	3	0	2	1	3	**1,26**
Reduction areas for soil consumption (soil sealing)	0	0	2	1	1	0	2	0	2	0	0	**0,65**
Demolition practice plan	1	0	0	1	3	1	2	0	1	0	0	**0,86**
5. Nature and Ecology												
Insights												
Quickscan: Inventory the current flora & fauna	0	0	3	1	0	0	2	0	0	0	0	**0,55**
Ecological target type determined	0	0	0	0	0	0	1	0	0	0	0	**0,18**
Agricultural backgrounds with natural values inventory	0	0	0	0	0	0	3	0	0	0	0	**0,53**
Management												
Management scheme for the maintaining of the diversity of urban nature	0	0	0	0	0	0	3	0	0	0	2	**0,63**
Noise nuisance prevention	0	0	0	0	0	0	3	0	0	0	0	**0,53**
Compost plants	0	0	2	1	3	2	3	0	1	0	0	**1,03**
Adoption green	0	1	0	0	0	2	3	0	3	0	3	**1,08**

Garden layout support for residents	0	1	2	1	1	2	2	0	1	0	1	**0,90**
Maintenance plan to promote ecological quality	0	0	0	0	1	3	3	0	0	0	1	**0,86**
Design												
Waste bins integrated in the design to reduce waste damage	0	0	0	0	3	0	1	0	0	0	0	**0,32**
Variation in landscape	0	0	0	0	0	0	3	0	0	2	1	**0,68**
Plant species that increase biodiversity and better the living environment	0	0	1	2	0	2	3	0	1	0	1	**0,95**
Greenery diversity with native trees, shrubs, perennials and seeds	0	0	3	2	0	2	3	0	1	0	2	**1,09**
Green and blue dry and wet spots realization	0	3	0	0	0	2	3	0	0	1	2	**1,12**
Reed edge in water	0	0	1	2	0	2	3	0	0	0	2	**0,95**
Pond for water capture with open space to relax	0	3	0	0	0	1	3	0	-1	0	2	**0,94**
Hedge with various native species	0	0	3	2	0	2	3	0	0	0	2	**1,04**
Streetscape greenery	0	0	1	1	0	2	3	0	0	1	2	**0,94**
Nature-friendly banks	0	0	1	0	0	1	3	0	0	1	1	**0,75**
Free migration stimulation	0	0	1	2	0	1	3	0	0	0	2	**0,87**
Bee strips	0	0	1	1	0	1	2	0	0	0	2	**0,63**
Flora and fauna in relation to target species	0	0	2	1	0	1	2	0	0	0	2	**0,68**
6. Space												
Design												
Design based on the environment	0	2	2	0	2	0	3	0	0	1	1	**1,01**
Flexible plan to build question based	0	0	0	1	1	1	1	0	2	0	1	**0,51**
Reduced parking norm	0	0	0	0	0	1	1	0	2	2	0	**0,46**
(Electric) Car sharing (in collaboration with companies)	0	0	0	1	0	0	0	0	1	1	0	**0,16**
Small private garden, large community garden	0	1	1	0	0	0	2	0	2	1	2	**0,74**
Flexible building (for example demountable)	0	0	0	0	2	0	2	0	0	0	1	**0,49**
7. Mobility												
Design												
Safe intersections	0	-1	0	0	0	0	-1	0	-1	1	0	**-0,27**
Fast cycling lanes to promote cycling to the centre of Voorhout	0	-1	0	0	0	2	-1	0	-1	3	0	**-0,01**
Bicycle parking spots	0	0	0	0	0	2	-1	0	-1	2	0	**0,03**

Access to public transport	0	0	0	0	0	2	0	0	1	3	0	**0,36**
Shared working space	0	0	0	0	0	2	-2	0	-2	1	-1	**-0,30**
(Electric) Car sharing (in collaboration with companies)	0	0	0	1	0	0	0	0	1	1	0	**0,16**
Sharing bikes	0	0	0	1	0	1	0	0	1	2	0	**0,29**
Aesthetic signs for easy way finding and to stimulate waking	0	0	2	2	0	1	0	0	-1	1	0	**0,29**
8. Living environment												
Insights												
Background noise map	0	0	0	0	0	0	3	0	0	0	0	**0,53**
Management												
Noise nuisance prevention	0	0	0	0	0	0	3	0	0	0	0	**0,53**
Heat and cold warning mechanism and strategy plan to react	0	0	0	0	0	0	3	0	0	0	3	**0,67**
Design												
Different function options in the environment	0	0	0	0	0	0	3	0	0	1	0	**0,58**
Flexible design, so that space can be used different in the future	0	0	0	0	2	0	2	0	0	0	1	**0,49**
Daylight accessible	3	0	0	0	0	0	0	3	0	0	0	**1,04**
Suitable trails for rollators, wheelchairs and mobility scooters	0	0	0	0	0	2	-1	0	-1	3	0	**0,08**
Fast cycling lanes to promote cycling to the centre of Voorhout	0	-1	0	0	0	2	-1	0	-1	3	0	**-0,01**
Community gardens	0	3	1	2	1	0	2	0	1	1	3	**1,10**
Shared working space	0	0	0	0	0	2	-2	0	-2	1	-1	**-0,30**
Community centre as a central meeting place and to organise activities, such as cooking, community eating, tv watching, yoga, drama class, a drink, etc.	0	-1	0	0	0	0	-2	0	-1	0	-1	**-0,55**
Virtual meeting place to organise activities in neighbourhood and community house (internet and app)	0	0	0	2	0	0	0	0	0	0	0	**0,12**
Small private garden, large community garden	0	1	1	0	0	0	2	0	2	1	2	**0,74**
Communal gardens for food production	0	3	1	0	2	0	2	0	1	0	3	**0,97**
Activity spaces	0	0	0	0	0	1	0	0	-1	1	0	**0,08**
Pet-friendly environment	0	0	0	0	0	0	0	0	0	0	2	**0,10**

Outdoor playing and sport places	0	0	0	0	0	0	0	0	0	0	1	**0,05**
Sound barrier around road	0	0	0	0	0	0	2	0	-2	0	0	**0,25**
Public toilet available, possibly in community Centre	0	0	0	0	0	0	-1	0	-1	2	0	**-0,12**
Adequate and uniform lighting conditions	2	0	0	0	0	0	3	0	0	1	0	**0,94**
Art	0	0	1	1	0	0	0	0	-1	0	0	**0,05**
9. Investments												
Insights												
Long term budget and look at the long-term investments	0	0	0	0	0	0	0	0	0	0	0	**0,00**
LCC for the planning, construction, usage and demolition phase.	0	0	0	2	2	0	0	0	2	0	0	**0,32**
Management												
Measures for which subsidy is given	1	1	0	1	0	2	1	1	0	0	1	**0,88**
Budget to prevent harm on area interests	0	1	1	0	1	1	1	0	0	0	0	**0,44**
Educational value through visible sustainable measures	0	0	0	0	0	0	0	0	0	0	0	**0,00**
Design												
Room for co-creation with inhabitants	0	1	1	1	0	1	1	1	0	1	1	**0,72**
Recyclable products	1	0	0	3	2	1	0	0	0	0	0	**0,53**

APPENDIX E.2. MCA CONDUCTION FOR THE ECONOMIC DIMENSION

APPENDIX E.2.1. ECONOMIC SPI WEIGHT DETERMINATION

TABLE E.5 ECONOMIC SPI IMPORTANCE SCORE

	Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**		**Average score**	**SPI importance = Average score / Sum average score**
Economic category (1-9)									
Design and construction time	7	5	8	8,5	1,5	7		6,2	**0,137037**
Design and construction costs	6	2	6	8,5	1,5	6		5,0	**0,111111**
Operational costs	4	1	4	5,5	5	2		3,6	**0,07963**
Maintenance costs	3	3	5	5,5	5	3		4,1	**0,090741**
End of life costs	8	8	7	5,5	5	5		6,4	**0,142593**
Durability of the measure	1	6	1	2,5	5	4		3,3	**0,072222**
Investment and related risks	5	7	2	2,5	8,5	8		5,5	**0,122222**
Flexibility	2	4	3	1	5	1		2,7	**0,059259**
Required skills and knowledge	9	9	9	5,5	8,5	9		8,3	**0,185185**
Sum								45,0	1

TABLE E.6 ECONOMIC SPI IMPORTANCE COMPARISON

	Design and construction time	Design and construction costs	Operational costs	Maintenance costs	End of life costs	Durability of the measure	Investment and related risks	Flexibility	Required skills and knowledge
Design and construction time	1	0,8	0,58	0,66	1,04	0,53	0,89	0,43	1,3514
Design and construction costs	1,2	1	0,72	0,82	1,28	0,65	1,1	0,53	1,6667
Operational costs	1,7	1,4	1	1,14	1,97	0,91	1,53	0,74	2,3256
Maintenance costs	1,5	1,2	0,88	1	1,57	0,8	1,35	0,65	2,0408
End of life costs	1	0,8	0,51	0,64	1	0,51	0,86	0,42	1,2987
Durability of the measure	1,9	1,5	1,1	1,26	1,97	1	1,69	0,82	2,5641
Investment and related risks	1,1	0,9	0,65	0,74	1,17	0,59	1	0,48	1,5152
Flexibility	2,3	1,9	1,34	1,53	2,41	1,22	2,06	1	3,125
Required skills and knowledge	0,7	0,6	0,43	0,49	0,77	0,39	0,66	0,32	1
SUM	**12**	**10**	**7,21**	**8,27**	**13,2**	**6,59**	**11,1**	**5,4**	**16,887**

TABLE E.7 NORMALIZED TABLE ECONOMIC SPI IMPORTANCE COMPARISON

	Design and construction time	Design and construction costs	Operational costs	Maintenance costs	End of life costs	Durability of the measure	Investment and related risks	Flexibility	Required skills and knowledge	Weight economic SPI
Design and construction time	0,1	0,1	0,08	0,08	0,08	0,08	0,08	0,08	0,08	**0,079962**
Design and construction costs	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,0987	**0,09862**
Operational costs	0,1	0,1	0,14	0,14	0,15	0,14	0,14	0,14	0,1377	**0,139131**
Maintenance costs	0,1	0,1	0,12	0,12	0,12	0,12	0,12	0,12	0,1208	**0,120767**
End of life costs	0,1	0,1	0,07	0,08	0,08	0,08	0,08	0,08	0,0769	**0,076055**
Durability of the measure	0,2	0,2	0,15	0,15	0,15	0,15	0,15	0,15	0,1518	**0,151724**
Investment and related risks	0,1	0,1	0,09	0,09	0,09	0,09	0,09	0,09	0,0897	**0,089655**
Flexibility	0,2	0,2	0,19	0,19	0,18	0,19	0,19	0,19	0,185	**0,184913**
Required skills and knowledge	0,1	0,1	0,06	0,06	0,06	0,06	0,06	0,06	0,0592	**0,059172**
SUM	1	1	1	1	1	1	1	1	1	1

APPENDIX E.2.2. ECONOMIC MEASURE MCA SCORE

TABLE E.8 MCA FOR THE ECONOMIC DIMENSION

Indicator	Design and construction time	Design and construction costs	Operational costs	Maintenance costs	End of life costs	Durability of the measure	Investment and related risks	Flexibility	Required skills and knowledge	Economic score
Weight	**0,08**	**0,10**	**0,14**	**0,12**	**0,08**	**0,15**	**0,09**	**0,18**	**0,06**	
Measure										
1. Energy										
Insights										
Feasibility study into renewable energy	-1	1	1	2	3	3	3	3	2	**2,02**
CO2 emissions calculation with DuboCalc or a comparable program	-1	1	2	1	3	3	3	2	2	**1,86**
CO2 emission mapping of maintenance work, work process and waste processing.	-1	1	2	2	3	3	3	2	2	**1,98**
Management										**0,00**
Efficient use of building tools/construction machines: switch them of when they are not needed	0	1	3	0	1	0	3	2	3	**1,41**
fuel/energy-efficient construction and machinery	0	1	2	0	1	0	3	2	3	**1,27**
Design										
Prioritization of walking and cycling in the design instead of car usage	-1	-1	1	0	-1	1	3	1	3	**0,67**
Pipe length reduction of heating and ventilation systems	-2	-1	2	4	2	1	3	-4	1	**0,40**
Windows on the south side of buildings with trees in front of them	0	1	3	4	3	3	3	4	5	**2,99**
Hot/cold networks:										**0,00**
Asphalt heat	-1	0	1	0	0	1	1	2	1	**0,73**
Riothermia: extract heat from waste water in the sewerage system	-2	0	0	0	0	2	-1	0	1	**0,11**
Surface water heating	-1	-1	0	-1	0	1	-2	3	1	**0,29**
Geothermal heating	-3	-3	0	0	0	3	0	-3	0	**-0,64**

Compressed air for underground heat storage	-3	-1	0	0	0	3	0	-3	-1	**-0,50**
Sun-/PV-panels	3	-1	0	-1	-1	2	2	2	3	**0,97**
Smart Grid	1	-1	2	0	0	3	2	3	1	**1,51**
Domotica systems	1	-1	2	0	0	2	2	3	1	**1,36**
Led lighting/ lights with integrated solar panels and battery	3	1	1	0	0	2	2	2	3	**1,51**
Multipurpose charging stations with LED lighting	2	-1	1	0	0	2	2	1	2	**0,99**
Smart Energy Floor	3	-1	0	-1	-1	1	1	0	1	**0,24**
2. Materials										
Insights										
Materials passport	-2	-1	5	5	4	5	4	3	4	**3,25**
Material loss chart of production	-2	1	5	5	5	5	5	5	4	**3,99**
Material origin substantiation	-1	1	5	5	1	5	5	3	4	**3,39**
Life cycle analysis (LCA)	-3	4	5	5	5	5	5	5	4	**4,20**
Management										
Waste management plan	4	1	5	1	5	4	5	5	5	**3,89**
Circular building materials	0	0	0	2	5	5	1	2	4	**2,08**
Design										**0,00**
Flexible building	4	4	3	0	4	5	4	5	3	**3,66**
New objects made from cut down trees	1	5	1	3	4	5	5	1	5	**3,07**
Shared sheds containing shared tools that people need occasionally	0	2	5	1	1	4	3	3	3	**2,70**
Smart led lighting to show half hardened parking spots	1	-1	3	-1	0	0	1	2	5	**1,03**
Roadway of reinforced grass or water-permeable paving (half open paving)	3	2	5	-2	3	4	4	2	2	**2,57**
Narrow walking strip in baked bricks	3	2	5	0	3	3	4	2	4	**2,78**
Mineral Olivine to absorb CO2	3	-2	5	3	0	5	-1	3	4	**2,56**
Verge cuttings recycling	5	5	5	5	5	5	4	5	3	**4,79**
3. Water										
Insights										
Water resource investigation (with a water-resource evaluation matrix)	-2	4	-1	5	5	5	5	0	0	**2,29**
Impact assessment	-3	3	-1	5	5	5	5	0	0	**2,11**
Groundwater ambitionlevel analyzation	-3	4	-1	5	1	2	5	0	0	**1,45**
Design										

Roadway of reinforced grass or water-permeable paving (half open paving)	3	2	5	-2	3	4	4	2	4	**2,69**
Green gardens without (much) pavement	5	5	2	-1	5	3	5	4	5	**3,37**
Existing water enlargement	0	0	0	-2	5	5	0	5	3	**2,00**
Pond for water capture with open space to relax	0	0	0	-2	5	5	5	5	3	**2,45**
Separate sewer for grey and black water	0	0	0	-1	4	5	5	3	2	**2,06**
Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wade's to infiltrate in the soil	0	0	0	-1	1	5	5	4	3	**2,08**
Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc.	0	0	0	-1	4	3	5	3	5	**1,94**
Water storage for rain water to use in black (toilet) water systems	0	0	0	0	3	3	3	2	5	**1,62**
4. Soil										
Insights										
Environmental Impact Assessment (EIA) with water and soil as subject of protection	0	2	3	5	5	3	4	4	5	**3,45**
Management										
Green area prioritization in urban planning	-1	0	0	3	5	5	5	5	5	**3,09**
Reduction areas for soil consumption (soil sealing)	3	3	3	4	5	4	4	2	5	**3,45**
Demolition practice plan	3	4	0	2	5	5	4	2	4	**2,98**
5. Nature and Ecology										
Insights										
Quickscan: Inventory the current flora & fauna	-1	0	-1	0	0	2	0	3	4	**0,88**
Ecological target type determined	2	1	0	1	0	5	3	-2	4	**1,27**
Agricultural backgrounds with natural values inventory	-2	-1	-1	0	0	4	3	0	4	**0,71**
Management										
Management scheme for the maintaining of the diversity of urban nature	3	0	-1	5	0	4	4	5	-1	**2,54**
Noise nuisance prevention	-1	-2	1	0	0	4	2	-1	3	**0,64**
Compost plants	-1	1	-2	4	0	4	4	3	5	**2,04**

Adoption green	1	3	4	4	3	5	3	3	4	**3,46**
Garden layout support for residents	-2	-1	-2	0	3	3	3	4	5	**1,45**
Maintenance plan to promote ecological quality	0	-2	0	-1	1	5	4	2	-1	**1,19**
Design										
Waste bins integrated in the design to reduce waste damage	2	0	0	-1	-1	-1	5	4	5	**1,30**
Variation in landscape	-1	2	0	0	0	3	5	-2	4	**0,89**
Plant species that increase biodiversity and better the living environment	-3	0	0	0	4	3	4	-1	1	**0,75**
Greenery diversity with native trees, shrubs, perennials and seeds	-1	2	0	0	4	3	3	-1	1	**1,02**
Green and blue dry and wet spots realization	-1	-1	0	-1	4	5	4	1	2	**1,43**
Reed edge in water	-2	4	0	0	4	3	5	3	4	**2,23**
Pond for water capture with open space to relax	-3	-3	3	-1	4	5	3	-4	2	**0,47**
Hedge with various native species	-1	3	-1	0	4	3	4	3	3	**1,93**
Streetscape greenery	2	3	-1	1	4	3	4	2	4	**2,16**
Nature-friendly banks	1	3	0	0	4	4	4	0	3	**1,82**
Free migration stimulation	-1	3	3	4	4	3	2	0	2	**2,17**
Bee strips	2	3	4	4	4	4	4	-2	3	**2,57**
Flora and fauna in relation to target species	1	3	4	3	4	3	4	-1	3	**2,41**
6. Space										
Design										**0,00**
Design based on the environment	-1	4	0	2	0	5	5	2	4	**2,37**
Flexible plan to build question based	3	4	3	4	1	4	5	5	3	**3,77**
Reduced parking norm	2	5	-1	4	5	3	-2	-1	1	**1,53**
(Electric) Car sharing (in collaboration with companies)	-1	3	-1	2	5	3	0	-2	1	**0,84**
Small private garden, large community garden	4	3	3	4	3	5	-1	4	4	**3,39**
Flexible building (for example demountable)	4	4	3	0	4	5	4	5	3	**3,66**
7. Mobility										**0,00**
Design										**0,00**
Safe intersections	-3	-3	5	-2	-1	4	4	-2	5	**0,73**
Fast cycling lanes to promote cycling to the centre of Voorhout	-2	-4	5	0	-2	4	2	-1	4	**0,83**
Bicycle parking spots	-1	-1	2	0	-1	4	4	1	4	**1,41**

Access to public transport	-3	-2	-1	0	0	3	3	2	-1	**0,46**
Shared working space	-3	-4	4	-1	-1	4	0	3	2	**1,01**
(Electric) Car sharing (in collaboration with companies)	1	3	5	2	2	4	0	5	2	**3,11**
Sharing bikes	0	2	3	2	3	4	0	4	2	**2,55**
Aesthetic signs for easy way finding and to stimulate waking	-1	1	1	-1	0	2	4	4	5	**1,73**
8. Living environment										**0,00**
Insights										**0,00**
Background noise map	-2	1	2	3	0	5	4	-1	2	**1,63**
Management										**0,00**
Noise nuisance prevention	-1	0	2	0	5	5	4	-2	0	**1,33**
Heat and cold warning mechanism and strategy plan to react	3	2	5	0	5	5	4	0	3	**2,81**
Design										**0,00**
Different function options in the environment	2	2	4	0	3	5	-2	5	2	**2,76**
Flexible design, so that space can be used different in the future	3	3	1	0	3	4	5	5	3	**3,06**
Daylight accessible	0	1	5	4	5	5	5	4	5	**3,90**
Suitable trails for rollators, wheelchairs and mobility scooters	-1	-3	0	-2	-1	3	4	0	3	**0,30**
Fast cycling lanes to promote cycling to the centre of Voorhout	-2	-4	5	0	-2	4	2	-1	4	**0,83**
Community gardens	4	3	3	4	3	5	-1	4	4	**3,39**
Shared working space	-3	-4	4	-1	-1	4	0	3	2	**1,01**
Community centre as a central meeting place and to organise activities, such as cooking, community eating, tv watching, yoga, drama class, a drink, etc.	-3	-3	2	-3	-2	5	4	3	3	**1,08**
Virtual meeting place to organise activities in neighbourhood and community house (internet and app)	-2	3	3	0	0	5	5	4	3	**2,68**
Small private garden, large community garden	4	3	3	4	3	5	-1	4	4	**3,39**
Communal gardens for food production	-1	2	4	2	5	3	1	4	4	**2,82**
Activity spaces	-2	-2	0	-1	-2	4	4	2	3	**0,88**
Pet-friendly environment	2	3	2	3	3	4	5	5	3	**3,48**
Outdoor playing and sport places	-2	-2	0	-1	-2	4	4	2	3	**0,88**

Sound barrier around road	-2	-2	0	0	3	5	4	1	0	**1,17**
Public toilet available, possibly in community Centre	2	2	-2	-1	-1	5	5	-4	4	**0,59**
Adequate and uniform lighting conditions	-1	0	4	0	0	4	4	3	3	**2,17**
Art	0	-3	0	-1	0	0	0	1	3	**-0,05**
9. Investments										**0,00**
Insights										**0,00**
Long term budget and look at the long-term investments	1	1	0	1	4	1	5	3	5	**2,05**
LCC for the planning, construction, usage and demolition phase.	-2	4	4	4	4	4	3	3	3	**3,19**
Management										**0,00**
Measures for which subsidy is given	0	4	0	0	0	3	2	-1	5	**1,14**
Budget to prevent harm on area interests	0	0	2	0	0	3	0	3	4	**1,52**
Educational value through visible sustainable measures	0	0	3	0	0	3	4	2	5	**1,90**
Design										
Room for co-creation with inhabitants	2	0	4	0	0	0	0	5	5	**1,94**
Recyclable products	0	0	0	0	5	0	0	1	2	**0,68**

APPENDIX E.3. MCA CONDUCTION FOR THE SOCIAL DIMENSION

APPENDIX E.3.1. SPI WEIGHT DETERMINATION

TABLE E.9 SOCIAL SPI IMPORTANCE SCORE

	Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**		**Average score**	**SPI importance = Average score / Sum average score**
Social category (1-11)									
Health, comfort and well-being of residents	2	1	2	2,5	5,5	1		2,3	**0,035088**
Influence on the local economy	10	11	9	8,5	10	8		9,4	**0,141604**
Functionality and usability of the physical space	4	3	5	6	5,5	4		4,6	**0,068922**
Aesthetic options and beauty of the environment	9	4	8	6	5,5	3		5,9	**0,088972**
Safety and security	5	2	4	8,5	1,5	6		4,5	**0,067669**
Community disturbance	8	5	11	10,5	10	11		9,3	**0,139098**
Influence on local social development	7	9	6	6	10	2		6,7	**0,100251**
Affordability	6	8	7	1	5,5	9		6,1	**0,091479**
User acceptance and satisfaction	1	6	4	2,5	1,5	7		3,7	**0,055138**
Neighbourhood accessibility and amenities	3	7	3	4	5,5	5		4,6	**0,068922**
Educational value	11	10	10	10,5	5,5	10		9,5	**0,142857**
Sum								66,5	1

TABLE E.10 SOCIAL SPI IMPORTANCE COMPARISON

	Health, comfort and well-being of residents	**Influence on the local economy**	**Functionality and usability of the physical space**	**Aesthetic options and beauty of the environment**	**Safety and security**	**Community disturbance**	**Influence on local social development**	**Affordability**	**User acceptance and satisfaction**	**Neighbourhood accessibility and amenities**	**Educational value**
Health, comfort and well-being of residents	1	4,0357	1,9643	2,535714	1,92857	3,964286	2,85714	2,6071	1,571429	1,9643	4,0714285 7
Influence on the local economy	0,24779	1	0,4867	0,628319	0,47788	0,982301	0,70796	0,646	0,389381	0,4867	1,0088495 6
Functionality and usability of the physical space	0,50909	2,0545	1	1,290909	0,98182	2,018182	1,45455	1,3273	0,8	1	2,0727272 7
Aesthetic options and beauty of the environment	0,39437	1,5915	0,7746	1	0,76056	1,56338	1,12676	1,0282	0,619718	0,7746	1,6056338
Safety and security	0,51852	2,0926	1,0185	1,314815	1	2,055556	1,48148	1,3519	0,814815	1,0185	2,1111111 1
Community disturbance	0,25225	1,018	0,4955	0,63964	0,48649	1	0,72072	0,6577	0,396396	0,4955	1,0270270 3
Influence on local social development	0,35	1,4125	0,6875	0,8875	0,675	1,3875	1	0,9125	0,55	0,6875	1,425
Affordability	0,38356	1,5479	0,7534	0,972603	0,73973	1,520548	1,09589	1	0,60274	0,7534	1,5616438 4
User acceptance and satisfaction	0,63636	2,5682	1,25	1,613636	1,22727	2,522727	1,81818	1,6591	1	1,25	2,5909090 9
Neighbourhood accessibility and amenities	0,50909	1	1	1,290909	0,98182	2,018182	1,45455	1,3273	0,8	1	2,0727272 7
Educational value	0,24561	1	0,4825	0,622807	0,47368	0,973684	0,70175	0,6404	0,385965	0,4825	1
SUM	**5,04665**	**19,321**	**9,9131**	**12,79685**	**9,73282**	**20,00635**	**14,419**	**13,157**	**7,930443**	**9,9131**	**20,547057 5**

TABLE E.11 NORMALIZED TABLE SOCIAL SPI IMPORTANCE COMPARISON FOR SOCIAL SPI WEIGHT

	Health, comfort and well-being of residents	Influence on the local economy	Functionality and usability of the physical space	Aesthetic options and beauty of the environment	Safety and security	Community disturbance	Influence on local social development	Affordability	User acceptance and satisfaction	Neighbourhood accessibility and amenities	Educational value	Weight social SPI
Health, comfort and well-being of residents	0,19815	0,2089	0,1982	0,198151	0,19815	0,198151	0,19815	0,1982	0,198151	0,1982	0,19815142	**0,199126**
Influence on the local economy	0,0491	0,0518	0,0491	0,049099	0,0491	0,049099	0,0491	0,0491	0,049099	0,0491	0,04909947	**0,049341**
Functionality and usability of the physical space	0,10088	0,1063	0,1009	0,100877	0,10088	0,100877	0,10088	0,1009	0,100877	0,1009	0,10087709	**0,101373**
Aesthetic options and beauty of the environment	0,07814	0,0824	0,0781	0,078144	0,07814	0,078144	0,07814	0,0781	0,078144	0,0781	0,07814422	**0,078529**
Safety and security	0,10275	0,1083	0,1027	0,102745	0,10275	0,102745	0,10275	0,1027	0,102745	0,1027	0,10274518	**0,103251**
Community disturbance	0,04998	0,0527	0,05	0,049984	0,04998	0,049984	0,04998	0,05	0,049984	0,05	0,04998414	**0,05023**
Influence on local social development	0,06935	0,0731	0,0694	0,069353	0,06935	0,069353	0,06935	0,0694	0,069353	0,0694	0,06935353	**0,069694**
Affordability	0,076	0,0801	0,076	0,076003	0,076	0,076003	0,076	0,076	0,076003	0,076	0,07600328	**0,076377**
User acceptance and	0,1261	0,1329	0,1261	0,126096	0,1261	0,126096	0,1261	0,1261	0,126096	0,1261	0,12609636	**0,126717**

satisfaction												
Neighbourhood accessibility and amenities	0,10088	0,05518	0,1009	0,100877	0,10088	0,100877	0,10088	0,1009	0,100877	0,1009	0,10087709	**0,096412**
Educational value	0,04867	0,05518	0,0487	0,048669	0,04867	0,048669	0,04867	0,0487	0,048669	0,0487	0,04866877	**0,04895**
SUM	1	1	1	1	1	1	1	1	1	1	1	1

APPENDIX E.3.2. SOCIAL MEASURE MCA SCORE

TABLE E.12 MCA FOR THE SOCIAL DIMENSION

Indicator	Health, comfort and well-being of residents	Influence on the local economy	Functionality and usability of the physical space	Aesthetic options and beauty of the environment	Safety and security	Community disturbance	Influence on local social development	Affordability	User acceptance and satisfaction	Neighbourhood accessibility and amenities	Educational value	Social score
Weight	**0,20**	**0,05**	**0,10**	**0,08**	**0,10**	**0,05**	**0,07**	**0,08**	**0,13**	**0,10**	**0,05**	
Measure												
1. Energy												
Insights												
Feasibility study into renewable energy	0	0	0	0	0	1	0	3	3	0	1	**0,71**
CO2 emissions calculation with DuboCalc or a comparable program	1	0	0	0	1	2	0	3	3	0	1	**1,06**
CO2 emission mapping of maintenance work, work process and waste processing.	1	0	0	0	0	1	0	3	3	0	1	**0,91**
Management												
Efficient use of building tools/construction machines: switch them of when they are not needed	2	0	1	0	1	3	0	3	3	0	0	**1,36**
fuel/energy-efficient construction and machinery	1	0	0	0	0	1	0	3	3	0	0	**0,86**
Design												

Prioritization of walking and cycling in the design instead of car usage	3	1	3	-2	3	3	2	2	3	2	1	**2,17**
Pipe length reduction of heating and ventilation systems	0	0	1	0	0	0	0	3	0	-1	0	**0,23**
Windows on the south side of buildings with trees in front of them	3	-1	-1	3	-1	0	0	3	3	-1	1	**1,14**
Hot/cold networks:												
Asphalt heating	1	-1	0	0	2	1	0	-1	3	1	0	**0,81**
Riothermia: extract heat from waste water in the sewerage system	0	1	0	0	1	-1	0	-2	3	0	1	**0,38**
Surface water heating	0	1	0	-1	0	-1	0	-1	2	-1	3	**0,15**
Geothermal heating	0	0	0	0	-1	-1	0	-3	3	0	0	**0,00**
Compressed air for underground heat storage	0	0	0	0	-2	-1	0	-3	1	0	0	**-0,36**
Sun-/PV-panels	0	1	1	-1	0	1	0	2	3	0	2	**0,75**
Smart Grid	3	1	2	0	1	2	0	1	3	0	1	**1,56**
Domotica systems	3	2	3	1	2	3	0	2	3	0	3	**2,12**
Led lighting/ lights with integrated solar panels and battery	2	2	1	1	1	0	0	3	3	0	2	**1,49**
Multipurpose charging stations with LED lighting	2	2	3	-1	1	0	0	3	3	0	3	**1,58**
Smart Energy Floor	1	0	1	2	1	0	1	3	3	0	3	**1,39**
2. Materials												
Insights												
Materials passport	1	1	0	0	1	0	0	3	3	0	0	**0,96**
Material loss chart of production	1	0	0	0	1	1	0	3	3	0	0	**0,96**
Material origin substantiation	0	1	0	0	0	0	0	2	3	0	0	**0,58**
Life cycle analysis (LCA)	1	2	0	0	1	1	0	3	3	0	0	**1,06**
Management												
Waste management plan	3	1	0	0	0	3	1	3	3	0	1	**1,53**
Circular building materials	0	0	0	0	0	1	0	2	3	0	1	**0,63**
Design												
Flexible building (for example demountable)	1	1	3	2	0	-1	0	1	1	1	1	**1,01**
New objects made from cut down trees	1	2	2	3	0	0	0	3	3	0	3	**1,49**
Shared sheds containing shared tools that people need occasionally	2	-1	1	0	0	-1	3	1	2	-1	3	**0,99**
Smart led lighting to show half hardened parking spots	1	1	1	1	2	0	0	2	2	1	1	**1,19**

Roadway of reinforced grass or water-permeable paving (half open paving)	2	1	1	0	1	1	0	3	2	1	3	**1,43**
Narrow walking strip in baked bricks	0	0	1	0	0	0	-1	3	0	1	1	**0,41**
Mineral Olivine to absorb CO2	-1	0	-1	0	0	0	0	1	2	0	3	**0,18**
Verge cuttings recycling	1	2	1	0	0	-1	0	3	3	0	2	**1,06**
3. Water												
Insights												
Water resource investigation (with a water-resource evaluation matrix)	1	0	2	1	2	1	0	3	3	0	0	**1,35**
Impact assessment	3	0	1	0	3	2	0	3	3	0	0	**1,72**
Groundwater ambitionlevel analyzation	1	0	1	0	2	2	0	1	3	0	0	**1,06**
Design												
Roadway of reinforced grass or water-permeable paving (half open paving)	2	1	1	0	1	1	0	3	2	1	3	**1,43**
Green gardens without (much) pavement	3	1	1	3	1	2	2	3	0	0	1	**1,60**
Existing water enlargement	3	0	0	3	1	-1	1	-1	3	-1	1	**1,21**
Pond for water capture with open space to relax	3	1	-1	3	0	-1	3	-1	3	0	1	**1,29**
Separate sewer for grey and black water	1	0	2	0	1	-1	0	-1	2	0	0	**0,63**
Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wade's to infiltrate in the soil	2	0	3	1	1	-1	0	1	2	0	3	**1,31**
Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc.	2	1	1	1	0	-1	0	1	2	-1	3	**0,96**
Water storage for rain water to use in black (toilet) water systems	1	0	2	0	1	0	0	1	3	0	0	**0,96**
4. Soil												
Insights												
Environmental Impact Assessment (EIA) with water and soil as subject of protection	1	0	2	1	3	3	0	3	3	0	1	**1,60**
Management												

Green area prioritization in urban planning	3	1	-1	3	0	2	1	3	3	-1	1	**1,51**
Reduction areas for soil consumption (soil sealing)	0	0	-2	0	0	1	0	1	0	-1	1	**-0,12**
Demolition practice plan	0	1	0	1	0	1	0	3	1	0	0	**0,53**
5. Nature and Ecology												
Insights												
Quickscan: Inventory the current flora & fauna	0	0	1	2	0	2	0	2	3	0	0	**0,89**
Ecological target type determined	0	0	1	1	0	3	0	3	1	0	0	**0,69**
Agricultural backgrounds with natural values inventory	0	1	1	2	0	1	1	2	1	0	1	**0,76**
Management												
Management scheme for the maintaining of the diversity of urban nature	2	2	1	3	0	2	0	3	3	0	0	**1,54**
Noise nuisance prevention	3	0	0	0	0	3	0	0	3	0	0	**1,13**
Compost plants	0	0	0	-1	0	-2	0	2	-1	0	3	**-0,01**
Adoption green	2	0	0	0	0	0	1	3	0	-1	1	**0,65**
Garden layout support for residents	1	0	1	1	0	0	1	2	2	0	2	**0,95**
Maintenance plan to promote ecological quality	0	2	0	2	0	0	0	3	3	0	0	**0,87**
Design												
Waste bins integrated in the design to reduce waste damage	3	0	1	-1	1	3	0	3	3	0	1	**1,53**
Variation in landscape	1	0	2	2	0	0	0	0	0	0	1	**0,61**
Plant species that increase biodiversity and better the living environment	1	0	0	1	0	0	0	2	2	0	1	**0,73**
Greenery diversity with native trees, shrubs, perennials and seeds	0	0	-1	2	0	0	0	2	2	0	1	**0,51**
Green and blue dry and wet spots realization	2	0	-2	3	0	-1	1	-1	2	0	1	**0,68**
Reed edge in water	1	0	-1	0	0	-1	0	3	0	-1	1	**0,23**
Pond for water capture with open space to relax	3	1	-1	3	0	-1	3	-1	3	0	1	**1,29**
Hedge with various native species	1	0	0	2	-1	0	0	3	2	-1	2	**0,74**
Streetscape greenery	1	0	-1	3	0	0	0	1	3	-1	1	**0,74**
Nature-friendly banks	0	0	1	3	0	0	0	1	2	0	1	**0,72**
Free migration stimulation	0	0	-2	0	0	0	0	0	0	-1	3	**-0,15**
Bee strips	0	0	-2	0	0	0	0	0	1	-1	3	**-0,03**
Flora and fauna in relation to target species	0	0	0	0	0	0	0	2	3	0	1	**0,58**

6. Space												
Design												
Design based on the environment	0	1	2	2	0	1	1	2	3	1	0	**1,16**
Flexible plan to build question based	1	0	3	2	0	1	0	1	1	1	1	**1,06**
Reduced parking norm	0	0	0	1	0	0	0	3	-1	-1	1	**0,13**
(Electric) Car sharing (in collaboration with companies)	0	1	0	0	0	0	2	3	1	1	2	**0,74**
Small private garden, large community garden	1	1	1	1	-1	0	2	3	0	1	1	**0,84**
Flexible building (for example demountable)	1	0	3	2	0	-1	0	-1	1	1	1	**0,81**
7. Mobility												
Design												
Safe intersections	1	0	0	-1	3	-1	1	1	3	3	0	**1,20**
Fast cycling lanes to promote cycling to the centre of Voorhout	3	1	3	-1	1	0	1	2	3	3	1	**1,92**
Bicycle parking spots	1	0	0	-1	1	0	0	3	3	2	0	**1,03**
Access to public transport	1	1	0	0	1	0	0	0	3	3	0	**1,02**
Shared working space	1	2	1	-1	0	-1	3	0	2	0	1	**0,78**
(Electric) Car sharing (in collaboration with companies)	0	1	0	0	0	0	2	3	1	1	2	**0,74**
Sharing bikes	1	1	0	0	0	0	2	3	1	2	1	**0,99**
Aesthetic signs for easy way finding and to stimulate waking	1	0	1	3	0	0	0	3	3	1	3	**1,39**
8. Living environment												
Insights												
Background noise map	3	0	0	0	0	1	0	1	3	0	0	**1,10**
Management												
Noise nuisance prevention	3	0	0	0	0	3	0	0	3	0	0	**1,13**
Heat and cold warning mechanism and strategy plan to react	2	1	0	0	3	0	0	0	3	0	2	**1,24**
Design												
Different function options in the environment	1	1	3	0	0	0	1	2	3	1	1	**1,30**
Flexible design, so that space can be used different in the future	1	1	3	2	0	0	1	-1	1	1	1	**0,98**
Daylight accessible	3	0	1	1	3	2	0	3	3	0	0	**1,80**
Suitable trails for rollators, wheelchairs and mobility scooters	3	0	1	-1	2	0	3	2	3	3	0	**1,86**

Fast cycling lanes to promote cycling to the centre of Voorhout	3	1	3	-1	1	0	1	2	3	3	1	**1,92**
Community gardens	1	1	1	2	0	0	2	3	2	1	1	**1,27**
Shared working space	1	2	1	-1	0	-1	3	0	2	0	1	**0,78**
Community centre as a central meeting place and to organise activities, such as cooking, community eating, tv watching, yoga, drama class, a drink, etc.	2	2	2	0	1	-1	3	-1	3	0	2	**1,36**
Virtual meeting place to organise activities in neighbourhood and community house (internet and app)	1	1	2	0	3	3	3	3	1	0	3	**1,62**
Small private garden, large community garden	1	1	1	1	-1	0	2	3	0	1	1	**0,84**
Communal gardens for food production	3	0	1	1	0	0	2	2	1	-1	2	**1,20**
Activity spaces	3	1	2	2	0	0	3	-1	2	0	1	**1,44**
Pet-friendly environment	3	2	0	1	1	0	2	2	1	0	0	**1,30**
Outdoor playing and sport places	3	1	2	2	0	0	3	-1	2	0	0	**1,39**
Sound barrier around road	3	0	-1	0	0	-1	1	-1	3	0	0	**0,82**
Public toilet available, possibly in community Centre	3	1	1	-1	1	0	2	1	3	1	0	**1,47**
Adequate and uniform lighting conditions	3	1	3	1	3	0	2	3	3	2	0	**2,28**
Art	2	0	-1	3	0	0	0	-1	2	0	1	**0,76**
9. Investments												
Insights												
Long term budget and look at the long-term investments	0	1	0	0	0	2	0	-1	3	0	0	**0,45**
LCC for the planning, construction, usage and demolition phase.	0	1	0	0	0	2	0	3	3	0	0	**0,76**
Management												
Measures for which subsidy is given	0	2	0	0	1	1	0	3	3	0	1	**0,91**
Budget to prevent harm on area interests	0	3	0	0	1	2	0	0	2	0	0	**0,61**
Educational value through visible sustainable measures	0	2	1	0	0	0	0	2	1	0	3	**0,63**
Design												
Room for co-creation with inhabitants	1	1	2	1	0	0	2	2	1	0	1	**1,00**

Recyclable products	0	0	0	0	0	0	0	1	2	0	0	**0,33**

APPENDIX E.4. TOTAL SUSTAINABILITY EVALUATION

APPENDIX E.4.1. SUSTAINABLE DIMENSION WEIGHT DETERMINATION

TABLE E.13 SUSTAINABLE DIMENSION WEIGHT DETERMINATION

	Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**	**Expert 6**		**Average score**	**Dimension weight**
Category (%)									
Environmental indicators	35	43	40	33	50	40		40	**0,401667**
Economic indicators	30	23	20	33	25	10		24	**0,235**
Social indicators	35	34	40	34	25	50		36	**0,363333**
Sum								100	**1**

APPENDIX E.4.2. MEASURES TOTAL SUSTAINABILITY SCORE

TABLE E.14 TOTAL SUSTAINABILITY SCORE PER MEASURE

	Sustainable dimension	**Social Score**	**Environmental score**	**Economic score**		**Total sustainability score**
	Dimension weight	**0,36**	**0,40**	**0,24**		
	Measure					
	1. Energy					
	Insights					
1	Feasibility study into renewable energy	0,7	1,1	2,0		1,2
2	CO2 emissions calculation with DuboCalc or a comparable program	1,1	1,4	1,9		1,4
3	CO2 emission mapping of maintenance work, work process and waste processing.	0,9	0,9	2,0		1,2

	Management					
4	Efficient use of building tools/construction machines: switch them of when they are not needed	1,4	1,1	1,4		1,3
5	Fuel/energy-efficient construction and machinery	0,9	0,9	1,3		1,0
	Design					
6	Prioritization of walking and cycling in the design instead of car usage	2,2	0,4	0,7		1,1
7	Pipe length reduction of heating and ventilation systems	0,2	0,8	0,4		0,5
8	Windows on the south side of buildings with trees in front of them	1,1	0,8	3,0		1,4
	Hot/cold networks:					
9	Asphalt heat	0,8	1,4	0,7		1,0
10	Riothermia: extract heat from waste water in the sewerage system	0,4	1,2	0,1		0,6
11	Surface water heating	0,1	1,0	0,3		0,5
12	Geothermal heating	0,0	1,0	-0,6		0,3
13	Compressed air for underground heat storage	-0,4	1,0	-0,5		0,1
14	Sun-/PV-panels	0,8	0,9	1,0		0,9
15	Smart Grid	1,6	1,5	1,5		1,5
16	Domotica systems	2,1	1,1	1,4		1,5
17	Led lighting/ lights with integrated solar panels and battery	1,5	0,7	1,5		1,2
18	Multipurpose charging stations with LED lighting	1,6	0,7	1,0		1,1
19	Smart Energy Floor	1,4	0,2	0,2		0,6
	2. Materials					
	Insights					
20	Materials passport	1,0	1,0	3,3		1,5
21	Material loss chart of production	1,0	0,6	4,0		1,5
22	Material origin substantiation	0,6	0,3	3,4		1,1
23	Life cycle analysis (LCA)	1,1	1,2	4,2		1,9
	Management					
24	Waste management plan	1,5	1,0	3,9		1,9
25	Circular building materials	0,6	0,7	2,1		1,0
	Design					
75	Flexible building (for example demountable)	1,0	0,5	3,7		1,4
27	New objects made from cut down trees	1,5	0,9	3,1		1,6

28	Shared sheds containing shared tools that people need occasionally	1,0	0,4	2,7		1,2
29	Smart led lighting to show half hardened parking spots	1,2	0,3	1,0		0,8
30	Roadway of reinforced grass or water-permeable paving (half open paving)	1,4	0,8	2,6		1,5
31	Narrow walking strip in baked bricks	0,4	0,8	2,8		1,1
32	Mineral Olivine to absorb CO2	0,2	0,1	2,6		0,7
33	Verge cuttings recycling	1,1	0,6	4,8		1,8
	3. Water					
	Insights					
34	Water resource investigation (with a water-resource evaluation matrix)	1,3	0,9	2,3		1,4
35	Water impact assessment	1,7	1,0	2,1		1,5
36	Groundwater ambitionlevel analyzation	1,1	0,6	1,4		1,0
	Design	0,0				
30	Roadway of reinforced grass or water-permeable paving (half open paving)	1,4	0,8	2,7		1,5
37	Green gardens without (much) pavement	1,6	1,4	3,4		2,0
38	Existing water enlargement	1,2	0,9	2,0		1,3
63	Pond for water capture with open space to relax	1,3	0,9	2,4		1,4
40	Separate sewer for grey and black water	0,6	0,8	2,1		1,0
41	Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wade's to infiltrate in the soil	1,3	0,9	2,1		1,3
42	Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc.	1,0	1,3	1,9		1,3
43	Water storage for rain water to use in black (toilet) water systems	1,0	0,8	1,6		1,1
	4. Soil					
	Insights					
44	Environmental Impact Assessment (EIA) with water and soil as subject of protection	1,6	0,9	3,4		1,8
	Management					
45	Green area prioritization in urban planning	1,5	1,3	3,1		1,8

46	Reduction areas for soil consumption (soil sealing)	-0,1	0,7	3,4		1,0
47	Demolition practice plan	0,5	0,9	3,0		1,2
	5. Nature and Ecology					
	Insights					
48	Quickscan: Inventory the current flora & fauna	0,9	0,6	0,9		0,8
49	Ecological target type determined	0,7	0,2	1,3		0,6
50	Agricultural backgrounds with natural values inventory	0,8	0,5	0,7		0,7
	Management					
51	Management scheme for the maintaining of the diversity of urban nature	1,5	0,6	2,5		1,4
52	Noise nuisance prevention	1,1	0,5	0,6		0,8
53	Compost plants	0,0	1,0	2,0		0,9
54	Adoption green	0,6	1,1	3,5		1,5
55	Garden layout support for residents	1,0	0,9	1,5		1,0
56	Maintenance plan to promote ecological quality	0,9	0,9	1,2		0,9
	Design					
57	Waste bins integrated in the design to reduce waste damage	1,5	0,3	1,3		1,0
58	Variation in landscape	0,6	0,7	0,9		0,7
59	Plant species that increase biodiversity and better the living environment	0,7	1,0	0,8		0,8
60	Greenery diversity with native trees, shrubs, perennials and seeds	0,5	1,1	1,0		0,9
61	Green and blue dry and wet spots realization	0,7	1,1	1,4		1,0
62	Reed edge in water	0,2	0,9	2,2		1,0
63	Pond for water capture with open space to relax	1,3	0,9	0,5		1,0
64	Hedge with various native species	0,7	1,0	1,9		1,1
65	Streetscape greenery	0,7	0,9	2,2		1,2
66	Nature-friendly banks	0,7	0,8	1,8		1,0
67	Free migration stimulation	-0,2	0,9	2,2		0,8
68	Bee strips	0,0	0,6	2,6		0,8
69	Flora and fauna in relation to target species	0,6	0,7	2,4		1,0
	6. Space					
	Design					
70	Design based on the environment	1,2	1,0	2,4		1,4

71	Flexible design plan to build question based, so that space can be used different in the future	1,1	0,5	3,8		1,5
72	Reduced parking norm	0,1	0,5	1,5		0,6
73	(Electric) Car sharing (in collaboration with companies)	0,7	0,2	0,8		0,5
74	Small private garden, large community garden	0,8	0,7	3,4		1,4
75	Flexible building (for example demountable)	0,8	0,5	3,7		1,4
	7. Mobility					
	Design					
76	Safe intersections	1,2	-0,3	0,7		0,5
77	Fast cycling lanes to promote cycling to the centre of Voorhout	1,9	0,0	0,8		0,9
78	Bicycle parking spots	1,0	0,0	1,4		0,7
79	Access to public transport	1,0	0,4	0,5		0,6
80	Shared working space	0,8	-0,3	1,0		0,4
81	Sharing bikes	1,0	0,3	2,5		1,1
82	Aesthetic signs for easy way finding and to stimulate waking	1,4	0,3	1,7		1,0
	8. Living environment					
	Insights					
83	Background noise map	1,1	0,5	1,6		1,0
	Management					
52	Noise nuisance prevention	1,1	0,5	1,3		0,9
84	Heat and cold warning mechanism and strategy plan to react	1,2	0,7	2,8		1,4
	Design					
85	Different function options in the environment	1,3	0,6	2,8		1,4
71	Flexible design plan to build question based, so that space can be used different in the future	1,0	0,5	3,1		1,3
86	Daylight accessible	1,8	1,0	3,9		2,0
87	Suitable trails for rollators, wheelchairs and mobility scooters	1,9	0,1	0,3		0,8
77	Fast cycling lanes to promote cycling to the centre of Voorhout	1,9	0,0	0,8		0,9
88	Community gardens	1,3	1,1	3,4		1,7
80	Shared working space	0,8	-0,3	1,0		0,4
89	Community centre as a central meeting place and to organise activities, such as cooking,	1,4	-0,5	1,1		0,5

	community eating, tv watching, yoga, drama class, a drink, etc.					
90	Virtual meeting place to organise activities in neighbourhood and community house (internet and app)	1,6	0,1	2,7		1,3
74	Small private garden, large community garden	0,8	0,7	3,4		1,4
91	Communal gardens for food production	1,2	1,0	2,8		1,5
92	Activity spaces	1,4	0,1	0,9		0,8
93	Pet-friendly environment	1,3	0,1	3,5		1,3
94	Outdoor playing and sport places	1,4	0,0	0,9		0,7
95	Sound barrier around road	0,8	0,3	1,2		0,7
96	Public toilet available, possibly in community Centre	1,5	-0,1	0,6		0,6
97	Adequate and uniform lighting conditions	2,3	0,9	2,2		1,7
98	Art	0,8	0,1	-0,1		0,3
	9. Investments					
	Insights					
99	Long term budget and look at the long-term investments	0,5	0,0	2,1		0,6
100	LCC for the planning, construction, usage and demolition phase.	0,8	0,3	3,2		1,2
	Management					
101	Measures for which subsidy is given	0,9	0,9	1,1		1,0
102	Budget to prevent harm on area interests	0,6	0,4	1,5		0,8
103	Educational value through visible sustainable measures	0,6	0,0	1,9		0,7
	Design					
104	Room for co-creation with inhabitants	1,0	0,7	1,9		1,1
105	Recyclable products	0,3	0,5	0,7		0,5

APPENDIX F. INFLUENCE OF MEASURES ON SUB-THEMES

TABLE F.1 INFLUENCE OF MEASURES ON THEME NUMBER

Measure	MCA score	Scenario 1	Scenario 2	Scenario 3
37. Green gardens without (much) pavement	2		4.5, 5.1, 7.2, 7.3, 8.5, 8.6	4.5, 5.1, 7.2, 7.3, 8.5, 8.6
86. Daylight accessible	2	5.3, 5.5	4.8, 5.1, 5.3, 5.5	4.8, 5.1, 5.3, 5.5
23. Life cycle analysis (LCA)	1,9	2.3, 2.4	1.5, 2.3, 2.4, 2.6	1.5, 2.1, 2.3, 2.4, 2.6
24. Waste management plan	1,9	2.2, 2.3, 2.4	1.5, 2.1, 2.2, 2.3, 2.4, 2.5	1.5, 2.1, 2.2, 2.3, 2.4, 2.5
33. Verge cuttings recycling	1,8			
44. Environmental Impact Assessment (EIA) with water and soil as subject of protection	1,8	5.1, 7.1, 7.2, 8.1, 8.3, 8.4, 8.5, 8.6	5.1, 7.1, 7.2, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6	5.1, 7.1, 7.2, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6
45. Green area prioritization in urban planning	1,8		5.1	5.1
88. Community gardens	1,7		4.2, 4.8, 4.9, 5.1	4.2, 4.8, 4.9, 5.1
97. Adequate and uniform lighting conditions	1,7	4.2, 5.3, 5.5	4.2, 4.8, 5.1, 5.3, 5.5	4.2, 4.8, 5.1, 5.3, 5.5, 6.4
27. New objects made from cut down trees	1,6	3	2.2, 2.3, 2.5, 2.6, 3.3	2.2, 2.3, 2.5, 2.6, 3.3
16. Domotica systems	1,5		1.1, 3.3, 5.1	1.1, 3.3, 5.1
17. Led lighting/ lights with integrated solar panels and battery	1,5		1.1	1.1
20. Materials passport	1,5	2.3	1.5, 2.2, 2.3 ,2.4, 2.5	1.5, 2.2, 2.3, 2.4, 2.5
21. Material loss chart of production	1,5			
30. Roadway of reinforced grass or water-permeable paving (half open paving)	1,5		4.5, 5.1, 5.3, 7.2, 7.3, 8.5, 8.6	4.5, 5.1, 5.3, 7.2, 7.3, 8.5, 8.6
35. Water impact assessment	1,5	4.5, 5.1, 7.1, 7.2, 7.3, 8.5, 8.6	4.5, 5.1, 7.1, 7.2, 7.3, 8.5, 8.6	4.5, 5.1, 7.1, 7.2, 7.3, 8.5, 8.6
54. Adoption green	1,5		3.3, 5.1, 5.4, 8.2	3.3, 5.1, 5.4, 8.2

71. Flexible design plan to build question based, so that space can be used different in the future	1,4		4.6, 4.7, 4.9	3.2, 4.6, 4.7, 4.9
91. Communal gardens for food production	1,5		4.2, 4.5, 4.8, 4.9, 5.1, 5.4, 5.5	4.2, 4.5, 4.8, 4.9, 5.1, 5.4, 5.5
2.CO2 emissions calculation with DuboCalc or a comparable program	1,4		1.1, 1.2, 2.4	1.1, 1.2, 2.4
8. Windows on the south side of buildings with trees in front of them	1,4		1.1	1.1
34. Water resource investigation (with a water-resource evaluation matrix)	1,4	4.5, 5.1, 7.2, 8.5, 8.6	4.5, 5.1, 7.2, 8.5, 8.6	4.5, 5.1, 7.2, 8.5, 8.6
51. Management scheme for the maintaining of the diversity of urban nature	1,4		6.3, 6.4, 6.5, 8.1, 8.2	6.3, 6.4, 6.5, 8.1, 8.2
70. Design based on the environment	1,4		4.7	4.7
74. Small private garden, large community garden	1,4		4.5, 4.7, 5.3, 5.5	4.5, 4.7, 5.1, 5.3, 5.5
75. Flexible building (for example demountable)	1,4		(2.1,4.7, 4.9)	2.1, 3.2, 4.7, 4.9
84. Heat and cold warning mechanism and strategy plan to react	1,4		(5.1)	4.5, 5.1
85. Different function options in the environment	1,4		4.8, 4.9	4.8, 4.9
4.Efficient use of building tools/construction machines: switch them of when they are not needed	1,3		1.2, 1.3, 1.5	1.2, 1.3, 1.5
38. Existing water enlargement	1,3	4.5	(4.5, 5.1, 7.2, 7.3)	4.5, 5.1, 7.2, 7.3
41. Water extraction area to capture clean rain water from roofs. Street water is guided away from the extraction area to wade's to infiltrate in the soil	1,3		4.5, 5.1, 7.2, 8.1, 8.2	4.5, 5.1, 7.2, 7.3, 8.1, 8.2
42. Helophyte filters to rinse grey wastewater from washing machines, showers, kitchen etc.	1,3		(7.1, 7.2, 7.3, 8.1)	7.1, 7.2, 7.3, 8.1
90. Virtual meeting place to organise activities in neighbourhood and community house (internet and app)	1,3		4.8, 4.9, 5.3, 5.4, 5.5	4.8, 4.9, 5.3, 5.4, 5.5
93. Pet-friendly environment	1,3		4.2, 4.8, 5.1, 5.3, 5.5	4.2, 4.8, 5.1, 5.3, 5.4, 5.5
1.Feasibility study into renewable energy	1,2	1.7	1.7	1.7
3. CO2 emission mapping of maintenance work, work process and waste processing.	1,2	1.2, 1.5	1.2, 1.5	1.2, 1.5
18. Multipurpose charging stations with LED lighting	1,2		(1.1)	1.1
28. Shared sheds containing shared tools that people need occasionally	1,2			
47. Demolition practice plan	1,2			
65. Streetscape greenery	1,2		5.1, 6.4, 8.2	5.1, 6.4, 8.2

100. LCC for the planning, construction, usage and demolition phase.	1,2		3.2	3.2
6. Prioritization of walking and cycling in the design instead of car usage	1,1		(5.3)	5.3
9. Asphalt heat	1,0		(1.1, 1.7)	1.1, 1.7
19. Smart Energy Floor	0.6			1.7, 3.3
22. Material origin substantiation	1,1		2.3	2.3
31. Narrow walking strip in baked bricks	1,1			
43. Water storage for rain water to use in black (toilet) water systems	1,1		(4.5, 5.1, 7.2, 7.3, 8.5, 8.6)	4.5, 5.1, 7.2, 7.3, 8.5, 8.6
64. Hedge with various native species	1,1		5.1, 6.4, 8.2	5.1, 6.4, 8.2
81. Sharing bikes	1,1		(4.8, 4.13)	4.8, 4.10, 4.13
104. Room for co-creation with inhabitants	1,1		3.1, 3.2, 4.1, 5.6	3.1, 3.2, 4.1, 5.6
5. Fuel/energy-efficient construction and machinery	1		4.11	1.2, 1.3, 1.5, 4.11
10. Riothermia: extract heat from waste water in the sewerage system	1			1.1
25. Circular building materials	1	2.4	2.3, 2.4, 2.5, 2.6	1.5, 2.2, 2.3, 2.4, 2.5, 2.6
36. Groundwater ambitionlevel analyzation	1		5.1, 7.1, 7.2, 7.3, 8.5, 8.6	5.1, 7.1, 7.2, 7.3, 8.5, 8.6
40. Separate sewer for grey and black water	1		(8.2, 8.5, 8.6)	5.1, 7.1, 7.2, 7.3, 8.2, 8.5, 8.6
46. Reduction areas for soil consumption (soil sealing)	1			
55. Garden layout support for residents	1			5.1
57. Waste bins integrated in the design to reduce waste damage	1		5.1	5.1
61. Green and blue dry and wet spots realization	1		5.1, 6.4, 7.1, 8.2	5.1, 6.4, 6.5, 7.1, 8.2
62.Reed edge in water	1		6.3, 6.4, 7.2	6.3, 6.4, 7.1, 7.2
63. Pond for water capture with open space to relax	1		(4.5, 5.1, 7.2, 8.5, 8.6)	4.5, 5.1, 7.2, 7.3, 8.5, 8.6
66. Nature-friendly banks	1		5.1, 6.3, 6.4, 7.1, 7.2, 8.2	5.1, 6.3, 6.4, 7.1, 7.2, 8.2
69. Flora and fauna in relation to target species	1		6.3, 6.4, 7.2, 8.2	5.1, 6.3, 6.4, 6.5, 7.1, 7.2, 8.2

82. Aesthetic signs for easy way finding and to stimulate waking	1		4.8	4.8, 4.10, 5.1
83. Background noise map	1	5.1	5.1, 5.2	5.1, 5.2
101. Measures for which subsidy is given	1		3.1, 3.2, 4.1	3.1, 3.2, 4.1
14. Sun-/PV-panels	0,9		1.1, 1.7, 3.3	1.1, 1.7, 3.3
15. Smart Grid	1,5		1.1	1.1, 8.2
53. Compost plants	0,9			6.4, 8.2
56. Maintenance plan to promote ecological quality	0,9		4.7, 6.3, 6.4, 8.1, 8.2	4.7, 6.3, 6.4, 6.5, 8.1, 8.2
60. Greenery diversity with native trees, shrubs, perennials and seeds	0,9	3.3	3.3, 5.1, 5.6, 8.2	3.3, 5.1, 5.6, 6.5, 8.2
77. Fast cycling lanes to promote cycling to the centre of Voorhout	0,9		(4.2, 4.8, 4.10, 4.11, 4.12, 5.1, 5.5)	4.2, 4.8, 4.10, 4.11, 4.12, 5.1, 5.5
29. Smart led lighting to show half hardened parking spots	0,8			5.1
48. Quickscan: Inventory the current flora & fauna	0,8	5.1, 6.4, 7.1, 7.2, 8.1	5.1, 6.3, 6.4, 6.5, 7.1, 7.2, 8.1	5.1, 6.3, 6.4, 6.5, 7.1, 7.2, 8.1, 8.2
52. Noise nuisance prevention	0,8	5.1	4.8, 5.1, 5.2	4.8, 5.1, 5.2, 6.4
59. Plant species that increase biodiversity and better the living environment	0,8		3.3, 5.1, 6.3, 6.4, 8.1, 8.2	3.3, 5.1, 6.3, 6.4, 6.5, 8.1, 8.2
67. Free migration stimulation	0,8		(3.3, 6.4, 7.2, 8.2)	3.3, 6.3, 6.4, 7.1, 7.2, 8.2
68. Bee strips	0,8			3.3, 6.3, 6.4, 8.2
87. Suitable trails for rollators, wheelchairs and mobility scooters	0,8		4.8, 4.11, 4.12, 5.1,	4.8, 4.11, 4.12, 5.1, 5.3
92. Activity spaces	0,8		4.2, 4.8, 5.1, 5.4, 5.5	4.2, 4.8, 5.1, 5.4, 5.5
102. Budget to prevent harm on area interests	0,8			
32. Mineral Olivine to absorb CO2	0,7			
50. Agricultural backgrounds with natural values inventory	0,7		5.1, 6.4, 6.5	5.1, 6.4, 6.5, 7.1
58. Variation in landscape	0,7		4.7, 5.4, 6.4	4.7, 5.4, 6.4, 6.5
78. Bicycle parking spots	0,7		(4.8)	4.8

94. Outdoor playing and sport places	0,7	3.3, 4.8, 4.9, 5.1, 5.5	3.3, 4.8, 4.9, 5.1, 5.4, 5.5	3.3, 4.8, 4.9, 5.1, 5.4, 5.5
95. Sound barrier around road	0,7	4.2, 4.8, 5.1	4.2, 4.8, 5.1	4.2, 4.8, 5.1
103. Educational value through visible sustainable measures	0,7	3.2, 3.3, 4.4	3.2, 3.3, 4.4	3.2, 3.3, 4.4
11. Surface water heating	0,6		(1.1, 1.7)	1.1, 1.7
49. Ecological target type determined	0,6		6.3, 7.2	6.3, 6.5, 7.2
72. Reduced parking norm	0,6		(4.13)	4.13
79. Access to public transport	0,6			4.8, 4.10, 4.11, 4.12
96. Public toilet available, possibly in community Centre	0,6			4.2, 4.8, 5.1, 5.4, 5.5
99. Long term budget and look at the long-term investments	0,6		3.2	3.2
7. Pipe length reduction of heating and ventilation systems	0,5		1.1, 8.2	1.1, 8.2
12. Geothermal heating	0,5			1.1, 1.7
73. (Electric) Car sharing platforms (in collaboration with companies)	0,5		4.8, 4.11, 4.13	4.8, 4.10, 4.11, 4.13
76. Safe intersections	0,5		4.8, 4.11, 4.12, 5.3	4.8, 4.11, 4.12, 5.3
89. Community centre as a central meeting place and to organise activities, such as cooking, community eating, tv watching, yoga, drama class, a drink, etc.	0,5			4.8, 5.4, 5.5
105. Recyclable products	0,5		3.2, 3.3	3.2, 3.3
80. Shared working space	0,4		(4.7, 4.8, 4.9)	4.7, 4.8, 4.9, 4.13
13. Compressed air for underground heat storage	0,1			1.1, 1.7
98. Art	0,3			4.8