Carbon net-zero urban area developments in the Netherlands

A **conceptual framework** *for* **developers** *to influence* **carbon offsets**

by Daphne Bedeaux

Master thesis report | D. Bedeaux | June, 2023

MSc Architecture, Urbanism, and Building Sciences
Delft University of Technology

Blank page

Colophon

Student

Name	Daphne Bedeaux
Student number	4444698

University

Name	Delft University of Technology
Faculty	Architecture and the Built Environment
Master Track	Management in the Built Environment (MBE)
Graduation lab	Urban Development Management

Supervisors

First mentor	Dr.ir. E.W.T.M. (Erwin) Heurkens
Second mentor	Dr.ir. A. (Angela) Greco
Delegate of the board of examiners	Ir. Y.J. (Ype) Cuperus

Graduation Organization

Organization	Dev_ real estate
Type of organization	Project management, project development, and consultancy
Location	Westdam 3G, 3441 GA, Woerden, The Netherlands
Mentor	S. (Saskia) Kroon

Preface

In 2016, I moved to Delft to start my studies in Architecture. During my bachelor, I was able to express my creativity and enthusiasm when working on projects where especially the complexity, organizational aspect and scale of the projects played a role. This led me to start the master in Management in the Built Environment.

Working in a team is central to this master. Working as a team to build the future, and that explains it. In the future, we all have to make sure that we leave a better world behind for the next generations. My generation can still make a difference, and that is what convinced me to research a major problem: carbon offsetting. And how wonderful it would be if this could be solved at the development site!

This research is a contribution to our understanding of carbon net-zero urban area developments. By studying the influence of developers in achieving carbon net-zero urban area developments, we can positively influence and encourage the creation of sustainable urban areas. This thesis aims to inspire collaboration and innovation as we work toward a sustainable and carbon-neutral future.

To my teachers, Erwin Heurkens and Angela Greco, thank you for your guidance during the writing of my thesis. What motivated me a lot was your enthusiasm for the topic and the resulting interesting questions that made me think again. Having both a critical view on the research helped me a lot to take steps. In addition, I would like to thank Monique Arkesteijn for starting up the thesis process. Taking a critical look at the design of my research and method has been a good basis for my research.

I would also like to thank my colleagues at Dev_ real estate, and especially my thesis supervisor Saskia Kroon, for the guidance during the past year. From everyone eager to spar on my topic, to critical eyes on my presentation.

Also like to thank the interviewees for participating in the interviews, without their valuable input it is impossible to come up with innovative results for my research.

Daphne Bedeaux

Rotterdam, June 2023

Blank page

Abstract

To prevent global warming, CO_2 emissions must be reduced by 95%. The building and construction industries account for over 15% of all direct CO_2 emissions. However, currently there are no regulations for carbon net-zero developments. Investors adhere to current sustainability requirements because there are many barriers develop carbon net-zero. To achieve carbon net-zero, buildings have to be energy-neutral, and climate-friendly as possible all other emissions must be minimized and compensated. What we now often see is that a forest is planted somewhere else to compensate for the carbon emissions. Instead, urban areas themselves could be a solution to compensate for carbon emissions. Furthermore, the UN argues that plans against global warming are still inadequate and also other parties have to take responsibility to reduce carbon emissions. Yet, how they should act is unknown. The one thing that is known is that private parties have a steering role in sustainable urban area developments. Based on this problem statement, the following main research question is formulated: *What can developers do to influence carbon offsets in the development areas in the Netherlands?* To answer this question, a literature review is conducted. Moreover, case studies with semi-structured interviews and an expert panel have been used to validate. Developers could translate indirect and direct influenceable barriers into opportunities and thereby influence each phase with the necessary parties and the necessary tool. The framework provides a structured approach to navigate complexities and maximize impact, resulting in a greener future with less carbon.

Keywords *– developers, influence, carbon net-zero, urban area development, conceptual framework*

Blank page

Executive summary

Introduction

Climate change awareness has grown significantly over the past two decades, with people recognizing the human impact on the climate through the burning of fossil fuels (Tillie, Van Den Dobbelsteen, Doepel, Joubert, De Jager, Mayenburg, 2009; Greenpeace Nederland, 2022). The Sustainable Development Goals and initiatives like the Green Deal and the Climate Agreement in the Netherlands aim to address climate change and reduce carbon emissions (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021). Achieving carbon-net zero involves minimizing carbon emissions and offsetting other emissions to ensure actions have no negative climate effects (Vrieling, 2022).

There is a gap in terms of knowledge on how to reach carbon net-zero urban area developments and how they can be influenced by developers. Therefore, the problem statement is as follows: Currently, achieving carbon net-zero is only considered at the building level. If offsetting is required for carbon emissions, suggestions are made to offset it far outside the planning area while the planning area itself is often disregarded. Furthermore, it is known that developers influence sustainable urban area developments under which carbon net-zero can be placed, but their influence specifically on this issue is unknown.

Based on the problem statement, the following main research question is formulated:

What can developers do to influence carbon offsets in the development areas in the Netherlands?

To answer the main question, seven sub-questions have been formulated.

1. How could carbon net-zero urban area development be described?
2. How are carbon emissions currently offset in the building and construction sector?
3. How can the developers' role be defined within sustainable urban area developments?
4. What are the current barriers and drivers for carbon net-zero developments?
5. What components are essential for developers to influence carbon offsets in the development areas in the Netherlands?
6. What opportunities do developers see to use the urban areas as a solution for achieving carbon net-zero in the Netherlands?
7. How can a conceptual framework be designed for developers to achieve carbon net-zero urban area developments in the Netherlands?

Research method

In figure 1 the research design is shown. This is the relation between the (sub)questions, the conceptual framework, and the research methods and techniques to be used.

Theoretical research

The research utilizes theoretical research methods to address the first four sub-questions. The selection of keywords for the search was based on the main concepts of each sub-question, and search engines like Scopus and Google Scholar were used. As the topic is quite recent, websites like gebiedsontwikkeling.nu and the central government website were also used.

To provide context for the research problem, Heurkens' (2012) conceptual steering model, "Value & power shift in the context of Dutch urban development," is introduced. This model examines economic and political factors, urban governance, and planning systems and policies, providing an understanding of the research context, in the Netherlands.

Empirical research

Explorative case studies are used in this research because this research answers a "what question", explorative case studies provide answers to those questions (Yin, 2009; Heurkens, 2023). To apply the theory to the Dutch real estate market, a multiple-explorative case study is conducted.

This has the advantage of allowing for data analysis both inside and across situations (Gustafsson, 2017). Semi-structured interviews are conducted for the selected case studies. The semi-structured interview approach is wherein the interview questions are based on the responses of the participants and are designed to cover a broad range of topics

For representative data, the sampling method is important (McIntosh & Morse, 2015). Shenton (2004) mentioned in his research four main themes to ensure trustworthiness in qualitative research projects: credibility, transferability, dependability, and confirmability.

Synthesis

All input from the literature reviews, case studies, interviews, and other data will be the basis for a conceptual framework for developers to influence carbon net-zero urban area developments by overcoming the barriers by creating actions for developers to achieve carbon net-zero urban area developments in the Netherlands. Different design steps are used to design an evidence-based tool, where is in this research the tool is a conceptual framework.

An expert panel is used to validate the findings, which simply refers to a qualitative (group) interview based on a subject that stresses the expert's expertise (Döringer, 2021). Every person reflects on the conclusions and they help to eventually develop an effective conceptual framework for developers to influence carbon net-zero urban area developments.

Figure 1: Research design (Own figure)

Theoretical research

In this thesis, the concept of carbon net-zero can be described as a development where the urban area serves for carbon offsetting from the developments on those plots. In doing so, the developments themselves should meet BENG requirements and include circularity in the project to reduce carbon emissions (Figure 2). The remaining carbon emissions are then offset in the development area itself to achieve a carbon net-zero urban area development.

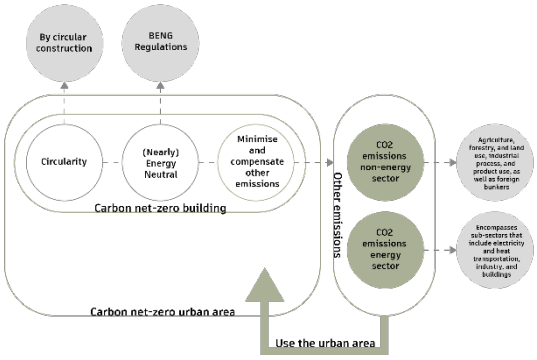


Figure 2: Carbon net-zero urban area developments (Own figure)

Those carbon emissions can be divided into three different scopes: Scope 1 refers to direct emissions from sources managed by the organization, Scope 2 includes indirect emissions from purchased energy, and Scope 3 includes indirect emissions not directly managed by the organization but within their supply chain. Different methods can be used to offset those carbon emissions. Currently, there are several ways for offsetting which are used at the moment: planting trees, and using building materials that absorb carbon.

Developers are important in the development process of sustainable urban area development. They are responsible for managing and coordinating the entire development process. Developers have several roles and responsibilities, including land acquisition, market analysis, development plans, design plans, feasibility analysis, financing/loans, marketing & sales, project management, development, and contracting. In addition, developers also have multiple steering roles.

This steering role is subdivided into strategic and project-based development orchestration and soft steering and hard steering. To function well in a competitive market environment, every developer has to fulfil all these roles.

The current barriers to carbon net-zero developments are mainly linked to economic, social, and technological reasons. The barriers that can be influenced when it comes to politics are mainly the lack of subsidies and unclear descriptions of carbon net-zero.

Economic barriers are either not influenceable or only indirectly influenceable by developers. This mainly includes the high costs associated with carbon net-zero developments, but also there is not enough demand. As for social barriers, these are mostly directly influenceable by developers. Here, this mainly involves knowledge, experience, and awareness that is lacking. Technological barriers are often not influenceable, or only indirectly influenceable. This involves the cost of new technology being too high, and not enough research having been done. In terms of the environment, influence is only possible for users who are concerned about sustainability. Last are the legal barriers. This mainly involves laws and regulations that are flawed, which can mainly be influenced indirectly.

The drivers are mainly linked to the categories of economic, social, and legal. Where the economic drivers are mainly linked to the developer's business model and customer demand. As for the social drivers, it is mainly about responsibility for a better world. In this, it can also be a business goal. For legal, regulation is mainly the driver.

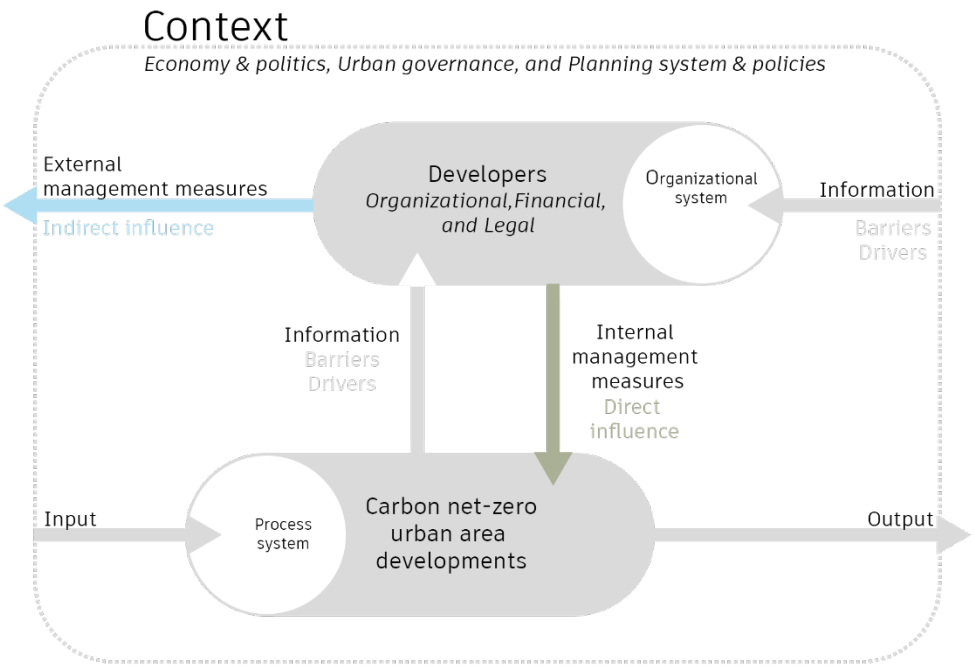


Figure 3: Conceptual steering model influence by developers (Own figure)

Empirical research

In the cross-case analysis, different barriers related to the PESTEL categories are shown. This shows that it is a complex task with many challenges that can be influenced by developers.

Political barriers are related to laws, regulations, and certificates, which can only be influenced indirectly. However, project choices by the municipality can be directly influenced. Economic barriers are related to the feasibility of the business case and the high cost of materials and equipment. Social barriers are related to knowledge and dependency, as developers must have sufficient knowledge about carbon zero, and contractors and consultants must be aware of the targets. Technological barriers are related to the availability of sustainable materials and the database of materials. Environmental barriers are mainly about the sites not being suitable. As for legal barriers, these also often involve laws and regulations.

A collaborative approach with all stakeholders is important. This approach should include more public awareness activities, early involvement of contractors, collaboration with sustainability experts, and the development of tools and databases that can help with decision-making. Achieving carbon-neutral urban developments is a big challenge, but it is a crucial step toward a more sustainable future.

Synthesis

The conceptual framework is divided into two parts: the indirect and direct influence of developers on carbon net-zero urban area developments.

There are six sub-categories of barriers that developers can indirectly influence. These barriers are not linked to a design phase but are more general points for a developer to indirectly influence. Therefore, indirect influence has been separated from direct influence. This has resulted in four focus points for developers for Part 1. These focus on the other parties and the type of action.

The second part is the conceptual framework itself, which is shown in Figure 4. Here, the X-axis shows the design phase. The Y-axis shows the parties involved along with the action the developer might perform. The conceptual framework briefly explains the actions, but there is also an appendix where the actions are explained in detail. A requirement to use the conceptual framework, as explained in figure 24, is to have at least one of the four drivers as a developer for carbon net-zero urban area developments.

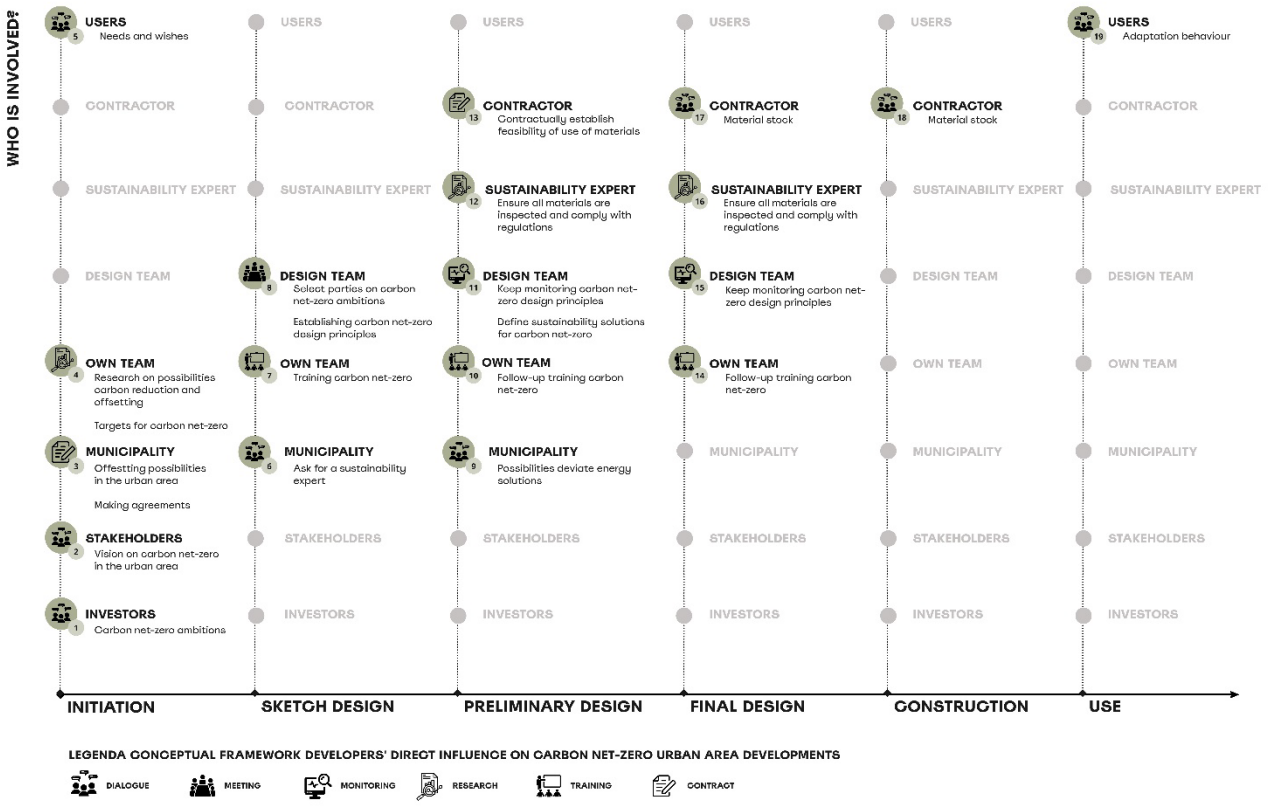


Figure 4: Conceptual framework (Own figure)

Conclusion

What can developers do to influence carbon offsets in the development areas in the Netherlands?

By using several strategies and actions, developers in the Netherlands can have a significant impact on carbon offsets in urban areas. A competitive position, intrinsic motivation, financial support, and a desire to build a better world are the first four drivers that developers must have. The development process is started based on these drivers.

Developers have the most impact on carbon net-zero developments during the design phase. They must carefully select the appropriate partners to work with and set up defined starting points and goals that are in line with carbon net-zero aims. To make sure that the sustainability objectives are being accomplished, regular review is required at every level of the development process.

For the project to be successful, collaboration with the entire supply chain is essential. Most importantly, the design team but also investors, and future residents.

This is reflected in the conceptual framework, which analyses data, translates barriers into opportunities, and groups them into sub-categories according to factors including direct and indirect influence, stakeholders, activities, and development phases.

The case studies have shown several barriers to carbon net-zero urban area developments that can be translated into opportunities for developers. As from the literature, practitioners confirm the feasibility of carbon net-zero developments within the business case, knowledge, user preferences, and laws and regulations as barriers. In addition, practice shows that the accumulation of requirements and regulations, certain project choices by the municipality, materials and equipment, dependency, availability, materials, collaboration, project level, and sites that are not suitable are also barriers experienced.

Influencing carbon offsets can be done by implementing specific measures. These include reusing existing buildings, selecting sustainable materials, planting trees, creating picking forests for local communities and establishing algae farms. Additionally, developing mobility plans to reduce car usage and providing financial support to help locals green their gardens and assist farmers in reducing their carbon footprint are effective strategies.

Developers could translate indirect and direct influenceable barriers into opportunities and thereby influence each phase with the necessary parties and the necessary tool. By using this framework, developers can contribute to carbon net-zero urban area developments. It provides a structured approach to navigate complexities and maximize impact, resulting in a greener future with less carbon.

Table of contents

01.

INTRODUCTION

The first chapter introduced the problem statement based on literature. In addition, the scientific and societal relevance is explained. This is followed by the research questions and then the goals and objectives.

Introduction

More than 20 years ago, few people realized that the climate was changing, and even fewer people knew that we humans appear to be able to significantly influence climate change by burning fossil fuels on a large scale (Tillie, Van Den Dobbelsteen, Doepel, Joubert, De Jager, Mayenburg, 2009; Greenpeace Nederland, 2022). However, in 1972, scientists realized that we need to take climate change into account (Meadows & Club van Rome, 1972). Meadows & Club van Rome (1972) state "We are convinced that becoming aware of the quantitative limits of the environment around the world and the tragic consequences of chaos is essential for initiating new ways of thinking" (pp. 198). At this moment, it is not only a small part of the world, but people all around the world are convinced that the climate is changing at a rate never before seen and the main societal issue is the depletion of our energy supplies, which is a social and economic issue as opposed to a technological one (Tillie et al., 2009).

To tackle climate change, countries worldwide are working on the Sustainable Development Goals (SDG) (UN, 2015). These SDGs are part of the Agenda 2030 launched by the United Nations (UN) and consist of 17 goals and 169 subgoals to make the world a better place by 2030 and aim to end poverty, inequality, and climate change (UN Global compact, 2021). The SDGs do also have a goal referring to the building and construction industry; ''Make cities and human settlements inclusive, safe, resilient and sustainable'' (United Nations, 2015, pp. 26).

To respond to climate change in Europe, we now have agreements such as the Green Deal, and in the Netherlands, we have the Climate Agreement (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2021). The main goal of the Climate Agreement is to reduce carbon dioxide (CO_2) emissions by 49% by 2030 compared to 1990 (Ministerie van Economische Zaken, Landbouw en Innovatie, 2020). By 2050, CO_2 emissions must be reduced by 95% to prevent global warming. Further in this thesis, CO_2 is also described as carbon.

Carbon emissions are produced when fossil fuels are burned (Vrieling, 2022). Being carbon-net zero means that overall, human actions do not contribute to an increase in global carbon emissions. To achieve carbon net-zero, carbon emissions can be net-zero by creating as little CO_2 as feasible through the design of business operations in the complete chain or by funding initiatives that lower emissions elsewhere, other emissions can be offset.

01.1 Problem Statement

We must now reduce our global carbon emissions to limit the temperature rise below two degrees to prevent catastrophic climate change (Greenpeace Nederland, 2022). Also, the built environment must comply with the Climate Agreement by 2050 because this sector is responsible for 38% of carbon emissions in the Netherlands (Dutch Green Building Council [DGBC], 2021). This consists of operational emissions (27%), emissions related to energy consumption through the use of the building, as well as material-related emissions (11%), and emissions related to materials and (building) processes.

Currently, for all new construction, both residential and non-residential, permit applications have to meet the requirements for Nearly Energy Neutral Buildings (BENG) (RVO, 2022b). However, regulations for developing carbon net-zero buildings are lacking, as a consequence there is less pressure to develop carbon net-zero. Also according to Heurkens (2020), there is a perception in the Netherlands that the construction industry innovates and adapts slowly to the changing environment.

To make it more attractive to invest and develop in sustainable buildings, the government already encourages sustainable buildings with subsidies to reduce the costs of the investments (Ministerie van Algemene Zaken. 2016).

For investors in real estate, sustainability is still seen as a cost rather than a profitable long-term investment (Heurkens, 2020a). The balance

between long-term sustainability and short-term profitability is missing. Next to this financial barrier, there are much more examples of barriers to developing sustainable and carbon net-zero buildings. For example, it is difficult for developers to understand exactly what tools are existing in the market; how these tools work, and what the output of these tools is (C. van Veen, personal communications, October 25, 2022). Because of different barriers, parties stick to the regulations and do not 'go beyond compliance' (Heurkens, 2020a).

Thus due to various barriers, it is difficult to develop carbon net-zero buildings, there is only one example in the Netherlands where carbon net-zero is developed on the building level: 'Floating Office Rotterdam' (Powerhouse Company, 2022). To achieve carbon net-zero buildings, there are three steps to take: The first step is to make buildings energy-neutral (Vrieling, 2022). The second step to achieving carbon-neutral buildings is to make the building as climate-friendly as possible. Finally, to build a completely carbon neutral, all other emissions must be minimized and compensated as a result of the construction.

So achieving carbon net-zero often requires offsetting somewhere. In various industries, for instance, at KLM you can buy an airline ticket and choose 'CO2 compensation' (KLM, 2022). KLM then ensures that, among other things, trees are planted with this contribution. ''It helps to restore the balance between CO_2 emissions and uptake: forests can absorb billions of tonnes of carbon dioxide a year. While we work in different ways to reduce our CO_2 emissions, reforestation helps reduce the existing CO_2 in the Earth's atmosphere.'' (KLM, 2022). Furthermore, as an example, real estate developer Synchroon (2022) mentioned on their website: ''To offset our remaining emissions over the past year, we planted 500,000 trees; over 10 km^2 of forest, based on our CO2 emissions''. So what we now often see is that a forest is planted somewhere else in the world to offset CO2 emissions. Why are these emissions not offset in the area of the development itself?

Besides, the UN currently argues that plans against global warming are still inadequate (NOS, 2022). They state that not only governments but also banks and institutional investors should radically change their policies to achieve the Climate Agreement. Success can only be achieved if there is a massive and quick increase in investment in zero-emission technology while at the same time a steep decrease in investment in fossil fuel and other carbon-emitting activities. Investments in fossil fuels must decline rapidly, as they are now thwarting the transition to clean energy and locking in greenhouse gas emissions for decades to come.

So not only the government has to steer to carbon net-zero developments, but also other parties have to take responsibility. Also according to Griendt (2022), stricter laws and regulations make sense and can get organizations moving, but action and acceleration should come from the intern parties. Heurkens (2020) mentioned in his research the question of whether private parties can play a steering role in making urban areas sustainable. Heurkens found out that multiple entrepreneurial, investing, initiating, and collaborating roles can make private parties leading and competitive in urban area development (Heurkens, 2020a).

To summarize, there are no regulations for carbon net-zero developments. According to the literature, there are barriers to investing in sustainable and carbon net-zero developments to achieve the Climate Agreement. To achieve carbon net-zero buildings, buildings have to be energy-neutral, and climate-friendly as possible all other emissions must be minimized and compensated as a result of the construction. However, what we now often see is that a forest is planted somewhere else to compensate for the carbon emissions. Why are these emissions not compensated in the area of development itself? Furthermore, the UN states that also other parties have to take responsibility to steer to carbon net-zero developments. Heurkens (2020) has investigated that, next to the public parties, private parties, especially developers, have a steering role in sustainable urban area development. There is a gap in terms of knowledge on how to reach carbon net-zero urban area developments and how they can be

influenced by developers. Therefore, the problem statement is as follows:

Currently, achieving carbon net-zero is only considered at the building level. If offsetting is required for carbon emissions, suggestions are made to offset it far outside the planning area while the planning area itself is often disregarded. Furthermore, it is known that developers influence sustainable urban area developments under which carbon net-zero can be placed, but their influence specifically on this issue is unknown.

01.2 Scientific relevance

Sustainability and carbon net-zero developments in the built environment have been a hot topic in recent years. As previously mentioned, investors see investing in sustainable buildings more as a short-term expense than a long-term investment which results in parties mostly sticking to the BENG standards on the building level. Public parties try to steer these investments with subsidies. However, there is almost no research on how private parties, in specific, developers have an influence on carbon net-zero developments, and in specific urban area developments. Therefore, this thesis aims to fill the knowledge gap by finding out how developers can assure that the built environment will be carbon net-zero by 2050.

01.3 Societal relevance

In addition to the scientific relevance, this research also has high societal relevance. As mentioned before, people throughout the globe are convinced that the climate is changing at a rate that has never been witnessed and that the primary socioeconomic problem—a social and economic one rather than a technological one—is the depletion of our energy resources (Tillie et al., 2009). The building and construction sector is responsible for 38% of carbon emissions in the Netherlands (Dutch Green Building Council [DGBC], 2021). This means if the building and construction sector make sure they develop carbon net-zero, this sector can make a real difference on earth to prevent global warming.

01.4 Research questions

From the research gap, the main research question and associated sub-research questions were formed. This chapter explains both the main and the sub-questions. For each question, it is made clear which data collection is used and how this will be done. First, a conceptual model (figure 5) is developed to visualize the relationships between the main concepts of the problem statement.

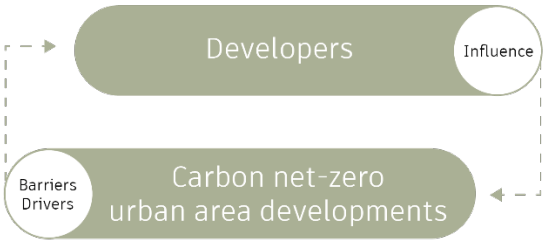


Figure 5: Conceptual framework (Own figure)

Main research question

Based on the problem statement, the following main research question is formulated:

What can developers do to influence carbon offsets in the development areas in the Netherlands?

To understand the main research question, the concepts: developers, carbon net-zero developments, and urban area developments are explained in chapter 3.

Research sub-questions

To answer the main question, seven sub-questions have been formulated.

1. How could carbon net-zero urban area development be described?
2. How are carbon emissions currently offset in the building and construction sector?
3. How can the developers' role be defined within sustainable urban area developments?
4. What are the current barriers and drivers for carbon net-zero developments?
5. What components are essential for developers to influence carbon offsets in the development areas in the Netherlands?
6. What opportunities do developers see to use the urban areas as a solution for achieving carbon net-zero in the Netherlands?
7. How can a conceptual framework be designed for developers to achieve carbon net-zero urban area developments in the Netherlands?

Relationship between sub-questions

To get an answer to the research question, the sub-questions must be structured in such a way that they achieve the intended goal step by step. This results in all sub-questions being interdependent. Figure 6 shows the relationships between the sub-questions.

Figure 6: Relationship between sub-questions (Own figure)

01.5 Goals and objectives

In less than 27 years, all urban areas need to be developed carbon net-zero (Ministerie van Economische Zaken, Landbouw en Innovatie, 2020). The goal of this research is to find out how developers have an influence on sustainable urban area developments towards carbon net-zero urban area developments before 2050. This results in the main objective of this research: ''This thesis aims to explore what developers can do to influence carbon net-zero urban area developments and how developers can apply this in practice.''

01.6 Dissemination and audiences

This study is intended for both real estate developers and investors. For developers, it is meant to provide guidelines and a conceptual framework during an urban area development so that they can use their steering role to help to meet the requirements for carbon net-zero urban area developments. In addition, for investors, it is to create awareness of why carbon net-zero urban area developments should be adopted as soon as possible.

01.7 Outline

The thesis is divided into different main chapters. The outline of the thesis is explained in table 1.

Chapter	Content
1. Introduction	The introduction starts with an outline of the context, after which the problem statement is explained. In addition, the scientific and societal relevance are also explained. Based on the problem statement, the research question and its sub-questions are explained. The research output is also discussed including the goals and objectives, deliverables, dissemination and audiences, and my personal study targets are highlighted.
2. Research method	The research method explains the methodology of this study. First, the research design is presented after which the theoretical research method and the empirical research method are highlighted. Following this, the data collection, data analysis, and data plan are explained. Ethical considerations are also zoomed in on.
3. Theoretical research	The literature study begins with an explanation of the conceptual steering model. This conceptual steering model is linked to the design of this study. Using this model, the context, developer, and carbon net-zero urban area development are explained. It also examines the barriers and drivers for carbon net-zero developments, the role of the developer, and carbon offsetting.
4. Empirical research	In this chapter, the data results arising from the interviews at the case studies are processed here. The sub-questions are answered herein.
5. Synthesis	In the synthesis chapter, the expert panel is central where the designed conceptual framework is shown and tested by experts.
6. Discussion, Conclusion, and reflection	This chapter first discusses the research. After the discussion, the main research question is answered. Finally, the research is reflected upon.

Table 1: Thesis outline (Own table)

02.

RESEARCH METHOD

This chapter presents the methodology adopted in this study, which utilizes various research methods to address the research question. First, the research design is elaborated upon, followed by an explanation of the methods and techniques employed in data collection and analysis. The method is split into three parts: theoretical research, empirical research, and synthesis, each linked to the sub-questions specific to that section. The chapter presents the research plan and finally, ethical considerations are highlighted.

Research method

02.1 Research design

In figure 7 the research design is shown. This is the relation between the (sub)questions, the conceptual framework, and the research methods and techniques to be used. In this research, qualitative methods will be used to answer the research question and sub-questions.

Through literature research and explorative interviews, it examines what are carbon net-zero urban area developments, how carbon emissions are currently offset in the building and construction sector, what is the role of developers in sustainable urban area developments, and the barriers and drivers for carbon net-zero urban area developments. These literature reviews answer the first four sub-questions

For the fifth and sixth sub-questions, semi-structured interviews are conducted. These sub-questions are the basis for the conceptual framework for developers which they can use to achieve carbon net-zero urban area developments in the Netherlands. To get a conceptual framework that works in practice, an expert panel is used to guarantee usability.

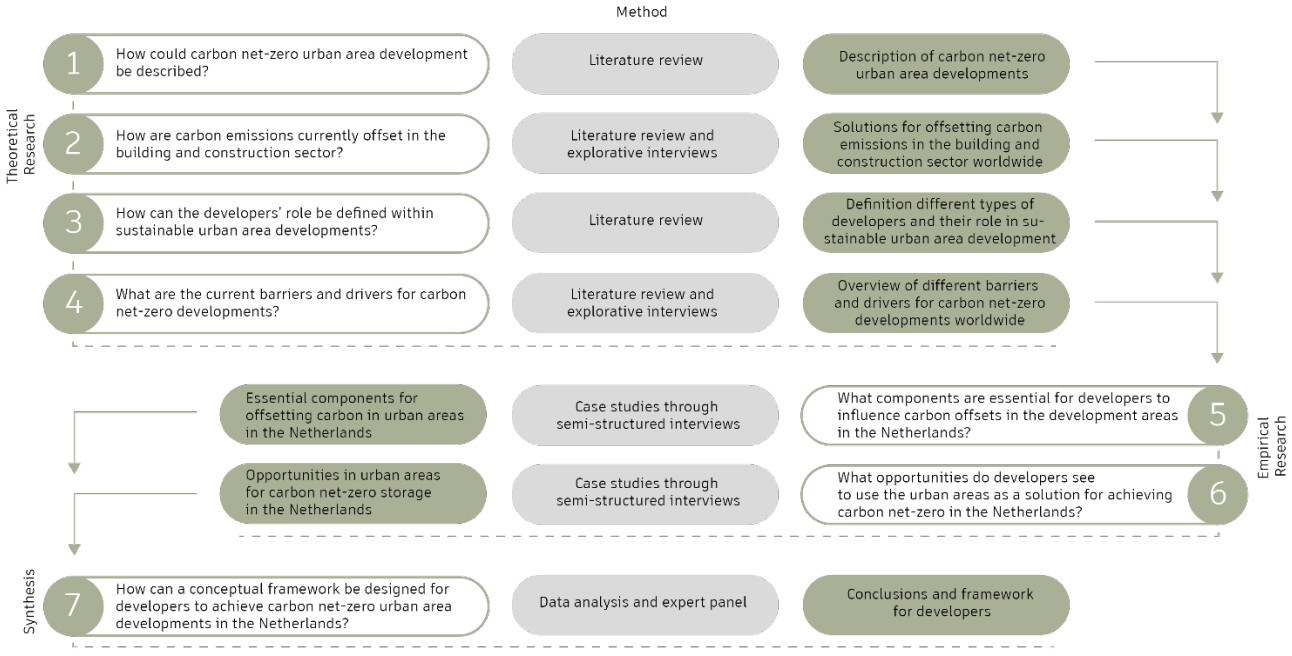


Figure 7: Research design (Own figure)

02.2 Methods and techniques, data collection and analysis

Theoretical research

To answer the four theoretical sub-questions, theoretical research is used. The keywords for searching were chosen by looking at the main concepts of each sub-question. Search engines used are Scopus and Google Scholar. As the topic is quite recent and there are constant changes, the websites gebiedsontwikkeling.nu and the central government website are also used.

For each sub-question, first, the purpose is explained after which is zoomed in on what combination of search terms was used for the search engine. Finally, the relationship with the other questions is explained.

Before the theoretical research starts, the context is explained using Heurkens' (2012) conceptual steering model: "Value & power shift in the context of Dutch urban development". It is crucial to define the situation in which the research problem arises to understand it completely. Economic and political factors, urban governance, and planning systems and policies are examined to understand the context. It is important to highlight this context precisely since this research mainly considers the Dutch market.

Sub-question 1: How could carbon net-zero urban area development be described?

The objective of this sub-question is to describe carbon net-zero urban area developments in general. By explaining urban area development and sustainable urban area development, the context is set for the carbon net-zero urban area development. To gather a diverse range of studies, many forms of defining the subjects are used interchangeably. The search proceeded as follows: (''Urban development project'' OR ''Area development'' OR ''Development'') AND (''Carbon net-zero'' OR ''Sustainable''). The output of this research question can be used for SQ5 and SQ6 and to develop a conceptual framework in SQ7.

Sub-question 2: How are carbon emissions currently offset in the building and construction sector?

The second sub-question focuses on investigating methods of carbon offsetting. This question provides insight into how and where carbon is currently offset in the sector worldwide. Many different ways of classifying subjects are used interchangeably to gather a varied variety of research. The search proceeded as follows: (''Urban development project'' OR ''Area development'' OR ''Development'') AND (''Carbon net-zero'' OR ''Sustainable'') AND (''Compensation'' OR ''Offset''). The output of this research question can be used for SQ5 and SQ6 and to develop a framework in SQ7.

Sub-question 3: How can the developers' role be defined within sustainable urban area developments?

The purpose of this sub-question is to clarify how the developers' role can be defined within sustainable urban area developments. First by explaining different types of developers through the themes of organizational, financial, and legal literature review, the context is set for the role of developers in sustainable urban area developments. Different ways of describing the topics are used interchangeably to acquire a broad set of studies. The search proceeded as follows: (''Urban development project'' OR ''Area development'' OR ''Development'') AND (''Carbon net-zero'' OR ''Sustainable'') AND (''Steering role'' OR ''Steering'' OR ''Manage'') AND (''Developer''). The output of this research question can be used for SQ5 and to develop a conceptual framework in SQ7.

Sub-question 4: What are the current barriers and drivers for carbon net-zero developments?

This sub-question investigates what barriers and drivers arise for carbon net-zero developments worldwide. To find out what the barriers and drivers are to carbon net-zero (urban area) developments, a literature review is conducted. Different ways of describing the topics are used interchangeably to acquire a broad set of studies. The search proceeded as follows: (''Driver'' OR ''Barrier'' OR ''Limitation'') AND (''Urban development project'' OR ''Area development'' OR ''Development'') AND (''Carbon net-zero'' OR ''Sustainable''). The output of this research question can be used for SQ5 and to develop a conceptual framework in SQ7.

Empirical research

This paragraph explains the empirical research method. This method consists of explorative case studies where semi-structured interviews are conducted.

Explorative case studies

For this research, explorative case studies are used. ''The essence of a case study is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result.'' (Schramm, 1971, emphasis added). A case study may be conducted if you want to understand a real-world event and believe that such knowledge will include critical contextual variables relevant to your case (Yin & Davis, 2007). The reason case study methods are chosen is because this research answers a "what question". Explorative case studies provide answers to who and what questions, arise in this research (Heurkens, 2023). Yin (2009) states that the more that your questions seek to explain some contemporary circumstance, the more that case study is relevant.

The case study method has the benefit of being grounded in and applicable to real-life, existing human situations, as well as providing in-depth relevant data (Krunsenvik, 2016). Case studies link directly to the everyday experience of the average reader and increase understanding of complicated real-life events. Its in-depth findings are not taken out of context, and they aid in the development of new hypotheses as well as the reinforcement of past research. The main issues with case studies are their low generalizability and precision. Because of the researcher's close engagement and influence on the study, which may bias the outcomes, the research is frequently questioned as scientific. Critics further contend that studying a single example provides no foundation for determining the reliability or generalizability of the results.

To apply the theory to the Dutch real estate market, a multiple-explorative case study is conducted. A multiple case study has the advantage of allowing for data analysis both inside and across situations (Gustafsson, 2017). To provide the literature with significant influences from its similarities, it is essential to understand the similarities between the cases. Other advantages include the fact that a multiple case study produces solid, trustworthy data.

Semi-structured interviews

Interviews are conducted for the selected case studies. These interviews are semi-structured. Semi-structured interviews are made to get individuals' different reactions to a certain situation or event they have experienced (McIntosh & Morse, 2015). The methodology employed in this study involves a semi-structured interview approach, wherein the interview questions are based on the responses of the participants and are designed to cover a broad range of topics. The researcher is permitted to go deeper into any replies given in response to these open-ended questions by the participants. This may be very relevant to this study because developers may tell a bit more than is known from theory. The semi-structured interviews are face-to-face because it has the advantage that the presence of the interviewer provides the interview structure (McIntosh & Morse, 2015).

For representative data, the sampling method is important (McIntosh & Morse, 2015). Shenton (2004) mentioned in his research four main themes to ensure trustworthiness in qualitative research projects: credibility, transferability, dependability, and confirmability. In chapter 4, the sampling method is clarified.

Synthesis

The results both from theoretical research and empirical research are the base for the synthesis.

Research by design – Conceptual framework

All input from the literature reviews, case studies, interviews, and other data will be the basis for a conceptual framework for developers to influence carbon net-zero urban area developments by overcoming the barriers by creating actions for developers to achieve carbon net-zero urban area developments in the Netherlands.

Different design steps are needed to design an evidence-based tool, where is in this research the tool is a conceptual framework. These steps are explained in detail in chapter 5.

Expert panel

An expert panel is used to validate the findings, which simply refers to a qualitative (group) interview based on a subject that stresses the expert's expertise (Döringer, 2021). The expert panel consists of four people working as real estate developers. Every person reflects on the conclusions and they help to eventually develop an effective conceptual framework for developers to influence carbon net-zero urban area developments.

02.3 Ethical considerations

A set of principles that direct your study designs and procedures are known as ethical considerations in research (Bhandari, 2022). These are to protect the right of the participants, to strengthen research validity and maintain academic integrity. In this research, participants have the option to step out of the research at any time. Furthermore, before agreeing or declining to participate, participants understand the study's objective, advantages, risks, and financing.

Blank page

03.

THEORETICAL RESEARCH

This chapter begins by explaining the conceptual steering model. Then the context in the Netherlands is explained. A literature review is then carried out on the topics of carbon net-zero urban area developments, developers, and barriers and drivers.

03 Theoretical research

03.1 Conceptual steering model

Urban development practice is often considered to be very complex and dynamic (Heurkens, 2012). By using Heurkens' (2012) conceptual steering model 'Value & power shift in the context of Dutch urban development' (Figure 8), the context is explained. It is important to have a constant point of view, thus the model is not used to understand urban development practice as a whole but rather the interaction between the context, organization, management, and effects of private sector-led urban development initiatives. This conceptual model helps to understand mechanisms between the relevant factors influencing the role of the developers in projects and urban area developments.

The context in the conceptual steering model shows the several layers of surrounds that a particular empirical item (of investigation) is a part of (Heurkens, 2012). Such a situation is frequently changeable. When applied to the field of urban development, this context (of a project) could, for instance, include geographical policies or economic conditions that are seen to be prerequisites for how urban development projects might be structured. The organizational system depicts several degrees of organizational structure aggregation, official and informal linkages, and responsibilities between various players. In this research, the organizational framework is used in the field of urban development and comprises different types of developers and their steering role within urban area developments. Third, the study's focus is on the processing system, which in this case is a carbon net-zero urban area development.

These three main elements are connected in ways that reflect the dynamics that occur both within and around projects (Heurkens, 2012). For example, a changing context might have an impact on the processing system, which is an input to the process. For instance, changes in the economy have an impact on how processes in urban development projects may be managed. This is based on information sent to the project organization (inside the organizational framework created to handle these operations) about evolving urban development processes. As a result, companies frequently adjust to deal with the changes. This is achieved by internal and external management measures. The structure or objectives of the project are intended to be influenced by internal management strategies, whilst the structure or objectives of the project's surroundings are affected by external strategies. Furthermore, the organizational system is supplied by data or signals gathered from the project environment. Because it is hard to manage a context of a project, the focus is on internal management measures. As a result, this conceptual steering model may be used to describe a wide range of project-related phenomena rather than serving as a static depiction of reality.

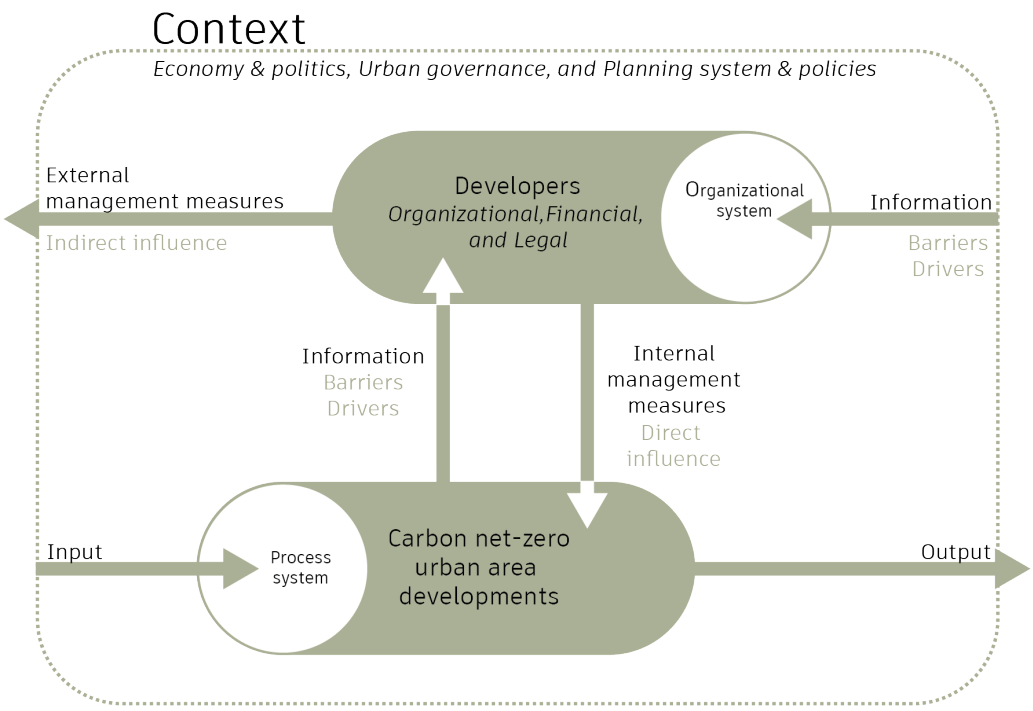


Figure 8: Conceptual steering model (Based on Heurkens, 2012)

03.2 Context

To fully understand the research problem, it is important to describe the context in which the problem occurs. As Heurkens (2012) points out, the context affects both the processing system and the organizational system. Three different contextual aspects are analyzed to understand the context: economy & politics; urban governance; and planning system & policies. This research only focuses on the Dutch market, so this context must be clearly described.

Economy and politics

Good climate policy offers opportunities to build a sustainable and strong economy (Ministerie van Algemene Zaken, 2022a). The Netherlands wants to make maximum efforts to keep the country and planet liveable and inhabitable. That is also why they pursue the climate target of no more than 1.5 degrees of the Paris Climate Agreement. The Netherlands wants to be a frontrunner in Europe in combating global warming. To be climate neutral by 2050, the Netherlands is tightening the 2030 target in the Climate Act to at least 55% CO_2 reduction. To make sure this target is also met, they agree to aim for a higher target in policy, amounting to around 60% in 2030. Even after 2030, it is necessary to continue ambitiously with CO_2 reduction. The aim is for a 70% reduction in 2035 and 80% in 2040. What is clear is that there is certainly a will to curb CO_2 emissions, but there is hardly any information on how the government intends to achieve this.

Urban governance

Over the last fifty years or more, the governance roles of and power relations between public, private, and civic actors in Dutch urban planning and development practice have changed (figure 9). (Heurkens, 2012). The interaction between the three actor groups and subsequent individual actor acts are fundamental to urban government. The rising trend in Dutch urban development is toward more demand-driven development strategies, where both human and business needs are given more significance. To assess development needs in collaboration with civic actors and provide a specialized supply for urban areas, these demands are most often assisted by public actors, with a growing leadership role for private players.

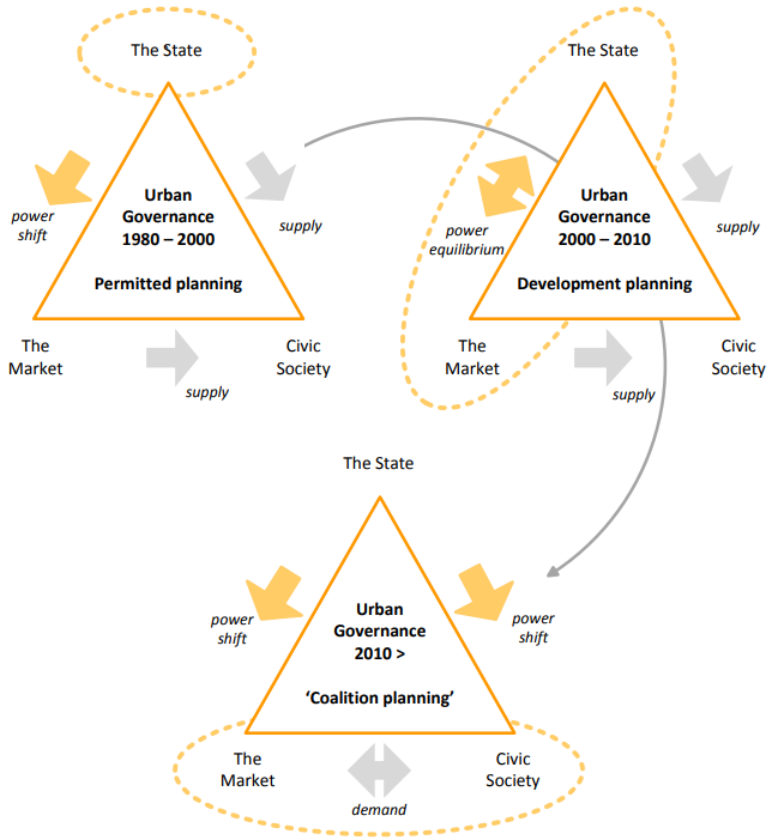


Figure 9: Dutch urban governance shifts over time (Heurkens, 2012)

Planning system and policies

To influence (sustainable urban area) developments, some regulations are related to the Dutch housing market. At this moment, there are different laws and regulations for the redevelopment and development of buildings.

First, the 'Bouwbesluit' sets requirements for the energy efficiency of new homes and utility buildings. The most important requirements in new construction are those for Nearly Energy Neutral Buildings (BENG), permit applications have to meet the requirements for BENG (RVO, 2022a; RVO, 2022b). The energy performance in BENG is determined based on three individually achievable requirements: the maximum energy demand in kWh per m2 of usable area per year (kWh/m2.yr); maximum primary fossil energy use, also in kWh per m2 of usable area per year (kWh/m2.yr); and the minimum of renewable energy in per cent (%).

Besides these regulations, the MPG score (MilieuPrestatie Gebouwen) indicates the environmental impact of the materials used in a building. It covers new office buildings (larger than 100 m^2) and new housing developments (RVO, 2021). In addition to the regulations, there are also other guidelines. Steering for purely financial and economic results needs to be more balanced with environmental and social concerns (Van de Griendt, 2022). To this end, the global standard for Environment, Social & Governance (ESG) was created. ''ESG is the ability to maximize long-term financial performance while contributing to environmental and social development through good governance.'' (Van de Griendt, 2022, pp. 13). To make it more attractive to invest and develop in sustainable buildings, the government already encourages sustainable building and remodelling with subsidies to reduce the costs for the investments (Ministerie van Algemene Zaken. 2016).

03.3 Carbon net-zero (urban area) developments

Besides the developers, the other main focus element in this research is the processing system which is the carbon net-zero urban area development. To understand what exactly is understood by this term, the theory is divided into carbon net-zero developments on the building level, urban area developments, and sustainable urban area developments.

Urban area development

To understand carbon net-zero urban area development, it is first important to first define urban area development. There are different definitions of urban area development. In this research, the definition of De Zeeuw (2018, p.7) is used: 'Urban area development is the art of connecting functions, disciplines, parties, interests, and money flows, intending to develop or transform an area.' Four ingredients are distinguished for the planning phase in an urban area development (De Zeeuw, 2018). Programme, Finance, Process and Design, and Realisation. With all the attention paid to process, organization and finance, the objectives of urban area development should not be affected.

In this research, urban area developments are developments in an urban area that have different functions and there are more than one building involved in the development. Furthermore, there is also public space between the buildings.

Sustainable urban area developments

The concept of sustainability, or rather 'sustainable development' was introduced in 1987 by the UN World Commission on Environment and Development: ‘meeting the needs of the present without compromising the ability of future generations to meet their own needs.’’ (Brundtland, 1987).

Sustainability and environmental quality are closely related (De Zeeuw, 2018). In environmental, health, and safety quality and the 'future value' dimension of spatial quality, the relationship is one-to-one. However, sustainability is a catch-all term, a grab bag that people bring up all the time, without specifying exactly what they mean. Sustainability in area development can be divided into the following themes: Energy supply and transformation; Climate resilience and adaptation; Health and safety; Mobility; Circular economy; History and identity of the area; and Green, biodiversity, and landscape.

In the practice of urban area development, the themes intertwine, and they can reinforce each other (De Zeeuw, 2018). However, the consideration has a broader character. After all, sustainability ambitions have to be balanced with financial-economic feasibility and stakeholder support. Undisciplined stacking of ambitions inevitably leads to the 'drama of good intentions'. Those who want to score a 10 on all themes get stuck; it becomes unfeasible financially, technically, in time, or in terms of the support base. Energy supply in urban area development cannot be separated from the energy transition. Central to this is the reduction of CO_2 emissions and cutting fossil fuel use, to implement the 'Paris Agreement' and Dutch implementation plans (De Zeeuw, 2018).

This study investigates carbon net-zero urban area developments, which are part of sustainable urban area development.

Carbon net-zero developments

CO_2 emissions are produced when fossil fuels are burned (Vrieling, 2022). Being carbon-net zero means that overall, your actions have no negative effects on the climate and do not contribute to an increase in global CO_2 emissions. To achieve carbon net-zero, CO_2 emissions can be carbon net-zero by creating as little CO_2 as feasible through the design of business operations in the complete chain or by funding initiatives that lower emissions elsewhere, leftover emissions can be offset.

As mentioned in the problem statement, buildings still play a major role in urban life, but their carbon footprints and inefficiencies provide a significant challenge to their owners, policymakers, local governments, and communities (Grainger, 2022). The life-cycle of a building should have zero carbon emissions to achieve climate-neutral buildings following

methods for fulfilling the Paris Agreement (Lützkendorf & Frischknecht, 2020). Carbon net-zero building is an ambitious modern method of constructing buildings with as little environmental impact as possible (Vrieling, 2022). The method broadly consists of three steps: The first step is to make buildings energy-neutral. For example, by generating their energy through solar panels. The second step to achieving carbon-neutral buildings is to make the building as climate-friendly as possible. This can be done through circular construction. This sustainable form of construction uses as many reusable raw materials and as few finite resources as possible. Finally, to build a completely carbon neutral, all other emissions must be minimized and compensated as a result of the construction. CO_2 is still produced today in the manufacturing of building materials and components, as well as in the supply chains of renewable energy sources (Lützkendorf & Frischknecht, 2020). This includes the production and transport of goods and energy consumption for construction work (Vrieling, 2022). Because in this research the focus is on carbon net-zero, the themes of energy and climate neutral are explained and the rest are excluded.

The quantity of carbon released when fossil fuels are used to produce energy and when land uses are changed as a result of deforestation and agricultural land expansion are determined by socioeconomic factors (Wimbadi & Djalante, 2020). As a result, the sources of carbon emissions may be divided into the energy sector and the non-energy sector. While the non-energy sector consists of agriculture, forestry, land use, industrial process, and product use, the energy sector encompasses sub-sectors that include electricity and heat, transportation, industry, and buildings.

For our net emissions to be zero, we must remove one greenhouse gas (GHG) from everyone that we release into the atmosphere (TED, 2020). To achieve net-zero, we must implement significant technology improvements for the future, such as replacing all GHG-producing activities with clean ones, as well as significant changes in how we live today. We also need to permanently store GHG that is taken in from the air.

The transition to carbon net-zero calls for modifications to business norms and beliefs, institutions, and society at large in addition to the viewpoints (Zhao et. Al., 2016). The way we plan and build new buildings will be significantly impacted by the shift to secure, sustainable, low-energy technologies (Glass, Dainty, and Gibb, 2008).

Energy

Buildings and the construction of new buildings continue to use more energy as a result of increased energy access in developing nations, rising air conditioning demand in tropical regions, increased ownership and use of energy-intensive appliances, and the rapid increase in the area of buildings around the world (International Energy Agency, 2021).

A project is energy neutral if, on an annual basis, no net imports of fossil or nuclear fuel from outside the system boundary are required to construct the building construction, use, and demolition (Alsema, 2009). This means that the energy use within the project scope is equal to the amount of renewable energy generated within the project scope is generated or attributable to the project based on external measures project may be attributed. The energy consumption resulting from the construction and demolition of the building will be allocated to an annual contribution settled based on the expected lifetime of the building.

The National Plan for Nearly Energy-Neutral Buildings stipulates that a fully energy-neutral building has an energy performance coefficient (EPC) = 0 (RVO, 2014). This EPC value is determined using the standard NEN 7120: Characteristics of these determination methods are: energy use is determined under standard use and climate conditions; only building-related energy use is valued in the energy performance; area-related measures can - if applicable - be valued using the EMG; - energy generation can take place inside and outside the building; - renewable energy sources are valued; - net energy use is determined over a year.

'The energy transition is one of five certainties that governments, businesses, civil society organizations, and citizens can count on (Daamen, 2022). Although its pace and the exact technological solutions are still unclear, since the outbreak of the war in Ukraine, we see that insulating existing homes has gained momentum. After all, affordable housing includes energy bills, and the Dutch are keen on cutting costs.

Realizing heat and energy facilities is complex for a developer (Allard, 2022). Buildings need to be provided with a new and sustainable heat and energy supply. In doing so, there are several hurdles to overcome before a heat supply can be realized. For example, area developers have to deal with the choices made by municipalities. Municipalities lay down in their heat plans which parts of the built-up area are to be connected to sustainable sources.

Circularity

Circularity is seen as a precondition for sustainability (Hopff, Nijhuis & Verhoef, 2019). ''The 'Circular Economy' is an economic system based on business models that replace the concept of 'end-of-life' with reducing, reusing and recovering raw materials in production, distribution and consumption processes, by operating at different levels of scale and to achieve sustainable development for present and future generations.'' (Hopff, Nijhuis & Verhoef, 2019. pp. 3-4). Circularity is linked to the economy, environment, and society. According to Van den Berghe & Vos (2019, pp. 4), ''circularity links to the (socio) economy, or in other words the circular economy. Although there is no consensus on what CE is, CE is a heterogeneous and composite economy of different sectors (e.g., financial, industrial, agricultural, etc.). Each of these has its own specific, and ever-changing, knowledge bases, labour profiles, experiences, market settings, and global production networks.''

Carbon net-zero urban area developments

As mentioned in the section on carbon net-zero developments, to achieve a carbon net-zero building, the building has to be climate-neutral, energy neutral, and the other emissions need to be compensated. The built environment involves different scales, so, carbon net-zero building is a part of the urban area. In figure 10, the different scales from the urban area level to the building level are shown. What becomes clear is carbon emissions of the non-energy sector and energy sector should be offset. This may be possible in the area where the development takes place.

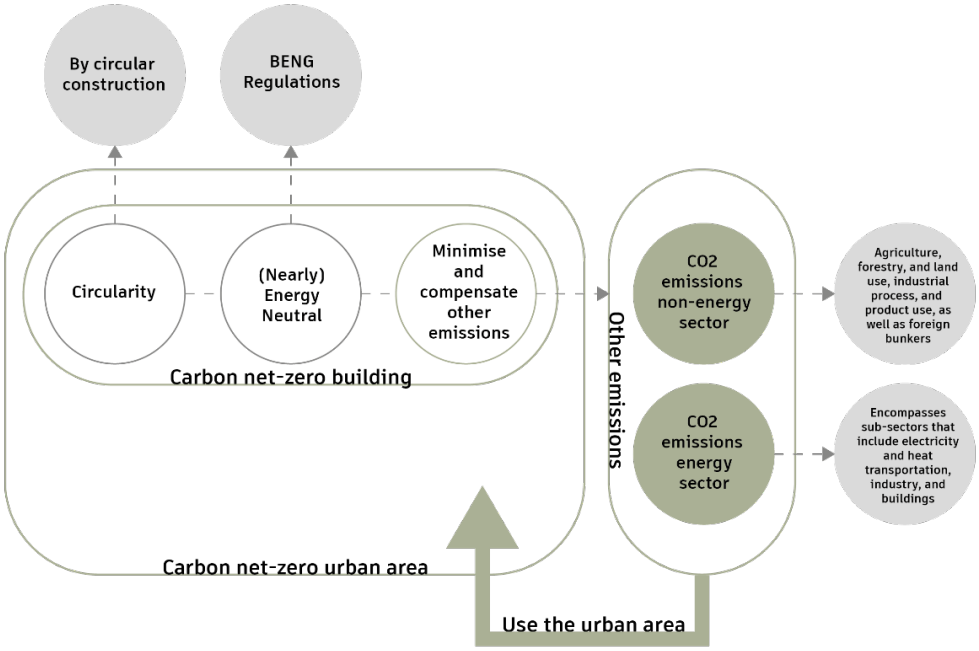


Figure 10: Carbon net-zero storage in urban areas (Own figure)

Carbon emissions

A common way for organizations to communicate what they emit is to divide it into three different scopes (Dutch Green Building Council [DGBC], 2021). The concept of these scopes was introduced by the Greenhouse Gas Protocol, defining how an organization controls the emissions it has a direct or indirect influence over. Scope 1 is the direct emissions from sources managed or part of the organization, e.g. emissions released by an organization's plant. Scope 2 is the indirect emissions from the generation of purchased energy, steam, heat, and cooling. The emissions do not take place directly at the organization itself, but as a user of energy, the organization is still responsible for these emissions from an energy supplier. Scope 3 is the indirect emissions that are not directly managed by or belong to an organization, but are in the organization's chain through purchasing (upstream) or sales (downstream), as well as through employee business travel. Material-related emissions can be minimized by closely examining where reductions can be made throughout the chain (Dutch Green Building Council [DGBC], 2021). This is a particular issue in new construction, given the new building challenge we face.

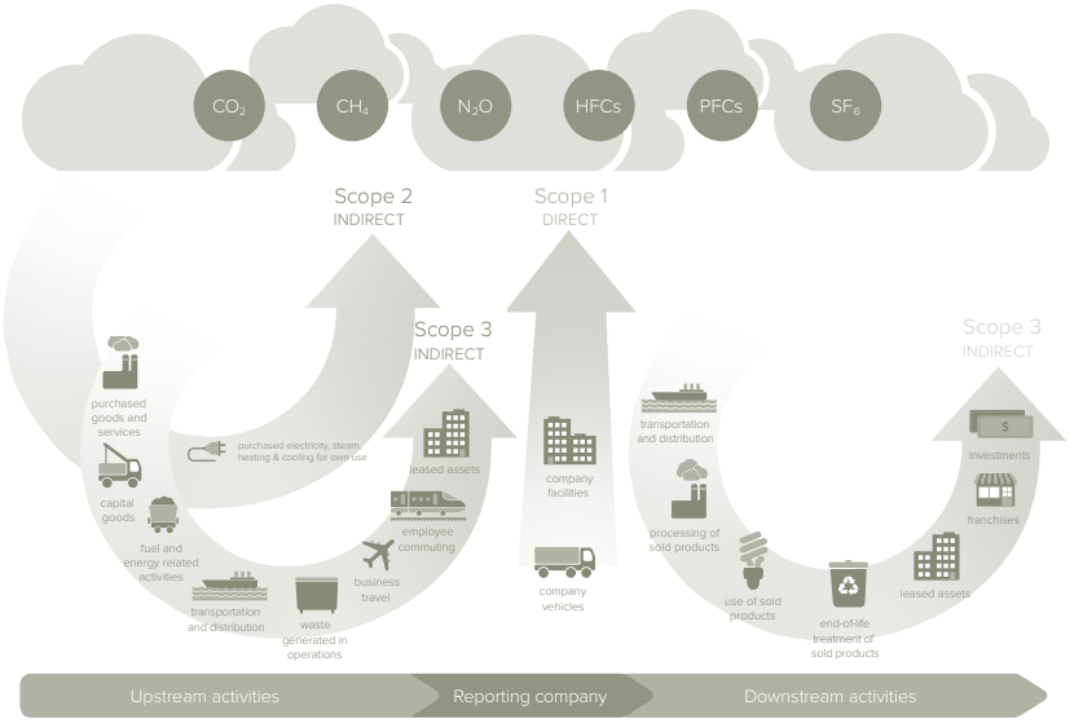


Figure 11: Schematic representation of scopes 1, 2, and 3 (Dutch Green Building Council [DGBC], 2021)

Offsetting carbon emissions

Several industries have no alternative to wind and solar. Certain chemical processes release carbon, e.g. cement production. By 2050, it will be difficult to stop these industries and in the meantime, we will still be emitting carbon (Benda, 2021; R. van Laak, personal communications, February 23, 2023). No emissions at all are not possible: 20% of emissions will continue to be needed to produce the necessary plastics, among other things (Vermaas, 2022). What you could do to counteract carbon emissions is then either stop using cement or do something with the carbon (R. van Laak, personal communications, February 23, 2023).

The University of Oxford (2020) has presented the ''Oxford Offsetting Principles'' for Net Zero Aligned Carbon Offsetting. These principles show an approach for offsetting to ensure a carbon net-zero society. The first principle is about reducing emissions. The second principle is the shift to carbon removal offsetting instead of carbon emission reductions. Third, as mentioned in the second principle, it is crucial to shift to carbon removals. However, it does not address the way how to remove the carbon. The shift from short to long-lived storage is a method to remove carbon from the atmosphere. Short-term storage entails approaches that are more likely to be reversed over time. Long-term carbon storage refers to carbon storage technologies that have a low risk of reversal over centuries to millennia, such as storing carbon in geological reservoirs or mineralizing carbon into stable forms. Offsets for short-lived storage help buy time to cut emissions and invest in long-term storage, but they are not a long-term option for establishing a balance between sinks and sources. As a result, investments in growing and enhancing the technologies that enable long-term storage must begin immediately. Generating demand for long-lived offsets now signals the market to increase the supply of such offsets. At last, it is important to support the development of carbon net-zero offsetting. The market for high-quality offsets required to achieve Principles 2 and 3 is limited and in need of early adopters to help it grow. Users of these principles can help to establish the market for net-zero aligned offsetting by using long-term agreements to assure certainty for developers; forming sector-specific alliances to collaborate with other parties to develop the market for carbon net-zero offsets; supporting the restoration and protection of a wide range of natural and semi-natural ecosystems in their own right; and implementing and publicizing these principles, as well as incorporating them into policy and standard-setting for offsetting and net-zero methods.

To offset carbon emissions, there are several ways to address this. Several options divided into on-site and off-site are explained below.

On-site offsetting

Building materials/biofuel

It is also possible to use building materials that absorb carbon. Once you have captured the CO2, you can turn it back into biofuels or building materials (R. van Laak, personal communications, February 23, 2023). Solutions for building materials that absorb carbon will not be available for years. Often the costs are still too high because it has to do with the economy of scale. It is still too early to make this cost-efficient. For example, there is a party working on making fuel from CO2, but this is around fifty times as expensive as petrol because it is still on such a small scale. After all, it takes a lot of time and money, investors have to be found and much is produced at the lab level. It needs time to scale up.

However, new technologies are already emerging. For example, some technologies inject carbon into concrete, as CarbonCure applies (Benda, 2021). With this technique, you store carbon in the concrete, but more importantly, it makes the concrete stronger, so you need less.

Carbon Capture Storage

Neptune Energy is in the process of storing carbon under the North Sea, this is called Carbon Capture Storage (CCS). Carbon will be injected into depleted gas fields 4 kilometres underground (R. van Laak, personal communications, February 23, 2023). Carbon then remains underground for thousands of

years. If you look at the balance of carbon, previously these atoms were all underground in the form of oil and gas. Mankind burned this and pumped it into the air. This way, you can bring the balance back slightly. To get carbon to these platforms at sea, there are plans by Shell and Total to build a pipeline from Rotterdam that will pass by the platforms to transport carbon. This pipeline will go to Rotterdam because of the amount of emissions from the industry sitting there. The Netherlands is quite central to taking on the function of carbon storage because the UK, the Netherlands, Belgium, and Germany have many industries and release a lot of carbon. To make use of such a network, the project location is important. This is because the carbon still needs to reach the pipelines. This can be done by pipeline but then it has to be paid for. For a residential area near Sneek, CCS would not be a logical solution. But should the project location now be near infrastructure and you have relatively central points it would certainly be interesting. A small capture unit could be used for this.

Direct air capture (DAC)

One of the primary technical answers to combating climate change is direct air capture (DAC) technology (Climeworks, 2023). It absorbs CO2 directly from the air, lowering CO2 concentrations in the atmosphere by exclusively utilizing renewable energy, energy-from-waste, or other waste heat as energy sources. Climeworks produces it on a bigger scale. There are different benefits of DAC: it is location independent, it is highly scalable, and measurable, and it is efficient for land usage.

In the Netherlands, a start-up company Carbyon is working on DAC which can also be applied on a smaller scale (De Jong, 2022). The unit directly filters CO2 from the air. The only thing is that operational costs are fairly high due to energy costs. However, Carbyon is working to reduce these costs considerably. This year, they will start the first test. If the tests are successful, Carbyon's technology should be able to be used commercially on a large scale from 2025 (De Jong, 2022). The machines will be fairly modular and they expect to capture 100 tonnes of CO2 per machine per year (B. Bos, personal communications, March 6, 2023). As a result, they will also be deployable on a small scale. However, the placement of the machines mainly depends on the renewable energy available nearby or close to the CO2 use. That is, the machine should mainly be placed where the CO2 will also be stored or used. For example, one of the markets the company investigating is greenhouses. It will then be able to place a machine next to a greenhouse and add the CO2 directly into the greenhouse to grow plants. The CO2 can also be stored or reused in new products. One of the big markets for that is concrete, maybe you can still look at that in the case of area development and building.

Olivine

There is still a lot of olivine available on the earth, you could grind it up and then it could absorb CO2. (Vermaas, 2022). Olivine is a mineral that has a structure in which CO2 can also dissolve. You can do this once, you can fix it in there and then it stays in that stone forever. On the other hand, a problem with this, though, is that it takes a long time; it has to be ground into a very fine substance to allow it to be absorbed. Furthermore, olivine has to be transported to the Netherlands, which is at the moment also not without carbon emissions.

Off-site offsetting

Donation

In projects, donation for carbon emissions is possible, often through planting trees (Milieu Centraal, n.d.). The offset is done by organizations that act as a middleman: they do not plant the forest or build the wind farm themselves, but invest the compensation money in projects in which this is done. The offset projects are almost always outside Europe.

Water

There is less than one per cent CO2 in the air, and getting it out of the air is a big task. The concentration of CO2 in water is around 150x higher than in air (Vermaas, 2022). It is therefore much easier to extract CO2 from the water. If you take CO2 out of the water, you also take it out of the air. The water is continuously

in equilibrium with the air. So if you take CO2 out of the sea, then more CO2 from the air can dissolve in the water. And in that way, you also take it out of the air. The machine is about 10 cm and is now a startup (SeaO2, 2023). The system can be retrofitted as a plug-and-play process, which allows small footprints and geometrical flexibility. For systems at sea level, you can become a ´storage partner´. The CO2 is eventually stored underground (CCS) or converted to chemicals/fuels through carbon capture and utilization (CCU).

03.4 Developers

Once it is clear what the context is, and what is understood by carbon urban area developments and carbon offsetting, it is important to zoom in on the other main focus element: developers. There are many different types of developers and they all have their institutional aspects. These aspects are divided into the following three topics: organizational; financial; and legal. In terms of internal management, the steering role of those developers will be explained.

Organizational aspects

Developers serve as a link between end users and contractors as well as a link between the supply and demand of real estate (Deloitte, 2010). ''Developers create, imagine, finance and orchestrate the process of development from beginning to end.'' (Heurkens, 2020b, pp. 4). The development of more useful working definitions for developers is now one of the largest issues since not all developers are the same. The term "developer" includes a wide range of contexts, including one-person businesses and multinational corporations (Boanada-Fuchs & Boanada-Fuchs, 2012). In this research, Heurkens's (2020b) description is used: The developers' traditional objective is to maximize profit through real estate development, against a manageable risk level (Heurkens, 2020b).

Thus, all developers have common objectives, yet developers differ from each other in certain points. In table 2, different types of developers are shown. It is important to understand the differences between those developers because different types of developers can result in different ways they act.

Type of developer	Characteristics
Independent developer	Small-sized, family companies, niche markets, parcel developers
Developers related to construction firms	Quantity/production driven, constant generation of cash flow, business continuity, small margins;
Developers related to investors	Develops for real estate portfolio institutional investment company, long-term yields, end user /occupier involvement;
Developers related to banks	Banks act as financiers of development, continuity and turnover, and access to capital;
Developers related to non-RE companies	Other core business companies (railway, hospitality, philanthropic, etc.)
Master/land developers	Urban development, strategic, integration, holistic, long-term involvement

Table 2: Different types of developers (Heurkens, 2020b)

Developers have a relatively short-term, project-based development focus, focusing on making high-quality integrated areas, making a decent profit, and mitigating financial risks (Heurkens, 2012a). Developing, institutional, and private investors (as well as housing associations) invest in, or develop themselves, a property portfolio of which they are (partly) owners, and in which the achievement of financial returns through property exploitation over the long term is central (Sturm et al., 2014).

Although there are different types of developers, they all have the same tasks and responsibilities. Heurkens (2020b) points out that those are: Many & various tasks Land acquisition, market analysis, development program, design plans, feasibility analysis, community consultation, securing finance/loans, marketing & sales, project management, real estate development, contracting, etc.

There are ten personal characteristics of successful developers in general (Heurkens, 2020b). Related to the development process, they have a thorough understanding of markets, construction, finance, and management ability. Related to personality, they have optimism, imagination & practical vision, judgment, decision-making ability, courage, and a 'thick skin' (Heurkens, 2020b).

According to Putman (2010), developers may also be identified by their weaker aspects, which include a lack of openness, a real estate industry with a reputation issue, a strong internal focus, a business strategy based on production repetition, and a lack of understanding of the end-user market.

Financial aspects

Still, all developers have in common that they are related to the topic of risk, in particular as it pertains to business strategies and financial success (Boanada-Fuchs & Boanada-Fuchs, 2012). According to the official discourse, developers are to be compensated in a given way for the risk they take on and the work they do. However, the link between risk and profits is not clear (Boanada-Fuchs & Boanada-Fuchs, 2022).

Legal aspects

Incentives for green buildings are extensively used (Fan & Hui, 2020). Governments and developers have various payoffs and prevailing methods under each incentive, which affects incentive effectiveness. Developers gained more influence during the development process initiative stages, which De Zeeuw (2007) referred to as "the forward integration of market actors.". There are several challenges and failures in the green building industry that prohibit developers from building sustainably (Fan & Hui, 2020). As a result, government incentives are required to overcome these hurdles and shortcomings. Incentives from governments essentially spread costs and advantages to governments and developers. This distribution affects their payoffs and decisions, which in turn determines incentive effectiveness. Four types of interactions between governments and developers influence incentive effectiveness: 1) governments' dominant strategies are dependent on developers' choices; 2) developers' dominant strategies are dependent on governments' choices; 3) two parties' dominant strategies are independent; and 4) their dominant strategies are interdependent (Fan & Hui, 2020).

Currently, there are no government regulations for developers to develop carbon net-zero. 03.2.3 Planning systems and policies explain which laws and regulations need to be complied with.

The municipality has various ways of making sustainable measures compulsory (Rechtbank Noord Nederland, 2020). For instance, the municipal council can impose sustainability requirements for new buildings in a zoning plan. But not every obligation is allowed. In its ruling of 9 December 2020, the North Netherlands District Court ruled that a municipality cannot impose obligations by contract (i.e. by private law) on sustainable building regulations. Under Section 2(5) of 'de Woningwet', the 'Bouwbesluit' can only include building regulations from the point of view of safety, health, usability, energy efficiency, and the environment (Catch legal, 2021). The court considered that the word environment should be interpreted broadly in this context. According to

the court, regulations on sustainable building fall under 'environment'. This is deduced, inter alia, from Section 7a of the Housing Act.

Steering role

As mentioned in the introduction, Heurkens (2020a) found out that private parties can have a steering role in urban area development. To understand the steering role, the definition of 'steering' is important. De Leeuw (2002, pp. 151) defined it as ''any form of directive influencing''. In urban area developments, it is seen as an open systems approach. It incorporates all kinds of different steering activities and it is based on some key principles (De Leeuw, 2002). First, there are three important dimensions in steering a project: uncertainty, unpredictability, and ambiguity. Second, there are three dominant aspects of managing a project: achieving objectives with people, steering a course, and problem-solving and designing solutions. According to De Zeeuw (2018), steering in urban area developments requires: Connecting different functions, parties, interests, money flows, and disciplines; responding to unexpected events with an entrepreneurial mindset; keeping up the progress; transferring substantive and process results to the next phase, reporting deviations to the supervisors; and thus ultimately secure the area development.

To look at how developers can steer area developments, we look at Heurkens' (2020a) framework (figure 12). This framework shows the multiple steering role of private parties for (sustainable) urban (area) development. The vertical axis distinguishes between strategic (long-term) and project-based (short-term) development focus, and the horizontal axis distinguishes between soft (relational) steering and hard (legal-financial) steering. To function well in a competitive market environment, every private party needs to engage in all these roles. Thus, corporate social responsibility and sustainability have become a 'must', with concrete physical, social, environmental, and economic results also having to be demonstrated.

In addition, an investment scope is an important condition for multiple value creation (Heurkens, 2020a). Ownership in the exploitation and management phase means higher returns in the long term and control of development risks. Participation in and formation of informal networks and coalitions, and entering into formal partnerships - private-public, private-private, and private society - combines knowledge and capacity for increased area quality. Finally, parties that initiate plans themselves by organizing 'unsolicited proposals' or placemaking activities can realize sound business cases and are less dependent on winning tenders.

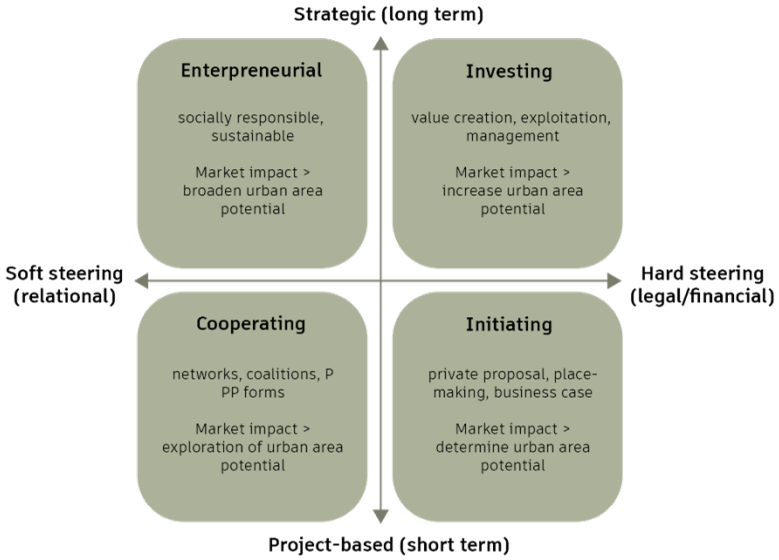


Figure 12: Multiple private steering roles in urban (area) development (based on Heurkens, 2020a)

03.5 Barriers and drivers

The information from both the processing system and the context includes the barriers and drivers to developing carbon net-zero urban areas within a given context. To get an idea of what barriers and drivers occur worldwide, a literature review is conducted. As sustainability is part of carbon net-zero, the barriers and drivers of sustainable urban area developments are included in the barriers for carbon net-zero developments.

Barriers

Barriers to sustainable urban area development can be characterized as phenomena that actively oppose and obstruct a desirable change or inertia that causes the change to advance slowly in comparison to problems and aims (Regales, 2017).

Pan and Maxey (2013) examined the challenges to delivering carbon net-zero buildings through a comprehensive literature review and grouped the identified challenges into six categories based on the political, economic, social, technological, environmental, and legal (PESTEL) analytical framework (table 3). The main barriers identified by developers may be divided into two categories: (1) greater costs when responding to unforeseen changes that restrict project budgets, and (2) conflicting interests and objectives amongst interdependent parties (Candel & Törna, 2022). These impediments are contextualized within the developer-municipality interaction.

According to Zhao et. al. (2016), social-cultural issues including consumer awareness and behaviour as well as the fragmented structure of the construction sector have a significant impact on both customer and builder awareness and the adoption of carbon net-zero buildings. Additionally, the erratic and uncertain political, legislative, and economic issues have a significant impact on the delivery of carbon net-zero buildings. The surplus produced through the implementation of innovative business models must be used to balance the financial obstacles, such as large upfront costs and ongoing operating expenses.

In table 3, the different barriers are linked to the conceptual steering model (figure 13). Developers can influence the barriers directly or indirectly. Every barrier is analyzed and has been placed in a category. If the barrier is linked to direct influence, it is highlighted in green. When the barrier is linked to indirect influence, it is highlighted in blue.

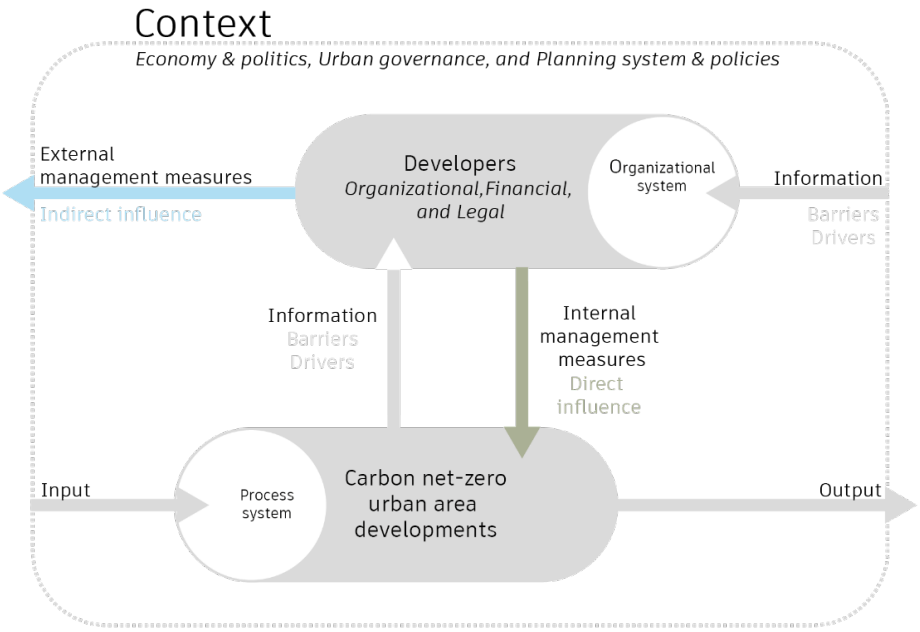


Figure 13: Conceptual steering model influence by developers (Based on Heurkens, 2012)

Type of barrier	Barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on
Political	Unclear definition of carbon net-zero		
	Inconsistent government policies		
	Limited financing, energy subsidies		
	Uncertainty of government's action		
Economic	Economic instability		
	Current small-scale carbon net-zero practise		
	Long financial pay-back period		
	Uncertain cost/demand for carbon net-zero		
	Limited customer demand		
	Lack of financial incentives		
	Imperfect market information		
	Hidden costs/benefits for end-user		
	The fragmented structure of the construction sector		
	Lack of collaborative integration of the supply chain		
	Lack of sustainable business cases		
	Risk perception		
	Short-term view/involvement vs municipality long-term involvement		
	Company size		
Social	Lack of awareness of sustainability		
	Attitude, culture, lifestyle and behaviours		
	Lack of confidence in new technology		
	User behaviour constraints		
	Reluctant to vary from traditional design/construction		
	Lack of knowledge, awareness or expertise		
	Insufficient transfer of knowledge		
Technological	Higher up-front and transaction cost		
	Volume builders' standard house design		
	Inadequate technical, and institutional capacities, skills shortage		
	A dearth of available advanced technologies		
	Project complexity		
	Scarcity of resources		
	Lack of integrated design methods		
	Insufficient support for research, learning and pilot projects		
	Lack of databases with information about sustainable developments		
	Lack of experience		
Environmental	Extreme weather events		
	Project location		
	Users' concerns about indoor air quality and thermal comfort		
Legal	Lack of clarity in requirements and expected outcomes		
	'Stick'-based legislation		
	The discrepancy between standard and performance		
	Lack of regulations		

Table 3: Barriers (Own table, based on; Candel & Törna, 2022; Chan et. al., 2018; Darko & Chan, 2017; Regales, 2017; Zhao et. Al., 2016)

Drivers

In the context of sustainable urban area development, a driver is ''a factor which causes a particular phenomenon to happen or develop'' (Regales, 2017, pp. 31). The table below shows the drivers to develop carbon net-zero. These have emerged from various studies.

Type of driver	Driver carbon net-zero developments
Political	Goals of the government
Economic	Increase in market value
	Risk reduction
	Cost reduction/cost-efficiency
	Increase in profit
	Faster sale/lease of buildings
	Client demand
	Client awareness
	The investment in a new type of urbanization
Social	Company strategy
	Corporate Social Responsibility
	Competition
	Innovation
	Pressure from society
	Marketing
	Intrinsic value
	Company culture
	Staff/organization
	Corporate responsibility
Technological	Technological innovation
	Investment in clean technologies
Environmental	Responsibility
Legal	Planning requirements/permits
	Building requirements
	Ahead of legislation changes
	Procurement
	Taxes and levies

Table 4: Drivers (Own table, based on Häkkinen & Belloni, 2011; Hepburn et. al., 2021; Pan & Pan, 2021; Parkin, 2000; Regales, 2017)

04.

EMPIRICAL RESEARCH

Chapter 4 introduces the empirical research. First, it explains which cases were selected and why they were selected. Then, based on document analysis, the cases are discussed substantively in terms of developer type and sustainability ambitions in the area and of the project. Following this, the semi-structured interviews provide insights on the themes of developers, barriers and drivers for carbon net-zero urban area developments, their role as a developer, and opportunities in the urban areas for carbon offsetting.

Case overview

Three cases in the Netherlands are analyzed as the basis for SQ5 and SQ6. The selection of the cases is based on the criteria in figure 14.

As the study is focused on the Dutch market with Dutch laws and regulations, it is important to use a Dutch case where this applies. Furthermore, it is important that the chosen case already has a (master) plan marking the completion of the design and feasibility phase to apply the theory to the plan at hand. Last, to get a building carbon net-zero, it is important that a building complies with the BENG Regulations and that circularity is included in the building (Figure 15). In addition, all other emissions must be offset. By setting up circularity and (nearly) energy neutrality as criteria, it is clear to the cases in which offsets are involved and how these can be managed by developers.

1. It is a Dutch development

2. It has a (master)plan marking the completion of the design and feasibility phase

3. The development complies with BENG Regulations and it has considered circularity

Figure 14: Case selection criteria

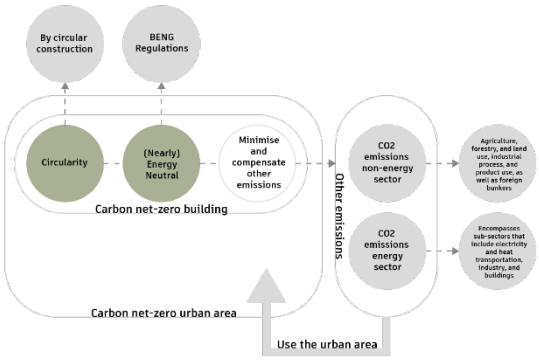


Figure 15: Case selection criteria #3

01 // Slotervaart CVZ

1. Location Amsterdam

2. Masterplan marking the completion of the design and feasibility phase

3. Complies with BENG regulations and has considered circularity

One real estate developer

02 // Cedar Office

1. Location Amsterdam

2. Delivered in 2020

3. Complies with BENG regulations and has considered circularity

Two real estate developers

03 // Harbour Park

1. Location Rijswijk

2. Masterplan marking the completion of the design and feasibility phase

3. Complies with BENG regulations and has considered circularity

Two real estate developers

01 // Slotervaart CVZ Amsterdam

Figure 16: Impression Slotervaart Centrum Voor Zorg (MVSA, 2022)

Slotervaart CVZ

The former Slotervaart hospital is located in Amsterdam Nieuw-West and is part of a cluster called 'De Plantijn' (Zadelhoff, Slotervaart, & NEXT Architects, 2021). As part of the Slotervaart garden city plan, a biomedical cluster was built here with, compared to its direct surroundings, large building volumes. Besides the former Slotervaart Medical Centre, it houses the Antoni van Leeuwenhoek Hospital, the Dutch Cancer Institute, Sanquin, and Hof van Sloten nursing home.

Over the next few years, the former Slotervaart Hospital will be transformed into the Centrum Voor Zorg (CVZ) (Zadelhoff et al., 2021). The 1975 'Kruisgebouw' will be renovated and is the beating heart of CVZ. It will be made suitable for care work in the lower building and a mix of education, living, and working in the upper building. The area around the Kruisgebouw will be developed as a new living/working area. An additional 80,000 m^2 will be built here, creating a highly urbanized mixed neighbourhood with a high building density. The ambition is to connect this new neighbourhood to developments in the direct surroundings. To achieve this, it is important to properly define the identity of this new area within the context of Amsterdam Nieuw-West.

Program

The ambition for the Plantijn is to densify the area by adding a substantial number of square meters to the program, while at the same time increasing the quality of the public space (Zadelhoff et al., 2021). It is important here to connect with the surrounding area. Not a closed enclave, but an open dynamic piece of the city. Around 90,000 m2 of a residential program can be realized in the Plantijn. The southern part of the Plantijn, including the Centrum Voor Zorg (CVZ) Slotervaart quadrant, lends itself well to this residential program. The Kruisgebouw will be renovated for care living, care work, and care education. The care residences fit in well with nearby care facilities.

As mentioned above, the starting point of the vision for the new CVZ is the existing 1975 Kruisgebouw. In its original design, together with the four tangents, it forms four enclosed inner courtyards. These inner courtyards are an important carrier of the plan and due to the different orientations and a different surrounding program, all have their character; care, meet relax, and move.

Ultimately, the new development of CVZ Slotervaart will provide around 80,000 m2 of mixed living and working space, of which around 70% will be residential. This residential and work program is under the developer's management and will also be leased by the developer. This will be undivided into 40% social housing, 40% middle income, and 20 free sectors.

Stakeholders

Real Estate Development Company

The company characterizes itself as a developing investor (Interviewee 1, 2023). They operate mostly in Amsterdam with a focus on monumental buildings. In 2020, the company bought the former Slotervaart Hospital. For each project, there is a focus on what can be done effectively on sustainability at this developing investor. As a result, sustainability is considered practically.

Municipality of Amsterdam

The Municipality of Amsterdam is a municipal organization that consists of 5 clusters, an administrative and corporate staff, 7 city districts, and 1 metropolitan area (Gemeente Amsterdam, 2023b). Slotervaart CVZ is part of the district Amsterdam Nieuw-West. The cluster 'Ruimte en Economie' is about creating the spatial and economic preconditions needed for Amsterdam to grow into a strong metropolis. The cluster does this based on tasks in the spatial economic sector. The Municipality of Amsterdam's core values guides everything that they do: active, open, and with integrity (Gemeente Amsterdam, 2023a).

Sustainability ambitions Municipality of Amsterdam

The Municipality of Amsterdam has several goals in terms of sustainability (Zadelhoff et al., 2021). For instance, they aim to enable transformation and function change. Another goal is to increase the urbanity and vibrancy of public spaces. Finally, the municipality would like to strengthen the interaction between buildings and public space.

Energy

From 2021, BENG regulations will apply to measure the energy performance of buildings (Zadelhoff et al., 2021). In Amsterdam, tightened BENG regulations apply to residential construction. There are also other regulations such as that all new construction must be natural gas-free. In addition, the municipality aims for a lower-temperature heat supply. For Schinkelkwartier, a concession with Westpoort Warmte applies until 2030. This states that all new buildings will be connected to district heating. Finally, in the final design, the developer must show a plan for how energy performance will be achieved. In doing so, the ultimate goal of the municipality of Amsterdam is to stimulate the use of sustainable energy.

Circularity

In terms of circularity, the Municipality of Amsterdam challenges developers to minimize the environmental impact of the materials to be used during construction and throughout the building's life cycle (Zadelhoff et al., 2021). This includes not only the initial construction, but also the impact of maintenance, replacements, and, at the end-of-life of elements/materials, the demolition and further processing of the material which can be expressed by an MPG calculation.

However, there is tension between the MPG calculation and the BENG standards (Zadelhoff et al., 2021). The more renewable energy is generated, the higher the MPG calculation will be. This is because solar panels are calculated as less circular in the MPG calculation. In this case, solar panels may therefore be disregarded for the MPG score.

Sustainability ambitions Schinkel-kwartier/De Plantijn

In addition, Schinkelkwartier and the Plantijn also have specific ambitions.

Energy

An understanding of local possibilities and a consideration of available alternatives are required for a sustainable energy system (Gemeente Amsterdam, 2020). The area offers opportunities to use local sources and locally generated energy. For example, Global Switch and the existing hospital cluster are potential suppliers of heat and cold. Connection to the high-temperature heat network is not the most sustainable solution for most functions in Schinkelkwartier. Connection to a return system or a decentralized network at a lower temperature is preferable to a connection to the existing heat network for sustainability reasons. In principle, the energy task can also be solved per building block. Connection to a low temperature is preferred, but it is recommended to elaborate on the choice of system per subarea.

Circularity

To better exploit opportunities for circular construction and dismantling, several alternatives were assessed (Gemeente Amsterdam, 2020). First of all, it is desirable to build buildings flexibly and adaptively, with open building systems and extra story height. In this way, buildings can facilitate different functions in the future. Furthermore, before demolition or dismantling, a mandatory inventory of raw materials is desirable to determine the value of materials. A closed soil and materials balance is the starting point. This means that existing materials in buildings, ground level, and subsoil in the area are (re)used. In addition, it is desirable to realize buildings with low environmental pressure, expressed in a low MPG with a score of no more than 0.8. This is achieved by using recycled concrete, wood for construction, and other renewable materials of biological origin. Finally, demountable temporary structures can make a valuable contribution to sustainability ambitions. Ideally, all materials used should be fully reusable.

Sustainability ambitions masterplan Slotervaart Centrum voor Zorg (CVZ)

Energy

First of all, the new building meets the BENG requirements set (Zadelhoff et al., 2021). In addition, an extensive study of possible sustainable energy solutions has been carried out.

Circularity

As previously explained, the cross-building will be reused which is already a big step towards circularity. Furthermore, the new building provides space for a clear 8.1-meter grid, within which different layouts, dwelling sizes, and residential programs are possible (Zadelhoff et al., 2021). With the 8.1-meter grid, all the typologies can be realized per block or mixed. The green public space and facilities are available to the entire neighbourhood and also serve as a rest and meeting place. In this way, the neighbourhood becomes socially stronger and better integrated into its surroundings.

02 // Cedar Office Amsterdam

Figure 17: Impression Cedar Office (EDGE, 2019)

Cedar Office

In 2017, two real estate developers started construction of a bank in their new headquarters called Cedar (Gemeente Amsterdam, n.d.). The office is located in Amsterdam Zuidoost next to Bijlmerdreef, between Foppingadreef and Dollingadreef. Cedar is part of Cumulus, an innovation district initiated by the bank (Muis, 2020). Here, the company collaborates with the Municipality of Amsterdam, Hogeschool van Amsterdam, and the ROC van Amsterdam in linkages between entrepreneurs, scientists, students, and companies.

The headquarters opened in 2020 (Banken, 2020). After several years of construction, a modern and above all sustainable building has emerged. The Cedar building is characterized by the use of a lot of glass, symbolizing the openness and transparency the company strives for.

Program

The office building can accommodate 2,800 employees (Banken, 2020). Space has also been reserved for innovative companies working with the company in the future. Together with four other company buildings, Cedar forms the heart of the new Cumulus Park innovation district. The district is intended to symbolize innovation and collaboration, or perhaps better still, innovation through collaboration.

The building was designed with the interior and the surrounding park as an integrated whole (Muis, 2020a). The architect moved the building to the edge of the plot, enabling the firm to create a large green zone in front of the building. This was designed as an urban garden with walking routes, places to stay, and seating areas. Thanks to the transparent facades, employees always have contact with the green park in front of the building. With a diversity of trees, plants, insect hotels, and ecological herb fields, the architect has designed pleasant spaces for humans and animals, the office explains (Muis, 2020b). The park is freely accessible and should not only be an inspiring place for its employees but also visitors, residents, and students.

The office building consists of two volumes of five floors each, with a glass air bridge connecting the upper four levels (Muis, 2020). The smooth, curved facades with floor-to-ceiling windows give the building a friendly and accessible appearance, to which the all-sided orientation also contributes. The facade canopies that extend around the entire building make the two volumes a visual unit; they also serve as sunshades.

The relatively low building is wide with large floor spans (Muis, 2020a). This provides the company with a lot of usable floor space per floor; at the same time, the logical layout ensures efficient routing at all times. The open floors also offer great flexibility and, if required, the possibility of using parts of the building differently in the future or letting them separately. The gross floor area of the building is 39,000 m2.

Stakeholders

Real Estate Development Company

This real estate development company is an office developer by excellence where you do see in recent times that they are also starting to do more housing and characterized mainly by just developing very sustainable and innovative projects (Interviewee 3).

When it comes to sustainability, the company always wants to be leading (Interviewee 4). The moment they make a pitch to the main board for a new plan, they say: what kind of BREAAM Label and well label do we achieve? Should we not have another label? What about energy, use, and consumption? How far are we above ‘bouwbesluit’? Can we be energy-neutral and what do we have to do for that?

Gemeente Amsterdam

The Slotervaart CVZ case study has already explained what the municipality of Amsterdam is as a stakeholder.

Sustainability ambitions Gemeente Amsterdam

The Slotervaart CVZ case study has already explained what the municipality of Amsterdam has as sustainability ambitions.

Sustainability ambitions Amsterdam Zuidoost

There is a healthy balance between the energy consumed to live comfortably and the amount of sustainably generated energy (Gemeente Amsterdam, 2021). Sustainable energy is generated by various solutions. Zuidoost profiles itself as the forerunner in the social energy transition. The energy transition is in Zuidoost together with residents and stakeholders to create a healthy, inclusive, and energy-neutral district. Residents on a small budget benefit directly from the transition through lower energy bills. They keep more money to invest in, for example, a sports subscription or tutoring for their children. Thus, the energy transition lays a healthy foundation for the next generation.

The public space in Zuidoost has been used as a source of sustainable energy (Gemeente Amsterdam, 2021). For example, heat is extracted from surface water for the nearby neighbourhoods. The heat networks of Amsterdam will be interconnected in 2040. In addition, geothermal drilling has been realized. This will be fed with biomass, data centre hot, and later via geothermal so that the existing heat network will be fed with sustainable geothermal heat so that there also minimal carbon emissions. Energy is not only generated by solar fields and wind turbines. There is also GreenGas is also generated by using sewage and fruit, vegetable, and food waste for the production of GreenGas, (for heat, cooking, and showering).

Sustainability Cedar office

Energy

Cedar's energy supply is mainly based on solar energy (Lazet & de Vries, 2019). There are a respectable 2,100 solar panels on the building itself. Together with a nearby field - near Diemen - where there are another 3,450 solar panels, this power supply is enough to generate energy for all installations and the building itself. Not only enough, according to Lazet (2019), there is even excess capacity and the company supplies power back to the grid. This makes the building energy-positive.

In addition, cooling the building in summer is an interesting point of sustainability (Lazet & de Vries, 2019). The cooling system uses surface water from the Gaasperplas and Ouderkerkerplas lakes. With this, we cool the entire building. Toileting is also part of overall water management. The use of urinals and smart taps saves 12 million litres of water per year.

Moreover, half of all parking spaces are equipped with electric charging stations, allowing people to recharge their cars. The building is, of course, equipped with a large bicycle parking area and Bijlmer-Arena Station is just around the corner.

Circularity

Both in use and in construction, circularity has been considered. For example, the concrete used in the building is 'green concrete' (Lazet & de Vries, 2019). Green concrete means that the concrete used for the building's walls and floors comes from the old building that used to stand there. In addition, concrete has been recycled for the widening of the adjacent highway (C. Koster, personal communications, March 23, 2023). Circularity is also considered on the user side. An important part of any office culture is of course coffee, on the way to a sustainable economy, De Vries & Lazet (2019) points to circular coffee cups and say goodbye to single-use plastics.

Blank page

03 // Harbour Park Rijswijk

Figure 18: Impression Harbour Park (MIES Architecture, 2022)

Harbour Park

Harbour Park is part of Havenkwartier Rijswijk, in which the industrial site Havenkwartier will be transformed in several phases and a large number of sub-plans into an attractive area for living, working, and recreation (Gemeente Rijswijk, 2023b). Rijswijk is located between The Hague, Rotterdam and Delft. Around 2,000 dwellings with high-profile architecture will be built in the various sub-plans. In many places, commercial spaces are planned in the plinth, with catering establishments, a neighbourhood supermarket, and all kinds of amenities. The plans also devote a lot of attention to the public space and an investigation is underway into the redevelopment of the harbour. With lots of greenery, water, and wide sightlines at street level, a unique part of Rijswijk will be realized with pleasant walking and cycling routes and atmospheric meeting places. Where you can spend time by or even on the water.

Program

The program for Harbour Park consists of about 300 apartments, about 3,900 m2 of activity, about 2,000 m2 of facilities, and about 125 parking spaces on-site and in the HUB.

Stakeholders

Real Estate Development Company 1

Developer 1 is purely a developer who then sells the project to an end investor (Interviewee 5). They make a product that they support, and for where we think there is a market. With that, sustainability is definitely on the agenda. However, it is not a must to show it as a company. For this project, sustainability is taken into account to the extent that there is looked at what is in the basics, according to the standards required in terms of sustainability, and they have the requirements of the Municipality of Rijswijk to realize the area, but certainly also the building: sustainably, circular, and climate adaptive.

Real Estate Development Company 2

In this project, developer 2 is the risk-bearing developer (Interviewee 6; interviewee 7). Developer 2 focuses on residential, healthcare, and leisure properties (Ridge, n.d.). They aim to create an attractive and sustainable living environment. Sustainability is an integral part of their projects. In cooperation with governments, healthcare organizations, property investors, and residents, this results in special and high-quality residential (healthcare) projects. Their mission is to develop appealing real estate projects that contribute positively to an improved living, working, and leisure environment for residents and users.

Municipality of Rijswijk

The municipality of Rijswijk is a municipal organization that consists of four domains: Operations, Social Developments, Spatial Developments, and the Social Domain (Gemeente Rijswijk, n.d.). Sustainability is important for the municipality of Rijswijk. This means that they make sure that people, the environment, and the economy all get enough attention. In this way, they ensure a social, green, and pleasant living and working environment.

Sustainability ambitions Municipality of Rijswijk

In general, the municipality of Rijswijk wants a housing stock that is future-proof (Gemeente Rijswijk, 2021). So a housing stock that meets the housing needs of our residents at every stage of life. A housing stock that is also energy-efficient, i.e. well insulated and insulated and using sustainable sources as much as possible.

Energy

The municipality of Rijswijk aims to be energy-neutral by 2050, following national agreements (Gemeente Rijswijk 2023a). Among other things, it means that the entire municipality must then be natural gas-free. At the heart of the energy transition is the fact that affordability and comfort for residents are paramount. Other principles are that the municipality will involve residents intensively, communicate openly and transparently, and cooperate closely with all relevant parties.

For all new construction, both residential and non-residential, permit applications from 2021 must meet the requirements for Nearly Energy Neutral Buildings (BENG). These requirements stem from the Energy Agreement for Sustainable Growth and the European Energy Performance of Buildings Directive (EPBD).

Circularity

A circular economy is about reusing products and sharing ownership (Gemeente Rijswijk, 2023a). Making more efficient use of what we already have help to consume fewer raw materials. The sharing economy, where property sharing is central, has taken off. The sharing economy (shared scooters, shared cars) is also growing in Rijswijk. Sharing property connects people and contributes to social cohesion.

Sustainability ambitions Havenkwartier

The municipality of Rijswijk has drawn up a spatial framework for the Havenkwartier. Havenkwartier will lead the way in sustainability, visible in mobility, water management, circular building, biodiversity, energy, and environmental quality (Gemeente Rijswijk, 2019). But progressive principles will be adopted in more areas so that sustainability can be used as a capstone for the transformation of Havenkwartier.

In Havenkwartier, customary standards in the field of sustainability will be applied, such as gas-free construction, EPC=0, zero-to-the-meter, etc (Gemeente Rijswijk, 2019). In addition, the developments are in line with the ambitions of the municipal Housing Vision and the Future Vision 2030. A sustainable living environment, sustainable Rijswijk housing with a healthy living environment, and more flexibility in the existing stock, transformation, and new construction are the sustainable targets. For the transformation of the Havengebied, it is proposed to go one step further by weaving sustainability into all aspects of planning; timeless, tangible, and visible. Sustainability is not about abstract concepts or quantitative targets, but about an underlying mindset, directly benefiting the experience and use of the area, now and in the future. This makes Havenkwartier a trendsetter by not just talking about it, but by making sustainable choices part of everyday life. This Spatial Framework translates the desired sustainable development of the area into seven principles: 1. diversity 2. connection with the environment 3. merging city and nature 4. flexibility 5. smart systems 6. outdoor space as a binding agent 7. people make the area The principles are intended as an inspiring guideline for everyone involved in planning in the coming decades

With its watery qualities, Havenkwartier adds a blue accent to green Rijswijk (Gemeente Rijswijk, 2019). Rijswijk is largely characterized by green features. On the one hand, this is due to the historical country estate zone and the city park zone, which together cover a large part of Rijswijk and organize the city. On the other hand, the green character is further enhanced by the large-scale post-war expansions in which the clear hierarchical road structure with generous tree plantings are characteristic, and the open buildings are mostly stamped. This has to do with the fact that place-making with blue and green is the ambition of the Spatial Framework. Water is a structuring element and green is a real place-maker. In doing so, the aim is to minimize the amount of paving and contribute to a pleasant microclimate. The outdoor and underground space is also used for surface storage and delayed discharge of rainwater.

Energy and circularity ambitions masterplan Harbour Park

Energy

Within the development, there are opportunities in the field of energy and sustainability (Gemeente Rijswijk 2023a). As far as energy is concerned, solar panels and a heating and cooling system are therefore being used. This development uses the SolarEis system for heat and cold generation. The SolarEis system combines the five natural energy sources for heating and cooling in the most economical way: sun, air, earth, water (and ice). To optimally realize the goals set by the municipality of Rijswijk, the developers integrated this system into the plans at an early stage within the theme of climate adaptation. The system offers the possibility of being scaled up within the entire Havenkwartier.

Circularity

Within the Harbourpark development, the existing shell of the Indola Factory on Klipperstraat will be preserved and reused in the design (Gemeente Rijswijk 2023a). In addition, the circular economy is also about sharing ownership. The development contributes to this aspect by using shared cars in the mobility plan. As a result, fewer private cars are needed. Finally, the Indola Factory provides space for companies working in the manufacturing industry. This sector plays an important role in the circular economy.

Analysis interviews

To get to know what components are essential for developers to influence carbon offsets in the development areas in the Netherlands, and to find out what opportunities developers see to use the urban area as a solution for achieving carbon net-zero in the Netherlands, semi-structured interviews with real estate developers are conducted for the three case studies.

04.2 Participant selection

To assure the data is representative, the participants are selected by different criteria. Because the final conceptual framework is designed for developers, and how they can have an influence, only developers are interviewed to gain insight into how they look at this. In addition, they must be involved in one of the three cases. Furthermore, the themes of 'urban area development' and 'sustainability' should be familiar to them. In summary, the participants:

1. Are involved in one of the cases
2. Needs to be familiar with the themes ‘urban area development’ and ‘sustainability’
3. Are real estate developers

Figure 19: Participant selection criteria

When the interviewees are invited, they receive information about the content of the interview, making it clear that the interview is divided into different themes linked to the study. In addition, they also receive the 'informed consent' form (Appendix 2) where they can agree to the data processing and publication of the data.

A total of seven interviews were conducted across the three different cases. One case has three interviews and two cases have two interviews. For each case, it still differed whether these persons are/were employed by the same developer; Figure 20 shows the distribution of interviewees by colour.

Figure 20: Distribution of interviewees

04.3 Analysis methods

After the interviews are conducted, they are transcribed and analyzed. This analysis is divided into four steps (figure 22)

01. Data allocation

The semi-structured interviews are analyzed according to the four interview themes. These themes are translated into four components:

- Developers' characteristics
- Barriers
- Drivers
- Influence of developers
- Opportunities in urban areas

Figure 21: Components interviews

02. Categorisation per case

After the data is linked to a component, they are categorized by component for each case. The theme 'developer' is incorporated into the introduction of the case description and is not included separately. This is because it is good to know what kind of developer mentioned something. After all, that can make a difference in the results. Besides, the barriers and drivers are considered first after which the influence of developers and opportunities in the development area are zoomed in on.

03. In-case analysis

For each case study, an analysis is carried out using insights from the developers. These are linked to the case study and the theoretical research. The aim is to find various links and similarities.

04. Cross-case analysis

For the cross-case analysis, all components are compared separately through the different cases. Again, this aims to find various links and similarities, but then through all the cases.

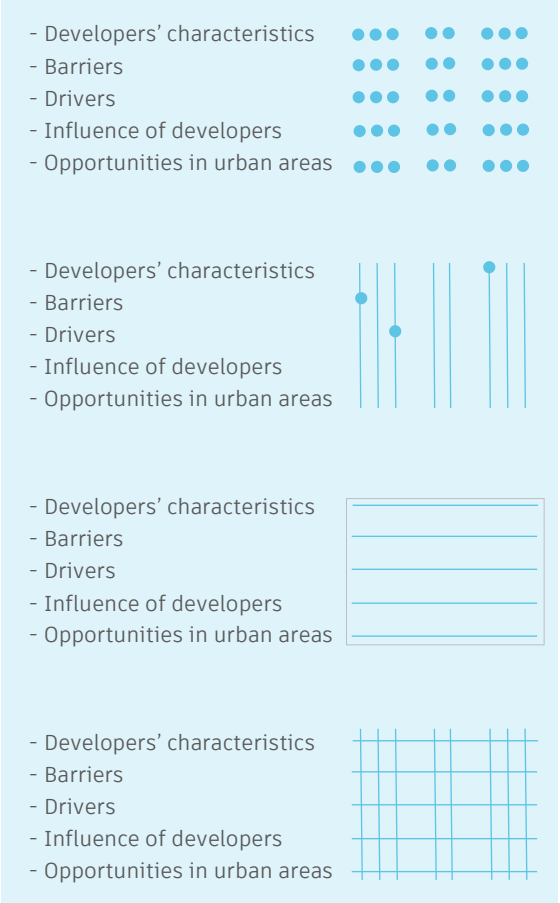


Figure 22: Analysis methods

04.4 Data allocation

All interviews were recorded with an audio device. Using the audio recording, the interview can be transcribed. In the transcript, the relevant information is linked to the different components as shown in figure 13. Although the interview is already divided into different categories, this does not mean that all the information on each component is already in the right category. This is because all interviews are semi-structured and interviewers may deviate from the interview questions. This means that at the first step, the data is still (partly) distributed in an unordered way in the transcript document.

The interview transcripts have not been added in full in this thesis due to privacy regulations.

04.5 Categorisation per case

Since the data has not yet been categorized, the next step is to categorize this data by component per case. All interview outcomes are then aggregated in their entirety by component: barriers, drivers, the influence of developers and opportunities in the urban area.

04.6 In-case analysis

For the in-case analysis, the findings of the four components are linked to the cases and based on the interviews. These findings are explained case-specific with supporting quotes from the interviewees. Before the findings are discussed, firs it is explained in how the barriers and drivers were analysed.

Barriers and drivers

The different barriers and drivers that emerged from the interviews are shown in the table per case subdivided by the PESTEL categories. The subdivision into the different categories is based on qualitative coding to increase the validity and enable transparency (Delve, n.d.). For the coding, codes are based on the barriers found in literature divided into the PESTEL categories. This categorization can be found in appendix 3. For the in-case analysis, only the barriers that developers can indirectly or directly influence are addressed.

The different barriers and drivers are also linked to the conceptual steering model as in the theoretical research (figure 13). At the light green and the blue marked words, developers can influence the barriers. Every barrier and driver is analysed and has been placed in a category. If the barrier or driver is linked to light blue or green, they are highlighted. As a result, all highlighted barriers and drivers are those that developers can influence based on practical experience.

In addition, the last column relates to theory. If the barrier and/or driver mentioned also appears in the theory, the box is coloured dark green.

04.7 In-case analysis Slotervaart CVZ

Barriers

Table 5 shows which barriers are experienced for carbon net-zero developments. What is immediately noticeable is that it is mainly technological barriers that are experienced. In addition, developers can exert direct or indirect influence on almost all barriers. What is also remarkable is that only two barriers match the theory.

01. Political

In terms of political barriers, this mainly concerns the certificates and regulations to be obtained. Not all carbon-neutral materials are included in the assessment criteria, making it difficult to convince the municipality of some sustainable choices.

02. Economic

When it comes to economic barriers, they are all related to technology. Which often involves high costs in the production of new materials in construction, but also the replacement of equipment involves costs. In addition, investors are also needed to scale up the production of carbon net-zero products.

03. Social

The social barriers mainly relate to knowledge. For instance, there is much uncertainty about what exactly carbon net-zero means and how it can then be offset. In addition, trust also plays a role. Because there are few reference projects where the contractor can prove to themselves that they can meet the requirements, this needs to be looked at in a different way to reduce risks. This also immediately relates to the last social barrier, you depend on the whole chain, and everyone has to cooperate to achieve the goals and at the moment this is often difficult.

''You also need contractors who are willing to put effort into it and to arrange carbon neutral products that are approved and can be applied, are fire-safe, and come from the right suppliers with the right warranties on them.''

- *Interviewee 1*

04. Technological

As mentioned earlier, there are many technological barriers. Where 'scale' is a recurring theme in several areas. For instance, not every contractor works with certain desired sustainable materials on a large scale, in addition, sustainable materials are often not available on a large scale at all, and it is also uncertain whether recycled materials are in stock at the point of starting construction. In addition to these scale-related barriers, the database of materials is not up to date and the method of assembly of sustainable materials is often not the same as that of traditional construction.

''Circular products often have unique sizes or attachment mechanisms that make it difficult to revert to traditional or basic designs, thereby increasing the risk of investing solely in circular products.''

- Interviewee 1

05. Environmental

No environmental barriers were experienced in this case study.

06. Legal

In line with the political barriers, often carbon-neutral materials are not necessarily covered by "certificates to be obtained".

Type of barrier	Barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research
Political	Difficult to get the Municipality on board when materials are not yet available for certificates			
Economic	Construction is a fairly slow sector			
	It is often more expensive than traditional construction			
	Replacing equipment to carry out construction is costly			
	To scale up material production for carbon-neutral materials, investors are needed			
Social	It is not clear how much carbon needs to be offset			
	Carbon net-zero building has become a catch-all term			
	You are dependent on the whole chain			
	You do not know if the contractor can deliver on the promises because there are hardly any carbon net-zero developments yet			
Technological	Many materials have not yet been sufficiently tested or inspected, making it uncertain whether you can use these materials			
	Not every type of material is available from every contractor			
	Sustainable materials are not yet available on a large scale			
	Innovative materials often have a different way of mounting so you cannot easily go back to a traditional design			
	Contractors should be willing to put effort into sustainable products and ensure that they are approved and can be applied while ensuring proper guarantees.			
	It is uncertain whether recycled products will be available when construction starts			
	A carbon-neutral option is not available for all materials			
	The process of testing new materials for carbon neutrality takes time			
	The database of materials is not up-to-date			
Environmental	-			
Legal	Carbon-neutral materials do not necessarily fall within 'certificates to be obtained			

Table 5: Barriers Slotervaart CVZ based on three interviews (Interviewee 1, 2023; Interviewee 2, 2023)

Drivers

What is noticed when looking at the drivers in Table 6, is that the drivers consist mainly of the social viewpoint. For example, a driver for developers is political support in the form of subsidies for the feasibility of the business case. In addition, there are main drivers at the social level, these mainly have to do with the intrinsic motivation for both the developer and the team to contribute to the climate goals. In addition, a driver can also be that it is a business goal of the developer himself. Furthermore, it also motivates to have a team of specialists in the team who have enough knowledge on the subject. Finally, it could also help to have a uniform measurement tool to measure sustainability so that having to use so many measurement tools side by side is no longer a barrier.

''As a developer, you set the milestones for where you want to go, but having the team that wants to get there is also very ambitious''.

- Interviewee 1

Type of driver	Driver carbon net-zero developments	Mentioned in theoretical research
Political	Political support in the form of subsidies	
Economic	-	
Social	We all want a better future for the world and all the people of the world	
	We have enough knowledge of the subjects	
	Intrinsic motivation of the developer as a person	
	Goals set by the developer himself for the company	
	An enthusiastic and motivated project team to contribute to the climate goals	
Technological	Working with specialists in the team who are knowledgeable about the topic	
Environmental	-	
Legal	Labels where everyone tests in the same way, a uniform testing material	

Table 6: Drivers based on three interviews (Interviewee 1, 2023; Interviewee 2, 2023)

Influence of developers

According to the developers, they have an impact on carbon net-zero developments in the Netherlands. Thus, as a developer, you choose the parties, you set the starting points and ambitions. Besides, the moment you win a tender developers have a say in what they submit and if you win you have to live up to it.

To achieve carbon net-zero developments, different parties are needed. The developer is a good initiator, but the whole chain is needed to get it done and the developers need support.

Overall, the people who are on a design team are important to make a difference. Parties that are in the design team that are crucial are: a pioneering architect; a contractor from the start with an incentive that the construction process incl. traffic flows and deployment of equipment also comply with carbon neutrality; a structural engineer well versed in many alternatives to regular structural materials; an installation consultant who wants to look ahead and has a good network with network operators to come up with solutions with them; a sustainability consultant who can take an integrated view; a landscape architect; municipality for permits; and a construction cost expert who knows about sustainability/circularity and its costs versus traditional building so that you start a project with a budget sufficient for something like this so that your business case is grafted onto carbon net-zero building.

Furthermore, you need motivation from the investor side for funding. The last important people are the future residents those who are going to use the building, because if the building is not used properly in the use phase then it will not have the desired effect.

The developers' influence is mainly in the design process, so from the initiative, setting the ambitions and goals, to the initial formation of the design and the selection of the contractor, i.e. the knowledge and skills of the party. It is also up to the developers to formulate the right ambitions with the contractor. But not only in the design phase do they have influence, the developers can also influence the carbon net-zero development at each stage because you work from course to fine. It is important to check in each phase whether the goals are still being met, developers need to keep monitoring this.

''If carbon net-zero is at the top of the list despite everything, that is the ambition you set and you check at each stage whether you can still meet it, whether it still fits in with all the other starting points you have, and whether it is therefore still feasible as you go along''

- Interviewee 1

Opportunities in the urban area

According to the interviewees, there are different ways to possibly support offsetting in an urban area development, based on the case. First, renovating an existing building already means you are not doing new construction, so in terms of carbon, it is much more beneficial. Second, creating greenery and planting trees for example using roofs is often the first thing that comes to mind. What also could be possible, is the storage of carbon.

''For me, carbon net-zero is also using as few materials as possible''

- Interviewee 1

To achieve carbon offsets, collaboration with other parties is essential. First, everyone involved in the area development should share the same ambition to get it done together and jointly draw up a plan on how best to apply it in the area. Everyone should be behind it and it should not be left to one party. Furthermore, residents are needed for support in the area.

What is important in practice, is to have backups should the sustainable product or material be unavailable. In doing so, checkpoints per phase for compliance with carbon net-zero solutions are essential.

''Ideally, you want to have options in your preliminary designs and your final design to choose a carbon neutral product, but have a backup plan in case it is not available in practice.''

- *Interviewee 1*

Furthermore, it is necessary to ensure that emissions are already managed so that it becomes clear how much needs to be offset. Besides, assembling a design team with a lot of knowledge about the topic including selecting parties that are willing to contribute to solutions for carbon offsetting is significant.

Insights case Slotervaart CVZ

There are several barriers against which developers can have an indirect influence. Political barriers mainly relate to certificates and regulations to be obtained, while economic barriers have to do with the high cost of production of new sustainable materials and scaling up production of carbon net-zero products. Barriers that developers can directly influence are the social and technological barriers, where social barriers relate to the lack of knowledge and trust between stakeholders as the design team and contractors and technological barriers are related to the availability and scale of sustainable materials. Intrinsic motivation of both the developer and the team is the main driver. Developers play an important role in initiating and setting the ambitions and targets for carbon-zero developments, and collaboration between stakeholders is necessary to achieve carbon net-zero urban area developments. Possibilities for carbon offsetting include renovating existing buildings, creating greenery and storing carbon, but collective ambitions and collaboration are necessary to succeed.

04.8 In-case analysis Cedar

Barriers

Table 7 shows an overview of all common barriers to carbon net-zero developments. What is striking here is that the political, economic, and legal barriers can mainly be influenced indirectly by developers. On the social, technological, and environmental barriers, a developer can often influence them directly. It is also striking that only a few barriers also occurred in theory.

01. Political

Most of the political barriers relate to regulations, which means that developers can only influence indirectly. Often, requirements and rules are not well aligned, nor is it clear whether complying with certificates is also better for the project specifically. For carbon offsetting, rules are also often too strict, currently, it is not possible to offset close to the plot. In addition, in some areas, it is mandatory to participate in district heat, for example, because the municipality has invested in it, but this is not always the most sustainable for the project.

You also see that in the local regulations locally, which vary from one municipality to another, they have a different agenda and then you find that some things are difficult

- Interviewee 4

02. Economic

As the theory research also shows, carbon net-zero development often does not fit the business case. Currently, the land price for an empty plot is often too high and demolition is often cheaper than redevelopment. This sometimes causes existing buildings to be demolished to complete the business case. In addition, carbon offsetting for timber construction is many times more expensive than carbon offsetting for concrete construction.

03. Social

When it comes to social barriers, it is important to look at the end users and other stakeholders in the area. Currently, the customer does not always ask for a carbon net-zero building. If the client asks for it, the end-user requirements need to be adjusted. Moreover, residents and other parties involved in the area should also cooperate in achieving carbon offsetting. It is also important to work with all parties involved in development to achieve the goals.

04. Technological

Because development takes years, sustainability solutions are often no longer 'new' during construction as innovations in technology are constantly taking place. In addition, there is no model where a choice can be made quickly for which materials are best to use concerning reducing carbon emissions.

05. Environmental

As for environmental barriers, some sites or buildings are not suitable for sustainability solutions.

06. Legal

In terms of legal barriers, regulations for sustainability in the built environment are lagging. In practise, more can often be done than current BENG regulations.

Type of barrier	Barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research
Political	Trust between government and market parties			
	Accumulation of requirements and rules and it does not always flow with each other.			
	Requirements are often imposed to obtain certification, but whether it is better for the project remains to be seen.			
	Regulations are too strict to do carbon offsetting anywhere outside the plot.			
	The municipality sometimes determines that you have to connect to district heat because they have invested in that infrastructure, while sometimes a different (more sustainable) installation is desired			
	Local laws and regulations have 'different agendas'			
	The municipality is asking a lot, but something can also be done on the municipality's part			
Economic	Building costs			
	The market is not yet ready for timber construction			
	It does not always fit within the business case			
	Paris Proof is not making money at the moment			
	The land price for an empty plot is too high			
	Construction costs are too high			
	Demolition is often cheaper than redevelopment			
	Offsetting carbon in timber construction is many times more expensive than offsetting carbon in concrete construction			
Social	The people living there have different needs			
	Comfort and tenant requirements need adjustment as much comfort is related to energy consumption			
	Everyone must participate			
	You cannot do it alone, you need many parties for this			
	The customer does not always ask for carbon net-zero			
Technological	What sustainability solutions you came up with during the beginning of the project may no longer be 'new' during implementation because a construction process takes years			
	In the raw materials sector, the company sometimes has a monopoly position			
	Dimensioning in redevelopment is often tricky for contractors			
	Wood moults quickly when weather setbacks occur			
	The fire brigade (and the municipality) considers some sustainable (PV) solutions to be a fire hazard			
	It is still unclear in models which scenario is best for carbon emissions in terms of materials so a trade-off can be made quickly			
Environmental	The environment is not suitable, it is site-specific where to apply which sustainability measures/solutions			
	Some sites are not suitable for certain sustainability solutions (e.g. too little roof area)			
	Sustainability is often only considered at the project level			
Legal	Regulations on sustainability lagging behind			

Table 7: Barriers based on two interviews (Interviewee 3, 2023; Interviewee 4, 2023)

Drivers

What is noticed here is that the drivers are mainly related to economic, social, and environmental reasons. As also mentioned in the theory, it is important to develop carbon net-zero for a competitive position as a developer. Also, otherwise, investors will no longer want to invest in the development. Financial support, with for instance a competitive land price, would motivate developers to develop carbon net-zero. In addition, intrinsic motivation is also a developer's driver. As for the environmental drivers, it is mainly about the better world you want to leave behind. You also use less energy if you make your buildings in Paris Proof at an earlier stage.

Furthermore, buildings with smart technology can also reduce energy demand. Finally, it is easier to adapt a building slightly to new requirements than to make it completely sustainable.

''If you do not get into it now, as a developer you are also going to lose your competitive edge and investors just will not want to buy your product anymore.''

- Interviewee 3

Type of driver	Driver carbon net-zero developments	Mentioned in theoretical research
Political	For an office building that is already well above regulations, it is easier to still comply in a few years or make minor adjustments to still comply	
Economic	If you avoid doing it now you lose your competitive position as a developer	
	Investors will not purchase your product otherwise	
	A competitive land price that motivates the development	
	Financial support	
Social	Intrinsic motivation to make a good and sustainable product/building	
	You want people to enjoy coming to the office	
	Your mission is to get it done together	
Technological	We need to make buildings with smart technology to reduce energy consumption	
Environmental	The sooner you make the building Paris proof, the less energy you need	
	You want to leave a better world behind	
	Creating a pleasant working environment	
Legal	-	

Table 8: Drivers based on two interviews (Interviewee 3, 2023; Interviewee 4, 2023)

Influence of developers

Besides developers themselves, many other parties are crucial in the process. First, municipalities have a lot of influence on their land price policy. In Amsterdam, for example, the municipality has a lot of land and can directly influence parties with it. Second, there is a need for contractors who must innovate in the use of building materials but must also look with their suppliers at how we can save as much carbon as possible in the products they make. Besides, the knowledge of designers is needed, but as a developer, you can steer on them. On the costs side, a building cost consultant is essential for the feasibility of the project.

Last, people in a team need to have the tools to understand the consequences of certain choices. The phase where you are going to shape the major part of the project and where you base your business case, which is the most important phase, is the planning phase up to sketch design. With that, you also start selecting parties you want to have on the project. Certain design choices and technologies should be determined

from the start. Should there be any technological changes, it is worthwhile to see if this is still possible to change the design later in the process.

''You notice that in a team of consultants where you try to stay ahead on technology as well as sustainability. And now also on CO2, you just have to give people the tools to understand the consequences of their choices. You just have to have the expertise for that.''

- Interviewee 4

Opportunities in the urban area

It is going to be very important to use the urban area to offset carbon emissions, just the question is how can that be done?

Cedar is a nice example of that. That was then looked at with the Amsterdam ArenA. The ArenA had a lot of space there to install PV panels. Could we enter into a kind of collaboration with them, so that we do not just put solar panels on the roof of the Cedar building locally, but also install solar panels for an area?

This is an example of offsetting in the urban area, but there are more ways to offset carbon. First, it is important to reduce carbon emissions by choosing materials efficiently and well. Furthermore, there can be looked at everything a bit more locally. Going to look at the area level, what is available in the area and how can we make use of it? To use the urban area to offset carbon emissions, a developer can initiate a mobility plan, which results in fewer cars in the urban area to reduce carbon emissions. Besides, making other buildings in the development area sustainable as part of the project can be an outcome. Finally, the building could be partly opened up to everyone to make the most efficient use of the building and also give something back to the residents in the area.

''You have to look very carefully at each other, how can we strengthen that area with each other?''

- Interviewee 4

Insights case Cedar

Developers can indirectly influence political and economic barriers. Political barriers mainly relate to regulations, while economic barriers include high land prices, demolition costs, and expensive carbon offsets for timber construction. However, Social barriers can directly be influenced and relate to the limited demand from end users and the need for cooperation from all stakeholders in the area. Technological barriers relate to the constant innovations in technology and the lack of a model to choose the best available materials. Environmental barriers have to do with unsuitable sites or buildings. Legal barriers relate to the lack of carbon net-zero regulations.

Despite these challenges, several drivers can motivate developers to develop carbon net-zero. Developers need to collaborate with different parties, such as municipalities, contractors, designers, and construction cost consultants. In addition, it is crucial to use the urban area to offset carbon emissions, for instance by reducing carbon emissions through efficient material choices, initiating a mobility plan, and making other buildings in the development area more sustainable. With collaboration and the use of innovative technologies, carbon net-zero solutions can become more accessible and feasible, opening the way to a carbon net-zero future.

04.9 In-case analysis Harbour Park

Barriers

Table 9 shows the perceived barriers to carbon net-zero developments. What immediately stands out is that barriers are mainly social. In addition, only one barrier matches the theory. Of the remaining barriers, some can be influenced directly or indirectly.

01. Political

When it comes to political barriers, it is related to municipalities. For instance, there is often no sustainability specialist from the municipality present during the development. In addition, it is also not clear where in the development area compensation would be allowed.

02. Economic

In terms of economic barriers, it mainly has to do with financial feasibility due to high construction costs and the demand for affordable housing. It is also difficult administratively.

''A lot is being asked and required, but on the other hand we also just want to take care of our people, so that they can live decently because that is the primary need of life and I think we should be able to find a balance in that.''

- Interviewee 5

03. Social

Most of the social barriers are related to knowledge. For instance, there is not enough knowledge about carbon net-zero, how the systems work, and the knowledge of carbon offsetting possibilities. In addition, it is not clear whether carbon offsetting is possible. Also, awareness of carbon net-zero is not yet clear to everyone. Furthermore, an area development often involves several developers, all with different interests. Finally, a tool summarising all laws and regulations is missing.

''Increased attention and awareness among developers regarding the issue of unawareness as a barrier can contribute to raising developers' consciousness on the matter. Such heightened consciousness can serve as an initial step in addressing the problem.''

- Interviewee 5

04. Technological

No technological barriers which can be influenced were experienced in this case study.

05. Environmental

No environmental barriers were experienced in this case study.

06. Legal

In terms of legal barriers, regulations sometimes contradict each other. For example, BENG is not necessarily good for the MPG score.

Type of barrier	Barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research
Political	From the Municipality, it is not clear where places are in the area to offset carbon			
	No (sustainability/carbon) specialist from the municipality is involved in the development.			
	The municipality has requirements to check but also wants to achieve other goals			
Economic	Financially, it is now too tight to build carbon neutrality within all laws and regulations. Also due to rising construction costs and the demand for affordable housing.			
	Administrative, it is not doable			
	Knowledge of the costs of the systems is lacking			
Social	Each developer in an urban area development is in it with a different interest.			
	Each investor has different interests in a project			
	Not everyone has enough knowledge about carbon net-zero			
	In an urban area development, there is no insight into the possibility of carbon offsetting			
	Awareness of carbon neutrality needs to be raised			
	Knowledge of how the systems fit into your development is lacking			
	Knowledge of what solutions are possible is lacking			
	You need to know so much as a developer, which often cannot be done.			
	Consultants are constantly pouring over laws and regulations. No one tool can be used that meets the objectives.			
Technological	Materials are difficult to dismantle for a building of this height			
	Installers do not have enough quality and capacity in them and nobody knows anymore			
Environmental	-			
Legal	Systems like BENG are made by and for consultants			
	What is good for BENG is not good for carbon. Methods contradict each other.			
	It takes a very long time to get a system into e.g. a BENG measurement method so that it can be used.			

Table 9: Barriers based on three interviews (Interviewee 5, 2023; Interviewee 6, 2023; Interviewee 7, 2023)

Drivers

The drivers are mainly linked to social responsibility. Doing something back for the climate and greening the environment. In addition, it has to be financially feasible, whereby a system whereby it is financially possible would motivate. According to interviewees, this would be possible in the form of subsidies. Furthermore, carbon offsets could also be seen as a marketing strategy for the developers themselves.

Type of driver	Driver carbon net-zero developments	Mentioned in theoretical research
Political	Political support in the form of subsidies	
Economic	If there is a building system where it is financially possible	
Social	Carbon offsets can be seen as marketing for developers themselves	
Technological	-	
Environmental	Thinking with the climate and eager to give something back	
	Urban areas want to change from 'grey' to 'green'	
Legal	-	

Table 10: Drivers based on three interviews (Interviewee 5, 2023; Interviewee 6, 2023; Interviewee 7, 2023)

Influence of developers

Developers influence carbon net-zero urban area developments, however, developers are part of the whole chain and you need them. Carbon net-zero should be included in the design from the sketch design onwards, so all parties involved in it are essential. However, parties that are willing to be able to take steps earlier are needed because the financial frameworks are better there. To achieve carbon offsets, it is useful to have an expert on board who has an overall understanding of carbon neutrality opportunities. Furthermore, an installation consultant is essential. Responsibility for the area and public space lies with the Municipality. As a developer, you have to contribute to the public area through the "area contribution". It would be great if developers could show the municipality that they want to reduce carbon emissions. As a municipality, you can encourage by including carbon net-zero in the area contribution. As a municipality, it is important to have a vision for the area and also discuss this with developers. In collaboration with experts/consultants in this area vision of how carbon net zero can be achieved from the ambition should not become a must.

The phase when a developer can exert the most influence is at the beginning of the project This is because the frameworks are the broadest. Eventually, you start working with a design team within certain frameworks and that, I think, is when you determine what is feasible.

Opportunities in the urban area

It seems very good to make carbon offsetting part of a development. Within the Netherlands, we can help each other through funds. Starting small within the local municipality, helping people (who are struggling) by, for example, greening their gardens. Besides, developing and picking forests for the municipality is a possibility, which is a plus for residents and also offsets carbon. Perhaps funds could also be used to offset some of it by helping farmers in the Netherlands. Besides, green compensation within the area or municipality may be possible. However, it is site dependent if there is maybe space in a forest that can be planted to compensate. If there is water nearby, an algae farm in the port can help to offset carbon emissions.

Insights case Harbour Park

According to the barriers, politically, there is often no sustainability specialist involved during the development, and locations for offsetting are undefined. Economically, financial feasibility is a challenge due to high construction costs and the demand for affordable housing. Societal barriers include a lack of knowledge and awareness of carbon net-zero and carbon offsetting opportunities and contradicting interests between developers. Legal barriers are about conflicting sustainability regulations. However, subsidies and carbon offsetting as a marketing strategy can be a driver for developers. Developers play a crucial role in achieving carbon zero, and this role should be included in the initial design phases. For carbon offsetting in the area, there are opportunities for offsetting within the municipality, such as planting forests, developing algae farms, and helping farmers offset carbon emissions.

04.10 Cross-case analysis

Through the different cases, all components are compared separately: barriers, drivers, the influence of developers, and opportunities in the urban area. For each component, the goal is to find different links and similarities across all of the cases. Those findings are explained in the following paragraphs per component with supporting quotes from the interviewees.

Barriers

The barriers of the different cases are explained per PESTEL category in a table. The 'comparison' column has been added so that it can be found where the barriers are the same. What is generally noticeable is that the cases do not mention a lot of the same barriers, but most of them can be categorized because the barriers are reasonably close to each other.

01. Political

What is immediately noticeable about the political barriers is that developers can mainly influence them indirectly. Most of the political barriers are related to laws and regulations and certificates to be obtained.

First of all, it is mostly an ***accumulation of requirements and rules*** and it does not always match with each other. Thus, local laws and regulations have a 'different agenda'. Besides, requirements are often imposed to obtain certification, but whether it is better for the project remains to be seen. Also related to certificates but not part of laws and regulations is that it is difficult to get the municipality on board when materials are not yet available for certificates. Furthermore, regulations are too strict to do carbon offsetting anywhere outside the plot. According to interviews, municipalities are asking a lot, but something can also be done on their part. In doing so, trust between municipalities and market parties is really important.

''The moment there are materials that are said to be carbon neutral, it does not mean that they also have all the certificates. And you have to have these before you can get a permit. And rightly so, because of course you also want your building to be fire-safe and to meet all safety requirements, but yes, if you don't have that check mark, it is also difficult to apply and that process can also take a very long time.''

- Interviewee 2

What can be managed directly, however, are certain ***project choices from the municipality.*** Mostly, there is no sustainability and/or carbon specialist from the municipality involved in the development. It would be valuable to also have a sustainability specialist from the municipality's side to look at the larger scale. This can be discussed at the start of the project. Besides, the municipality sometimes determines that you have to connect to district heat because they have invested in that infrastructure, while sometimes a different (more sustainable) installation is desired.

''In the context of area development, it is important for municipalities to designate specific areas for preservation as green spaces or meadows. Additionally, tell the developers how they can compensate for what they intend to build in the area. By adopting such an approach, municipalities can facilitate more constructive dialogue.''

- Interviewee 5

Political barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research	Comparison
Difficult to get the Municipality on board when materials are not yet available for certificates				
Trust between government and market parties				
Accumulation of requirements and rules and it does not always flow with each other.				
Requirements are often imposed to obtain certification, but whether it is better for the project remains to be seen.				
Regulations are too strict to do carbon offsetting anywhere outside the plot.				
The municipality sometimes determines that you have to connect to district heat because they have invested in that infrastructure, while sometimes a different (more sustainable) installation is desired				
Local laws and regulations have 'different agendas'				
The municipality is asking a lot, but something can also be done on the municipality's part				
From the Municipality, it is not clear where places are in the area to offset carbon				
No (sustainability/carbon) specialist from the municipality is involved in the development.				

Table 11: Political barriers (in)directly influenced by developers based on all interviews

02. Economic

What is immediately noticeable is that all economic barriers can only be influenced indirectly by developers.

The recurring theme is that the carbon net-zero developments do ***not always fit within the business case.*** This is mentioned repeatedly in two cases. Due to rising construction costs and the demand for affordable housing, is too tight at the moment to build carbon-neutral within all laws and regulations. Besides, the land price for an empty plot is often too high which results in the demolition of an existing building because it is often cheaper than redevelopment.

"It is often much more expensive, if you look at carbon neutral concrete, for example, you pay twice as much for this because it takes twice as long the moment you use carbon neutral cement because your hardening time takes longer, so then you have your schedule and the cost."

- Interviewee 2

Besides feasibility for the business case, another economic barrier, ***materials and equipment*** is a more frequently recurring category. First, replacing equipment to carry out construction is costly. Besides, investors are needed to scale up material production for carbon-neutral materials. Also offsetting carbon in timber construction is many times more expensive than offsetting carbon in concrete construction.

"We all want to start using carbon-neutral equipment, but it is not there yet. A lot of the equipment used by contractors lasts a long time and most of it is still diesel-fuelled. When you all have to replace it, the question is: will it be very sustainable and should we be willing to pay more for it?"

- Interviewee 2

Economic barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research	Comparison
Replacing equipment to carry out construction is costly				
To scale up material production for carbon-neutral materials, investors are needed				
It does not always fit within the business case				1
Paris Proof is not making money at the moment				1
The land price for an empty plot is too high				
Demolition is often cheaper than redevelopment				
Offsetting carbon in timber construction is many times more expensive than offsetting carbon in concrete construction				
Financially, it is now too tight to build carbon neutrality within all laws and regulations. Also due to rising construction costs and the demand for affordable housing.				1
Administrative, it is not doable				
Knowledge of the cost of the systems is lacking				

Table 12: Economic barriers (in)directly influenced by developers based on all interviews

03. Social

Compared to the other PESTEL categories, there are many social barriers. These can be influenced both indirectly and directly by developers.

Most barriers that can be indirectly influenced by developers are related to ***knowledge.*** First, it is not clear how much carbon needs to be offset. Besides, it is unclear what the possible solutions for carbon offsetting could be. What could help is transparency on the amount of carbon to be offset. This refers to values linked to certain products and processes. These values are not yet available for every material or process. What also makes it complicated for developers is that consultants are constantly pouring over laws and regulations. No one tool can be used that meets the objectives.

The barriers that are directly influenced by developers are also related to ***knowledge.*** This is mentioned repeatedly in two cases. First, not everyone has enough knowledge about carbon net-zero. As a developer, you need to know so much which often cannot be done. Besides, a carbon net-zero building has become a catch-all term. From the other point of view, in an urban area development, there is no insight into the possibility of carbon offsetting. In addition, developers do not know if the contractor can deliver on the promises because there are hardly any carbon net-zero developments yet.

''The more knowledge you have of systems available on the market and what the cost of those systems is, how they would fit into your development, the better it is and the more, the easier it is to apply them.''

- Interviewee 7

The second recurring theme is related to ***dependency.*** This is mentioned repeatedly in two cases. Developers are dependent on the whole chain and all parties must participate. The awareness of carbon neutrality needs to be raised by all parties by developers. However, each developer in an urban area development has a possible different interest in the project.

The last social barriers are categorized under ***user preferences.*** First, the customer does not always ask for carbon net-zero. Besides, the people living there have different needs and comfort and tenant requirements need adjustment as much comfort is related to energy consumption.

''You have to be prepared to adjust your program of requirements. This means that your comfort, the requirements you have as a tenant, also have to be adjusted slightly. So you have to instead of waiting four seconds for the elevator now a waiting time for six or seven seconds, and you do have to include everyone in that.''

- Interviewee 3

Social barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research	Comparison
It is not clear how much carbon needs to be offset				
Carbon net-zero building has become a catch-all term				2
You are dependent on the whole chain				1
You do not know if the contractor can deliver on the promises because there are hardly any carbon net-zero developments yet				
The people living there have different needs				
Comfort and tenant requirements need adjustment as much comfort is related to energy consumption				
Everyone must participate				1
You cannot do it alone, you need many parties for this				1
The customer does not always ask for carbon net-zero				
Each developer in an urban area development is in it with a different interest.				
Not everyone has enough knowledge about carbon net-zero				2
In an urban area development, there is no insight into the possibility of carbon offsetting				
Awareness of carbon neutrality needs to be raised				
Knowledge of how the systems fit into your development is lacking				
Knowledge of what solutions are possible is lacking				
You need to know so much as a developer, which often cannot be done.				
Consultants are constantly pouring over laws and regulations. No one tool can be used that meets the objectives.				

Table 13: Social barriers (in)directly influenced by developers based on all interview

04. Technological

Technological barriers can also be distinguished by several recurring themes. Several technological barriers are linked to ***availability.*** This is mentioned repeatedly in two cases. Thus, sustainable materials are not yet available on a large scale and it is uncertain whether recycled products will be available when construction starts. Those barriers can be indirectly influenced by developers. For example, a higher demand for those products can ensure more investment in those products which can result in larger-scale production. Besides, not every type of material is available from every contractor. However, developers can directly influence this barrier by discussing the problem with the contractor in advance and involving them early on in the design process to avoid this barrier.

''There is significant uncertainty surrounding the availability of recycled materials at the start of the construction process, particularly for projects beginning in a few years. This presents a considerable challenge, as it is difficult to anticipate what materials will be available and in what quantities. Additionally, there are potential cost implications, as these materials may be more expensive than traditional alternatives.''

- *Interviewee 1*

The following recurring theme is the ***materials*** themselves. First, the database of materials is not up-to-date. Besides, it is still unclear in models which scenario is best for carbon emissions in terms of materials so a trade-off can be made quickly. As a developer, you can indirectly indicate to sustainability experts that there is a need for a tool where you can immediately see how much carbon offsetting is required for certain design choices. Additionally, innovative materials often have a different way of mounting so you cannot easily go back to a traditional design. As a developer, you can take this into account at the beginning of a project. It is important to work with the constructor to identify opportunities for sustainable solutions and how they can be technically fitted into the project. Also, all technological developments are going very fast these days. What sustainability solutions you came up with during the beginning of the project may no longer be 'new' during implementation because a construction process takes years. It is therefore important as a developer to ensure that space, time, and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

The latest technology barriers fall under ***collaboration.*** Contractors should be willing to put effort into sustainable products and ensure that they are approved and can be applied while ensuring proper guarantees. Besides, the fire brigade (and the municipality) considers some sustainable (PV) solutions to be a fire hazard. Where it is important to ensure that all materials are inspected and properly recorded in a database to avoid these concerns.

''The procurement of approved circular products that meet relevant guarantees necessitates the commitment of contractors to seek and arrange these products. Without such efforts, contractors may not be inclined to utilize circular products. Consequently, a deliberate decision at the outset is crucial in ensuring the availability of such products.''

- *Interviewee 1*

Technological barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research	Comparison
Not every type of material is available from every contractor				
Sustainable materials are not yet available on a large scale				1
Innovative materials often have a different way of mounting so you cannot easily go back to a traditional design				
Contractors should be willing to put effort into sustainable products and ensure that they are approved and can be applied while ensuring proper guarantees.				
It is uncertain whether recycled products will be available when construction starts				1
The database of materials is not up-to-date				
What sustainability solutions you came up with during the beginning of the project may no longer be 'new' during implementation because a construction process takes years				
The fire brigade (and the municipality) considers some sustainable (PV) solutions to be a fire hazard				
It is still unclear in models which scenario is best for carbon emissions in terms of materials so a trade-off can be made quickly				

Table 14: Technological barriers (in)directly influenced by developers based on all interviews

05. Environmental

For the environmental part, there are only two barriers that can be influenced by developers, both directly. First of all, some ***sites are not suitable*** for certain sustainability solutions. This is often related to the design of the building and area. If there is clarity about which carbon offsets should be included in the area, or which sustainability applications should be included in the building, this can be taken into account.

In addition, sustainability is often only considered at the ***project level***.

''The extent of what can be achieved in a particular location is highly dependent on the geographical and regulatory constraints of that area. Thus, it is essential to carefully consider these limitations when implementing sustainability initiatives. This calls for improved communication and trust-building between government and market players to facilitate effective collaboration and decision-making.''

- Interviewee 4

Environmental barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research	Comparison
Some sites are not suitable for certain sustainability solutions (e.g. too little roof area)				
Sustainability is often only considered at the project level				

Table 15: Environmental barriers (in)directly influenced by developers based on all interviews

06. Legal

As with political barriers, these fall under the category of ***laws and regulations***, which also means a developer can only indirectly influence them. First, regulations on sustainability lagging. Also, carbon-neutral materials do not necessarily fall within 'certificates to be obtained'. Thus, it takes a very long time to get a system or material into a measurement method so that it can be used. Furthermore, methods are contradicting, what is good for BENG is not good for carbon.

''As a developer, you should be able to assume that if you meet the requirements that are set, that means you also meet the regulations.''

- Interviewee 7

Legal barrier carbon net-zero developments	Developers can indirectly influence on	Developers can directly influence on	Mentioned in theoretical research	Comparison
Carbon-neutral materials do not necessarily fall within 'certificates to be obtained				
Regulations on sustainability lagging behind				
What is good for BENG is not good for carbon. Methods contradict each other.				
It takes a very long time to get a system into e.g. a BENG measurement method so that it can be used.				

Table 16: Legal barriers (in)directly influenced by developers based on all interviews

Drivers

When the drivers of the three different cases are put side by side, it is immediately noticeable that they are often related to the social drivers. Thus, in each case, the importance of developing carbon net-zero emerges for the *competitive position as a developer*.

In addition, two cases mention that *intrinsic motivation* from the developer can also be a driver.

''The perfect world would be that there is some kind of intrinsic motivation in a developer that you say in advance: I want to get a certain yield from this project. If it's a bit more, then, we compensate for that extra part in the area.''

- Interviewee 5

Besides the social drivers, there is a major economic driver, namely *financial support*. This is repeated in every case study. This financial support could be through subsidies or a competitive land price, for example.

The last driver that emerges in several cases is environmental. Several people indicated that they would like to *leave a better world behind*. They want to give something back to the climate and green the environment.

''We all know that construction and the built environment have a pretty big impact on the environment and nature and that we all made that Paris agreement to reduce it some more, all the bad impact we have, so that the intrinsic drive, in the end, is that we all want a better future for the world and for all the people who will be around then, and if we continue at this moment, that that just will not work''

- Interviewee 2

Influence of developers

In all cases, it became clear that developers have an impact on carbon net-zero developments in the Netherlands. As a developer, you choose the parties and decide on starting points and goals. In each case, it emerged that different parties are required to achieve carbon net-zero developments. The developer is a beneficial initiator, but the entire chain is needed for a successful project, and they require cooperation. The *design team* was first mentioned in all cases that are important to make a difference. Parties in the design team that are crucial following the interviewees are a pioneering *architect*; a *contractor* interested in sustainability and carbon net-zero at all levels and stages; a *structural engineer* well versed in many alternatives to regular structural materials; an *installation consultant* who wants to look ahead and has a good network with network operators to come up with solutions with them; a *sustainability consultant* who can take an integrated view with a focus on carbon net-zero; a *landscape architect*; *municipality* for permits, their land price policy, and the area contribution; a *construction cost expert* who knows about sustainability/circularity and its costs versus traditional building. Some parties were not mentioned in multiple cases, but these are important to include because these parties are crucial in the design process because they were mentioned. These are the *investors* for funding and the *future residents*.

''In the context of cooperation, there is significant leverage to make meaningful progress toward desired goals. With the support of like-minded partners, significant progress can be made towards mutually beneficial goals.''

- Interviewee 1

What emerges from all the interviews is the developers' influence mostly felt throughout the *design phase*, which includes everything from the first concept of the design to the selection of the contractor. They influence not only in the design phase but also at *each level* in the development process since you work from coarse to fine. It is critical to *assess whether the goals are still being met* at each phase.

''In a previous project, a matrix was created using the shell model at the outset of a circular workshop. The matrix was designed to assess different aspects that could be influenced at different scales, and it was implemented across sketch design, preliminary design, and definitive design levels. This approach can maybe also be used for carbon reduction.''

- Interviewee 1

Opportunities in the urban area

Every interviewee agrees that it is very good and very important to make carbon offsetting part of a development. According to interviewees, there are several ways to support possible offsetting in an urban area development, some ideas are mentioned more often by interviewees, but even if the idea is only mentioned once it is still mentioned in the cross-case analysis. The more ideas, the greater the possibilities.

First of all, renovating an existing building already means you are not doing new construction, so in terms of carbon, it is much more beneficial. Besides, it is important to reduce carbon emissions by choosing materials efficiently and well.

''For me, carbon net-zero is using as few materials as possible. So in that way smart thinking about cooperation between building and site.''

- Interviewee 1

Second, *creating greenery and planting trees* is often the first thing that comes to mind. However, it is site dependent if there is maybe space in a forest that can be planted to compensate. Developing picking forests for the municipality is a possibility, which is a plus for residents and also offsets carbon. If there is water nearby, an *algae farm* in the port can help to offset carbon emissions.

''In addition to your building, you also incur costs for the public area. I can imagine that you think together with the municipality about what are we all producing here and how can we put that back into the area, for example in the greenery or in planting some extra trees? Or can we give back some setbacks, some space to the public area where we can add greenery?''

- Interviewee 5

Furthermore, there can be looked at everything a bit more locally. Going to look at the area level, what is available in the area and how can we make use of it.

Within the Netherlands, we can help each other through funds. Starting small within the local municipality, helping people (who are struggling) by, for example, greening their gardens. Funds could perhaps also be used to offset some of it by helping farmers in the Netherlands. Besides, making other buildings in the development area sustainable as part of the project can be an outcome.

To use the urban area to offset carbon emissions, a developer can initiate a mobility plan, which results in fewer cars in the urban area to reduce carbon emissions.

Finally, the building could be partly opened up to everyone in order to make the most efficient use of the building and also give something back to the residents in the area.

Insights cross-case analysis

The different cases discussed in the cross-case analysis show different barriers related to the PESTEL categories. This shows that it is a complex task with many challenges that can be influenced by developers.

Political barriers are related to laws, regulations, and certificates, which can only be influenced indirectly. However, project choices by the municipality can be directly influenced. Economic barriers are related to the feasibility of the business case and the high cost of materials and equipment. Social barriers are related to knowledge and dependency, as developers must have sufficient knowledge about carbon zero, and contractors and consultants must be aware of the targets. Technological barriers are related to the availability of sustainable materials and the database of materials. Environmental barriers are mainly about the sites not being suitable. As for legal barriers, these also often involve laws and regulations.

A collaborative approach with all stakeholders is important. This approach should include more public awareness activities, early involvement of contractors, collaboration with sustainability experts, and the development of tools and databases that can help with decision-making. Achieving carbon-neutral urban developments is a big challenge, but it is a crucial step toward a more sustainable future.

05.

SYNTHESIS

Chapter 5 introduces the synthesis. The results both from theoretical research and empirical research are the base for the synthesis. First, step by step design of the conceptual framework is explained. From here, the designed conceptual framework is then tested by an expert panel. Based on the results of the expert panel, the final conceptual framework is designed for developers to influence carbon offsets in urban areas in the Netherlands.

Synthesis

05.1 Designing the conceptual framework

Designing a conceptual framework requires several design steps. These design steps emerged from the cross-case analysis. Based on an exploratory interview, a few more important steps for a conceptual framework from the developers' point of view are explained.

1. Data belongs to the conceptual framework

The first step is to examine which data should be included in the conceptual framework. This is determined from the results of the cross-case analysis. The cross-case analysis created sub-categories for each of the categories: barriers, drivers, the influence of developers, and opportunities in the urban area.

Thus, barriers have been translated into opportunities for developers so that they can influence these barriers. Therefore, for the sub-categories of barriers, four main subdivisions have been made for this purpose. The first is whether developers can influence directly or indirectly, which derives from the conceptual framework based on Heurkens (2012). The second is who the developers should work with. This arises from interviews that revealed the importance of working with other parties to achieve carbon net-zero area developments. The third is what kind of action the developer should take, what comes from the role and perspective of the developer, and what should they do. Last, at what stage of the development process the action should be taken? This is relevant because a project can take as long as years, and from the developers' perspective, work is primarily done on a per-phase basis.

Figure 23 shows an example of how the sub-category 'knowledge' is summarised within the social barriers. In addition, table 17 shows a schematic overview of how the sub-categories of the barriers, based on the PESTEL analysis, are subdivided. Thereby, green is directly influenceable by developers, and blue is indirectly influenceable by developers. The complete categorization for the conceptual framework can be found in Appendix 4.

Social barriers

Knowledge

Influence	Direct
Collaboration	Municipality
Action developer	Dialogue
Phase	Initiation

Explanation
What developers can do is engage with the municipality to look together at the beginning of the project to see where in the area carbon can be offset and in what way that could be done so that it is included in the design.

Figure 23: Conceptual framework categories (Own figure)

	P		E		S							T				E		L
Influence																		
Collaboration																		
Action developer																		
Phase																		
Explanation																		

Table 17: Overview synthesis method barriers (Own table)

In the cross-case analysis, four drivers matter for a developer to influence carbon net-zero area developments. A developer must therefore have at least one of the four drivers (figure 24) to make use of the conceptual framework.

- Competitive position
- Intrinsic motivation
- Financial support
- Better world

Figure 24: Drivers

In terms of the influence of developers, two sub-categories emerged from the cross-case analysis. These are, first, the parties that are important to work with and the stage at which influence can be made (Appendix 4). These parties and phases are then linked to the opportunities for developers to influence the barriers to carbon net-zero area developments.

Last, there are several ways to do carbon offsetting in the area (appendix 4). These are summarised and linked to steps in the conceptual framework to achieve carbon net-zero.

2. Base of the conceptual framework

The next step is to find out what the base of the conceptual framework is. The framework is *for developers* to influence carbon net-zero urban area developments in the Netherlands. This means looking at it project-wise from the developers' perspective when designing the conceptual framework and translating the barriers from the PESTEL categories into opportunities. From the barriers, four sub-categories have emerged on how a developer can potentially influence the barriers. These four sub-categories, therefore, serve as a basis because they are already linked to the developer's perspective.

First, the conceptual framework is split into direct and indirect influence. Of these other three sub-categories, the 'phase' is the one that gives the most guidance to a developer. For each phase, it is then possible to visualize which actions a developer needs to take and which parties need to collaborate with.

3. Design of the conceptual framework

As explained in the previous paragraph, the conceptual framework is divided into two parts: the indirect and direct influence of developers on carbon net-zero urban area developments.

Table 17 shows that there are six sub-categories of barriers that developers can indirectly influence. These barriers are not linked to a design phase but are more general points for a developer to indirectly influence. Therefore, indirect influence has been separated from direct influence. This has resulted in four focus points for developers for Part 1. These focus on the other parties and the type of action (Appendix 5).

The second part is the conceptual framework itself, which is shown in Appendix 5. Here, the X-axis shows the design phase. The Y-axis shows the parties involved along with the action the developer might perform. The conceptual framework briefly explains the actions, but there is also an appendix where the actions are explained in detail. A requirement to use the conceptual framework, as explained earlier in figure 24, is to have at least one of the four drivers as a developer for carbon net-zero urban area developments.

No conceptual framework yet exists to guide carbon net-zero urban area developments. There are roadmaps to net-zero, but they are mostly general and not from the developer's perspective. In addition, these roadmaps are very general and only answer the "what" question and not the "how" question.

05.2 Testing the conceptual framework: Expert panel

An expert panel is organized for recommendations and additions to the research, recognition of results, and reflection on the conceptual framework.

Expert selection

To assure the data is representative, the experts are selected by different criteria. Because the final conceptual framework is designed for developers, they must reflect on the usability. In addition, the themes 'urban area development' and 'sustainability' should be familiar to them. And because they have to be experts, they need to have at least 5 years of experience in the real estate development field. In summary, experts:

1. Are real estate developers
2. Needs to be familiar with the themes ‘urban area development’ and ‘sustainability’
3. Have at least 5-year experience in the real estate development field

Figure 25: Expert selection criteria

When the experts are invited, they receive information about the topic of the expert panel, however, they are not given comprehensive information about the content of the expert panel so the experts think about the statements on the spot and do not do preliminary research. In addition, they receive the 'informed consent' form (Appendix 2) where they can agree to the data processing and publication of the data. A total of four experts are invited to the expert panel.

Findings expert panel

The expert panel is held according to the expert panel protocol (Appendix 5). It first briefly explains the topic and important concepts to understand everything. This is followed by four statements on the results, followed by showing and testing the conceptual framework designed.

Statement 1: Training developers internally on the topics of sustainability and carbon net-zero will eliminate the need for sustainability advisers.

All developers disagree with this statement. Development is a profession that has a lot of generalist knowledge. You, therefore, have quite some knowledge of sustainability topics and which directions you can take in the development process, but the actual solutions are often technical. You could perhaps become less dependent on sustainability consultants. Therefore, internal training and broadening the knowledge are good, but if you go in-depth, advisers need to get involved. However, for strategic thinking, it is good to broaden more knowledge so that you can include it a bit more in the design process. The better your basic knowledge of the more technical knowledge, the sooner the developer can include it in the initial phase as an integral part already. It then becomes a starting point more quickly and it also becomes more obvious that certain decisions will be made.

Statement 2: Intrinsic motivation of the developer is a requirement for a carbon net-zero area development.

Everyone agrees that there is motivation from the developer if you want to develop an area of carbon net-zero. But anything you want to go above and beyond depends on who is going to buy it from you. Thereby, the link with the investor is very important. The role of the developer is very limited, he makes something and then he gets out. The motivation to do something in a certain way has to be some kind of urgency. The developer does it to make money and bring quality in addition. But if no money can be earned then it cannot bring quality. There has to be an urgency to do certain things. That urgency is in laws and regulations. And what you are looking for here is up there. It is then interesting to look at the triggers to do that and whether there is a market for that. If the investor is willing to buy a certain product or not, only then is there urgency or motivation.

Statement 3: The most essential party to work with to develop a carbon net-zero area is the municipality.

All experts agree that the municipality is an important party to help drive a project forward. If certain developments contribute to a carbon net-zero area and are subsidized, that is a driving factor. However, besides the municipality, you have to deal with other parties in a development. You have to be on the same page with all the parties you work with within a development. Together you are stronger and can come up with better solutions. How are you going to design and use the area, you need your neighbours for that.

Statement 4: Creating a fund to offset carbon is a developer's responsibility.

None of the experts agree with this statement. It is everyone's responsibility to do their bit, the government, the developer, the investor, and the end user. It is a moral responsibility, but it only happens if there is sufficient motivation. It seems everyone is pointing at each other in creating a fund to offset carbon, referring to the circle of blame.

Testing the conceptual framework

After discussing the statements, the framework is discussed. It is the first time the experts have seen this framework. The questions asked included: What is the first impression of the conceptual framework? How would you read the framework? What is clear and unclear? Could this conceptual framework be used in practice?

According to the experts, the initial phase is very decisive. That is where you make your business case, that is where you make your agreements with those who set the frameworks. The municipality then determines what your ambition is as a minimum, and that is where you turn your business case as a developer to whom you are going to sell that. The rest is all elaboration. Everything about ‘’what” is in the initiative phase. That is where 90% of the choices are made that impact your project.

With that, everything starts with the user and you could involve this group much earlier. You start by making it for someone, you don't make something to develop something. That person also pays for the use. It doesn't have to be a name, but you have to understand the identity of the user. Especially in the initiation phase, you want to know this. In monitoring it is a ‘’how” question and in initiation, it is about the ‘’why” question.

In addition, ''Other developers'' is used when it is often not just developers in the area. Since it is often owners who are decisive, it would be better to use ''stakeholders''.

In addition, a scale in the vertical sense is missing. Here, 'Who is involved?' could be added.

The experts see dialogue mainly as informal consultation and a meeting is seen as a way to make decisions for a project.

Furthermore, in the initiation phase, you are not in dialogue with the municipality but in hard bargaining: which is more contractual. This is where you lay down the antecedent agreement and other procedures. This is sometimes cast in the form of a dialogue but it is not. This is where agreements are laid down that determine your entire project.

Monitoring is also used as a phase and a tool in the conceptual model. In this, the phase would be best changed to use phase change.
In general, the experts are satisfied with the type of conceptual framework. It is clear how it should be read and the experts also indicate that it can serve as a framework to bring other parties in the project into the process. It is clear and clearly explained in a scheme.

Framework in practise

To use the framework in practice, it is possible to translate the framework into concrete actions for developers. For example, the framework can be included as an agenda item for each phase. Furthermore, it is also relevant to determine the KPIs yourself at the start of the project, so that everything becomes measurable and this is easier to check per phase.

05.3 Final design conceptual framework

Part 1 - Indirect influence by developers in general

1. Dialogue, meeting, and contracting with the municipality about regulations and subsidies

Start a conversation about the view of the accumulation of laws and regulations and where their focus lies. It is also important to know how they deal with sustainable materials not yet included in laws and regulations.

Talk about softening regulations for offsetting just outside the plot.

Start a dialogue with incentives such as subsidies for a carbon net-zero building.

2. Meeting and contracting with the government about regulations

Indicate to the government that it is difficult to apply sustainable materials in development because they are not officially compliant.

3. Dialogue with sustainability experts about tools and instruments

Create awareness for the need for factsheets and indicate that it is difficult to work with so many tools at once and that the preference is for an integrated tool to work with.

There is a need for a tool where you can immediately see how much carbon offsetting is required for certain design choices.

4. Dialogue with investors about the demand for sustainable materials

Indicate a demand for affordable tested sustainable materials, so they dare to take risks to invest in scaling up production of these kinds of materials which ensures lower prices of the products.

Figure 26: Conceptual framework part 1 (Own figure)

Part 2 - Direct influence by developers in general

Part 2 is divided into the conceptual framework and the supporting document. To understand the framework, the actions are first explained.

DIALOGUE

An informal conversation in which you gather input

RESEARCH

Conducting research into

MEETING

A formal meeting to make decisions for a project

TRAINING

Educating

MONITORING

Keeping track of

CONTRACT

Contractual agreements

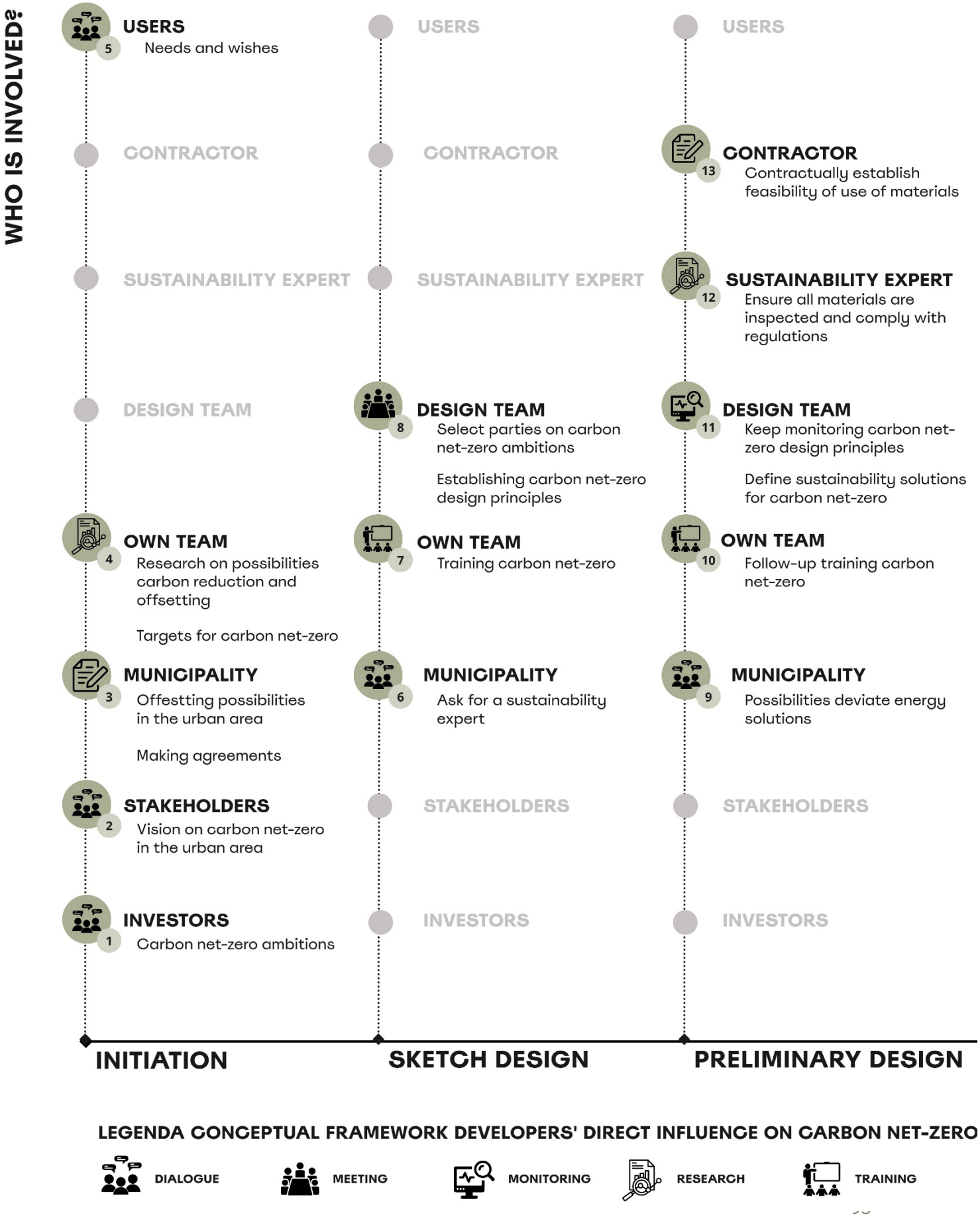
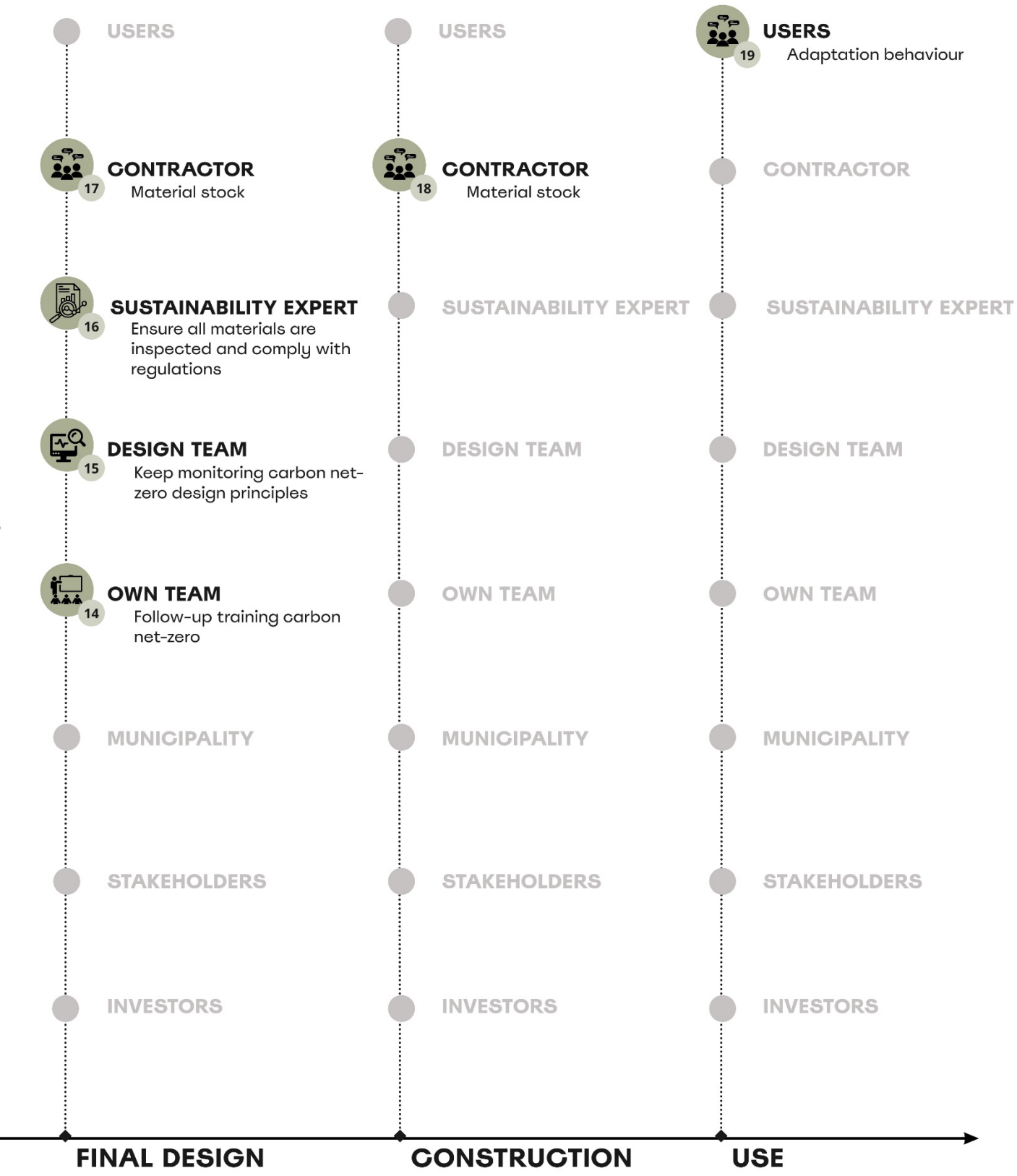

WHO IS INVOLVED?
USERS
5
Needs and wishes
USERS
USERS
CONTRACTOR
CONTRACTOR
CONTRACTOR
13
Contractually establish feasibility of use of materials
SUSTAINABILITY EXPERT
SUSTAINABILITY EXPERT
SUSTAINABILITY EXPERT
12
Ensure all materials are inspected and comply with regulations
DESIGN TEAM
DESIGN TEAM
8
Select parties on carbon net-zero ambitions
Establishing carbon net-zero design principles
DESIGN TEAM
11
Keep monitoring carbon net-zero design principles
Define sustainability solutions for carbon net-zero
OWN TEAM
4
Research on possibilities carbon reduction and offsetting
Targets for carbon net-zero
OWN TEAM
7
Training carbon net-zero
OWN TEAM
10
Follow-up training carbon net-zero
MUNICIPALITY
3
Offestting possibilities in the urban area
Making agreements
MUNICIPALITY
6
Ask for a sustainability expert
MUNICIPALITY
9
Possibilities deviate energy solutions
STAKEHOLDERS
2
Vision on carbon net-zero in the urban area
STAKEHOLDERS
STAKEHOLDERS
INVESTORS
1
Carbon net-zero ambitions
INVESTORS
INVESTORS
INITIATION
SKETCH DESIGN
PRELIMINARY DESIGN
LEGENDA CONCEPTUAL FRAMEWORK DEVELOPERS' DIRECT INFLUENCE ON CARBON NET-ZERO
DIALOGUE
MEETING
MONITORING
RESEARCH
TRAINING

Figure 27: Conceptual framework part 2 (Own figure)



URBAN AREA DEVELOPMENTS

CONTRACT

Initiation phase

1. Dialogue with investors

Engage with the investor for willingness to purchase a carbon net-zero (area) development.

2. Dialogue with other developers for an area vision regarding carbon net-zero

As a developer, it is important to discuss with all developers in the area to look at an area vision or strategy.

3. Contracting and dialogue with the municipality

Engage with the municipality to look together at the beginning of the project to see where in the area, as a location, carbon can be offset and in what way that could be done so that it is included in the design. Examples of offsetting and reduction possibilities:

- Greenery and trees
- Picking forest
- Algae farm
- Mobility plan
- Funds for locals/farmers/renovating other buildings

4. Research with the own development team

Look for possible ways for carbon reduction in the development and carbon offsetting in the urban area.

Define targets for the carbon net-zero urban area development

5. Dialogue with the users

You start with developing for someone, who also pays for its use. Engage with the user to discuss requirements and wishes

Sketch design

6. Dialogue with the municipality

Ask for a sustainability expert from the municipality to join the design team from the area vision.

7. Training own development team

Ensure that the developers are trained in carbon net-zero developments and have enough knowledge about them.

8. Design team selection and meeting

Include carbon net-zero ambitions in the party selection criteria. The following parties are essential:

- Municipality (incl. sustainability expert)
- Architect
- Contractor
- Structural engineer
- Installation consultant
- Sustainability expert
- Landscape architect
- Construction cost expert

Establishing carbon net-zero design principles

- Create awareness of carbon net-zero by all parties.
- Focus on a large scale during the design process to look at carbon offsets.
- Ensure that space, time, and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

Figure 28: Conceptual framework part 2 (Own figure)

Preliminary design

9. Dialogue with the municipality

Enter the conversation as to whether they are willing to deviate from standard energy solutions in the area and create awareness that alternatives might be more sustainable.

10. Own team

Organize follow-up training for employees to update their knowledge about carbon net-zero.

11. Design team

Keep monitoring carbon net-zero design principles

- Create awareness of carbon net-zero by all parties.
- Focus on a large scale during the design process to look at carbon offsets.
- Ensure that space, time, and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

Define what kind of sustainability solutions will possibly be used to design the area and building in a way all carbon net-zero solutions will fit.

12. Sustainability expert

Ensure that all materials that will be used are inspected and properly recorded in a database to avoid concerns.

13. Contractor

Add a 'feasibility' section in the contractor selection process and contractually define the agreements well.

Final design

14. Own team

Organize follow-up training for employees to update their knowledge about carbon net-zero.

15. Design team

Keep monitoring carbon net-zero design principles

- Create awareness of carbon net-zero by all parties.
- Focus on a large scale during the design process to look at carbon offsets.
- Ensure that space, time, and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

16. Sustainability expert

Ensure that all materials that will be used are inspected and properly recorded in a database to avoid concerns.

17. Contractor

Talk about the material stock in advance and involve them early on in the design process to avoid a shortage of sustainable materials.

Construction

18. Contractor

Keep talking about the material stock to avoid a shortage of sustainable materials.

Use

19. Users

It is important to involve the users in the project and include them in the sustainability story. That they also have to adapt their behaviour to meet the climate targets.

06.

DISCUSSION & CONCLUSION

This chapter reflects on the theoretical research, the empirical research, and the synthesis. Afterward, the research questions are answered in the conclusion. Furthermore, some recommendations for follow-up research can also be found.

Discussion

For the discussion, first of all, the theoretical contribution is explained. Then the empirical research is discussed, and the results are compared with the results from the theory by category. Next, the context, the scale of carbon net-zero urban area developments and the conceptual framework are discussed. Then the quality of the research design is reviewed. Finally, the limitations of the research are zoomed in on.

Theory

This thesis aims to explore what developers can do to influence carbon net-zero urban area developments and how developers can apply this in practice.

The fundament of the research is linked to Heurkens' (2012) conceptual steering model. For this research, this model helped to set frameworks and, above all, did not disregard the context of the problem statement. The context, divided into economy and politics, urban governance, and planning system and policies, is based on the Netherlands. For these subcategories, the context has been outlined as well as possible, but it remains difficult to include all the details in the thesis. The focus for the context was therefore placed on how the Netherlands deals with sustainability and thus carbon emissions in the built environment in various areas. Of course, the context is not just about sustainability; it includes many more components that have been excluded.

After the context, there is zoomed in on the process system: the carbon net-zero (urban area) developments. Whereas it first started with the basis: of describing an area development, then zoomed in from sustainable area developments to carbon net-zero developments.

Next, carbon offsetting is zoomed in on. Here, several possibilities were explained and then there is zoomed in on developers. In doing so, different types of developers have been explained according to the different themes. Besides, research was conducted on the current barriers and drivers for carbon net-zero developments. These barriers and drivers were gathered from various literature reviews worldwide.

In addition, a distinction was made between the indirect and direct influence of developers on the barriers. These are linked to Heurkens' (2012) conceptual steering model. For this, the barriers have been placed in the model to see whether a developer can exert direct or indirect influence on them.

Empirical research

For the discussion of the empirical research, the results of the case studies are compared with the theory. After this, there is looked at what corresponds and what are the additions from practice. If a result occurs in both theory and practice, it is underlined and possibly coloured blue for indirect guidance and green for direct guidance. If there is a new insight from practice, it is made bold and also coloured in the same colours as previously explained. Agreeing on results and additions is essential for the framework, therefore the discussion will also help which values should be included in the final framework for developers to influence carbon net-zero area developments in the Netherlands.

Political barriers

From the theory, the influential political barriers are that there is an unclear definition of carbon net-zero and that there is a lack of energy subsidies.

What is immediately obvious about the political barriers in practice, is that they are mostly indirectly influenced by developers. The majority of political barriers are connected to rules, laws, and certification requirements. First of all, it is mostly an accumulation of requirements and rules and it does not always flow with each other. What can be managed directly, however, are certain project choices from the municipality.

The political barriers that have emerged from practice all differ from those that have emerged from theory. The theory puts focus on the unclear definition of carbon net-zero and the limited energy subsidies, which do not appear in practice. It could be valuable to research why it is not reflected in practice but mentioned in theory.

On the other hand, the practice puts focus on the accumulation of requirements and rules and the project choices from the municipality which are both not mentioned in theory. This implies that in practice these barriers are experienced, even if they do not occur in theory. It is therefore important to include the **accumulation of requirements and rules** and certain **project choices from the municipality** for further research and practice.

The reason could be that laws and regulations have changed faster than research has been done recently. Thereby, for example, project choices from the municipality are fairly site-specific, while all the literature was less site-specific.

	T	
	Unclear definition	Lack of energy subsidies
P	Accumulation of requirements and rules	
	Project choices from the municipality	

Table 18: Theory and practise political barriers (Own table)

Economic barriers

In theory, only risk perception can be influenced directly. Indirectly influenceable barriers can be grouped into different themes: feasibility of the business case, demand and supply, financial incentives, dependency construction sector, and stakeholder involvement.

In practice, all economic barriers can only be influenced indirectly. The recurring theme is that the carbon net-zero developments do not always fit within the business case. Besides, materials and equipment are a more frequently recurring category.

Both theory and practice highlight that economic barriers can only be influenced indirectly by developers. Besides, both stress the feasibility of carbon net-zero developments within the business case is an economic barrier.

The dependence of the construction sector on the fragmented structure of the construction sector and the lack of collaborative integration of the supply chain are only mentioned in theory. In addition, stakeholder involvement is also mentioned only in the theory, focusing on the difference between the involvement of the municipality and the developer. It can be useful to investigate why it is mentioned in theory but not mentioned in practice.

In practice, **materials and equipment** are a common barrier which suggests that even while this barrier might not exist in theory, it is still a problem in practice. This barrier must be taken into account for it to be studied further and used in practice.

The reason that materials and equipment have only been mentioned in practice may be because theory focuses primarily on economics from the perspective of developer feasibility, linked to money. Where materials and equipment may not be immediately thought of, but it is an actual barrier.

		T					
		Feasibility business case	Stakeholder involvement	Dependency construction	Financial incentives	Demand and supply	Risk perception
P	Business case	X					
	Materials and equipment						

Table 19: Theory and practise economic barriers (Own table)

Social barriers

The theory mainly extracts barriers that can be directly influenced by developers. Most barriers are related to knowledge. In addition, barriers can be linked to user preferences.

In practice, many social barriers can be influenced both indirectly and directly by developers. Most barriers that can be indirectly influenced by developers are related to knowledge. The second recurring theme is related to dependency on the whole chain and other stakeholders. The last social barriers are categorized under user preferences.

Both theory and practice name knowledge and user preferences as barriers. Practice does add dependency on the whole chain and other stakeholders. This suggests that even though these barriers may not exist in principle, they are nonetheless experienced in practice. For future research and use in practice, it is essential to take into account the **dependency** on the entire chain and other stakeholders.

The reason that dependency only recurs as a barrier in practice could be because perhaps other factors besides the developer's perspective have not been considered as broadly from theory.

		T	
		Knowledge	User preferences
P	Knowledge		
	Knowledge	X	
	Dependency		
	User preferences		X

Table 20: Theory and practise social barriers (Own table)

Technological barriers

The theory shows that technological barriers are mainly indirectly influenceable. These are mainly knowledge barriers. Barriers that are directly influenceable fall under design and project-related barriers.

In practice, technological barriers can also be distinguished by several recurring themes. Several technological barriers are linked to availability. The following recurring theme is the materials themselves. The latest technology barriers fall under collaboration.

When theory and practice are compared, it is striking that none of the barriers match. The theory focuses on knowledge and design and project-related barriers. It could be valuable to research why it is not reflected in practice but mentioned in theory.

The mismatch also applies to the perspective from practise. There, the emphasis is on **availability, materials** and **collaboration**. This implies that although these barriers might not exist in theory, they are nonetheless encountered in practice. It is crucial to consider those barriers for future study and use in practice.

The reason there is such a large mismatch in barriers could be due to the rapid changes in technology, but also the war in Ukraine, which has caused a shortage of materials.

		T	
		Knowledge	Design and project-related
P	Availability		
	Materials		
	Collaboration		

Table 21: Theory and practise technological barriers (Own table)

Environmental barriers

From theory, the only barrier that can be directly influenced is users' concern about indoor air quality and thermal comfort.

For the environmental part in practice, there are only two barriers that can be influenced by developers, both direct. First of all, some sites are not suitable for certain sustainability solutions. In addition, sustainability is often only considered at the project level.

When theory and practice are compared, it is noticeable that the barriers do not match. The theory addresses the users' concern as a barrier, which does not appear in practice. Investigating why it is mentioned in theory but not practice can be useful.

The practice addresses the **project level** and that **sites are not suitable** as barriers. This implies that in practice these barriers are experienced, even if they do not occur in theory. It is therefore important to include those barriers for further research and practice.

The reason the barriers do not match may have to do with scale, environmental barriers can be interpreted very broadly.

		T
		Users' concern about indoor air quality and thermal comfort
P	Sites are not suitable for sustainability solutions	
	Sustainability is only considered at the project level	

Table 22: Theory and practise environmental barriers (Own table)

Legal barriers

From theory, several barriers can be categorized under laws and regulations. These barriers can all be influenced indirectly by developers. There is also one barrier that can be influenced directly, namely the discrepancy between standard and performance.

As with political barriers in practice, these fall under the category of laws and regulations, which also means a developer can only indirectly influence them.

When theory and practice are put side by side, it is noticeable that both have laws and regulations as barriers. Moreover, the theory also names the discrepancy between standard and performance. Because this barrier does not exist in practice, it may be interesting to investigate why it is described in theory but not in practice.

		T	
		Laws and regulations	The discrepancy between standard and performance
P	Laws and regulations	X	

Table 23: Theory and practise legal barriers (Own table)

Drivers

In theory, drivers occur most frequently in the categories of economic, social, and legal. Where the economic drivers are mainly linked to the developer's business model and customer demand. As for the social drivers, it is mainly about responsibility for a better world which can also be a business goal. For legal, regulation is mainly the driver.

In practice, drivers are often related to social categories. The importance of developing carbon net-zero emerges for the competitive position as a developer. In addition, intrinsic motivation from the developer can also be a driver. Besides the social drivers, there is a major economic driver, namely financial support. The last driver is about to leave a better world behind.

Both theory and practice recognize the importance of social drivers for carbon net-zero developments. The alignment with social responsibility and the competitive advantage for developers are common factors. However, theory highlights the additional influence of economic and legal drivers, while practice emphasizes the role of financial support.

The theory addresses the influence of economic and legal drivers as a driver, which does not appear in practice. Investigating why those drivers are mentioned in theory but not practice can be useful.

The practice addresses **financial support** as a driver. This implies that in practice this driver is experienced, even if it does not occur in theory. It is therefore important to include this driver for further research and practice.

That financial support is still cited as an additional driver that may have to do with the economic barriers currently in place due to rising construction prices. The literature is not all from the last two years, so that may still be missing

Influence

As theory discusses, developers are important in the development process of sustainable urban area development. They are responsible for managing and coordinating the entire development process. In addition, developers also have multiple steering roles which are subdivided into strategic and project-based development orchestration and soft steering and hard steering. To function well in a competitive market environment, every developer has to fulfil all these roles.

In the Netherlands, developers have a key role in the design phase, from the initial concept to contractor selection, and throughout the development process to achieve carbon net-zero developments. They have the power to choose the parties, starting points, and goals. Collaboration amongst various stakeholders is essential for projects to achieve their goals. The design team was consistently mentioned as being essential. Future residents and investors for funding were also recognized as essential parties. At every stage of the project, it is crucial to regularly evaluate whether or not the objectives of sustainability are being met to adjust where necessary.

Both in theory and practice the emphasis for developers is on managing and coordinating the development process. Practice highlights the particular influence and **decision-making power** developers have **throughout the design phases**. Also, emphasis on **collaboration** and **stakeholder engagement** is only mentioned as important in the practical context.

The reason for this may be to go deeper into detail, at what stage specifically do developers have influence, and by what actions and what parties are needed?

Carbon net-zero offsetting possibilities

In theory, carbon emissions can be divided into three different scopes: Scope 1 refers to direct emissions from sources managed by the organization, Scope 2 includes indirect emissions from purchased energy, and Scope 3 includes indirect emissions not directly managed by the organization but within their supply chain. Different methods can be used to offset those carbon emissions. Currently, there are several ways for offsetting which are used at the moment: planting trees, and using building materials that absorb carbon.

In practice, it is important to reduce carbon emissions and also use the urban area as a place to offset carbon. Some ways to do this include reusing buildings, choosing the right sustainable materials, planting trees, establishing picking forests for local people, and setting up algae farms. It is also possible to reduce the use of cars by drawing up a mobility plan. Furthermore, funds could help locals green their gardens and it helps farmers reduce their carbon footprint.

Theory and practice both stress the significance of sustainable actions including using the right materials, planting trees, and using urban areas to reduce carbon emissions. Both also highlighted the potential advantages of funding environmental programs.

The differences arise when discussing the exact methods and techniques used in practice. While theory emphasizes generic ways for offsetting, practice builds on these ideas and adds new tactics like **creating picking forests, and using algae farms**. The practical viewpoint also highlights the need to **reduce car use** and the contribution of **funds to help locals and the agricultural sector** to reduce carbon emissions.

The reason for this is that the interviews specifically asked for creative ideas beyond standard solutions.

Context

To fully understand the research problem, it is important to describe the context in which the problem occurs as mentioned in theory.

For economy and politics, The Netherlands wants to make maximum efforts to keep the country and planet liveable and inhabitable and therefore, the Paris Climate Agreement is signed. However, there is hardly any information on how the government intends to achieve this. For urban governance, the rising trend in Dutch urban development is toward more demand-driven development strategies, where both human and business needs are given more significance. To assess development needs in collaboration with civic actors and provide a specialized supply for urban areas, these demands are most often assisted by public actors, with a growing leadership role for private players. For planning systems and policies, to influence (sustainable urban) developments, different laws and regulations are related to the Dutch housing market.

In practice, it became clear that context plays an important role. Many barriers were related to laws and regulations, which, after all, vary from country to country. In addition, you see in practice that a carbon net-zero urban area development requires a lot of cooperation between parties, and also the municipality and the government to come up with a solution together for offsetting carbon net-zero in the urban areas.

In conclusion, practice confirms the theory of how important it is to include context in a carbon net-zero area development

The scale of carbon net-zero urban area developments

The scale matters for carbon net-zero offsetting in urban areas. It was clear from several interviews that it is location-dependent whether offsetting can be done. For example, a development site in the middle of Amsterdam is often more difficult with the limited space to do carbon offsetting. For the case study Rijswijk, which is on the waterfront, opportunities for offsetting with the water were immediately thought of. Also, for locations outside cities, it is easier to create greenery close to the plot because of often the space in the surrounding area. However, offsetting can also be done on a smaller scale in close cooperation with the municipality. For example, subsidies for residents to green their gardens.

Conceptual framework

What emerged from the results is that carbon offsetting mainly also starts with carbon reduction. This goes one on one together and has ensured that the framework has also focused on carbon reduction and not just carbon offsetting. In addition, in principle, the framework can be used by any developer, but ultimately it depends on the intrinsic motivation of the developer whether they do so.

Quality of the research design

The quality of empirical research is tested using three criteria commonly used for case studies research design:

- Construct validity
- External validity
- Reliability

Construct validity

Construct validity is about determining the most suitable operational approaches for the concepts being examined (Yin, 2009). To test construct validity, multiple sources of evidence must be used. This study uses documents, (exploratory) interviews and an expert panel. Besides, it is important to review the draft case study report with the main informants. Documents have not yet been verified with the primary informants. For those documents not checked, it has been checked during interviews and expert panel discussions to see if the information is accurate.

External validity

External validity is about demonstrating the viability of generalizing case study results and how to achieve this (Yin, 2009). This research focuses on the Dutch market, partly due to laws and regulations that differ from country to country. The research can be used for all developers in the Netherlands. However, the basis has been laid for research worldwide. After all, much of the theory is not specific to the Netherlands.

Reliability

Reliability provides that a study's processes, such as its data-gathering methods, can be repeated and provide the same outcomes (Yin, 2009). The implementation of a case study methodology to address the documentation issue in depth and the creation of a case study database go beyond simple documentation to eliminate these concerns. First, for the study protocol, chapter 2 explains the methods and techniques, data collection and analysis. This is explained in more detail in Chapter 4 and Chapter 5 with the selection of the interviewees and the case studies. There is also an interview protocol for both the interviews and the expert panel. Second, a case study database is created at the repository of Delft University of Technology.

Limitations

Definition of carbon net-zero urban area developments

There is no description of carbon net-zero urban area developments in the literature. As a result, the theory is used to develop a model of how carbon net-zero urban area developments can be described. When all literature on sustainability, urban area developments, and carbon net-zero developments are combined, everything comes together in the developed model. However, only the supervisors verified the model, which ensures that the model is not foolproof.

Case studies

The cases were only analysed from a developer's point of view. Other perspectives were barely considered, which might ultimately affect the results. As seen in the framework based on Heurkens (2012), many factors and context play a role in an urban area development. Many choices are linked to other parties, which may cause outcomes to still differ.

Two cases are located in Amsterdam, which is also more densely populated than many other cities. As a result, there is also comparatively less 'empty' space, which may make developers think differently about the ways of offsetting in the area.

One of the three cases has already been delivered in 2020, which may mean that the developers are no longer fully up-to-date in terms of the project.

Availability and time of participants

In the end, only one case managed to interview three developers. For the other two cases, two developers were interviewed. The more interviews, the more input for the results which meant that there was less input. In the end, many barriers and drivers were still mentioned per case by the interviewees which did ensure that there were many results within the case.

Conclusion

SQ1 - How could carbon net-zero urban area development be described?

In this thesis, the concept of carbon net-zero can be described as a development where the urban area serves for carbon offsetting from the developments on those plots. In doing so, the developments themselves should meet BENG requirements and include circularity in the project to reduce carbon emissions (figure 29). The remaining carbon emissions are then offset in the development area itself to achieve a carbon net-zero urban area development.

SQ2 - How are carbon emissions currently offset in the building and construction sector?

Carbon emissions can be divided into three different scopes: Scope 1 refers to direct emissions from sources managed by the organization, Scope 2 includes indirect emissions from purchased energy, and Scope 3 includes indirect emissions not directly managed by the organization but within their supply chain. Different methods can be used to offset those carbon emissions. Currently, there are several ways for offsetting which are used at the moment: planting trees, and using building materials that absorb carbon.

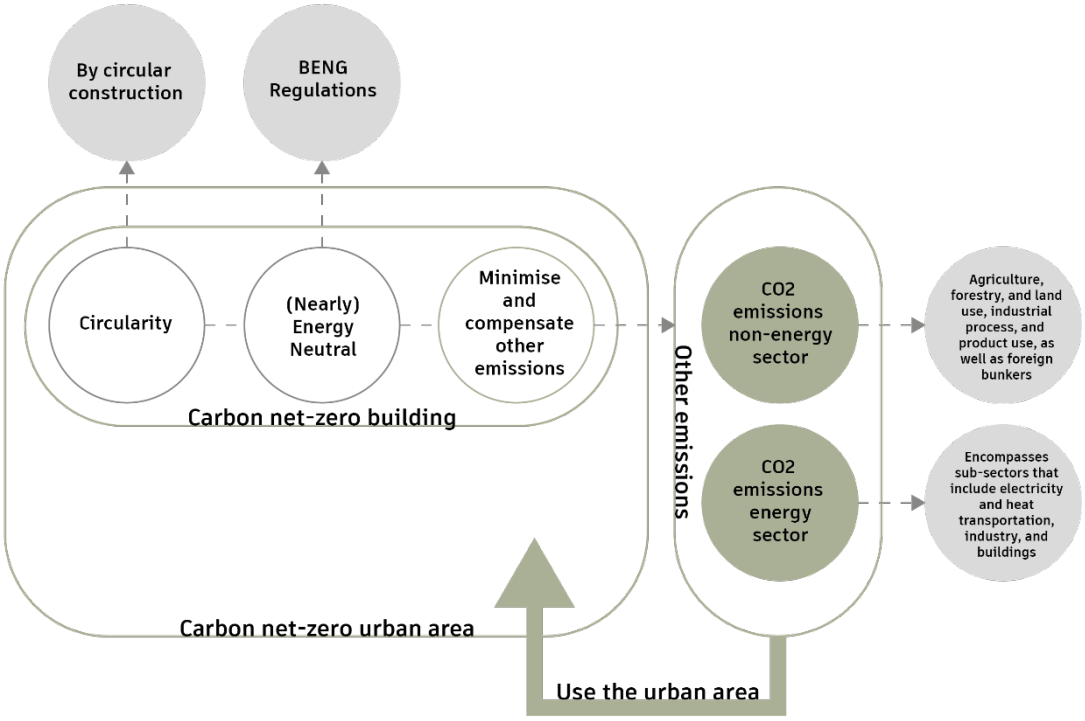


Figure 29: Carbon net-zero urban area developments (Own figure)

SQ3 - How can the developers' role be defined within sustainable urban area developments?

Developers are important in the development process of sustainable urban area development. They are responsible for managing and coordinating the entire development process. Developers have several roles and responsibilities, including land acquisition, market analysis, development plans, design plans, feasibility analysis, financing/loans, marketing & sales, project management, development, and contracting. In addition, developers also have multiple steering roles. This steering role is subdivided into strategic and project-based development orchestration and soft steering and hard steering. To function well in a competitive market environment, every developer has to fulfil all these roles.

SQ4 – What are the current barriers and drivers for carbon net-zero developments?

The current barriers to carbon net-zero developments are mainly linked to economic, social, and technological reasons. The barriers that can be influenced when it comes to politics are mainly the lack of subsidies and unclear descriptions of carbon net-zero.

Economic barriers are either not influenceable or only indirectly influenceable by developers. This mainly includes the high costs associated with carbon net-zero developments, but also there is not enough demand. As for social barriers, these are mostly directly influenceable by developers. Here, this mainly involves knowledge, experience, and awareness that is lacking. Technological barriers are often not influenceable, or only indirectly influenceable. This involves the cost of new technology being too high, and not enough research having been done. In terms of the environment, influence is only possible for users who are concerned about sustainability. Last are the legal barriers. This mainly involves laws and regulations that are flawed, which can mainly be influenced indirectly.

The drivers are mainly linked to the categories of economic, social, and legal. Where the economic drivers are mainly linked to the developer's business model and customer demand. As for the social drivers, it is mainly about responsibility for a better world. In this, it can also be a business goal. For legal, regulation is mainly the driver.

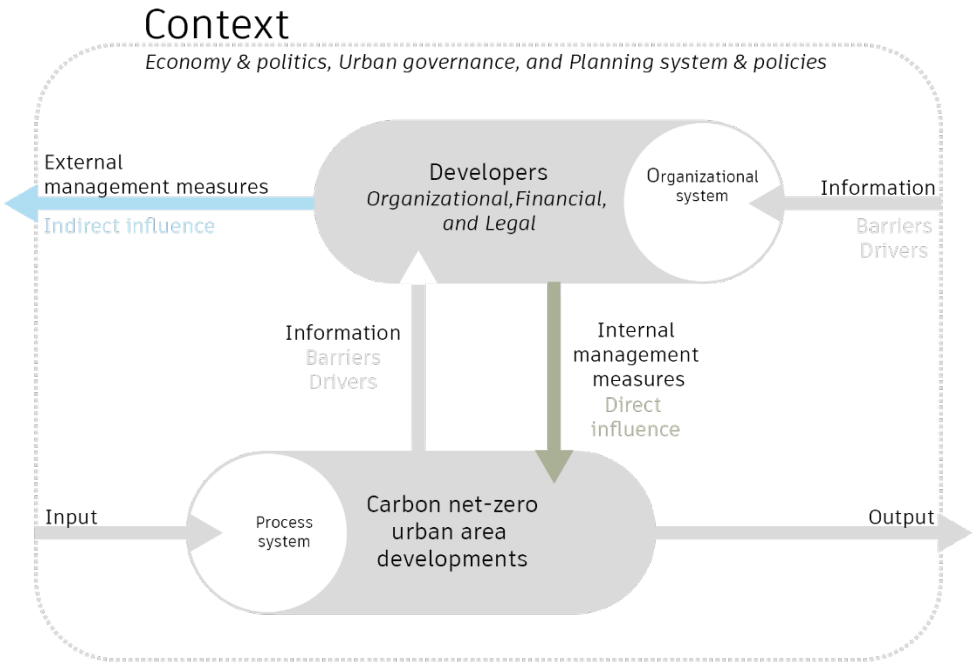


Figure 30: Conceptual steering model (based on Heurkens, 2012)

SQ5 – What components are essential for developers to influence carbon offsets in the development areas in the Netherlands?

Developers have an impact on carbon net-zero developments in the Netherlands. Carbon net-zero urban area developments all start with the drivers for developers to achieve this. These are four drivers: a competitive position as a developer; intrinsic motivation; financial support; and leaving a better world behind. When developers have at least one of these drivers, the development process can be started. For them, it is important to choose the right parties and decide on starting points and goals related to carbon net-zero. Throughout the design phase, they have the most influence, but on each level in the development process, they need to assess whether the goals are still being met. Besides, collaboration with the entire chain is needed for a successful project in which the design team is most important. But also investors are needed for funding and future residents are needed for support.

SQ6 – What opportunities and barriers do developers see to use the urban areas as a solution for achieving carbon net-zero in the Netherlands?

It is important to reduce carbon emissions and also use the urban area as a place to offset carbon. Some ways to do this include reusing buildings, choosing the right sustainable materials, planting trees, establishing picking forests for local people, and setting up algae farms. It is also possible to reduce the use of cars by drawing up a mobility plan. Furthermore, funds could help locals green their gardens and it helps farmers reduce their carbon footprint.

SQ7 – How can a conceptual framework be designed for developers to achieve carbon net-zero urban area developments in the Netherlands?

Designing a conceptual framework in this research begins with analysing relevant data from the cross-case analysis and transforming barriers into opportunities. The framework categorizes barriers into sub-categories, addressing direct and indirect influence, collaborating parties, actions, and phases of the development process. Important drivers for developers to develop carbon net-zero have been identified, and the framework highlights the importance of collaborating with stakeholders and the influence at all phases. Because direct and indirect influence differs in actions, the conceptual framework is divided into two parts with the first part offering focus points and the second part providing a detailed framework. Importantly, developers must possess at least one of the four drivers to effectively utilize the framework.

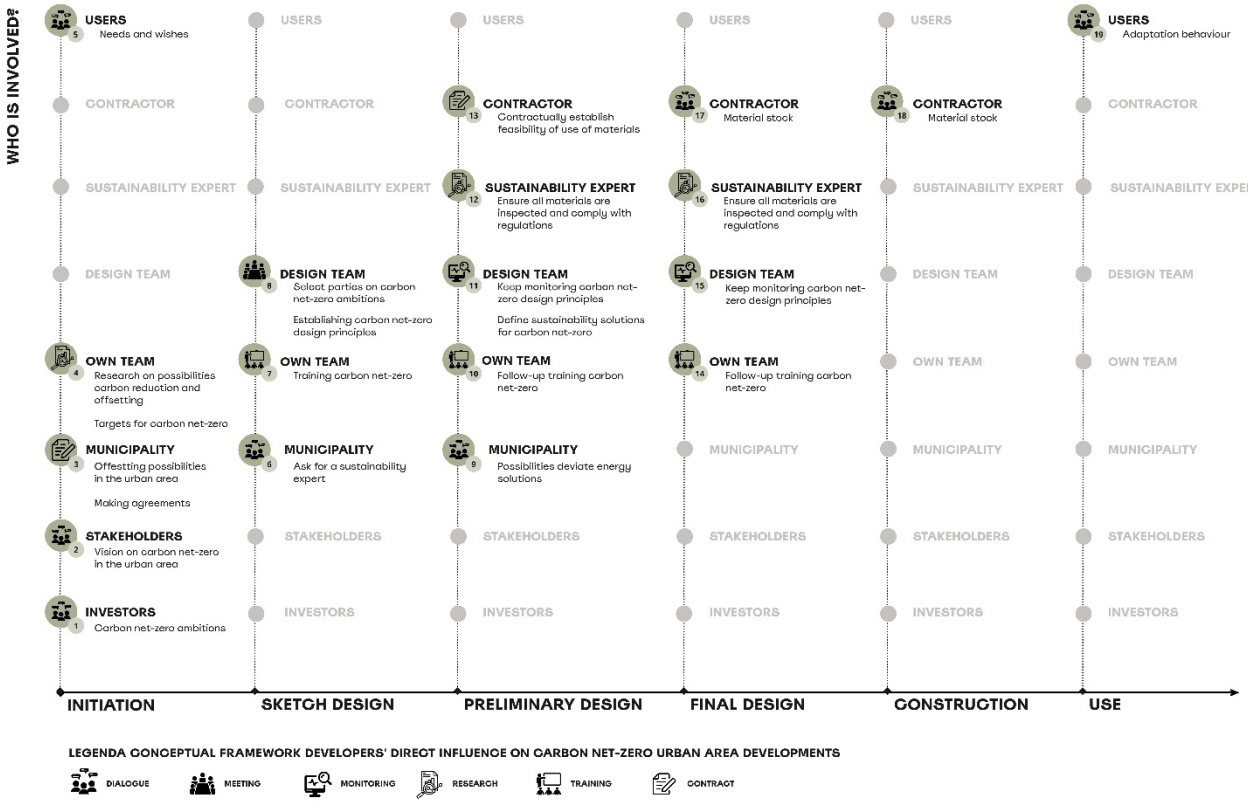


Figure 31: Conceptual framework (Own figure)

What can developers do to influence carbon offsets in the development areas in the Netherlands?

By using several strategies and actions, developers in the Netherlands can have a significant impact on carbon offsets in urban areas. A competitive position, intrinsic motivation, financial support, and a desire to build a better world are the first four drivers that developers must have. The development process is started based on these drivers.

Developers have the most impact on carbon net-zero developments during the design phase. They must carefully select the appropriate partners to work with and set up defined starting points and goals that are in line with carbon net-zero aims. To make sure that the sustainability objectives are being accomplished, regular review is required at every level of the development process.

For the project to be successful, collaboration with the entire supply chain is essential. Most importantly, the design team but also investors, and future residents.

This is reflected in the conceptual framework, which analyses data, translates barriers into opportunities, and groups them into sub-categories according to factors including direct and indirect influence, stakeholders, activities, and development phases.

The case studies have shown several barriers to carbon net-zero urban area developments that can be translated into opportunities for developers. As from the literature, practitioners confirm the feasibility of carbon net-zero developments within the business case, knowledge, user preferences, and laws and regulations as barriers. In addition, practice shows that the accumulation of requirements and regulations, certain project choices by the municipality, materials and equipment, dependency, availability, materials, collaboration, project level, and sites that are not suitable are also barriers experienced.

Influencing carbon offsets can be done by implementing specific measures. These include reusing existing buildings, selecting sustainable materials, planting trees, creating picking forests for local communities and establishing algae farms. Additionally, developing mobility plans to reduce car usage and providing financial support to help locals green their gardens and assist farmers in reducing their carbon footprint are effective strategies.

Developers could translate indirect and direct influenceable barriers into opportunities and thereby influence each phase with the necessary parties and the necessary tool. By using this framework, developers can contribute to carbon net-zero urban area developments. It provides a structured approach to navigate complexities and maximize impact, resulting in a greener future with less carbon.

Recommendations

For practice

Sharing knowledge about sustainability and carbon net-zero

Since we observe that there is a lack of knowledge about sustainability and carbon net-zero, it is important to continue to share knowledge on sustainability within the own team and the design team. To be able to incorporate strategic thinking a little bit more into the design process, it is good to broaden your knowledge. The more technical and fundamental your knowledge is, the sooner the developer may incorporate carbon net-zero as a core component during the initiative phase.

Involving an urban planner

Since the surrounding area is very important for carbon offsetting, it would be valuable for each case to also involve an urban planner in the study to look at the opportunities in the area for carbon offsetting.

Involve the municipality

Since the municipality is needed for offsetting possibilities in urban areas, it is important to involve them. Many barriers cannot be directly influenced because they require the municipality. Involving this party in the study can therefore provide new insights for carbon net-zero area developments.

Advice from a sustainability expert

Since the lack of knowledge is a barrier, involving a sustainability specialist in the study and also go into the actual offsetting figures can be valuable. Because there is also a lot of uncertainty about the actual numbers to be offset, this can be useful.

Change manager

Work with a change manager to ensure that everyone becomes aware of the goals to be achieved and that the steps towards this process are also achieved

For further research

Case selection based on location

Selecting cases based on location could be a good starting point for follow-up research because offsetting opportunities are mainly linked to available space in the development area. A cross-case analysis for cases situated in different locations in the Netherlands might provide new insights.

Carbon net-zero building as a baseline

In the future, if more carbon net-zero buildings are developed, it could be viewed from these buildings. Here you will then know exactly how many carbon emissions need to be offset, and have a little more clarity on how that can then be translated into offsetting opportunities

Research worldwide

Research carbon net-zero offsetting possibilities in other countries that are also high emitters, such as Germany and England. This is because they have slightly more public space.

Influence economic barriers

Based on the research, economic barriers can only be influenced indirectly. But economic barriers can influence design because, for example, certain carbon net-zero solutions are not economically feasible. The question then is to what extent can developers still directly influence economic barriers? In principle, the influence of developers on economic barriers remains indirect, because developers cannot bring about change themselves, but often an intermediary is needed to convert the barrier into opportunities. Many of these economic barriers are also related to politics, requiring government and municipalities. However, a developer's design choice may have a direct impact on economic policy in politics because the government does want to achieve Paris Proof goals. If the developer does not meet the Paris Proof goals, it could mean that the government takes direct action to work on the barriers so developers can get to work developing carbon net-zero area developments. It would therefore be interesting to investigate the extent to which economic barriers are indirectly or directly influenced by the design choices of developers.

Reflection

During the master track Management in the Built Environment, the focus is on managing the urban development and construction process by guiding all stakeholders to obtain high-quality and financially beneficial developments. This is done by managing the process at the object level and the supply level. My interest is in complexity and managing all stakeholders. Where the perspective of a developer is then central. Besides, the climate is changing and my generation will face this. The best thing for me was combining these two subjects, which would allow me to learn a lot from the complexity of managing the process but at the same time introduce me to the threats of climate change and how developers deal with this.

The question I have answered was: ‘’What can developers do to influence carbon offsets in the development areas in the Netherlands?’’. Before, I mentioned the combination of the complexity of all stakeholders and the changing environment. It is already in the word 'changing', right now the changes in terms of sustainability and carbon net-zero are going so fast, that sometimes it is hard to keep up with innovations or new rules. That also makes research interesting, last year I had very many times when I opened the news and could use the first article I came across for my graduation. New insights every time, that's what makes it interesting. And with that, it is also good to think, about where I draw the line. There is constantly so much new information you want to include in your research, but this is not possible. Constantly thinking about relevance has therefore been a recurring theme for me.

My graduate internship at Dev_ real estate helped me get relevant cases and in the process also helped me connect with developers involved in the projects. From theory to empirics, it was very important for me to properly describe and visualise the concept of carbon net-zero urban area developments. This is because no one knows what it is, and it does matter that everyone has a clear understanding of exactly what it means. This allowed me to clearly explain to the interviewees what is meant by it, which ensured that interviewees with background knowledge of carbon net-zero and sustainability also provided a lot of valuable input to my research. It only becomes clear in retrospect how much a visualisation of your idea can help a lot with the research.

On the other hand, the design also gave me other insights into my research. It emerged from the results that carbon offsetting goes hand-in-hand with carbon reduction. I knew this was related and that reduction makes for less offsetting, but this was not addressed this way from the first step. As mentioned in my recommendations, it would be valuable to also look at carbon offsets from the reduction perspective.

As explained in the introduction, we in the Netherlands want to participate in the Paris Proof Agreement. The clock is ticking; there are only a little over 26 years left to reduce CO_2 emissions everywhere. This also applies to construction, and this is where developers can contribute. My graduation research focuses on this issue, including how developers can influence it so that a better world can be created as soon as possible.

Due in part to the fact that laws and regulations vary from country to country, this research concentrates on the Dutch market and applies to all Dutch developers. However, the basis has been done for global research. The results can certainly be transferred to all developers in the Netherlands. In other countries, it depends on laws and regulations. Moreover, my graduation company also indicated that my conceptual framework could also be used for a different interpretation. For instance, it could also be used to visualise a different process, linked to stakeholders and design phases.

Method

In the beginning, it was a bit of a search as to which method I would use for this research. What was quickly clear was that I wanted to use case studies because the subject was quite new and there was hardly any data yet. However, there are no cases where carbon net-zero area developments apply. Weighing up internationally or within the Netherlands, or still looking at carbon net-zero buildings (of which hardly any have been built). From various options, I chose cases where circularity and BENG are already included in the project, but where carbon emissions are not yet zero. I did this so that developers do have an idea of 'what is left to offset'. And I think it worked out, this method ensured that developers started thinking in terms of possibilities, came up with new ideas, and became aware of the carbon emissions that need to be compensated. Also, the Netherlands was the best option because I found out that all the laws and regulations are so specific per country and that space also differs per country for any carbon offsetting making international comparison simply more difficult for thesis research.

Semi-structured interviews also worked well for my research. This ensured that interviewees were free to digress when asked questions, and I also really got the tone of the answers right which allowed me to know how an answer should be interpreted.

At the beginning of the research, it was a bit of a search for how the interview results should be grouped. This was first done using comparisons with theory, and placing results that could be placed in a category there. However, not everything can be placed in the same category, so we decided to code the results. This coding was done based on subjects arising from the theory. This made the research replicable. Almost all of the barriers could be overtly linked to a particular code. However, with political and legal there was sometimes some confusion with certificates and regulations, as these are closely related and often connected.

Most of the feedback on my research was about how exactly I was going to approach the research, which ended up making me critically examine many ways, what is or is not useful to do, and why.

Process

I enjoyed the graduation process. Also thanks to my mentors and my graduation company.

In the beginning, it was mainly searching for 'Where does my topic end'. You want to research all kinds of things in the first weeks of graduation and eventually find out that you can only research a minuscule part because you only have limited time. That demarcation was difficult in the beginning, but my lecturers helped a lot with that. In addition, it helped a lot that I was graduating from a company together with another graduate student. This way, we made 'normal' working weeks and I had good planning for each deadline that I could stick to.

Just before my P2, I was told that I would get a different second mentor after all, so I experienced this as stress at first, but both my tutors handled this super well and took the stress out of my hands, so I no longer had to worry and could continue with my graduation.

The theme meetings also helped me, so you knew where you had to be in terms of planning and you also got an insight into how others tackled it.

All in all, a successful year, very nice to be introduced to the practice and theory within graduation and I look back on a very educational, independent, and challenging period!

Blank page

REFERENCES

References

Allard, D. (2022, April 13). Hoe gebiedsontwikkelaars voor duurzame warmte zorgen. Retrieved November 21, 2022, from https://www.gebiedsontwikkeling.nu/artikelen/hoe-gebiedsontwikkelaars-voor-duurzame-warmte-zorgen/

Alsema, E. A. (2009, October). *Stevige ambities, Klare taal!* W/E Adviseurs.

Banken. (2020, January 8). ING's nieuwe hoofdkantoor Cedar is geopend. Retrieved March 28, 2023, from https://www.banken.nl/nieuws/22115/ings-nieuwe-hoofdkantoor-cedar-is-geopend

Bhandari, P. (2022, December 2). Ethical Considerations in Research | Types & Examples. Retrieved from https://www.scribbr.com/methodology/research-ethics/

Benda, B. (2021, October 21). Bouwmaterialen hebben flink aandeel in CO2-uitstoot (en dat aandeel groeit). Retrieved February 27, 2023, from https://www.universiteitleiden.nl/nieuws/2021/10/bouwmaterialen-hebben-flink-aandeel-in-co2-uitstoot-en-dat-aandeel-groeit

Berghe, K. van den, & Vos, M. (2019). Circular area design or circular area functioning? A discourse-institutional analysis of circular area developments in Amsterdam and Utrecht, The Netherlands. *Sustainability*, 11(18), 4875.

Blaikie, N., & Priest, J. (2019). *Designing Social Research: The Logic of Anticipation*. Hoboken, NJ, United States: Wiley.

Boanada-Fuchs, A., & Boanada-Fuchs, V. (2022, June). The role of real estate developers in urban development. *Elsevier*. Elsevier. Retrieved from https://doi.org/10.1016/j.geoforum.2022.05.009

Bossche, T. van den (2022, November 7). In stad van de toekomst wonen geen consumenten maar circulenten. Retrieved November 21, 2022, from https://www.gebiedsontwikkeling.nu/artikelen/in-stad-van-de-toekomst-wonen-geen-consumenten-maar-circulenten/

Brundtland, G. H. (1987). Our common future—Call for action. Environmental Conservation, 14(4), 291-294.

Candel, M., & Törnå, N. (2022). Housing developers' perceived barriers to implementing municipal sustainability requirements in Swedish sustainability-profiled districts. *Journal of Housing and the Built Environment*, 37(4), 1693-1721.

Catch Legal. (2021, April 1). Duurzaam bouwen als verplichting in een contract? Retrieved January 13, 2023, from https://www.catchlegal.nl/duurzaam-bouwen-als-verplichting-in-een-contract/

Chan, A. P. C., Darko, A., Olanipekun, A. O., & Ameyaw, E. E. (2018). Critical barriers to green building technologies adoption in developing countries: The case of Ghana. *Journal of cleaner production*, 172, 1067-1079.

Climeworks. (2023). Direct air capture technology. Retrieved February 28, 2023, from https://climeworks.com/direct-air-capture

CRREM. (2022, May 25). Decarbonisation Pathways. Retrieved September 28, 2022, from https://www.crrem.org/pathways/

Daamen, T. (2022, November 11). Gebiedsontwikkeling in tijden van (on)zekerheid. Retrieved November 21, 2022, from https://www.gebiedsontwikkeling.nu/artikelen/gebiedsontwikkeling-in-tijden-van-onzekerheid/

Darko, A., & Chan, A. P. (2017). Review of barriers to green building adoption. Sustainable Development, 25(3), 167-179.

Deloitte (2010). Schuivende panelen: Een visie op gebiedsontwikkeling. Utrecht: Deloitte Real Estate Advisory & Praktijkleerstoel Gebiedsontwikkeling TU Delft.

Delve. (n.d.). Essential Guide to Coding Qualitative Data. Retrieved May 30, 2023, from https://delvetool.com/guide

Döringer, S. (2021). 'The problem-centred expert interview'. Combining qualitative interviewing approaches for investigating implicit expert knowledge. *International Journal of Social Research Methodology*, 24(3), 265–278. https://doi.org/10.1080/13645579.2020.1766777

Dutch Green Building Council [DGBC]. (2021, September). Whole life in carbon. *DGBC*. Retrieved from https://www.dgbc.nl/upload/files/Publicaties/circulariteit/Position%20Paper%20Whole%20Life%20Carbon%20-%20DGBC.pdf

Fan, K., & Hui, E. C. (2020). Evolutionary game theory analysis for understanding the decision-making mechanisms of governments and developers on green building incentives. *Building and Environment*, 179, 106972.

Gemeente Amsterdam. (2020, October). *Samenvatting Concept Omgevingseffectrapport Schinkelkwartier*.

Gemeente Amsterdam. (2021, June). *Visie Amsterdam Zuidoost Energieneutraal 2040: Uitgave 2*. Retrieved from https://openresearch.amsterdam/nl/page/72690/visie-amsterdam-zuidoost-energieneutraal-2040---editie-2021

Gemeente Amsterdam. (2023a). Kernwaarden. Retrieved March 29, 2023, from https://amsterdam.nl/stijlweb/huisstijl/kernwaarden/#:~:text=De%20kernwaarden%20van%20de%20gemeente,%3A%20actief%2C%20open%20en%20integer.

Gemeente Amsterdam. (2023b, January 5). Organisatie. Retrieved April 3, 2023, from https://www.amsterdam.nl/bestuur-organisatie/organisatie/

Gemeente Amsterdam. (n.d.). ING Cedar, bouw nieuw kantoor en paviljoen. Retrieved March 28, 2023, from https://www.amsterdam.nl/projecten/arenapoort/afgerond/ing-cedar/

Gemeente Rijswijk. (2019, May). *Havenkwartier Rijswijk: Ruimtelijk kader Havengebied Plaspoelpolder*. Studio Hartzema.

Gemeente Rijswijk. (2021, May). Vertrouwd stedelijk wonen in Rijswijk. *Rijswijk*. Retrieved from https://www.rijswijk.nl/sites/default/files/2023-01/actualisatie_woonvisie_2015-2025.pdf

Gemeente Rijswijk. (2023a). Harbourpark. Retrieved March 6, 2023, from https://www.ruimtelijkeplannen.nl/documents/NL.IMRO.0603.bpHarbourpark-ON01/t_NL.IMRO.0603.bpHarbourpark-ON01.html#_4.14_Duurzaamheidenklimaatadaptatie

Gemeente Rijswijk. (2023b). Harbourpark – Havenkwartier Rijswijk. Retrieved March 6, 2023, from https://havenkwartier.nl/Harbourpark/

Gemeente Rijswijk. (n.d.). Retrieved April 19, 2023, from https://www.rijswijk.nl/over-de-organisatie

Glass, J., Dainty, A. R., & Gibb, A. G. (2008). New build: materials, techniques, skills and innovation. *Energy Policy*, 36(12), 4534–4538.

Grainger, G. (2022, November 7). To create net-zero cities, we need to look hard at our older buildings. Retrieved November 21, 2022, from https://www.us.jll.com/en/views/to-create-net-zero-cities?utm_source=linkedin

Greenpeace Nederland. (2022, May 31). Het probleem: klimaatverandering. Retrieved September 20, 2022, from https://www.greenpeace.org/nl/oplossingen/klimaatverandering/het-probleem-klimaatverandering/

Griendt, B. van de. (2022). *Het ABC van ESG voor vastgoedprofessionals* (1st ed.). Spryg Real Estate Academy.

Gustafsson, J. (2017). Single case studies vs. multiple case studies: A comparative study.

Häkkinen, T., & Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research & Information*, 39(3), 239-255.

Hepburn, C., Qi, Y., Stern, N., Ward, B., Xie, C., & Zenghelis, D. (2021). Towards carbon neutrality and China's 14th Five-Year Plan: Clean energy transition, sustainable urban development, and investment priorities. *Environmental Science and Ecotechnology*, 8, 100130.

Heijer, A. den, Voordt, D. van der, Heurkens, E. & Sturm, C. (2013). *Vastgoedmanagement & gebiedsontwikkeling. BK6MA3 – Beheer en Herontwikkeling*. Technische Universiteit Delft. P.7

Heurkens, E. (2012). *Private Sector-Led Urban Development Projects: Management, Partnerships and Effects in the Netherlands and the UK*. Zaltbommel, Netherlands: Van Haren Publishing.

Heurkens, E. (2020a, January 2). Zo spelen private partijen een rol in duurzame stedelijke ontwikkeling. Retrieved September 15, 2022, from https://www.gebiedsontwikkeling.nu/artikelen/de-rol-van-private-partijen-duurzame-stedelijke-ontwikkeling/

Heurkens, E. (2020b). Real Estate Developers [Slide show] [TU Delft].

Heurkens, E. (2023). Case studies als onderzoeksmethode [Slide show] [TU Delft].

Hoffman, A. J., & Henn, R. (2008). Overcoming the social and psychological barriers to green building. *Organization & Environment*, 21(4), 390-419.

Hoornstra, A. (2021, August 16). CO2-negatieve gebiedsontwikkeling met de best beschikbare techniek. Retrieved November 21, 2022, from https://www.gebiedsontwikkeling.nu/artikelen/co2-negatieve-gebiedsontwikkeling-met-de-best-beschikbare-techniek/

Hopff, B., Nijhuis, S., & Verhoef, L. A. (2019). New dimensions for circularity on campus—framework for the application of circular principles in campus development. *Sustainability*, 11(3), 627.

International Energy Agency. (2021). Buildings A source of enormous untapped efficiency potential. Retrieved September 20, 2022, from https://www.iea.org/topics/buildings

Jong, M. de (2022, March 2). Vier vragen over 'direct air capture.' Retrieved February 28, 2023, from https://www.vpro.nl/programmas/tegenlicht/lees/artikelen/2022/vier-vragen-over-dac.html

KLM. (2022). Duurzaamheid. Retrieved November 24, 2022, from https://www.klm.nl/information/sustainability

Krusenvik, L. (2016). Using case studies as a scientific method: Advantages and disadvantages.

Lazet, R. & de Vries, S. (2019, October 14). Nieuw duurzaam hoofdkantoor ING nadert voltooiing. Retrieved March 29, 2023, from https://www.banken.nl/nieuws/21955/nieuw-duurzaam-hoofdkantoor-ing-nadert-voltooiing

Leeuw, A.C.J. de (2002). Bedrijfskundig Management: Primair Proces, Strategie en Organisatie. Assen: Koninklijke van Gorcum.

Lützkendorf, T., & Frischknecht, R. (2020). (Net-) zero-emission buildings: a typology of terms and definitions. Buildings and Cities, 1(1).

McIntosh, M. J., & Morse, J. M. (2015). Situating and constructing diversity in semi-structured interviews. *Global qualitative nursing research*, 2, 2333393615597674.

Meadows, D. L., & Club van Rome. (1972). *Rapport van de club van rome : de grenzen aan de groei* (Ser. Aula-boeken, 500). Het Spectrum.

Milieu Centraal. (n.d.). CO2-compensatie: klimaatimpact compenseren. Retrieved from https://www.milieucentraal.nl/klimaat-en-aarde/klimaatverandering/co2-compensatie/

Ministerie van Algemene Zaken. (2016, October 18). Is duurzaam bouwen duurder? Retrieved September 22, 2022, from https://www.rijksoverheid.nl/onderwerpen/duurzaam-bouwen-en-verbouwen/vraag-en-antwoord/is-duurzaam-bouwen-duurder

Ministerie van Algemene Zaken. (2022a, February 14). Klimaat en energie. Retrieved from https://www.rijksoverheid.nl/regering/coalitieakkoord-omzien-naar-elkaar-vooruitkijken-naar-de-toekomst/2.-duurzaam-land/klimaat-en-energie

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2021, July). Aanbieding Rapport Staat van de Woningmarkt 2021 (2021–0000348782). *Rijksoverheid*. Rijksoverheid. Retrieved from https://open.overheid.nl/repository/ronl-60430922-d774-4f5b-9914-4f3597f8d4f7/1/pdf/aanbieding-rapport-staat-van-de-woningmarkt-2021.pdf

Ministerie van Economische Zaken, Landbouw en Innovatie. (2020, January 22). Wat is het Klimaatakkoord? Retrieved September 22, 2022, from https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatakkoord/wat-is-het-klimaatakkoord

Ministerie van Infrastructuur en Waterstaat. (2022, June 23). Kabinet investeert 1,2 miljard in infrastructuur voor het sneller bouwen van 135.000 nieuwe woningen. Retrieved September 22, 2022, from https://www.rijksoverheid.nl/actueel/nieuws/2022/06/23/kabinet-investeert-12-miljard-in-infrastructuur-voor-het-sneller-bouwen-van-135.000-nieuwe-woningen

Muis, R. (2020a, January 8). Nieuw kantoorgebouw ING gericht op openheid en verbinding. Retrieved March 28, 2023, from https://architectenweb.nl/nieuws/artikel.aspx?ID=46999

Muis, R. (2020b, January 9). Park rond ING-kantoor Cedar als stedelijke tuin. Retrieved March 28, 2023, from https://architectenweb.nl/nieuws/artikel.aspx?ID=47006

NOS. (2022, October 27). VN: plannen tegen opwarming van de aarde nog altijd onvoldoende. Retrieved October 27, 2022, from https://nos.nl/collectie/13871/artikel/2449961-vn-plannen-tegen-opwarming-van-de-aarde-nog-altijd-onvoldoende

Ohene, E., Chan, A. P., & Darko, A. (2022). Prioritizing barriers and developing mitigation strategies toward net-zero carbon building sector. *Building and Environment*, 109437.

Pan, W., & Maxey, L. (2013). Challenges and opportunities of low or zero carbon building: prospects of business models. *Proceedings of the 19th CIB world building congress*

Pan, W., & Pan, M. (2021). Drivers, barriers and strategies for zero carbon buildings in high-rise high-density cities. *Energy and Buildings*, 242, 110970.

Parkin, S. (2000, November). Contexts and drivers for operationalizing sustainable development. In Proceedings of the institution of civil engineers-civil engineering (Vol. 138, No. 6, pp. 9-15). Thomas Telford Ltd.

Powerhouse Company. (2022, April 22). Powerhouse Company - Floating Office Rotterdam (FOR). Retrieved November 24, 2022, from https://www.powerhouse-company.com/floating-office-rotterdam

Putman, M. (2010). Een nieuwe ontwikkelaar?: Een toekomstperspectief voor de projectontwikkelaar in gebiedsontwikkeling (Thesis). Rotterdam: Master City Developer.

Randeraat, G. van, Versteijlen, L., Veen, J. de, & Graaf, K. de (2022, May). Versnellen voorfase gebiedsontwikkelingen: hoe dan? *Rijksoverheid*. Rijksoverheid. Retrieved from https://www.rijksoverheid.nl/documenten/rapporten/2022/05/02/versnellen-voorfase-gebiedsontwikkelingen-hoe-dan

Rechtbank Noord Nederland. (2020, December 14). ECLI:NL:RBNNE:2020:4348. Retrieved January 13, 2023, from https://uitspraken.rechtspraak.nl/#!/details?id=ECLI:NL:RBNNE:2020:4348

Ridge. (n.d.). Retrieved from https://www.ridge.nl/page-over-ridge/over-ridge

Rijksoverheid. (2019, June). *Klimaatakkoord*. Author. Retrieved from https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatakkoord/wat-is-het-klimaatakkoord

RVO. (2014, November). Infoblad Energieneutraal bouwen: definitie en ambitie. *RVO*. RVO. Retrieved from https://www.rvo.nl/sites/default/files/Infoblad%20Energieneutraal%20bouwen%20Definitie%20en%20ambitie%20april%202013.pdf

RVO. (2021, October 11). MilieuPrestatie Gebouwen - MPG. Retrieved December 8, 2022, from https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/milieuprestatie-gebouwen-mpg

RVO. (2022a, August 17). Bouwbesluit. Retrieved December 8, 2022, from https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/bouwbesluit

RVO. (2022b, September 21). Energieprestatie - BENG. Retrieved September 28, 2022, from https://www.rvo.nl/onderwerpen/wetten-en-regels-gebouwen/beng#energieprestatie-indicatoren---beng

Sante, M. van (2022, July 11). Woningbouw: Gestegen nieuwbouwprijzen vooral gunstig voor grondbezitter en projectontwikkelaar. Retrieved September 22, 2022, from https://www.ing.nl/zakelijk/kennis-over-de-economie/uw-sector/outlook/woningbouw.html

Schramm, W. (1971, December). Notes on case studies of instructional media projects. Working paper for the Academy for Educational Development, Washington, DC.

$SeaO_2$. (2023). $SeaO_2$. Retrieved February 28, 2023, from https://www.sea02.nl/technology

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for information*, 22(2), 63-75.

Sturm, C., Heurkens, E., & Bol, N. (2014, June). Lessen van binnenstedelijke herontwikkeling in de V.S.. *Real Estate Research Quarterly*.

Synchroon. (2022, September 12). 4. CO2 Reductie. Retrieved from https://synchroon.nl/circulair/co2-reductie/

TED. (2020, October 13). *What is net-zero? | Kristen Bell + Giant Ant* [Video]. Retrieved from https://www.youtube.com/watch?v=QPmUAfuqM08

Tillie, N., Van Den Dobbelsteen, A., Doepel, D., Joubert, M., De Jager, W., Mayenburg, D; Towards CO2 Neutral Urban Planning: Presenting the Rotterdam Energy Approach and Planning (REAP). *Journal of Green Building* 1 August 2009; 4 (3): 103–112. doi: https://doi.org/10.3992/jgb.4.3.103

UN Global Compact. (2021, December 17). Sustainable Development Goals. Retrieved September 22, 2022, from https://gcnetherlands.nl/sdgs/

United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. *United Nations Department of Economic and Social Affairs.* Retrieved from https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

University of Oxford. (2020, September). The Oxford Principles for Net Zero Aligned Carbon Offsetting. *University of Oxford.* Retrieved from https://www.smithschool.ox.ac.uk/sites/default/files/2022-01/Oxford-Offsetting-Principles-2020.pdf

Vermaas, D. (2022, December 27). CO2 uit de lucht halen: een greep uit de meest effectieve methoden. Retrieved February 28, 2023, from https://www.nporadio1.nl/nieuws/wetenschap-techniek/69855815-28a7-485d-9269-9202a82d0355/co2-uit-de-lucht-halen-een-greep-uit-de-meest-effectieve-methoden

Vrieling, A. (2022, April 21). Wat is CO2-neutraal? | Alles wat je moet weten in 2020. Retrieved September 30, 2022, from https://nlco2neutraal.nl/wat-is-co2-neutraal/

Wilkinson, M. D., Dumontier, M., Aalbersberg, Ij. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.-W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., ... Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data, 3, 160018. https://doi.org/10.1038/sdata.2016.18

Wimbadi, R. W., & Djalante, R. (2020, February). *From decarbonization to low carbon development and transition: A systematic literature review of the conceptualization of moving toward net-zero carbon dioxide emission (1995-2019)*. Elsevier. Retrieved from https://doi.org/10.1016/j.jclepro.2020.120307

Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5). sage.

Yin, R. K., & Davis, D. (2007). Adding new dimensions to case study evaluations: The case of evaluating comprehensive reforms. In G. Julnes & D. J. Rog (Eds.), Informing federal policies for evaluation methodology (New Directions in Program Evaluation, No. 113, pp. 75–93). San Francisco: Jossey-Bass.

Zadelhoff, Slotervaart, & NEXT Architects. (2021, November). Masterplan CVZ Slotervaart.

Zeeuw, W.T.C.F. de (2007). De engel uit het marmer: Reflecties op gebiedsontwikkeling. Delft: Praktijkleerstoel TU Delft.

Zeeuw, W.T.C.F. de (2018). *Zo werkt gebiedsontwikkeling* (Tweede druk). NPN Drukkers Breda.

Zhao, X., Pan, W., & Lu, W. (2016). Business model innovation for delivering zero carbon buildings. *Sustainable cities and society*, 27, 253-262.

Blank page

APPENDIX

A1 - Interview protocol

Voorafgaande het interview

- ☐ Uitnodiging interview verzonden
- ☐ Formulier geïnformeerde toestemming getekend
- ☐ Tijd, locatie (evt. teamslink) verzonden
- ☐ Teams en opname apparatuur klaarzetten

Start interview

- ☐ Bedanken meewerken interview
- ☐ Controle geïnformeerde toestemming
- ☐ Wijzen op opnemen interview en opnieuw toestemming vragen ter controle
- ☐ Aanzetten teams en back-up apparaat geluidsopname
- ☐ Korte introductie onderzoeker en onderzoek

Checklist na afloop interview

- ☐ Vragen of de geïnterviewde nog iets kwijt wilt of vragen heeft
- ☐ Procedure validatie kort toelichten
- ☐ Laten weten dat de scriptie gedeeld kan worden indien gewenst
- ☐ Bedank mail sturen met het transcript

Interview categorieën

Introductie

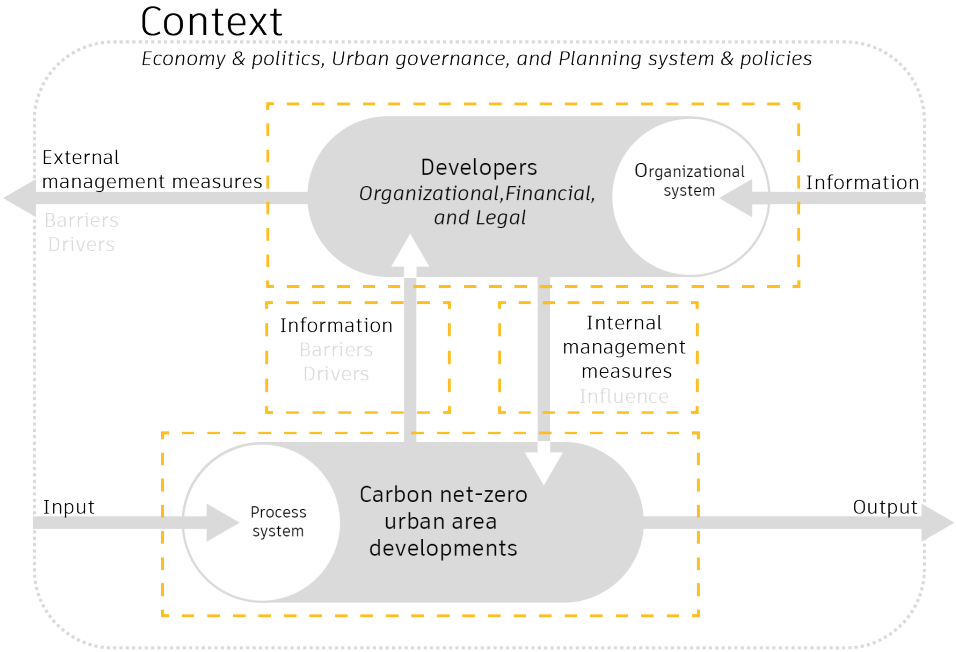
Het interview is opgedeeld in vier verschillende categorieën. Deze categorieën zijn gekoppeld aan het conceptuele sturingsmodel gebaseerd op Heurkens (2012).

Deel 1 – Developers

Deel 2 – Huidige status, barrières en drivers van CO_2 neutraal ontwikkelen

Deel 3 – Invloed van ontwikkelaars op het CO_2 neutraal ontwikkelen

Deel 4 – Kansen in het stedelijk gebied om CO_2 neutraal te ontwikkelen

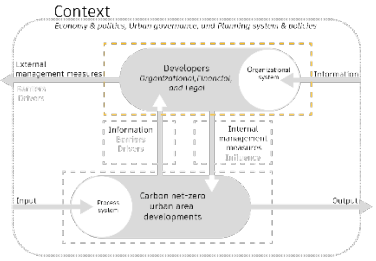


Deel 0 – Introductie interview

Goedemorgen, allereerst wil ik u alvast bedanken voor het meewerken aan dit interview. Graag zou ik nogmaals willen vragen of u instemt met het opnemen van dit interview? Voordat ik beginnen met het interview, ik mijzelf even voorstellen. Ik ben Daphne Bedeaux en ben op dit moment bezig met het afronden van de master Management in the Built Environment aan de TU Delft.

Mijn afstudeeronderzoek gaat over wat ontwikkelaars kunnen doen om ervoor te zorgen dat gebiedsontwikkelingen in Nederland CO_2 neutraal worden. Op dit moment zijn er in Nederland nog geen CO_2 neutrale gebiedsontwikkelingen. Het is daarom van belang voor dit onderzoek om goed in beeld te hebben wat een CO_2 neutrale gebiedsontwikkeling inhoudt. Dit komt in het eerste deel van het interview ter sprake. Het doel van mijn afstudeeronderzoek is om een conceptueel framework te ontwikkelen voor ontwikkelaars die gebruikt kan worden om invloed uit te oefenen op CO_2 neutrale gebiedsontwikkelingen in Nederland.

Het interview zal niet langer dan een uur zal duren. Gedurende deze tijd heb ik voor het interview een aantal vragen opgesteld met betrekking tot het afstudeeronderzoek. Mocht u hier extra informatie aan toe willen voegen dan hoor ik dat graag tijdens het interview. Wanneer we in tijdsnood komen, dan zou het kunnen zijn dat ik u zal sturen op het kort houden van uw antwoord. Zijn er verder nog vragen voorafgaande de start van het interview? Zo niet, dan kunnen we beginnen.



Deel 1 - Developers

1) **Kunt u iets over uzelf vertellen, wie bent u en wat is uw huidige functie?**

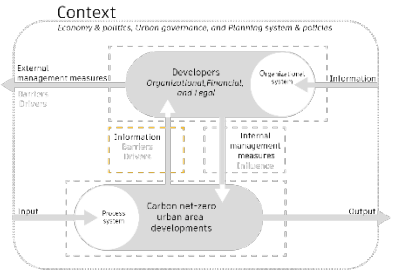
2) **Bij wat voor een type ontwikkelaar bent u werkzaam?**
    a. Welke kenmerken horen volgens u bij het type ontwikkelaar waar u werkzaam bent?

3) **In hoeverre is duurzaamheid opgenomen in de bedrijfsstrategie van uw bedrijf?**

4) **Hoe wordt er binnen het bedrijf omgegaan met gestelde duurzaamheidseisen vanuit de gemeente voor een ontwikkeling?**

Nederland heeft er mee ingestemd om zich in te zetten om in 2050 de doelen van het Parijs Akkoord te behalen. Dit houdt in dat de CO_2 uitstoot met 95% teruggedrongen moet worden ten opzichte van de huidige uitstoot.

5) **Hoe ziet u uw rol als ontwikkelaar bij het behalen van de doelen van het Parijs Akkoord voor 2050?**

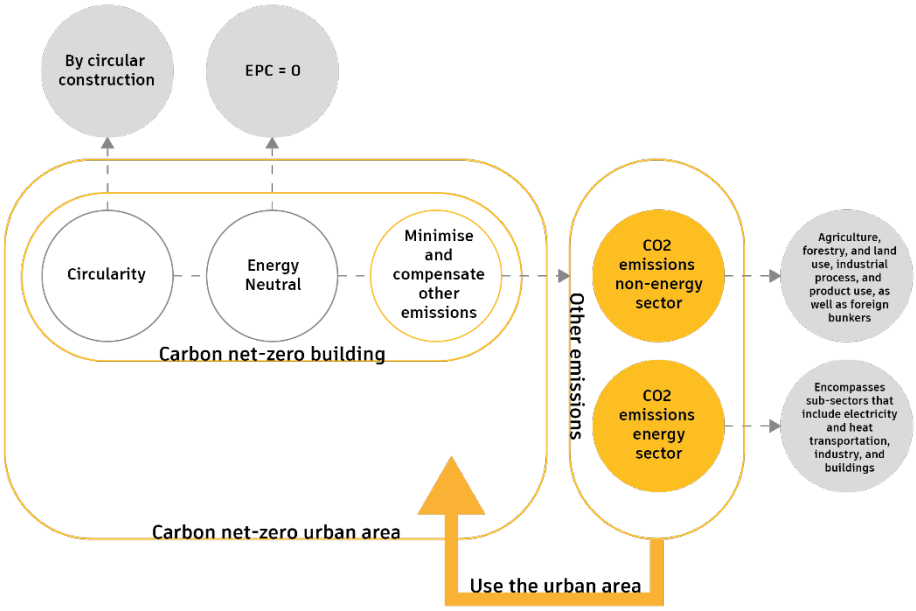


Deel 2 - Barrières en drivers

6) Wat verstaat u onder CO_2 neutraal ontwikkelen?

7) Wat verstaat u onder CO_2 neutrale gebiedsontwikkelingen?

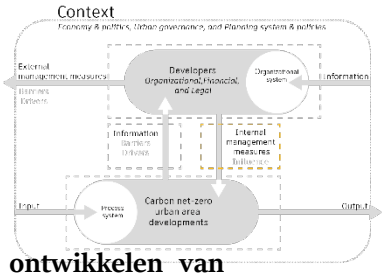
Om beter te begrijpen wat CO_2 neutrale gebiedsontwikkelingen zijn heb ik een figuur ontwikkeld waarbij duidelijk gemaakt wordt wat dit precies is. Het begint bij een gebouw, om CO_2 neutraal te ontwikkelen moet een gebouw (bijna) energie neutraal zijn en circulariteit meegenomen hebben in het ontwerp om zo min mogelijk CO_2 uit te stoten. Echter blijft er altijd een hoeveelheid CO_2 uitstoot over wat dan gecompenseerd kan worden om de CO_2 uitstoot naar netto nul terug te dringen. Deze CO_2 uitstoot kan wellicht gecompenseerd worden in het omliggende gebied, wat dan zal zorgen voor een CO_2 neutrale gebiedsontwikkeling.



8) Er zijn verschillende barrières op politiek, economische, sociaal, technologisch, milieu en juridisch vlak om CO_2 neutraal te ontwikkelen. Welke barrières ervaart u vanuit het perspectief van de ontwikkelaar?

9) Naast barrières zijn er ook drijfveren op deze vlakken voor ontwikkelaars om CO_2 neutraal te ontwikkelen. Welke drijfveren ervaart u?

Deel 3 - Invloed van ontwikkelaars



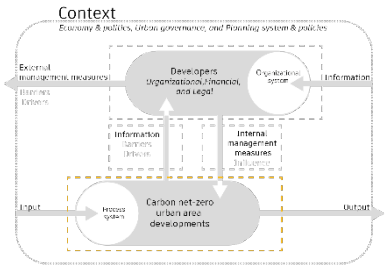
10) Hoe hebben ontwikkelaars volgens u invloed op het CO_2 neutraal ontwikkelen van projecten in Nederland?

11) Welke partijen zijn daarbij onmisbaar in het proces om CO_2 neutraal ontwikkelen?

12) In welke fase van een ontwikkelproject zou een ontwikkelaar de meeste sturing kunnen geven naar CO_2 neutraliteit?

13) De gemeente stelt verschillende eisen voor duurzame gebouwen en geeft onder andere subsidies uit voor duurzame oplossingen in de bouwsector. Hoe ziet u de rol van de gemeente in de ontwikkeling bij het bereiken van het Parijs Akkoord voor 2050?

a. Hebben ontwikkelaars de gemeente nodig om CO_2 neutrale gebiedsontwikkelingen te bereiken?



Deel 4 - Kansen stedelijk gebied

Op dit moment wordt CO_2 vaak gecompenseerd door financieel bij te dragen aan het planten van een bos in bijvoorbeeld Afrika. Echter speelt Nederland een grote rol in de CO_2 uitstoot in Europa en wereldwijd.

14) Zoals toegelicht in het eerste deel van het interview zou het ontwikkelgebied kunnen dienen als mogelijkheid voor CO_2 compensatie. Hoe kijkt u hier tegenaan?

15) Op welke manieren zou volgens u CO_2 gecompenseerd kunnen worden in het ontwikkelgebied en wat is daar voor nodig?

16) Welke partijen zijn volgens u cruciaal om er voor te zorgen dat het stedelijke gebied gebruikt kan worden om CO_2 te compenseren?

In de Noordzee wordt CO_2 voor honderden jaren onder de grond opgeslagen op plaatsen waar olie en gas uit de grond is gehaald. De CO_2 wordt vervoerd via ondergrondse netwerken via o.a. Rotterdam naar de zee.

17) **Hoe kijkt u naar het samenwerken met partijen uit de industrie of andere sectoren om de doelen van het Parijs Akkoord van 2050 te behalen?**

Deel 5 – Afsluiting interview

Ik denk dat de belangrijkste vragen behandeld zijn, heeft u zelf nog verdere opmerkingen die ik zou kunnen gebruiken voor het onderzoek? Graag wil ik u van harte bedanken voor uw tijd en de medewerking aan het onderzoek. Alle gegevens worden geanonimiseerd. Mocht u nog verdere vragen hebben dan kunt u mij per mail bereiken. Daarnaast zal ik het transcript van het interview naar u mailen. Mocht er iets niet juist zijn, dan heeft u de kans om dit aan te geven zodat dit gewijzigd kan worden. Ook zal ik na afloop van het afstudeeronderzoek, indien gewenst, de thesis naar u versturen.

A2 – Informed Consent

Naam van het onderzoeksproject	CO2 neutrale gebiedsontwikkelingen in Nederland
Doel van het onderzoek	Dit onderzoek wordt geleid door Daphne Bedeaux. U bent van harte uitgenodigd om deel te nemen aan dit onderzoek. Het doel van dit onderzoek is om een framework te ontwikkelen voor ontwikkelaars die gebruikt kan worden om te sturen op CO_2 neutrale gebiedsontwikkelingen in Nederland.
Gang van zaken tijdens het onderzoek	U neemt deel aan een interview waarin aan u vragen zullen worden gesteld over CO_2 neutrale gebiedsontwikkelingen en de rol van de ontwikkelaar hierbij. U dient tenminste 18 jaar te zijn om deel te nemen aan dit onderzoek. Van het interview zal een audio-opname worden gemaakt, zodat het gesprek later ad-verbum (woord voor woord) kan worden uitgewerkt. Dit transcript wordt vervolgend gebruikt in het verdere onderzoek.
Potentiële risico's en ongemakken	Er zijn geen fysieke, juridische of economische risico's verbonden aan uw deelname aan deze studie. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. Uw deelname is vrijwillig en u kunt uw deelname op elk gewenst moment stoppen.
Vertrouwelijkheid van gegevens	Uw privacy is en blijft maximaal beschermd. Er wordt op geen enkele wijze vertrouwelijke informatie of persoonsgegevens van of over u naar buiten gebracht, waardoor iemand u zal kunnen herkennen. Voordat onze onderzoeksgegevens naar buiten gebracht worden, worden uw gegevens **anoniem** gemaakt: geanonimiseerd. Enkele eenvoudige voorbeelden hiervan: - uw naam wordt vervangen door anonieme, op zichzelf betekenisloze combinatie van getallen. - uw leeftijd zelf wordt niet verwerkt, maar in een categorie geplaatst. Bijvoorbeeld: leeftijd: tussen 18-25 jaar / tussen 25-35 jaar etc. - uw woonplaats wordt niet gebruikt, maar de provincie waarin u woont. In een publicatie zullen of anonieme gegevens of pseudoniemen worden gebruikt. De audio-opnamen, formulieren en andere documenten die in het kader van deze studie worden gemaakt of verzameld, worden opgeslagen op een beveiligde locatie bij de TU Delft en op de beveiligde (versleutelde) computers van de onderzoekers. De onderzoeksgegevens worden indien nodig (bijvoorbeeld voor een controle op wetenschappelijke integriteit) en alleen in anonieme vorm ter beschikking gesteld aan personen buiten dit onderzoek.

Vrijwilligheid

Deelname aan dit onderzoek is geheel vrijwillig. Je kunt als deelnemer jouw medewerking aan het onderzoek te allen tijde stoppen, of weigeren dat jouw gegevens voor het onderzoek mogen worden gebruikt, zonder opgaaf van redenen.

Dit betekent dat als je voorafgaand aan het onderzoek besluit om af te zien van deelname aan dit onderzoek, dit dit op geen enkele wijze gevolgen voor jou zal hebben. Tevens kun je tot 5 werkdagen (bedenktijd) na het interview alsnog de toestemming intrekken die je hebt gegeven om gebruik te maken van jouw gegevens.

In deze gevallen zullen jouw gegevens uit onze bestanden worden verwijderd en vernietigd. Het stopzetten van deelname heeft geen nadelige gevolgen voor jou of de eventueel reeds ontvangen vergoeding.

Als je tijdens het onderzoek, na de bedenktijd van 5 werkdagen, besluit om jouw medewerking te staken, zal dat eveneens op geen enkele wijze gevolgen voor je hebben. Echter: de gegevens die u hebt verstrekt tot aan het moment waarop uw deelname stopt, zal in het onderzoek gebruikt worden, inclusief de bescherming van uw privacy zoals hierboven beschreven. Er worden uiteraard geen nieuwe gegevens verzameld of gebruikt.

Als u besluit om te stoppen met deelname aan het onderzoek, of als u vragen of klachten heeft, of uw bezorgdheid kenbaar wilt maken, of een vorm van schade of ongemak vanwege het onderzoek, neemt u dan aub contact op met de onderzoeksleider:

Daphne Bedeaux (d.bedeaux@student.tudelft.nl)

Toestemmings-verklaring

Met uw ondertekening van dit document geeft aan dat u minstens 18 jaar oud bent; dat u goed bent geïnformeerd over het onderzoek, de manier waarop de onderzoeksgegevens worden verzameld, gebruikt en behandeld en welke eventuele risico's u zou kunnen lopen door te participeren in dit onderzoek

Indien u vragen had, geeft u bij ondertekening aan dat u deze vragen heeft kunnen stellen en dat deze vragen helder en duidelijk zijn beantwoord. U geeft aan dat u vrijwillig akkoord gaat met uw deelname aan dit onderzoek. U ontvangt een kopie van dit ondertekende toestemmingsformulier.

Ik ga akkoord met deelname aan een onderzoeksproject geleid door Daphne Bedeaux. Het doel van dit document is om de voorwaarden van mijn deelname aan het project vast te leggen.

1. Ik kreeg voldoende informatie over dit onderzoeksproject. Het doel van mijn deelname als een geïnterviewde in dit project is voor mij helder uitgelegd en ik weet wat dit voor mij betekent.

2. Mijn deelname als geïnterviewde in dit project is vrijwillig. Er is geen expliciete of impliciete dwang voor mij om aan dit onderzoek deel te nemen.

3. Mijn deelname houdt in dat ik word geïnterviewd door (a) onderzoeker (s) van de TU Delft. Het interview zal ongeveer 60 minuten duren. Ik geef de onderzoeker (s) toestemming om tijdens het interview opnames (geluid / beeld) te maken en schriftelijke notities te nemen. Het is mij duidelijk dat, als ik toch bezwaar heb met een of meer punten zoals hierboven benoemd, ik op elk moment mijn deelname, zonder opgaaf van reden, kan stoppen.

	4. Ik heb het recht om vragen niet te beantwoorden. Als ik me tijdens het interview ongemakkelijk voel, heb ik het recht om mijn deelname aan het interview te stoppen. 5. Ik heb van de onderzoeksleider de uitdrukkelijke garantie gekregen dat de onderzoeksleider er zorg voor draagt dat ik niet ben te identificeren in door het onderzoek naar buiten gebrachte gegevens, rapporten of artikelen. Mijn privacy is gewaarborgd als deelnemer aan dit onderzoek. 6. Ik heb dit formulier gelezen en begrepen. Al mijn vragen zijn naar mijn tevredenheid beantwoord en ik ben vrijwillig akkoord met deelname aan dit onderzoek. 7. Ik heb een kopie ontvangen van dit toestemmingsformulier dat ook ondertekend is door de interviewer.	
Handtekening en datum	**Naam Deelnemer**	**Naam Onderzoeksleider** Daphne Bedeaux
	Handtekening	**Handtekening**
	Datum	**Datum**

A3 – Coding barriers

Based on barriers found in literature, the PESTEL categories are coded using the following codes:

Political	Economic	Social	Technological	Environmental	Legal
Policies	Scale	Knowledge	Availability	Location	Regulations
Government	Business case	Behaviour	Technologies		
Municipality viewpoint	Cost	Culture	Skills		
Subsidees		Awareness	Materials		
Certificates		Dependency			

Political barrier carbon net-zero developments	Case	Developers can indirectly influence on	Developers can directly influence on	Coding
Difficult to get the Municipality on board when materials are not yet available for certificates	1			Certificates
Trust between government and market parties	2			Government
Accumulation of requirements and rules and it does not always flow with each other.	2			Policies
Requirements are often imposed to obtain certification, but whether it is better for the project remains to be seen.	2			Policies
Regulations are too strict to do carbon offsetting anywhere outside the plot.	2			Certification
The municipality sometimes determines that you have to connect to district heat because they have invested in that infrastructure, while sometimes a different (more sustainable) installation is desired	2			Municipality viewpoint
Local laws and regulations have 'different agendas'	2			Policies
The municipality is asking a lot, but something can also be done on the municipality's part	2			Municipality viewpoint
From the Municipality, it is not clear where places are in the area to offset carbon	3			Municipality viewpoint
No (sustainability/carbon) specialist from the municipality is involved in the development.	3			Municipality viewpoint

Economic barrier carbon net-zero developments	Case	Developers can indirectly influence on	Developers can directly influence on	Coding
Replacing equipment to carry out construction is costly	1			Cost
To scale up material production for carbon-neutral materials, investors are needed	1			Scale
It does not always fit within the business case	2			Business case
Paris Proof is not making money at the moment	2			Business case
The land price for an empty plot is too high	2			Business case
Demolition is often cheaper than redevelopment	2			Cost
Offsetting carbon in timber construction is many times more expensive than offsetting carbon in concrete construction	2			Cost
Financially, it is now too tight to build carbon neutrality within all laws and regulations. Also due to rising construction costs and the demand for affordable housing.	3			Business case
Administrative, it is not doable	3			Business case
Knowledge of the cost of the systems is lacking	3			Cost

Social barrier carbon net-zero developments	Case	Developers can indirectly influence on	Developers can directly influence on	Coding
It is not clear how much carbon needs to be offset	1			Knowledge
Carbon net-zero building has become a catch-all term	1			Knowledge
You are dependent on the whole chain	1			Dependency
You do not know if the contractor can deliver on the promises because there are hardly any carbon net-zero developments yet	1			Knowledge
The people living there have different needs	2			Culture
Comfort and tenant requirements need adjustment as much comfort is related to energy consumption	2			Behaviour
Everyone must participate	2			Dependency
You cannot do it alone, you need many parties for this	2			Dependency
The customer does not always ask for carbon net-zero	2			Awareness
Each developer in an urban area development is in it with a different interest.	3			Behaviour
Not everyone has enough knowledge about carbon net-zero	3			Knowledge
In an urban area development, there is no insight into the possibility of carbon offsetting	3			Knowledge
Awareness of carbon neutrality needs to be raised	3			Awareness
Knowledge of how the systems fit into your development is lacking	3			Knowledge
Knowledge of what solutions are possible is lacking	3			Knowledge
You need to know so much as a developer, which often cannot be done.	3			Knowledge
Consultants are constantly pouring over laws and regulations. No one tool can be used that meets the objectives.	3			Knowledge

Technological barrier carbon net-zero developments	Case	Developers can indirectly influence on	Developers can directly influence on	Coding
Not every type of material is available from every contractor	1			Availability
Sustainable materials are not yet available on a large scale	1			Availability
Innovative materials often have a different way of mounting so you cannot easily go back to a traditional design	1			Materials
Contractors should be willing to put effort into sustainable products and ensure that they are approved and can be applied while ensuring proper guarantees.	1			Materials
It is uncertain whether recycled products will be available when construction starts	1			Availability
The database of materials is not up-to-date	1			Materials
What sustainability solutions you came up with during the beginning of the project may no longer be 'new' during implementation because a construction process takes years	2			Technologies
The fire brigade (and the municipality) considers some sustainable (PV) solutions to be a fire hazard	2			Skills
It is still unclear in models which scenario is best for carbon emissions in terms of materials so a trade-off can be made quickly	2			Technologies

Environmental barrier carbon net-zero developments	Case	Developers can indirectly influence on	Developers can directly influence on	Coding
Some sites are not suitable for certain sustainability solutions (e.g. too little roof area)	2			Location
Sustainability is often only considered at the project level	2			Location

Legal barrier carbon net-zero developments	Case	Developers can indirectly influence on	Developers can directly influence on	Coding
Carbon-neutral materials do not necessarily fall within 'certificates to be obtained	1			Regulations
Regulations on sustainability lagging behind	2			Regulations
What is good for BENG is not good for carbon. Methods contradict each other.	3			Regulations
It takes a very long time to get a system into e.g. a BENG measurement method so that it can be used.	3			Regulations

A4 – Conceptual framework categories

Political barriers

Accumulation of requirements and rules

Influence	Indirect
Collaboration	Municipality
Action developer	Dialogue
Phase	No specific phase

Explanation

Developers could start a conversation with the municipality on how they view the accumulation of laws and regulations and where their focus lies. It is also important to know how they deal with sustainable materials not yet included in laws and regulations. Finally, a developer can open the conversation about softening regulations for offsetting just outside the plot.

Project choices from the municipality

Influence	Direct
Collaboration	Municipality
Action developer	Dialogue
Phase	Sketch/Preliminary design

Explanation

Developers can ask the municipality to ensure that a sustainability advisor joins the team from the area vision. In addition, developers can also enter the conversation as to whether the municipality is willing to deviate from standard energy solutions in the area and create awareness that alternatives might be more sustainable.

Economic barriers

It does not always fit within the business case

Influence	Indirect
Collaboration	Municipality
Action developer	Dialogue
Phase	No specific phase

Explanation

To still make it feasible to develop carbon net-zero, developers could start dialogue with the municipality for incentives such as subsidies for carbon net-zero building.

Materials and equipment

Influence	Indirect
Collaboration	Investors
Action developer	Dialogue
Phase	No specific phase

Explanation

Developers can indicate that there is demand for affordable tested sustainable materials, so investors dare to take risk to invest in scaling up production of these kinds of materials which ensures lower price of the products.

Social barriers

Knowledge

Influence	Indirect
Collaboration	Sustainability experts
Action developer	Dialogue
Phase	No specific phase

Explanation

Developers can indirectly influence by creating awareness for the need for factsheets to sustainability experts. They could also indicate to them that it is difficult to work with so many tools at once and their preference is for an integrated tool to work with.

Knowledge

Influence	Direct
Collaboration	Municipality
Action developer	Dialogue
Phase	Initiation

Explanation

What developers can do is engage with the municipality to look together at the beginning of the project to see where in the area carbon can be offset and in what way that could be done so that it is included into the design.

Knowledge

Influence	Direct
Collaboration	Contractors
Action developer	Dialogue/Contract
Phase	Preliminary design

Explanation

As a developer, it is important to add a 'feasibility' section in the contractor selection process and contractually define the agreements well.

Knowledge

Influence	Direct
Collaboration	Team
Action developer	Training
Phase	Sketch design

Explanation

Developers an influence by having sustainability specialists involved in the development process or ensuring that their own developers are trained enough so that they have enough knowledge about carbon net-zero developments.

Dependency

Influence	Direct
Collaboration	Other developers
Action developer	Dialogue
Phase	Initiation

Explanation

As a developer, it is important to discuss with all developers in the area to look at an area vision or strategy.

Dependency

Influence	Direct
Collaboration	Design team
Action developer	Dialogue/Selection
Phase	Preliminary design

Explanation

The awareness of carbon neutral needs to be raised by all parties by developers. It is also possible to include this in the party selection criteria.

User preferences

Influence	Direct
Collaboration	Users
Action developer	Dialogue
Phase	Monitoring and controlling

Explanation

It is important to involve the users in the project and include them in the sustainability story. That they also have to adapt their behaviour to meet the climate targets.

Technological barriers

Availability

Influence	Direct
Collaboration	Contractor
Action developer	Dialogue
Phase	Preliminary/Construction/ Final design

Explanation

Developers can directly influence by discussing the problem with the contractor about the material stock in advance and involving them early on in the design process to avoid this barrier.

Materials

Influence	Indirect
Collaboration	Sustainability experts
Action developer	Dialogue
Phase	No specific phase

Explanation

As a developer, you can indirectly indicate to sustainability experts that there is a need for a tool where you can immediately see how much carbon offsetting is required for certain design choices.

Materials

Influence	Direct
Collaboration	Own team
Action developer	Planning
Phase	All design phases

Explanation

It is important as a developer to ensure that space, time and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

Collaboration

Influence	Direct
Collaboration	Sustainability experts
Action developer	Check material data
Phase	Preliminary design

Explanation

It is important to ensure that all materials are inspected and properly recorded in a database to avoid concerns.

Environmental barriers

Suitability sites

Influence	Direct
Collaboration	Design team
Action developer	Meeting
Phase	Preliminary design

Explanation

It is important to clarify at an early stage what kind of sustainability solutions will possibly be used to design the area and building in a way all carbon net-zero solutions will fit.

Project level

Influence	Direct
Collaboration	Design team
Action developer	Meeting
Phase	All design phases

Explanation

To also look at carbon offsets on a larger scale, the developer can provide guidance on that during the design process to focus on that as well.

Legal barriers

Laws and regulations	
Influence	Indirect
Collaboration	Sustainability experts
Action developer	Dialogue
Phase	No specific phase

Explanation
It is up to the developer to indicate to the government and sustainability consultants that this way it is difficult to apply sustainable materials in a development because they are not officially compliant.

Drivers

Drivers	
Driver	Competitive position
	Intrinsic motivation
	Financial support
	Better world

Influence of developers

Cooperation with the entire chain	
Design team	Architect
	Contractor
	Structural engineer
	Installation consultant
	Sustainability expert
	Landscape architect
	Municipality
	Construction cost expert
Other parties	Investors
	Future residents

Explanation
As a developer, you choose the parties and decide on starting points and goals.

Phase	
Most impact	Design phase
Influence	Each level

Explanation
They influence not only in the design phase, but also at each level in the development process since you work from coarse to fine. It is critical to assess whether the goals are still being met at each phase.

Opportunities in the urban area

Possible offsetting	
Offsetting	Renovating
Collaboration	
Action developer	
Phase	
Offsetting	Greenery and trees
Collaboration	
Action developer	
Phase	
Offsetting	Picking forests
Collaboration	
Action developer	
Phase	
Offsetting	Algae farm
Collaboration	
Action developer	
Phase	
Offsetting	Mobility plan
Collaboration	
Action developer	
Phase	
Offsetting	Fund for locals/farmers
Collaboration	
Action developer	
Phase	
Offsetting	Fund for renovating other buildings
Collaboration	
Action developer	
Phase	

A5 – Conceptual framework version 1

Part 1 - Indirect influence by developers in general

1. Dialogue with the municipality about regulations and subsidies

Start a conversation about the view of the accumulation of laws and regulations and where their focus lies. It is also important to know how they deal with sustainable materials not yet included in laws and regulations.

Talk about softening regulations for offsetting just outside the plot.

Start dialogue with for incentives such as subsidies for a carbon net-zero building.

2. Dialogue with the government about regulations

Indicate to the government that it is difficult to apply sustainable materials in a development because they are not officially compliant.

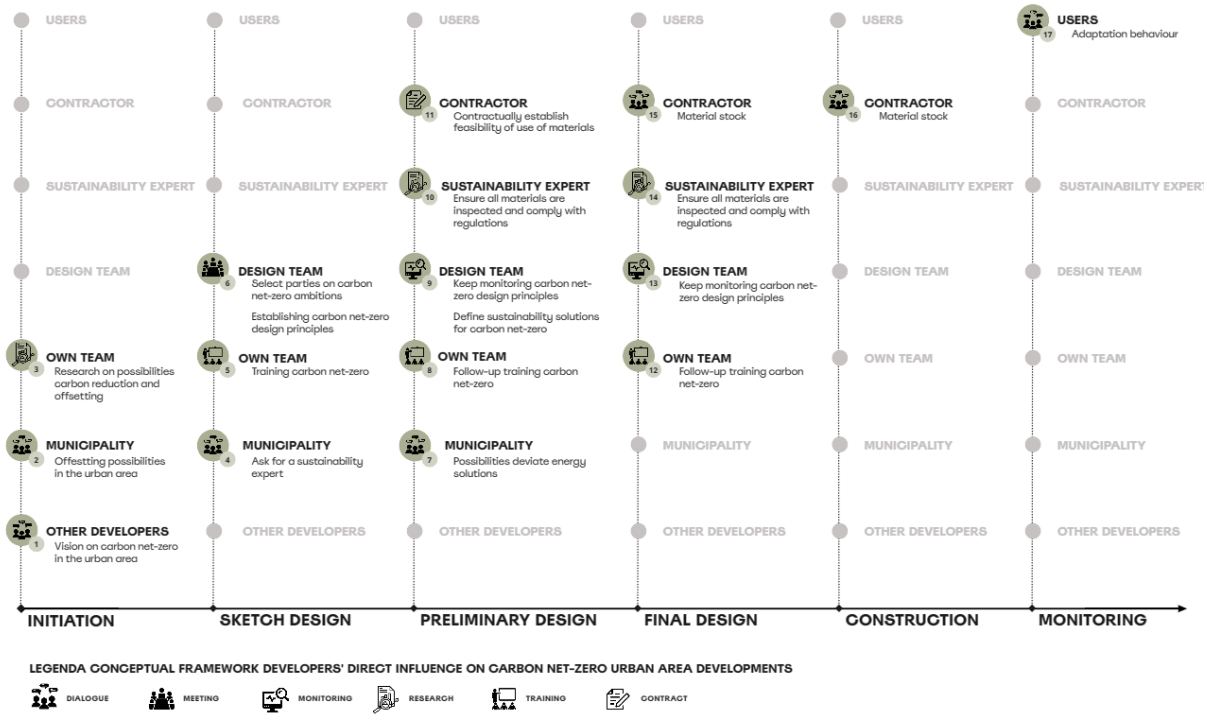
3. Dialogue with sustainability experts about tools and instruments

Create awareness for the need for factsheets and indicate that it is difficult to work with so many tools at once and that the preference is for an integrated tool to work with.

There is a need for a tool where you can immediately see how much carbon offsetting is required for certain design choices.

4. Dialogue with investors about the demand for sustainable materials

Indicate a demand for affordable tested sustainable materials, so they dare to take risk to invest in scaling up production of these kinds of materials which ensures lower price of the products.



Conceptual framework (Own figure)

Initiation phase

1. Dialogue with other developers for an area vision regarding carbon net-zero

As a developer, it is important to discuss with all developers in the area to look at an area vision or strategy.

2. Dialogue with the municipality

Engage with the municipality to look together at the beginning of the project to see where in the area, as a location, carbon can be offset and in what way that could be done so that it is included into the design. Examples offsetting and reduction possibilities:

- Greenery and trees
- Picking forest
- Algae farm
- Mobility plan
- Funds for locals/farmers/renovating other buildings

3. Research with the own development team

Look for possible ways for carbon reduction in the development and carbon offsetting in the urban area.

Define targets for the carbon net-zero urban area development

Sketch design

4. Dialogue with the municipality

Ask for a sustainability expert from the municipality joining the design team from the area vision.

5. Training own development team

Ensure that the developers are trained in carbon net-zero developments and have enough knowledge about it.

6. Design team selection and meeting

Include carbon net-zero ambitions in the party selection criteria. The following parties are essential:

- Municipality (incl. sustainability expert)
- Architect
- Contractor
- Structural engineer
- Installation consultant
- Sustainability expert
- Landscape architect
- Construction cost expert

Establishing carbon net-zero design principles

- Create awareness of carbon net-zero by all parties.
- Focus on large scale during the design process to look at carbon offsets.
- Ensure that space, time and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

Preliminary design

7. Dialogue with the municipality

Enter the conversation as to whether they are willing to deviate from standard energy solutions in the area and create awareness that alternatives might be more sustainable.

8. Own team

Organize follow-up trainings for employees to update their knowledge about carbon net-zero.

9. Design team

Keep monitoring carbon net-zero design principles

- Create awareness of carbon net-zero by all parties.
  - Focus on large scale during the design process to look at carbon offsets.
- Ensure that space, time and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

Define what kind of sustainability solutions will possibly be used to design the area and building in a way all carbon net-zero solutions will fit.

10. Sustainability expert

Ensure that all materials that will be used are inspected and properly recorded in a database to avoid concerns.

11. Contractor

Add a 'feasibility' section in the contractor selection process and contractually define the agreements well.

Final design

12. Own team

Organize follow-up trainings for employees to update their knowledge about carbon net-zero.

13. Design team

Keep monitoring carbon net-zero design principles

- Create awareness of carbon net-zero by all parties.
  - Focus on large scale during the design process to look at carbon offsets.
- Ensure that space, time and design freedom are also set up during the process to possibly apply other systems or sustainable materials in the project.

14. Sustainability expert

Ensure that all materials that will be used are inspected and properly recorded in a database to avoid concerns.

15. Contractor

Talk about the material stock in advance and involving them early on in the design process to avoid a shortage of sustainable materials.

Construction

16. Contractor

Keep talking about the material stock to avoid a shortage of sustainable materials.

Monitoring

17. Users

It is important to involve the users in the project and include them in the sustainability story. That they also have to adapt their behaviour to meet the climate targets.

A6 - Expert panel protocol

Deel 1 – Introductie interview

Goedemorgen, allereerst wil ik jullie alvast bedanken voor het meewerken aan dit expert panel. Graag zou ik nogmaals willen vragen of u instemt met het opnemen van het expert panel? Voordat ik begin zal ik mijzelf even voorstellen. Ik ben Daphne Bedeaux en ben op dit moment bezig met het afronden van de master Management in the Built Environment aan de TU Delft.

Mijn afstudeeronderzoek gaat over wat ontwikkelaars kunnen doen om ervoor te zorgen dat gebiedsontwikkelingen in Nederland CO_2 neutraal worden. Het doel van mijn afstudeeronderzoek is om een conceptueel framework te ontwikkelen voor ontwikkelaars die gebruikt kan worden om invloed uit te oefenen op CO_2 neutrale gebiedsontwikkelingen in Nederland.

Het expert panel zal niet langer dan een uur zal duren. Gedurende deze tijd heb ik voor het expert panel een aantal statements opgesteld met betrekking tot het conceptuele framework. Zijn er verder nog vragen voorafgaande de start van het expert panel? Zo niet, dan kunnen we beginnen.

Deel 2 – Statements

Statement 1 – Barriers

Het intern opleiden van de ontwikkelaars binnen het bedrijf over de thema's duurzaamheid en carbon net-zero zal ervoor zorgen dat er geen duurzaamheidsadviseurs meer nodig zijn.

Statement 2 - Drivers

Intrinsieke motivatie van de ontwikkelaar is een vereiste voor een carbon net-zero gebiedsontwikkeling.

Statement 3 – Influence developers

De meest essentiële partij om mee samen te werken om een carbon net-zero gebied te ontwikkelen is de gemeente.

Statement 4 – Opportunities in urban areas

Een fonds opzetten om CO2 te compenseren is de verantwoordelijkheid voor een ontwikkelaar.

Deel 3 – Conceptueel framework

Wat is de eerste indruk van het conceptueel framework? Hoe zouden jullie het framework lezen? Wat is er duidelijk en onduidelijk? Zou dit conceptuele framework gebruikt kunnen worden in de praktijk? Zo ja, hoezo wel, zo nee, wat zou er anders kunnen?

Deel 4 – Afsluiting expert panel

Alle statements zijn behandeld en het conceptuele framework is besproken, hebben jullie nog verdere opmerkingen die ik zou kunnen gebruiken voor het onderzoek? Graag wil ik jullie van harte bedanken voor de tijd en de medewerking aan het onderzoek. Alle gegevens worden geanonimiseerd. Mocht u nog verdere vragen hebben dan ben ik per mail bereikbaar. Na afloop van het afstudeeronderzoek zal ik, indien gewenst, de thesis naar jullie versturen.