MASTER

Realizing Industrial Zero Energy Buildings (I-ZEBs)
a model for municipalities to accelerate the realization of industrial Zero Energy Buildings

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Award date:
2013

Link to publication
GRADUATION THESIS

Realizing Industrial Zero Energy Buildings (I-ZEBs)
A model for municipalities to accelerate the realization of Industrial Zero Energy Buildings

June 28th, 2010
Final version

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[APPENDIX IS CONFIDENTIAL]
Colophon

Report type: Master thesis
Status: Final version
Main title: Realizing Industrial Zero Energy Buildings (I-ZEBs)
Subtitle: A model for municipalities to accelerate the realization of Industrial Zero Energy Buildings
Content: Literature study, Case study, Design
Date: 28-06-2010
Page numbers: 116 (excl. appendix)
Font main text: Calibri (12 pt)
Font headings: Cambria (varying)

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Graduation company: N.V. Brabantse Ontwikkelings Maatschappij (BOM), division Brabantse Herstructureringsmaatschappij voor Bedrijventerreinen B.V. (BHB), Tilburg, the Netherlands.

Commission TU/e: prof. dr. ir. W.F. (Wim) Schaefer (Voorzitter)
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Preface

My Master’s thesis describes how a municipality can stimulate industrial companies to save energy, be more energy efficient or even use renewable energy sources with having industrial zero energy buildings as highest ambition.

This thesis wouldn’t be possible without the help from the people of the Eindhoven University of Technology (TU/e) and my graduation company, the Brabantse Ontwikkelings Maatschappij (BOM). I want to thank in particular my supervisors Mr Den Otter, Mrs Q. Han (TU/e) and Mr Wagemakers (BOM) for their professional input and support. I want to thank my parents, my sisters, my family and friends for their support in any way. Last but not least I want to say thanks to the CME staff members and my fellow CME students for their help and knowledge acquisition. To my soccer team I want to apologize for my limited input this year but I will make it up next season!

This thesis is a qualitative study based on interviews with industrial companies and municipal officials. The gained insights don’t give a straight answer, but serve as recommendations to municipal officials as well as other relevant parties like the BOM how to stimulate industrial companies as much as possible to realize industrial zero energy buildings as highest possible ambition. I want to finish this preface with a citation of Rudolf Diesel, the inventor of the diesel engine, which reflects perfectly the difficulty of realizing industrial zero energy buildings:

"An invention is not a pure idea, but rather the product of a struggle between the ideal and Nature. The product is always a compromise between the Ideal and the Attainable, and working out the details of this compromise is a part of the process of invention."

Lynwood Bryant,
"The Development of the Diesel Engine”,
Technology and Culture, Vol. 17, No. 3 (Jul., 1976), pp. 432-446
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Summary

INTRODUCTION [Chapter 1]
Last October 2009, the Club of Rome visited Amsterdam for their annual meeting, called the Global Assembly. During this meeting experts have shown the strong link between the climate crisis, energy crisis and economic crisis (IMSA, 2010).

To be able to solve the energy- and climate crisis, an energy transition toward a modern, sustainable energy household based on the Trias Energetica is inevitable (Opstelten, et al., 2007). In 2001, the Dutch government already stated in their 4th nation environmental policy plan (NMP4) that this transition is required. The last few years many plans, programs and covenants have been set up, of which the built environment is one of the main targets of the government. In this built environment, which was responsible for almost one third of the total energy consumption in 2006, the government has the ambition to realize zero energy new estate (Versteeg, T., et al., 2009).

Despite the advantages of an energy transition and the years of energy- and climate policies which the Dutch government is working on, there are still many barriers, criticism and misted opportunities that prevent real breakthroughs in the field of energy transition towards zero energy estate. These barriers indicate that the policies to promote sustainable development in general are not effective enough.

To be able to realize this energy transition toward zero energy buildings, good cooperation and understanding between public and private parties is desirable. Especially municipalities are able to make these necessary connections (Senternovem, 2008). Therefore, the goal of this thesis is to advice municipalities how they can improve the execution of their energy- and climate policy in such a way it accelerates the realization of zero energy buildings. The focus in this thesis will be on industrial buildings because they have many opportunities other buildings don’t have like the high investment potential and the possibilities of re-using of residual heat of the production processes in their built environment.

METHOD
Desk research
First, an elaborated literature study has been conducted. With this literature study an understanding has been created about what policy and industrial zero energy buildings (I-ZEBs) are [resp. chapter 5 & 2], how I-ZEBs can be realized [chapter 3] and how they can be implemented in the market in the fastest way [chapter 4].

Case studies
Second, by making usage of semi-structured questions, interviews have been conducted in the following six municipalities: Tilburg, ’s Hertogenbosch, Eindhoven, Waalwijk, Boxtel and Geldrop-Mierlo. All these municipalities have high ambitions for the environmental- and energy
topic. In mostly every municipality, two municipal officials and two industrial entrepreneurs have been interviewed [chapter 6].

By interviewing the municipal officials, of whom one responsible for the energy- and climate policy and one of Economic Affairs, understanding has been created about their current municipal energy- and climate policy and their relationship with the local entrepreneurs. By interviewing the industrial entrepreneurs, understanding has been created about their reflection on the municipal energy- and climate policy, and their advantages, barriers and opportunities concerning I-ZEBs.

PRECONDITIONS & ANALYSIS [resp. chapter 7 & 8]
All the created understandings form the Desk research and Case studies have been combined around related content. This resulted in 15 statements from the municipal's perspective in what they should do to improve their current energy- and climate policy execution to accelerate the realization of I-ZEBs [paragraph 7.3]. These statements are the preconditions for the model that need to be fulfilled by the model.

Because of a lacking coherence between these statements, first the statements had to be analyzed to be able to have a proper starting point for designing the model [paragraph 8.2.1]. This analysis is done by asking for every statement repeatedly the "how"-question [paragraph 8.2.2]. By doing so, eventually this resulted in a specific target for every statement where to focus on in designing the model [paragraph 8.2.3].

DESIGN & CONCLUSION
Based on the analysis, it was possible to design a model that takes all 15 statements into account. This model consists of the following three parts: The actors, a Collaborative Environment and 8 topics [paragraph 8.3]. In the Collaborative environment the actors conjointly work towards a common goal, which is to accelerate the realization of I-ZEBs. The relevant actors do that by picking up one of the 8 prescribed topics that can be seen in the table below.

<table>
<thead>
<tr>
<th>Municipal energy- &amp; climate policy planning</th>
<th>Subsidy for I-ZEBs</th>
<th>Persuasion to realize I-ZEBs</th>
<th>Promoting sustainable regeneration of business parks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal energy- &amp; climate policy execution</td>
<td>Promotion of I-ZEBs</td>
<td>Participation in realizing I-ZEBs</td>
<td>Realization of a Municipal Sustainable Energy Company (MSEC)</td>
</tr>
</tbody>
</table>

*Table 1: 8 topics for accelerating the realization of I-ZEBs.*

These topics are all related to the municipal energy- and climate policy execution and accelerate in their own specific way the realization of I-ZEBs. For every specific topic, this Collaborative environment setting is displayed in separate sub models [paragraph 8.4]. These sub models show which specific actors participate and what roles and tasks they have in order of time.

An example is provided below for the topic ‘subsidy for I-ZEBs’. 
It can be concluded that by picking up these 8 topics by the relevant actors via a Collaborative environment, indeed the energy- and climate policy execution of the municipality is being improved in such a way it accelerates the realization of industrial zero energy buildings (I-ZEBs) [paragraph 9.2].
1 Research layout

1.1 Introduction

In 1972 the Club of Rome brought out a report under the title 'Limits to growth'. In this report the relationship is made between economic development and the environment. According to this report, the growth will reach its limits within 100 years if the current development of the growing world population, industrialization, pollution, food production and the depletion of natural resources are not put to a stop (Club of Rome, 2010). On October the 26th and 27th 2009, the Club of Rome visited Amsterdam for their annual meeting, the Global Assembly, their last meeting before the UN climate conference in Copenhagen in December 2009. In this meeting, experts have shown the strong link between the climate-, energy- and economic crisis (IMSA, 2010).

The climate or ecologic crisis is a result of different natural and human causes. The human influence is the most important one. Human bring additional greenhouse gasses in the atmosphere by burning fossil fuel for generating energy, by deforestation, agriculture and cattle breeding. These greenhouse gasses, of which CO₂ is the most important one, influence the climate resulting in a rising average world temperature and extreme weather conditions (VROM, 2010).

A worldwide energy crisis can emerge within eight years according to the International Energy Agency (IEA). The demand for fossil fuels will rise with 50% the coming twenty years. About half of the increase of the energy need comes from the emerging countries China and India. There will be a battle about the declining stock of fossil fuels, resulting in much higher energy prices. This can lead to serious conflicts (IEA, 2009).

The increasing demand for fossil fuels, its decreasing stock and the emission of greenhouse gasses as a result of burning fossil fuels, show the relationship between the climate- and the energy crisis. In addition, the current financial and economic crisis plays an important related role too. First of all, the economic crisis results in less demand for fossil fuels, which has a positive impact on the CO₂-emissions and energy prices. But on the other hand, this crisis currently prevents the search to and investment in alternative, renewable energy sources (IEA, 2009).

To be able to lower the CO₂-emissions and be less dependent on fossil fuels, an energy transition is inevitable. "The discussion is no longer about the need to contemplate the future of energy supplies but about the way we can meet the future energy demand in a sustainable way" (Opstelten, et al., 2007).

The energy- and environmental crises are listed high on de Dutch nation's agenda for several years. In 2001, the Dutch government already stated in their 4th nation environmental policy plan (NMP4) that a transition, fundamental changes in functional systems in e.g. energy
household, agriculture etc., is required (Kemp, R. and Loorbach, D., 2005). In case of an energy transition, this means a switch between regimes to a modern, sustainable energy household based on the Trias-Energetica (SER, 2008). This transition is needed to solve the remained big environmental problems that the national and international societies have been unable to handle, despite the fact the problems are known for some time and are widely acknowledged as seriously like the climate change and overexploitation of natural resources. According to the NMP4, through a well-organized effort high ambitions can be reached (Kemp, R. and Loorbach, D., 2005).

The Dutch government is continuously focused in reducing and preventing climate- and energy problems in the Netherlands. The last few years many plans, programs and covenants have been set up, of which the built environment is one of their main targets (Tambach, M. et al., 2009). In the Netherlands, almost one third of the total energy consumption is used in this built environment (Senternovem, 2010). Although many measures have been taken in the past to improve the energy performance, still there is a potential for even more improvements by making an energy transition towards a zero energy built environment (Opstelten et al., 2007). This potential is also acknowledged by the Dutch government.

The Netherlands wants to make big steps toward an energy transition to become one of the most sustainable and efficient energy supplier in Europe in 2020. The State governmental program “Schoon en Zuinig” from 2007 describes the way to realize this ambition (VROM, 2007). The Dutch government also set up a different program in 2007, called: “Nederland Ondernemend Innovatieland”. This program focuses on the better usage of knowledge and renewed entrepreneurship to solve social issues. Because both programs have much in common and innovation is necessary to realize the wanted transition, an integrated agenda is set up: “De innovatieagenda Energie” (RET, 2008). One of the targets in this Innovation Agenda is the built environment, with the ambition to realize zero energy new estate and sustainable existing estate (Versteeg, F., et al., 2009).
1.2 Research approach

1.2.1 Problem definition

The climate crisis and the potential energy crisis devote people to an energy transition. Since 2001 the energy transition is included in the Dutch policy. Despite the advantages of an energy transition and the years of energy- and climate policies which the Dutch government is working on, there are still many barriers, criticism and misted opportunities.

First of all, there is criticism of the public-private Taskforce EnergieTransitie\(^1\) and the public-private platform Energietransitie Gebouwde omgeving (PEGO)\(^2\). The criticism of both was the too big influence of the so-called regime players (Hisschemöller, M., 2008). In case of the Taskforce it was e.g. multinational Shell that had too much influence, which resulted in non-optimal choices. In case of the PEGO, it was (and still is) the overrepresentation and important positions of big firms like BAM (Senternovem, 2010). If a transition arena has too many regime players, the threat exists that the protection of established interests has more the interests than realizing real breakthroughs (Jones, P. and Meyere, V. de, 2009).

Secondly, the government missed a big opportunity in realizing energy savings in the built environment, in this case on business locations. In the covenant ‘business locations’ (Government, 2009), signed in 2009 between the State government, provinces and municipalities, no conditions are mentioned in the field of environment and climate. The main reason why no additional conditions were implemented is that environmental requirements could have influenced the covenant signing process in a negative way (Wesselink, J., 2008).

Finally there are still many barriers that prevent sustainable building, including zero energy building (Versteeg, F., Poolen, M., et al., 2009), (Lindt, M. van de, et al., 2008), (PEGO, 2007), (Bueren, E. van, and Jong, J. de, 2007). One of the barriers is identified as the circle of blame, which can be seen in the figure below. This circle is a vicious circle in which all the participating parties in the built environment avoid their responsibilities and blaming each other for the lacking of sustainable real estate, and so zero energy buildings (RICS, 2008).

---

\(^1\) The Taskforce is founded by the Government in 2005, consisting of representatives from the government, business, research institutions and social organizations. This Taskforce was mainly focusing in the sketching of ambitions and bringing the energy transition under public attention. The Taskforce advises the government in their energy- and climate policy (TFE, 2006). Since 2008 the Taskforce is called Regieorgaan EnergieTransitie that has the task to give advice in the governmental policy (Senternovem, 2010).

\(^2\) PEGO, founded in 2006, is a cooperation between the government, business, research institutions and social organizations. PEGO focuses to all parties in the building column to save energy. They also want to advise/reach government, municipalities and provinces (Senternovem, 2010).
This circle of blame shows how important the role of the (local) government can be. They have the tools and instruments to break this vicious circle. In case of a sector wide energy transition, pilot projects are also necessary to investigate its feasibility in practice, the bottlenecks and the obstacles (SER, 2008). Short term successes, “the quick wins”, are needed so that the (local) governments create support from the audience for executing long-term interferences like the energy transition topic. By starting practical and small with enough impact and credibility, the local governments in any case give the good example (Roos, J., et al., 2007). Unfortunately, sometimes local governments are struggling to address higher-level governmental issues concerning sustainable energy policies (Knigge, J., 2008).

The barriers show that the policies to promote sustainable development in general are not effective enough. Bueren and de Jong (2007) show there is a bottleneck to the effectiveness of policies promoting sustainable development resulting from the institutionally fragmented building process. They suggest policy improvement at instrument and policy level. (Bueren, E. van, and Jong, J. de, 2007).

Problem: “An energy transition in the built environment toward zero energy buildings is needed to deal with the energy- and climate problem, but there are many barriers that private parties face. Better governmental policy is needed”.

Figure 1: Circle of blame (RICS, 2008)
1.2.2 Research goal

On (inter)national governmental level, the energy and climate ambitions are broad. The Netherlands has the ultimate goal to realize a zero energy built environment. Without innovation this transition is not possible. To be able to realize this transition, acceptance from the private sector is needed to create support and because eventually they have to pay and realize the zero energy buildings (ZEBs). Good cooperation and understanding between public and private parties is desirable. However, many measures are only realizable on local public level. Only municipalities and provinces are able to make good connections between parties and only than concrete results are realizable (Senternovem, 2008).

Based on the still existing barriers and the needed close relationship between public and private parties to realize the desired energy transition toward ZEBs, the goal of this research is to find the best way local governments can stimulate zero energy building in their municipality. Specifically industrial zero energy buildings (I-ZEBs) are being investigated because they have many opportunities other buildings don’t have. This will be further explained in a chapter 2, paragraph 2.3.

The main question is:
How can the current municipal energy- and climate policy execution be improved so that it accelerates the realization of I-ZEBs?

1.2.3 Sub questions

SECTION 1: THEORY

1.1 What is the definition of an I-ZEB?
1.2 What are the steps needed to successfully realize an I-ZEB?
1.3 What are the steps needed to successfully implement an I-ZEB in the market?
1.4 What is the definition of a policy and how does the policy process looks like?

SECTION 2: CASE STUDY

2.1 What does the comparison look like of the current climate- and energy policy executions of certain big municipalities?
2.2 What does the comparison look like of the current climate- and energy policy executions of certain small municipalities?
2.3 What does the comparison look like between the big and small municipalities in their current climate- and energy policy execution?
2.4 What are the entrepreneurs’ general (non-municipal specific) opinions on the energy- and climate policy execution?
2.5 What are the entrepreneurs’ advantages, barriers and opportunities in taking measures for realizing I-ZEBs?
1.2.4 Hypothesis

The hypothesis of this research is:

*By having insight in how the current municipal energy- and climate policy execution can be improved, the municipal officials are be able to accelerate the realization of 1-ZEBs.*

1.2.5 Objective

The municipality plays an important role in the desired energy transition toward 1-ZEBs. Especially in this start-up phase where much innovation and cooperation is needed, widespread support from the community is required. In the past this was not that successful as reflected in the many barriers.

The objective of this research is therefore to design a policy framework that a municipality can use to improve their current energy- and climate policy execution in such a way, that it stimulates industrial entrepreneurs to realize 1-ZEBs.

1.2.6 Definition of scope

To be able to finish this graduation research in time and to come to potential interesting insights, this research needs to be well defined. Therefore assumptions are needed. The assumptions are:

- The focus will be on the Dutch province of Noord-Brabant. This gives more chance public and private parties will participate in this research because the University is also located in this province. Besides, the N.V. Brabantse Ontwikkelings Maatschappij, which also participates in this research, has close contacts with private and public parties in the region of Noord-Brabant. The focus is acceptable because there are no reasons why the outcome would differ from other provinces in the Netherlands. This makes generalization of the results to other regions and municipalities in the Netherlands still possible.

- In case of the public parties, the focus will be on the most ambitious municipalities in the field of energy- and climate policy; three large (>100,000 inhabitants), and three smaller municipalities (<50,000 inhabitants). The expectation is that ambitious municipalities can give more insights in the execution of their energy- and climate policy than less ambitious municipalities. Besides, if improvements can be made in ambitious municipalities, these improvements will certainly apply on less ambitious municipalities. There is also made a distinction between big and smaller municipalities. The expectation is that there are interesting differences in their approach although they have the comparable high ambitions.

- Being zero energy can be applied on many ambition levels. A province can choose to be zero energy, but also municipalities, districts, business locations or buildings can have
this ambition. This so-called project boundary that will be used in this thesis, is on individual building level. This has several advantages:

- First of all by focusing on individual buildings the maximum potential of the building owner itself can be used. Also realizing an I-ZEB is more ambitious than realizing a zero energy business location or municipal.
- Secondly, by focusing on individual buildings, also less ambitious municipalities or municipalities with fewer resources can use the results because they don't have to participate in large scale projects. Successes can be made possible on individual building scale.
- Because of the conceptual character of I-ZEBs and the continuous improvements and technological innovations in this field, there will be no specific elaboration in the techniques that can be applied to make an I-ZEB. The focus will be on in-depth investigation in optimizing the process towards realizing I-ZEBs in the best possible way.

### 1.3 Methodology

#### 1.3.1 Research method

To be able to answer the main question and belonging sub questions, the following research strategies are used:

- **Desk research: literature study (internet and library)**
  The literature study gives answers on sub questions 1.1, 1.2, 1.3 and 1.4. Answering these sub questions give insight in (Industrial) ZEB and policy in general.

- **Case studies (literature study and interviews)**
  The case studies give answers on sub questions 2.1, 2.2, 2.3, 2.4 and 2.5. Answering these sub questions give specific insights in the current municipal energy- and climate policy execution. They also give insights in the entrepreneurs' general reflection on this municipal energy- and climate policy execution and their advantages, barriers and opportunities in taking measures for realizing I-ZEBs.

The goal is to interview at least two companies per municipality and at least two municipal officials per municipality. This makes a total of at least 24 interviewees. For the interview, semi-structured questions will be used, which allow for focused, conversational, two-way communication.
1.3.2 Research model/framework

Figure 2: Research framework
SECTION 1: THEORY

This section displays the result of the literature study. It is an extensive description to get answers on the first sub questions to be able to generate understanding what (industrial) zero energy buildings are and what policy means in general. For the literature study, the available scientific papers, reports, and other relevant online and offline documents are used. This Theory Section also helps with making good question lists that are used in the Case study, which is described in Section 2.

The conclusions mentioned in this Section 1 will be reflected on the conclusions of Section 2: the Case study. This reflection will be done in Section 3: Reflection. This reflection can be found in chapter 7, which acts as the preconditions for the eventual model (chapter 8).

2 Theory zero-energy buildings (ZEBs)

2.1 Introduction
This chapter gives an answer on the following sub question (1.1): What is the definition of an 1-ZEB? First the international definitions will be explored and secondly the national definitions. Finally this chapter explains why is chosen to focus on 1-ZEBs.

2.2 Definition ZEB

2.2.1 International
Much literature is available about zero energy buildings (ZEBs) or sometimes called energy neutral buildings. In the literature, sometimes they do not mean zero energy but actually CO₂ neutral or climate neutral buildings. These latter two are buildings with a lower sustainable ambition than ZEBs (Roos, J., Braber, K. et al., 2007).

This misapprehension is not that odd as it seems, because there exists not a clear definition of ZEBs (Voss, K. and Riley, M., 2009). In the report of the National Renewable Energy Laboratory of the United States Department of Energy (DOE) the authors use the following general definition of ZEB:

"A net zero energy building (NZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies" (Torcellini, P., Pless, S. et al., 2006).

However, the authors also point out clearly the undefined "zero": "Despite the excitement over the phrase "zero energy", we lack a common definition, or even a common understanding, of what it means." They also mention that the way how the zero energy goal is defined, affects the choice that designers make to achieve this goal and whether they can claim success.
Furthermore, in the paper the authors point out that the definition of a ZEB can be constructed in several ways, depending on the project goals, and the values of the design team and building owner. They list the following four commonly used definitions (Torcellini, P., Pless, S. et al., 2006):

**Net Zero Site Energy:** A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site. Building designers use this definition because they may be interested in site energy use for energy regulation requirements.

**Net Zero Source Energy:** A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building’s total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers. Organizations such as the DOE use this definition because they are concerned with national energy numbers, and are typically interested in primary or source energy.

**Net Zero Energy Costs:** In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year. Building owners use this definition because they typically care about energy costs.

**Net Zero Energy Emissions:** A net zero emissions building produces at least as much emissions-free renewable energy as it uses from emission producing energy sources. Those who are concerned about pollution from power plants and the burning of fossil fuels will be using this definition (Torcellini, P., Pless, S. et al., 2006).

These (four) definitions from the United States DOE are widely accepted in the recent scientific publications around the world (ECSEE, 2009), (Hernandez, P. and Kenny, P., 2009), (Marszał, A.J., and Heiselberg, P., 2009), (PEGO, 2009).
2.2.2 National

Also in the Netherlands, there is discussion about the definition of zero energy (= energy neutral), climate neutral and CO\textsubscript{2} neutral, which makes it difficult to compare municipalities with each other. Because there is a big need for comparison, both the project group Energy in the Built Environment (PeGO) and Senternovem\textsuperscript{3} have been working on a study that gives clarity about these definitions. (Vliet, R. van, Rovers, V. et al., 2008) This study is just finished and published.

In this study the following definitions for zero energy (energy neutral), climate neutral, and CO\textsubscript{2} neutral are determined:

- **Zero energy (energy neutral):** “A project is zero energy if on a yearly basis no net import of fossil or nuclear fuel from outside the system boundary is needed to build, use and demolish the building. This means that the energy consumption within the project/system boundary is equal to the amount of renewable energy that is being generated within the system boundary or because external measures (e.g. green certificates) are allowed to attribute to the project. The energy usage resulting from the build and demolition of the building is debited to a yearly contribution based on the expected life expectancy of the building” (PEGO, 2009).

- **Climate neutral:** “A building (or a collection of buildings) is climate neutral if on a yearly basis no net emission of greenhouse gasses is needed to build, use and demolish the building. This means that the greenhouse gas emission within the project/system boundary is equal to the amount of greenhouse gasses that is being captured, stored or compensated and can be attributed to the project. The emission resulting from the build and demolition of the building is debited to a yearly contribution based on the expected life expectancy of the building” (PEGO, 2009).

- **CO\textsubscript{2} neutral:** “The same definition of climate neutral can be used. In this case, the only greenhouse gas is carbon dioxide (CO\textsubscript{2})” (PEGO, 2009).

The definitions hold for only the built environment. These definitions include the following energy usages (PEGO, 2009):

- **Building bounded energy usage:** Energy for (water) heating, cooling, and electricity for installations and lighting.
- **Consumer bounded energy usage:** natural gas for cooking and all electricity except installation and lighting (fridge, refrigerator, television)
- **Material bounded energy usage:** Extraction, production, transport and waste treatment of the materials for constructing the building.

\textsuperscript{3} Senternovem is an agency of the Ministry of Economic Affairs specialized in sustainability and innovation (Senternovem, 2010).
The definition does not include:
- Utility energy usage (public lighting and drainage)
- Energy for mobility of residents/users
- Indirect energy usage for residents/users (food, consumption goods)
- Energy used for the production of goods

Where needed, the proposed definition of the PEGO and Senternovem of a zero energy project will be used. This is acceptable because this thesis is an advice towards municipalities, and all contributors to this definition are part of the State Government.

2.3 Industrial zero energy building (I-ZEB)

This thesis focuses on I-ZEBs, so the built environment. The built environment consists of all residential and non-residential/utility buildings (Senternovem, 2010). The built environment was in 2006 responsible for almost one third of the total energy consumption in the Netherlands as can be seen in the left table below (Senternovem, 2010). The biggest consumer is the industry, which consumed in 2006 46.4% of the total energy consumption in the Netherlands.

Despite the limited share of industrial buildings in the total energy consumption, which can be seen in the right table below (Lindt, M. van de, Elkhuizen, B. et al., 2008), still this thesis will focus on this type of utility building. Industrial buildings are defined by Senternovem as: “a building or portion of a building, which building or portion is intended for purposes of processing or storage of materials or goods, apparent by its construction and layout (Factories, warehouses, stockrooms, workshop and so on)” (Senternovem, 2010).

<table>
<thead>
<tr>
<th>SECTORS</th>
<th>CONSUMPTION (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>15.9%</td>
</tr>
<tr>
<td>Utility</td>
<td>15.9%</td>
</tr>
<tr>
<td>Industry</td>
<td>46.4%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>4.1%</td>
</tr>
<tr>
<td>Transportation</td>
<td>17.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BUILT ENVIRONMENT</th>
<th>CONSUMPTION (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential buildings</td>
<td>63%</td>
</tr>
<tr>
<td>Offices</td>
<td>22%</td>
</tr>
<tr>
<td>Education, Hospitals, Nursing and Caring</td>
<td>5%</td>
</tr>
<tr>
<td>Other utility buildings (e.g. industrial halls, Supermarkets, hotels, etc.)</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 1: Relative energy consumption sectors  Table 2: Relative energy consumption built environment

There are several reasons why is chosen to focus on industrial buildings. First of all, the tables above make clear that the share of industrial building in the energy consumption of the built environment is limited. But the mission towards a zero energy built environment is so complex, that everyone is needed. Especially those players who are experts in their niche market. These players, that can be an ambitious industrial company in this field, play an essential role in knowledge sharing and improving the transmission of experiences toward less ambitious companies (Versteeg, F., 2009).
Second reason why to focus on industrial buildings is the fact that many improvements can be made in these buildings in the field of energy savings because of lacking private and public interests.

The private interest lacks because the building owners/entrepreneurs often do not concern about these buildings. The many reasons for this lacking concern can be found in the chapter 6, paragraph 6.4.4.

The public interest lacks because for an industrial building there are no requirements regarding energy performance (EPC)\(^4\), unlike e.g. offices, shop and residential buildings. Except if the industrial building is heated (T >15°C) it still has to be isolated. In case there is a small office that belongs to the industrial building, the office also does not require an EPC if more than 90% of the total building can be characterized as industrial building (Senternovem, 2010). On a larger scale, on business locations, many energy savings can be realized with a potential of 30% with only a payback time of a few years (PEGO, 2009). The same saving potential can also be applied to industrial spaces/halls (Senternovem, 2010).

Third reason to focus on industrial buildings is the fact that the utility sector in general is essential in the development and diffusion of an innovation, which can also reflect on realizing I-ZEBs. This important role comes from the investment potential in this utility sector and the fact that an innovative image in general and in some sub-sectors in special, plays an important role. Additionally, this makes the utility sector attractive for large players (e.g. Philips, Shell, NUON) that are also involved in other sectors than the construction industry (Lindt, M. van de, et al., 2008). Besides, by focusing on industrial buildings two sectors can be captured. This can lead to spillovers between these two sectors by taking measures in the industry sector or in the sector built environment (residential & utility buildings). In general it can also be said that larger firms are implementing more innovations than smaller firms (Dieperink, C. et al., 2004).

Fourth reason is that industrial buildings have several opportunities other buildings don’t have thanks to the production processes that taking place inside. The residuals of the production processes like cold, heat, residues for fuel and burning of high calorific residues can be used to heat or cool the building itself (PEGO, 2009). But according to the definition of ZEBs the production processes are not allowed to take into account. Still it is essential for an industrial building to make a connection between the industrial activities taking place inside the buildings and the built environment itself. In this way all the available opportunities are being used as much as possible in order to realize an I-ZEB in the long run.

The graph below explains the relationship in an I-ZEB between the industrial activities and the built environment.

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\(^4\) EPC is an energy performance coefficient, which indicates the energy efficiency of a building (the lower the better). Since 1995 this EPC calculation is required for obtaining a building permit for most buildings (Senternovem, 2010).
The energy that is being used for the process (E1), is not taken into account in an I-ZEB to be consistent with the definition of ZEBs. In the process an opportunity can arise, which is presented as residual energy (E4). This residual energy can be used in the building e.g. for heating. The energy demand in the built environment can be fulfilled by using renewable energy sources internal (E3) or import energy (E2). Also the residual energy of the process (E4) can be used if available. To be able to have a zero energy building, the total energy consumption (excluding E1) within the building is equal to the amount of renewable energy that is being generated within the system boundary (E3 or E4) or because external measures (e.g. emission trade or external green energy) are allowed to attribute to the project (E2).
2.4 Conclusion

The international papers make clear that a proper definition for (Industrial) ZEBs is lacking, resulting in several specific definitions. In the Netherlands this lacking of a proper definition resulted recently in a definition study by Senternovem and PEGO to solve this problem for the Netherlands. Their definition for (Industrial) ZEBs will also be used in this thesis.

The focus in this thesis will be on industrial buildings, as part of the built environment. There are several reasons to do so because of the many potential improvements, their importance in the development and diffusion of an innovation and the possible advantages of connecting the processes to their buildings to improve energy efficiency.

As an answer on the sub question (1.1): What is the definition of an I-ZEB?, the following definition is used: "An industrial building is zero energy if on a yearly basis no net import of fossil or nuclear fuel from outside the system boundary is needed to build, use and demolish the building. This means that the energy consumption within the project/system boundary is equal to the amount of renewable energy that is being generated within the system boundary or because of external measures (e.g. green certificates) are allowed to attribute to the project. The energy usage resulting from the build and demolition of the building is debited to a yearly contribution based on the expected life expectancy of the building".

This definition only holds for the built environment, so only including building-, consumer- and material bounded energy usage. This means the energy needed for e.g. process or the production of goods is not taken into account. But the residual energy from these processes can provide an opportunity by re-using it in the built environment and contribute in realizing I-ZEBs. Therefore residual energy is also taken into consideration.
3 Realizing industrial zero energy buildings

3.1 Introduction
The previous chapter explained what an I-ZEB is. This chapter describes how I-ZEBs in general can be realized. An answer will be given on the following sub question (1.2):

What are the steps needed to successfully realize an I-ZEB?

Because I-ZEBs can be seen as an innovation, this chapter will make use of the diffusion theory of innovations. The diffusion research began about a century ago when sociology and anthropology were emerging as new social sciences (Rogers, E., 2003). In 1903 Frenchman Gabriel Tarde observed that the rate of adoption of a new idea followed an S-shaped curve. Although, it took about 40 years that Tarde’s insights were followed up by empirical studies of diffusion by e.g. Ryan and Gross in the 1940’s (Rogers, 2003), (Hornor, M., 1998). Ryan and Gross laid the groundwork for the diffusion theory, and their study was followed by hundreds of diffusion studies in the 1950’s and 1960’s among various topics (Valente, T. et al., 1999).

In 1962, with an update in 1971, Rogers conducted a series of investigations in these existing publications about the diffusion theory and discovered eight main types of diffusion theories e.g. rate of adoption, opinion leadership and communication channel usage. His collective work among many researches resulted in e.g. the Innovation-Development Process (Rogers, E., 2003). The work of Rogers made the theory of diffusion of innovations popular (Anis, S., 2009).

This Innovation-Development Process of Rogers will be used as a guideline to answer the sub question. This gives the opportunity to properly structure and explain all the necessary steps needed to realize and eventually implement I-ZEBs into the market.

Because Rogers’ theories are a collective result of hundreds of scientific publications throughout the world (Rogers, E., 2003) and he is being seen as a pioneer and a leading author about the innovation topic, it is acceptable to only focus on his work (Dieperink, C. et al., 2004) & (Rivera, M.A, et al., 2004). Besides, the Dutch government is also using his understandings as a base in its policies as can be seen in the State governmental Innovation Agenda Built Environment (Versteeg, F., et al., 2009).

3.2 The Innovation-Development Process
An I-ZEB can be seen as an innovation, according to Everett M. Rogers’s definition. He defines an innovation as: “an idea, practice or object that is perceived as new to an individual or another unit of adoption”. The existence of innovations in general or I-ZEBs in specific is the result of the so-called Innovation-Development Process, developed by Everett M. Rogers (Rogers, E., 2003). The graph below shows this process.
This Innovation-Development Process consists of six stages. These stages are somewhat arbitrary because they do not always occur in exactly the same order and certain stages may be skipped in the case of certain innovations. The stages are (Rogers, E., 2003):

1. **Needs/Problems**: The process normally starts with the recognition of a (future) problem or need. This stimulates the research and development activities to solve the problem or satisfy the need.

2. **Research**: An invention is often the result of basic research that leads via applied research to a development. In the case of I-ZEBs, this is the research in the field of renewable energy sources and energy-saving techniques.

3. **Development**: This is the process of putting a new idea in a form that is expected to meet the needs of an audience of potential adopters. In the case of I-ZEBs, this means the actual construction of a building in which no net import of fossil or nuclear fuel from outside the system boundary is needed to build, use and demolish the building.

4. **Commercialization**: Is the conversion of an idea in a product or service that can be bought via the market. In the case of I-ZEBs, this means everyone in the market has the opportunity to realize an I-ZEB if they want.

5. **Diffusion and adoption**: Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. The innovation can be adopted or not. In the case of I-ZEBs, this means that more and more people know about the existence of I-ZEBs and can make the choice between building them or not.

6. **Consequences**: This is the last phase in the Innovation-Development process. The consequences are the changes that occur to individuals or a social system, resulting from the adoption or rejection of an innovation. In the case of I-ZEBs, this means the consequences of the realization and non-realization of I-ZEBs.

The next paragraphs elaborate on the Innovation-Development stages 1 until 6.
3.3 Innovation-Development stage 1
This first stage of the Innovation-Development process begins with the recognition of the needs or problems. In the case of I-ZEBs, the problems are the potential ecologic and energy crisis that trigger the need for measures in the built environment to realize an energy transition, as described in the first chapter.

3.4 Innovation-Development stage 2 & 3
In the Innovation-Development stage 2 & 3, respectively mention the research and development stage. As a result of the continuing R&D-activities taken place in these two stages, measures have been developed in order to realize the transition in the built environment toward (industrial) zero energy buildings.

To be able to realize ZEBs or I-ZEBs in specific, author Opstelten (Opstelten, I., et al., 2007) refers to the following measures that are based on the Trias Energetica, first introduced by Erik H. Lysen in 1996 (Lysen, E.H., 1996). The measures can be seen in the graph below.

![Trias Energetica Graph](ECN, 2010)

Important is the order of these steps. The first step, reducing demand, is the most sustainable solution because the cleanest energy is the energy that is not being used. It is essential to take as much measures as possible from this first step. If this is not possible measures from step two have to be used. Less preferred are the measures from step three because still fossil fuels are being used, and so this step is the least sustainable (ECN, 2010).

The same principle of the Trias Energetica to realize I-ZEBs is also mentioned by the International Energy Agency (IEA)\(^5\) (Voss, K. et al., 2007).

Author Torcellini uses a different approach in his paper. He developed a ranking of renewable energy sources as can be seen in the table below. This first option (option 0) is the best and most preferable. Torcellini refers to option number 0 as demand-side technologies and these are considered efficiency measures. Least preferred option is option 4. This last option can be

\(^5\) The International Energy Agency (IEA) is an intergovernmental organization that acts as energy policy advisor to 28 member countries (including the Netherlands) in their effort to ensure reliable, affordable and clean energy for their citizens (www.iea.org).
used for making I-ZEBs, but a building that buys all its green energy from a central location like wind farms has little incentive to reduce its building loads. This latter type of supply options is called off-site (Torcellini, et al., 2006).

<table>
<thead>
<tr>
<th>Option Number</th>
<th>ZEB Supply-Side Options</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Reduce site energy use through low-energy</td>
<td>Daylighting, high-efficiency HVAC equipment,</td>
</tr>
<tr>
<td></td>
<td>building technologies</td>
<td>natural ventilation, evaporative cooling, etc.</td>
</tr>
<tr>
<td>1</td>
<td>Use renewable energy sources available within</td>
<td>PV, solar hot water, and wind located on the building.</td>
</tr>
<tr>
<td></td>
<td>the building’s footprint</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Use renewable energy sources available at the</td>
<td>PV, solar hot water, low-impact hydro, and wind located on-site, but not on the building.</td>
</tr>
<tr>
<td></td>
<td>site</td>
<td></td>
</tr>
</tbody>
</table>

On-Site Supply Options

<table>
<thead>
<tr>
<th>Option Number</th>
<th>ZEB Supply-Side Options</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Use renewable energy sources available off site</td>
<td>Biomass, wood pellets, ethanol, or biodiesel that can be imported from off site, or waste streams from on-site processes that can be used on-site to generate electricity and heat.</td>
</tr>
<tr>
<td></td>
<td>to generate energy on site</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Purchase off-site renewable energy sources</td>
<td>Utility-based wind, PV, emissions credits, or other “green” purchasing options. Hydroelectric is sometimes considered.</td>
</tr>
</tbody>
</table>

Table 3: Ranking of ZEB supply options (Torcellini, et al., 2006).

To realize I-ZEBs, Torcellini argues that connection to the grid is allowed and necessary for the energy balance. An I-ZEB uses traditional energy sources when on-site generation does not meet the loads. When on-site generation is greater than the building’s load, excess electricity can be exported to the utility grid. This prevents oversized energy production from renewable resources. By connecting to the grid, according to the definition it is still possible to realize an I-ZEB, even if you use fossil fuels during peak demand. The appropriate term for this is Net-I-ZEB (Torcellini, et al., 2006).

Also the IEA acknowledges that with the existing technology, the off-grid approach has been and still is a technical, economical and ecological challenge for most applications. The Net-I-ZEB approach, with connection to the utility grid, is therefore necessary. In this Net-I-ZEB, the focus is on achieving an annual balance of energy supply and demand through interactions with utility grids and other utilities such as community energy systems (Voss, K. et al., 2007).

The final author that will be described in this paragraph is Madsen. She mentions in her paper that three things have to happen to be able to realize ZEBs (Madsen, J., 2007):

1. Setting the goal early and the project team makes integrated decisions;
2. Energy consumption is cut dramatically (efficiency improvement);
3. Investment in on-site (green) power generation.

The big difference with the other authors is option number 1: Setting the goal early and the project team makes integrated decisions. Because of its importance to realize I-ZEB, this option will be explained below by comparing the integral building process (and integral building technology) with the traditional building process.
3.4.1 Traditional building process

The current traditional building process characterizes itself by the big crumbling of activities and the bad mutual harmony of these activities. There is an enormous focus on the lowest production cost of every individual component, without a clear coherence and without a total outline of quality and usage. This leads to sub-optimizations, harmonizing losses, additional work, failing cost, overrunning of budget and time and often an unhappy customer. The causes of these situations are the dominance of the designers (architect and advisors) and the executing parties like the contractor in the beginning of the building process (Zaal, T., 2007).

The architect is mostly one-sided focused on shaping the structural space and not giving attention to the fill-in of the demands of installations. The contractor is mainly concerned about the expensive building's structure. Because of the free market, this leads to contracting based on the lowest price. This results in less attention for modern installation techniques. Other involved parties like finishing- or installation companies are being involved in a much later stage. They can often participate, based on a sparing specifications and sharp prices. This squeezing on price leads of course not to optimal performance. Thinking along with the other parties for delivering the best possible solution is not possible (Zaal, T., 2007). This indicates the traditional building process will not work for realizing I-ZEBs.

Madsen mentions in her paper that setting the goal early and the integral decision-making of the project team is crucial in realizing I-ZEB. Especially the architect and mechanical and electrical engineers as part of the project team have to understand the impact of their decisions. The building has to be designed together with its systems. It is important a project team knows how to work together, and they need to understand that what they do affects what the rest of the team does. A trade-off needs to be made in many cases, and every decision and how it will affect energy consumption must be considered. Details are crucial (Madsen, J., 2007).

3.4.2 Integral building process

In an integral building process, the phases are more going across each other and other parties are involved earlier in the process than compared with the traditional building process. This results in design information that is longer available (see figure below). For example, an installer is being involved in the design phase to make use of his knowledge in realizing an installation, or a contractor who can better assess the execution aspects of new techniques in the design process. Especially with buildings with a high ambition in the field of energy savings and inner climate, an integral building process can have big advantages.

In this integral building process, the participants in the process are brought in on the moment that they can deliver a contribution, dependent on the project. In this manner, the process is organized in such a way an end-product with a good price-quality ratio is developed in the most efficient way (Senternovem, 2009). The difference between the traditional and integral process can be seen in the graph below. The graph shows that using an integral building approach
results in a higher influence, which means parties can better implement their expertise (Senternovem, 2007).

\[ PR = \text{Program of Requirements} \]
\[ PD = \text{Preliminary Design} \]
\[ FD = \text{Final Design} \]
\[ TS = \text{Tender Specifications} \]

Figure 6: Traditional building process vs. integral process (Senternovem, 2009)

### 3.4.3 Integral building technology

To be able to realize an I-ZEB, integral cooperation among the parties is not enough (Versteeg, et al., 2009). An integral design is needed in which not only is looked to the individual components, but to the components as a whole, the so-called system approach (Heijnen, P., et al., 2007).

The Netherlands is already working for many years with the principle of the integral approach. A good example is the Energy Performance coefficient (EPC), introduced in 1995 in the Building act (Bouwbesluit) as an integral energy requirement in which a building has to comply.

Because of the importance of the system approach, this approach is one of the targets of the LT-EOS\(^6\) governmental research program of which the Eindhoven University of Technology is involved. One of the targets in this program is the built environment, both the new and existing building. The research areas are:

1. **System approach in the built environment. Examples are:**
   - Integration of living and work and research on the effects on living and residential concepts;

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\(^6\) The long term energy research subsidy (LT-EOS) brings the quality and knowledge in the Netherlands on a higher level by stimulating the development of new technologies, with the goal to realize a sustainable energy supply. EOS focuses on universities, knowledge institutions and the industry (Senternovem, 2010).
• Studies to intelligent energy systems and installations for alignment of supply and demand (so-called smart buildings).

2. Innovative systems with their components. Examples are:
• Compact, high-efficient storage systems for energy that result in uncoupling of supply and demand;
• Implementing ICT and sensor technology to reduce energy demand;
• Integrated lighting system, advanced insulation materials.

These techniques are under continuous development. Therefore, the examples are limited and are only to indicate the current research goals and possibilities for realizing a system approach (Heijnen, P., et al., 2007).

3.5 Innovation-Development stage 4

The Innovation-Development stage 4 refers to the commercializing of zero energy buildings (ZEBs). In commercializing ZEBs, it is important to gain insight in:
• The important parties involved;
• The advantages of having ZEBs;
• The potential opportunities of ZEBs;
• And the barriers to realize ZEBs that need to be solved or reduced.

This paragraph does not focus specifically on industrial zero energy buildings (I-ZEBs), but on ZEBs in general.

3.5.1 The parties involved

In realizing ZEBs, many parties are involved. These are the demanding parties like the project developers or private developers, supplying parties like the architect, contractor and installer and facilitating parties like the municipality and external advisors. The important parties for realizing ZEBs are listed below.

Building owners/client: These can be commercial institutions (project developers or investors), non-profit organizations (social Housing Corporations) or private clients (Smeets, J., et al., 2007). These parties make the decision to build a ZEB or not.

End users: The end users are the actual parties that are utilizing the building. It is important a ZEB fulfills the expectations of the end-user. If the end-user is satisfied, the chance is higher the building keeps maintained properly and keeps scoring high on energy-saving. Because the end-user is often not the building owner/client, involving the end-user at the start of the building process as part of an integral building process is therefore essential (Pols, J.P., 2009).

Architect: The architect is the person who designs the ZEB. He is responsible for shaping the building and the fit in of the required functions into the building. He stays involved from the initiation phase to the actual delivery (Senternovem, 2009). Because the design is crucial in
realizing a ZEB, the architect needs to have affinity with realizing ZEB and can work properly in an integral team.

**Building physicist:** The building physicist is engaged with the heat, moisture, air transportation, sound and light. He plays an important role in the sustainability of the building, comfort and energy household, and consequently the technical feasibility of the ZEB. Characteristic for his role is the integral contemplation of the building and inner climate. He is normally involved directly from the initiation phase together with the installation advisor to think about energy-saving concepts, and stays involved up to and including the design phase. The physicist normally determines the preconditions for the installations. A good cooperation between the both advisors is therefore essential (Senternovem, 2009).

**Installation advisor:** The installation advisor develops the installation concept and designs the installation, based on the preconditions of the building physicist. The installation includes the climate installation, electrics, lightning, ICT and water- and sewage system. It is important to involve this advisor as early as possible with a close cooperation with the building physicist. The advisor normally stays involved until the delivery (Senternovem, 2009).

**Building manager:** If involved, this manager is responsible for the building process. His main task is to develop the project according to the specifications of the client. He stays involved from the initiation phase until the delivery of the building (Senternovem, 2009). As responsible manager, he plays the most important role in realizing an integral building process, which is needed to realize a ZEB. The better the integral process (aspects of organization, information and communication), the higher the probability the expected aspects of cost, time and quality, including the energy performance of the ZEB will be reached (Maas, G., et al., 2004).

**Building cost advisor:** This advisor is specialized in the determining the cost of the building (on element scale), including installation. Mostly the advisor is being involved at the end of the design phase (Senternovem, 2009). However, in realizing a ZEB the building cost advisor can have an important advising role not only for the investment cost but also for the exploitation cost. Higher investments can result in even higher reduction during the exploitation phase (Francissen, R., 2007). Earlier involvement of the building cost advisor as part of the integral building process is important.

**Contractor and installer:** These parties respectively realize the building and installations. They need to have affinity with building ZEBs, including the specialized installations. Normally these parties are being involved in the realization phase, but earlier involvement is recommended to advise how the ZEB can be built the best (Senternovem, 2009).

**Insurer/financer:** These parties insure and finance the ZEB. They can play an important role in realizing ZEB. Because ZEB offer many loss prevention benefits and are less risky due to higher real-estate value, the insurer and financer can launch products with attractive conditions for ZEB (RICS, 2008).
Valuer/real estate agent: One of their tasks is to value real estate (Makelaarsland, 2010). Because sustainable buildings like a ZEB have a higher market value, real estate agents can advise sellers to take first energy-saving measures to gain higher profits (Eichholtz, P. et al., 2008) & (Brounen, D. et al., 2009).

External (ZEB) advisor: A specialist in the field of sustainable buildings or even ZEB can be added in the integral building process. This advisor helps in realizing the ZEB in the best and most efficient way. Especially when the parties in the building process don’t have the experience or knowledge required to realize a ZEB, involvement of a ZEB advisor as soon as possible is essential.

Municipality: Depending on the municipality’s climate ambitions, they can play a very important role in realizing ZEB within their municipal boundaries. They can inform, make agreements, stimulate financially, prescribe or facilitate in making buildings more sustainable or even zero energy (Senternovem, 2004).

Energy supplier: An energy supplier delivers the energy to companies or consumers. The energy supplier purchases this energy from producers or brokers. The energy consumers can choose freely their energy supplier, which can be very interesting for ZEB-owners (Consuwijzer, 2010). Certain energy suppliers have the possibility to deliver green energy. Additionally, the conditions and price that suppliers offer for the delivering of electricity back to the electricity/utility grid, differs.

### 3.5.2 Advantages of ZEBs

**Reduction greenhouse gasses:** By lowering the energy demand, improving efficiency and usage of renewable energy sources, the usage of fossil fuels is reduced (MRA, 2008).

**Reduction in exploitation cost:** Because less energy is consumed, the energy bill is lower. The expectation is that the prices of fossil fuels will become even higher, which makes investments in additional energy reduction measures even more attractive (MRA, 2008).

**Better and healthier climate indoors:** By having optimal climate installations for every situation and the removal of polluting sources resulting from an integral building process and technology, the productivity of the building users can improve with 15%, the sickness absence reduces, and the general satisfaction improves (Profnews, 2010), (Senternovem, 2010).

**Reducing dependency on fossil fuels:** By realizing ZEBs, which make use of renewable energy sources, the dependency on depleting fossil fuels is reduced. By using renewable energy sources the energy prices become more stable and the supply is ensured (PDE, 2008).
3.5.3 Opportunities of ZEBs

Image improvement: By investing in a green or even energy neutral building, the image of the building owner improves and contributes to ‘Social Responsible Management’, in Dutch: ‘Maatschappelijk Verantwoord Ondernemen’ (Senternovem, 2010).

Higher selling and rental price: The greener a building is being built, the higher the selling price will be. For an average building with a green label, the absolute additional selling price is increased with 8385 Euro (Brounen, D., et al., 2009). The same results apply also for rental buildings. The rents are higher, the occupancy levels are higher and the renters stay longer (Eichholtz, P., et al., 2008).

Stimulating innovation and employment: To realize ZEBs, existing technologies have to be improved and new technologies have to be developed in the field of efficiency improvement, demand reduction and renewable energy sources. Also improvement in the building process is required. This results in innovation demand and extra employment for companies, which have a positive influence on the national and regional economy like Brainport/Noord-Brabant (Milieudefensie, 2010).

Connection production process: Looking at industrial buildings, several have opportunities other buildings do not have thanks to its production process taking place inside the building. The residuals of the production process like cold, heat, residues for fuel and burning of high calorific residues can be used to heat or cool the building itself (PEGO, 2009).

3.5.4 Barriers of ZEB

Insufficient technology: The technologies that are being used are currently insufficient developed or are being seen as a technically/financially risk. Innovation is lacking, which is a result of the incidental character of the building process, discontinuity of the building teams (PEGO, 2007) and the claim-culture. The existing claim-culture in the built environment results in using only proven technologies and processes by the builders as well as the customers. (Lindt, M. van de, et al., 2008) Co-development of industry and knowledge institutes is taken place in a limited way (Versteeg, et al., 2009).

Limited integration of technology: The performance ambitions for integral building and area concepts require mutually harmony of the different technologies. There are insufficient examples for such connected system concepts (Versteeg, et al., 2009). The fragmented building chain lacks the view on system- or living concept level. A building is still not seen as a product of connected and mutual strengthening components, but rather seen as a combination of individual components. Innovation is therefore also taking place on only individual component level (PEGO, 2007).
No proper standards and methodology: Proper standards and methodology are missing to determine sustainability (Lindt, M. van de, et al., 2008), which results in no benchmarks and innovation (Vink, A., 2009).

High investment costs: The high investment cost to make a sustainable building, is an important barrier, especially for ZEB. Developers are not all convinced the higher investments are being retained by the higher selling price or rent or lower exploitation cost (Vink, A., 2009). Besides, generally it is the user who benefits the energy saving measures, not the investor if not everything can be implemented in the selling price or rent (Lindt, M. van de, et al., 2008). A switch is needed from minimizing the investment cost toward maximizing the value in the exploitation phase.

Limited demand and knowledge: The knowledge of and the demand for energy-efficient building concepts from end-users and building actors is insufficiently present. Because there is no early market (supply-side) and no early adopters (demand-side), the step from prototype towards market product does not exist (Versteeg, et al., 2009). Besides, there is not a clear understanding of the definition of an energy neutral building, which results in no demand.

Traditional building process: Making buildings zero energy implies an integral building process, in which parties steer on values instead of cost. This is not possible within the current culture of the building industry because it faces institutional barriers. The required cooperation in the organization of the building process including finance is still not tailored on this integral approach (Versteeg, et al., 2009). The decisions in the process are made by various actors with its own aims and interests (Bueren, E. van, et al., 2007). The focus is still on cost- and risk reduction, which reflects in a fragmented building process (Lindt, M. van de, et al., 2008). This barrier is seen as the major obstacle in the sustainable built environment (Bueren, E. van, et al., 2007).

The industry focuses on core-business: The industry is not willing to take the leading role in supplying waste/residual heat, resulting from their company processes, to third parties. They want to stay focused on their core-business (RET, 2008).

Unreachable energy performance: The energy performance that can be realized theoretically, is often not reached in practice. This is caused by the unclear systematical monitoring. The monitoring focuses on improving the concepts, but this takes place insufficiently (Versteeg, et al., 2009).

Unclear cooperation: A clear cooperation is missing between the front-runners (mix of knowledge and financial institutions and market actors) that connect the construction industry with the energy industry. There are also insufficient incentives for integral cooperation between parties that can take away the institutional barriers (Versteeg, et al., 2009).

Rebound-effect: This term means that a measure aimed at reducing environmental impacts induces a (behavioral) response that offsets the intended effect of the implemented measure.
An example is the efficiency measures of dwellings that are not working properly. Energy usage still grows absolutely because the living standard/luxury rises (Bueren, E. van, et al., 2007). Another example is the introduction of the economy lamp (spaarlamp), which resulted in using low energy consuming lights on places that were not necessary like in gardens. This resulted absolutely in more energy consumption instead of less.

**No Sense of urgency:** The consciousness and sense of urgency for the green ambitions is limited. This is mainly caused by the relative low energy prices (Lindt, M. van de, et al., 2008) and the bad reflection of the scientific reports and political agreements in building and planning resulting in low commitment (Bueren, E. van, et al., 2007).

**Unreliable government:** The government speaks nice words, but lacks in making clear choices. An example is the abolition of the subsidy on solar energy systems in 2003 (Eco-express, 2010). Project developers and other parties are cautious in investing in subsidized technology, because they do not know if the subsidy is still available when they need it. Additionally, the governmental rules are experienced fragmented and are not fitting in with each other properly (Lindt, M. van de, et al., 2008).

**Regulation:** building and environmental permit trajectories are long and costly in case of non-standard buildings/technology. E.g. for wind turbines (UWTs), a building permit is necessary. But wind turbines are mostly not integrated in a zoning plan, which results in a long permit trajectory with high fees and project cancellations (Cace, et al., 2007). The same applies in case an environmental permit is necessary for e.g. heat- and cold-storage (LEI, 2008).

**Circle of blame:** The differentiated building process and the different interests of the involved parties results in the circle of blame (Lindt, M. van de, et al., 2008).

The circle of blame is a vicious circle in which all the participating parties in the built environment avoid their responsibilities and blaming each other for the lacking of sustainable real estate (Sijbrandij, J., 2009).
The goal is to break this circle of blame and to move toward a circle of engagement. There are enough possibilities to realize this as can be seen in the graph below. However, the problem that the market faces today is that the feedback mechanisms, which can encourage and facilitate change, are not yet fully in place. To realize this, everyone involved needs to be provided with appropriate feedback on the environmental aspects and social aspects of the building performance, as well as on its various interrelations with financial performance and property value (RICS, 2008). How to do this exactly is beyond the scope of this thesis. This thesis only focuses on municipalities vs. industrial entrepreneurs in which the feedback will be taken into account.

![Circle of engagement with feedback mechanisms](RICS, 2008)

3.6 **Innovation-Development stage 5**

This Development stage is about the diffusion and adoption of an innovation, in this case I-ZEBs. Because of its importance, this stage will be explained separately in the next chapter, chapter 5.

3.7 **Innovation-Development stage 6**

This Development stage reflects on the consequences of the adoption or rejection of the innovation on the individuals or social system. Because I-ZEBs are still in their child shoes and not many I-ZEBs have been realized yet, it would be speculative to talk about the consequences. Therefore, this thesis does not explain this stage any further.
3.8 Conclusion

This chapter gave an answer on the sub question (1.2): What are the steps needed to successfully realize an I-ZEB?

To be able to successfully realize an I-ZEB, the following steps are needed:

- First reduce the demand in energy (energy savings), secondly maximize the usage of renewable energy sources and finally use fossil fuels in the cleanest possible way. In using renewable energy sources, first sources should be used that are available within the building’s footprint (e.g. solar panels), secondly sources available at the site (e.g. wind turbine), thirdly using sources available off site to generate energy on site (e.g. biodiesel) and finally renewable energy sources should be purchased off-site (e.g. green energy).

- It is important an I-ZEB stays connected to the power grid. This allows peak demands can be absorbed and overproduction of renewable energy can be given back to the grid so that on a yearly basis no net import of fossil or nuclear fuel is needed. This is consistent with the definition of I-ZEBs.

- Integral building process is necessary to (re)develop an I-ZEB. With this approach, the goal is set early and the project team makes integrated decisions.

- Realizing a ZEB, or an I-ZEB in specific, is difficult. There are many advantages and opportunities, but also many barriers. It is essential the usage of the advantages and opportunities are maximized, and the barriers have to be compensated, reduces or solved. A proper feedback mechanism about these advantages and opportunities is therefore needed that can encourage and facilitate change towards I-ZEBs.
4 Innovation-development stage 5: Diffusion and adoption

4.1 Introduction
The previous chapter explained the steps needed to successfully realize I-ZEBs by using the Innovation-Development process, developed by Everett M. Rogers (Rogers, E., 2003). This chapter describes specifically the 5th stage of the Innovation-Development process, the diffusion and adoption, to be able to answer the following sub question (1.3): What are the steps needed to successfully implement an I-ZEB in the market?

4.2 Diffusion & Adoption
Rogers's definition of diffusion is: "the process in which an innovation is communicated through certain channels over time among the members of a social system". Diffusion is a special type of communication in which information is exchanged about a new idea. The diffusion can be intended or unintended. The rate of adoption is the speed by which an innovation spreads throughout the system (Rogers, E., 2003).

The diffusion and rate of adoption depends on many variables, which will be explained in separate paragraphs including the relationship with I-ZEBs.

4.2.1 Characteristics of innovations
The speed of the diffusion and adoption of an innovation in general, depends on the following five characteristics of innovations (Rogers, E., 2003):

- Relative advantage: The degree to which an innovation is perceived as better than the idea it supersedes. A higher relative advantage results in a faster adoption.
  - For I-ZEB this means the general advantages mention in paragraph 3.5.2. have a positive influence in the adoption rate. But it is crucial to have a good balance between the advantages, so being target specific. For example people who do not have any concern about the environment it should still be possible to get them in I-ZEBs. Focusing on other advantages of I-ZEBs, like reduction in exploitation costs instead of environment, is the solution (Hall, A. van, 2005).

- Compatibility: The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. A higher compatibility results in a faster adoption.
  - The compatibility towards I-ZEBs of the building owner plays an important role. No interest in sustainable building or bad experiences with it lowers the diffusion and adoption. Good communication and giving advice is essential to improve the compatibility.
• **Complexity:** The degree to which an innovation is perceived as relatively difficult to understand and to use. A higher complexity results in a lower adoption.
  
  o The complexity of an I-ZEB can prevent building owners to chose for those buildings. E.g., they are afraid of budget exceeding or bad functioning of the building in the exploitation. Also good communication and advice is essential to limit its complexity.

• **Trialability:** The degree to which an innovation may be experimented with on a limited basis. A higher trialability results in a higher adoption.
  
  o For I-ZEBs, trialability is difficult to fulfill. However, it is easy to try I-ZEBs indirectly by making use of the experience by others.

• **Observability:** The degree to which the results of an innovation are visible to others. A higher observability results in a higher adoption.
  
  o The observability of I-ZEBs is limited. It is difficult to see if a building is actual zero-energy, which lowers the speed of diffusion. Although certain elements of I-ZEBs can be observed easily like wind turbines or solar panels.

To have a fast diffusion of I-ZEBs, the building should approach the five characteristics as good as possible.

### 4.2.2 The Social System

Rogers defines the social system as: "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The members or units of a social system may be individuals, informal groups, organizations and/or subsystems" (Rogers, E., 2003).

The social system forms a boundary in which the diffusion of an innovation takes place. A social system has a social structure (like classes), communication structure (someone talks with someone else) and norms. The norms tell what kind of behavior of an individual is expected in that system and can have a positive or negative influence on adoption. In a social system you have also opinion leaders and change agents (Rogers, E., 2003).

Opinion leaders influence the attitude or behavior of the members in the system. Opinion leadership is earned and maintained by the individual’s technical competence, social accessibility, and conformity to the system’s norms, not its formal position or status in the system. An opinion leader is exposed to different forms of external communication, has a higher social status and is more innovative. He is the center of the interpersonal communication network (Rogers, E., 2003). Opinion leaders can play an important role in stimulating people or entities by influencing them to implement I-ZEBs.

A change agent is someone from outside the system who wants to steer the decisions about the adoption of an innovation and therefore often uses the help of an opinion leader. Change agents are often much heterophilious, compared to the members of the system it wants to
influence (Rogers, E., 2003). Also change agents can contribute in stimulating people or entities by influencing them to implement ZEBs, although the impact is lower than by opinion leaders.

There are three types of innovation-decisions (Rogers, E., 2003):

- **Optional innovation-decisions:** Choices to adopt or reject an innovation that are made by an individual independent of the decisions of the other members of the system (but still can be influenced by the norms of the system and interpersonal communication).

- **Collective innovation decisions:** Choices to adopt or reject an innovation that are made by consensus among the members of a system. All units in the system usually must conform to the system's decision once it is made.

- **Authority innovation-decisions:** Choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise. An individual member of the system has little or no influence in the authority innovation-decision.

The fastest way to adopt/implement (or reject) I-ZEBs is by using authority innovation-decisions, followed by the collective decision. Slowest is the optional innovation-decision.

4.2.3 Communication

For the diffusion of innovation, at least the following elements are needed (Rogers, E., 2003):

- An innovation;
- An individual or other unit of adoption that has knowledge of, or has experienced using, the innovation;
- Another individual or other unit that does not yet have knowledge of, or experience with, the innovation, and
- A communication channel between the two.

A channel is the way by which a message gets from the source to the receiver. Scientists divide communication channels into two categories, which play different roles in creating knowledge versus persuading individuals to change their attitude towards an innovation (Rogers, E., 2003):

- **Interpersonal channels** or mass media;
- Coming from localite or cosmopolite sources.

**Mass media channels:** are all those means of transmitting messages that involve a mass medium (radio, television, newspapers, and so on.), which enable one or a few individuals to reach an audience of many. Mass media is suitable for reaching a large group of people, to create knowledge and spread information and to cause changes in weak attitudes.

**Interpersonal channels:** involve a face-to-face exchange between two or more individuals. Interpersonal channels are suitable to form or cause changes in strong attitudes and to clarify for an individual an innovation of another individual.
Localite sources: are sources from inside the social system and cosmopolite sources are sources outside the social system.

Especially interpersonal channels are effective for diffusion and so eventual adoption. Most people leave their choice to adoption of an innovation dependent on personal subjective evaluations of people like themselves who already have adopted the innovation. The communication is more effective if it’s coming from localite sources, from congeners. The more similar they are, the bigger the effect. In general it can be stated that mass media channels and cosmopolite sources are important to create awareness of I-ZEB. Interpersonal channels and localite sources are important in the persuasion stage in actually realizing them (Rogers, E., 2003).

Also people or entities differ in their innovativeness. Globally two categories can be identified, the early adopters and the rest. Between those two, major differences exist such that the diffusion of innovation can be hindered. The early adopters are more enthusiasts, while the rest is more calculated, which result in a difficult task for the early adopters to persuade the rest. Mass media channels are relatively more important than interpersonal channels for earlier adopters than for later adopters. Cosmopolite channels are relatively more important than localite channels for earlier adopters than for later adopters (Rogers, E., 2003).

In general it can also be said that larger firms are implementing more innovations than smaller firms (Dieperink, C. et al., 2004).

Taken into account the above, it is therefore essential to have the right communication channel from the right source to get an effective and efficient diffusion and adoption of innovations, in this case I-ZEBs.
4.3 Conclusion

This chapter gave an answer on the sub question (1.3): What are the steps needed to successfully implement an I-ZEB in the market?

To be able to successfully implement I-ZEBs in the market, the following variables are important:

- The 5 characteristics of innovations: relative advantage, compatibility, complexity, trialability and observability. The lower the complexity and the higher the other characteristics, the higher the probability will be that I-ZEBs are being adopted.
- Larger firms are implementing more innovations than smaller firms. The easiest way to implement I-ZEBs, are therefore in bigger firms.
- Social system: Opinion leaders, and change agents in a more limited extent, can play an important role in influencing the behavior or attitude of entities or people to implement I-ZEBs.
- I-ZEBs can be implemented in the fastest way by using authority, followed by a collective decision. The slowest way to implement I-ZEB is by leaving the choice to the entity himself.
- Communication: Interpersonal communication by congeners to convince/persuade people to realize I-ZEB. Mass media by non-congeners to create awareness of the existence of I-ZEBs. The less the people or entities are innovative, the more important is the interpersonal communication by congeners and vice versa.
5 Public policy

5.1 Introduction

The previous chapter explained how I-ZEBs can be implemented in the market. To be able to answer the main question, this chapter gives an answer on the following sub question (1.4): What is the definition of a policy and how does the policy process looks like?

5.2 Definition

There are many definitions about policy, but one of the most common definitions of policy is the definition of Hoogerwerf (1979): “Policy is the deliberate and purposeful act, aimed at achieving certain purposes with certain means in a certain time sequence”. The means can be subsidy, norms, legal regulation and so on. The definition implies that policy is a process and asks for planning (Bosch, F. van den, et al., 2004) & (Hoesel, P. van, et al., 2005).

5.3 Policy process

The policy process to develop a policy consists of several phases. This policy development focuses on the discovery of instruments that governmental institutions can use to reach their goals in the most efficient way. The phases in the policy process are globally (Bosch, F. van den, et al., 2004) & (Hoesel, P. van, et al., 2005) & (Iedema, R. et al., 2004):

Agenda formation: Is the process through which social problems gain attention of the public and/or policy makers. In this thesis, the concern for the climate and energy crisis plays a central role. These themes are listed high on the social and political agenda.

Policy preparation: Is collecting and analyzing information and formulating opinions with the focus on the possible policies. Taking in mind this thesis topic, the preparation can be a research about the main energy consumers like the built environment, possible energy reduction measures, stimulation tools, and so on.

Policy determination: Is the decision-making about the content of the policy, including choosing and specifying the final goals, the means/instruments and point in times. The policy end goal can be the realization of an energy transition in the built environment to prevent an energy- and climate crisis. The intermediate goal can be the realization of I-ZEBs. The instruments can be regulation, subsidy and so on, during certain points in time.

Policy execution: Is applying the chosen means for achieving the chosen end goals. In this example, executing the realization of I-ZEBs is the intermediate goal, which eventually contributes in the realization of the end goal to realize an energy transition toward a sustainable energy supply.

Feedback: Is the processing of information and evaluation about the content, process and/or effects of a policy and the adjusting of the policy or policy process based on this.

Policy ending: Stopping the pursued policy.
This policy process is of course a simplification of what is actual happening in real-life. Sometimes there is being switched back and forth between the phases, the order of the phases differs or even phases are being skipped in practice.

5.3.1 Policy Execution
The policy execution, as one of the steps of the policy process above, plays an important role in this thesis. The policy execution is explained as the application of the chosen means for achieving the chosen end goals. The means that governments have available are called policy instruments. A policy instrument is hence defined as a mean which the government uses to try achieving a policy goal (Bosch, F. van den, et al., 2004).

In general, the following types of policy instruments can be distinguished (Bosch, F. van den, et al., 2004):

**Legal instruments**: These instruments influence the behavior of civilians by introducing orders and prohibitions with legal sanctions when broken (e.g. law and regulation).

**Economic instruments**: These instruments influence the behavior of the civilians by connecting financial advantages or disadvantages to the behavior (e.g. subsidy, tax).

**Communicative instruments**: These instruments influence the behavior by convincing them that a certain behavior is (un)wanted or (un)dangerous (e.g. education).

**Structuring instruments**: These instruments are indirect instruments in which not the way how behavior is being influence is the central theme, but actually the input of other instruments steers or supports (e.g. policy plans, information management).

It is important the government chooses the right instruments that provide the best means to realize the proposed goals. A mix of instruments can be needed.

Choosing and applying the right instruments is essential to execute the energy- and climate policy effective and efficient. An effective policy is the ability to achieve the goals, an efficient policy is the high ratio of effective output to the input required to achieve it (Robbins, S. et al., 2007).

5.3.2 Policy reflection
Despite the advantages and governmental programs for ZEBs, still there are many barriers that prevent its breakthrough. The barriers show that the policies to promote sustainable development in general are not effective. This is also noticed by Van Bueren and De Jong (2007). They see the institutionally fragmented context of the design, construction, exploitation and maintenance of the built environment as the main cause of this bottleneck, the so-called traditional building. The authors mention several lessons that can be of use in developing policies for a sustainable built environment, and so for 1-ZEBs.
The first lesson is to balance attention to processes and substance/content. The content means the sustainable built environment itself like I-ZEBs in specific, and process means the communication and interaction towards a sustainable built environment or I-ZEBs in specific. For planning in general the focus should be more on the content and less on the process to prevent separation of processes and procedures from the content or substance of a problem. Policies for sustainable building should focus on the process, not on the substance to be able to let actors participate. This realizes understanding, support and commitment.

Second lesson is the priority setting in policy processes. There is always the temptation of putting the topic sustainability on the political agenda, but also leaving it there without any further actions when decisions have to be made, and cost and benefits allocated. Policy-makers should push for clear sustainability goals that can be monitored effectively. This makes it possible to grant rewards or impose sanctions. For measuring and monitoring, appropriate instruments and tools are needed.

Third lesson is the need for continued coupling of research and practice. The researchers have to be sure their ideas and models meet the practitioners’ actual needs (Bueren, E. van, et al., 2007).
5.4 Conclusion

This chapter gave an answer on the sub question (1.4): What is the definition of a policy and how does the policy process looks like?

A policy is defined by Hoogerwerf (1979) as: "Policy is the deliberate and purposeful act, aimed at achieving certain purposes with certain means in a certain time sequence". A policy consists in general of the following processes: agenda formation, policy preparation, policy determination, policy execution, feedback, and finally policy ending. The policy execution plays an important role in this thesis. In this phase the chosen means for achieving the chosen end goals are brought into practice. The means or policy instruments a government can use are: legal instruments, economic instruments, communicative instruments and structuring instruments.

Choosing and applying the right instruments in a good mix is essential to execute the energy- and climate policy effective and efficient. An effective policy is the ability to achieve the goals, an efficient policy is the high ratio of effective output to the input required to achieve it.

There are still many barriers in the field of sustainable buildings, and so I-ZEBs. These show the policies to promote sustainable development in general is not effective. Several lessons can be learned:

First lesson: In (policy) planning, the focus should be on the content, e.g. I-ZEBs, less on the process. In policy execution to achieve certain purposes like I-ZEBs, the focus should be on the process, less on the content.

Second lesson: Policy makers should push for clear sustainability goals like realizing I-ZEBs, with effective monitoring, to grant rewards or impose sanctions.

Third lesson: A continued coupling is needed between research and practice.
SECTION 2: CASE STUDY

This section displays the result of the interviews, held with the municipalities and industrial companies. It is an extensive description to get answers on the last sub questions to be able to generate an in-depth understanding about the current municipal energy- and climate policy execution and the companies' satisfaction about this policy.

The focus is especially on the current policy execution, not the future. The future is too uncertain to also take this into account. The (regional) economy, the environmental status of the earth, new technologies, priority settings in national and municipal politics, etcetera have a huge influence in the future municipal energy- and climate policy. This is also mentioned by the municipalities themselves, which can be seen in their energy- and climate plans. These plans are flexible and can be adjusted and changed in all directions. Therefore the choice is made to only focus on the current energy- and climate policies to prevent this thesis becomes too speculative.

In this Section 2, the insights gained from Section 1: Theory will also be used where needed. E.g. this is essential to make good question lists for the respondents and to be able to have a good reflection afterward.

The conclusions mentioned in this Section 2 will be reflected on the conclusions of Section 1: the Case study. This reflection will be done in Section 3: Reflection. This reflection can be found in chapter 7, which acts as the preconditions for the eventual model (chapter 8).

6 Case study

6.1 Scope of interviews

The previous chapter explained what a policy is, how the policy process looks like and what lessons can be learned. This chapter will answer the remaining sub questions to be able to solve the main question. To be able to answer these final sub questions, the case study approach will be used. Six municipalities in Noord-Brabant will be investigated by interviewing two relevant people: Municipal officials and industrial entrepreneurs. The goal is to interview at least two companies per municipality and at least two municipal officials per municipality. For the interview, semi-structured questions will be used which allow for focused, conversational, two-way communication.

The municipalities that are being interviewed are: Tilburg, s' Hertogenbosch, Eindhoven, Boxtel, Waalwijk and Geldrop-Mierlo. The choice for these specific municipalities is based on their high ambitions for the environmental- and energy topic, which can be seen on the websites of www.klimaatkaart.nl & www.duurzaamheidsmeter.nl and of course their energy- and climate policies. The expectation is that focusing on ambitious municipalities gives the best options in
answering the sub questions. Besides, if improvements can be made in ambitious municipalities, these improvements will certainly apply on less ambitious municipalities.

Also a distinction is made between big (>100,000 inhabitants) and small municipalities (<50,000 inhabitants). The expectation is that there are interesting differences in their approach although they have the comparable high ambitions. The results can be found in the following paragraphs.

Finally, before looking at the municipalities, it is worthwhile to have knowledge about the (current) energy- and climate policy on international and national level because these higher level policies are influencing the municipal policies. To give an example, the SLOK-arrangement, resulting from the signed covenant between State government and the municipalities, subsidizes municipalities to stimulate the realization of energy saving plans (VNG, 2007). The knowledge about national and international energy- and climate policies does not play a vital role in this thesis. Therefore the explanation is included in the Appendix, paragraph 11.1 etc.

6.2 Introduction
This chapter gives an answer on the following sub questions to be able to answer the main question at the end. The sub questions are:

2.1 What does the comparison look like of the current climate- and energy policy executions of certain big municipalities?
2.2 What does the comparison look like of the current climate- and energy policy executions of certain small municipalities?
2.3 What does the comparison look like between the big and small municipalities in their current climate- and energy policy execution?
2.4 What are the entrepreneurs' general (non-municipal specific) opinions on the energy- and climate policy execution?
2.5 What are the entrepreneurs' advantages, barriers and opportunities in taking measures for realizing 1-ZEB?

6.3 Interview setup
In total 12 companies are being interviewed in 6 different municipalities. To get a good overall understanding about the industrial companies' advantages, barriers, opportunities and satisfaction about their municipality, the choice for the companies is based on the following criteria:

- Willingness to participate;
- Industrial activities (good mix in between industrial activities);
- Size (good mix between big and small companies);
- Ambition (good mix between high and low ambitions);
- Location on a business location that is being regenerated (except for Geldrop-Mierlo).
Where possible, the interviews with the municipal official will be done with someone from the department of Economic Affairs for insights in the relationship with companies, and someone from the department of Environment, for insights in the municipal energy- and climate policy. Where possible, the interviews with the companies will be done with the CEO or at least with someone who is in the position to decide about the energy- and climate policy in the company.

To be able have a proper structure, the interview results of the municipalities and industrial companies are following specific aspects. These aspects are the result of the insights gained from section 1: Theory. In this way a good reflection can be made possible in Section 3 (chapter 7) between the Theory and Case study, to be able to make statements how the municipality can improve their energy- and policy execution. The aspects are being explained in the following specific paragraphs below.

There are differences between the several aspects of the municipalities and the industrial companies. This has to do with the fact that the focus differs between the results of the interviews with the municipalities and the interviews with the companies. In case of the municipalities, the results focus on the six municipalities to search for specific similarities and differences. In case of the companies, the results do not focus specifically on individual municipalities to be able to give a general reflection of the companies' opinions.

For this approach is chosen because of two reasons. First of all, the specific opinions of the industrial companies on their municipality (=satisfaction) are already implemented in the results of the interviews with the municipalities. This is needed to be able to compare the municipalities with each other. Secondly, by splitting up the interviews with the companies in municipal satisfaction and general opinions will result in better preservation of the interview details.

6.4 Interview results

The following paragraphs show the results of the interviews and are a direct answer on the sub questions. A summary of every interview and the elaborated interviews can be found in the appendix, paragraph 11.4 etc.

To be able to answer the sub questions 2.1, 2.2 and 2.3, both the interviews with the municipal officials and the industrial entrepreneurs are used if possible. This gives better possibilities to compare the municipalities with each other by implementing the satisfaction of the entrepreneurs. Only the satisfaction of the company is included if it points directly to the company's own municipality or if it is a direct answer on that specific aspect. Although the municipalities differ in ambition level and organization, in this way it is still possible to compare the municipalities thanks to the implementation of these entrepreneurs' satisfactions.

To be able to answer the sub questions 2.4 and 2.5, only the interviews with the entrepreneurs are being used. The results show in general the reflection of the entrepreneurs on the municipal policy execution without being specific about their own municipality and show the advantages, barriers and opportunities (based on Section 1: Theory) the entrepreneurs face.
6.4.1 Big municipalities: Tilburg vs. Eindhoven vs. 's Hertogenbosch

In this paragraph the following sub question will be answered:

Sub question 2.1: **What does the comparison look like of the current climate- and energy policy executions of certain big municipalities?**

For the interview results with the municipalities, these aspects are:

- **Ambition:** This aspect describes the ambition levels of the municipalities in their energy- and climate policy;
- **Organization:** This aspect describes how the municipal organization functions in executing their energy- and climate policy;
- **Legal instruments:** This aspect describes what the municipal possibilities are in public and private law- and regulation to realize I-ZEBs;
- **Financial instruments:** This aspect describes what the municipal possibilities are in providing financial incentives to realize I-ZEBs;
- **Communication:** This aspect gives insights in the communication with the industrial entrepreneurs about topics in the field of I-ZEBs;
- **Monitoring:** This aspect describes how the municipality monitors the results of their energy- and climate policy;
- **Regeneration vs. Sustainability:** This aspect describes how the municipality deals with the topic 'sustainability' in regeneration projects of business locations;
- **Integral (re)build:** This aspect describes if and how the municipality can stimulate companies to realize their buildings in an integral approach;
- **Municipality as (building) advisor:** This aspect describes if the municipality can play an advising role during the realization of buildings.

### AMBITION:

<table>
<thead>
<tr>
<th>Relative ranking (1 = best)</th>
<th>1. Eindhoven</th>
<th>2. Tilburg</th>
<th>3. 's Hertogenbosch</th>
</tr>
</thead>
</table>

All three municipalities have different goals. Eindhoven wants to be energy neutral (zero energy) in 2045, 's Hertogenbosch wants to be climate neutral in 2050 and Tilburg wants to be climate neutral and climate proof in 2045. Eindhoven has the highest ambition, but is the least in their policy execution and organization of the three to realize the goals. 's Hertogenbosch describes their goals as political goals, reaching them are less important. Tilburg is on track to realize their goals.

### ORGANIZATION:

<table>
<thead>
<tr>
<th>Relative ranking (1 = best)</th>
<th>1. Tilburg</th>
<th>2. 's Hertogenbosch</th>
<th>3. Eindhoven</th>
</tr>
</thead>
</table>

The three municipalities have its own specific organization to execute their energy- and climate policy. In Eindhoven 4 people of the department Environment working on the execution of the
policy in which there is currently 1 fulltime project manager and a coordinator for all 76 specified projects. They work quite independent from the other departments and searching for internal contacts in other departments.

In 's Hertogenbosch 4 people (3 FTE) are executing the energy and climate policy in an informal organization with much freedom to start project/exploit opportunities. There is cooperation with almost all departments.

In Tilburg they have a climate team for executing, guiding and initiating the program, but this is more and more shifting toward a climate community with 8 alliances (klimaatschap) in which the municipality and other (private) parties are involved.

### LEGAL INSTRUMENTS:

<table>
<thead>
<tr>
<th>Relative ranking (1 = best)</th>
<th>1. Tilburg</th>
<th>2. 's Hertogenbosch</th>
<th>3. Eindhoven</th>
</tr>
</thead>
</table>

In public law, all three municipalities mention the Environmental Law and the Building regulations as public legal instrument. Only Eindhoven does not use the possibility to force companies to implement measures with a payback time of 5 years or less. 's Hertogenbosch goes even further by implementing unenforceable additional restrictions in zoning plans for awareness.

In private law, 's Hertogenbosch and Tilburg make use of unenforceable agreements and indirect measures, Eindhoven not and they see itself as a missed opportunity.

Most of the companies mention the same legal instruments as the municipalities. The companies in Tilburg are really happy with the support and efforts of the municipality in realizing permits, but one company found it difficult dealing with the inconsistency between municipality and province and who was the responsible authority in dealing with permits, which resulted in barriers. A company in 's Hertogenbosch finds in unfair company Heineken has the monopoly for using ground water for cooling.

### FINANCIAL INSTRUMENTS:

<table>
<thead>
<tr>
<th>Relative ranking (1 = best)</th>
<th>1. Tilburg</th>
<th>2. Eindhoven</th>
<th>3. 's Hertogenbosch</th>
</tr>
</thead>
</table>

's Hertogenbosch and Eindhoven don't have any financial instruments in this field. The budget is limited in 's Hertogenbosch, and focuses on the organizing of platforms, business location policy, workshops and so on. Eindhoven sees opportunities in green loans and fiscal measures. Tilburg does have a specific subsidy amount for the provincial pilot project, besides provincial subsidy, (Energy neutral business location on Vossenberg) to help companies to become energy neutral/zero energy.
All three municipalities make use of mass media and have close contacts with the entrepreneurial organizations. All three municipalities have account managers as contact person towards companies.

In Tilburg there are 11046 companies, of which 729 are industrial companies. The municipality has 4 account managers specialized in business locations. 2 junior account managers for the inner districts, 1 account manager for the warm contacts for companies outside Tilburg, and 1 account manager for the cold contacts for companies outside Tilburg.

In Eindhoven there are 14307 companies, of which 767 are industrial companies. The municipality has 1 account manager specialized in companies and business locations, 1 account manager for international promotion and acquisition, 1 account manager for the creative industry and several other account managers for other sectors. The municipality also has an assistant account manager for supporting the other managers.

In ‘s Hertogenbosch there are 10100 companies, of which 470 are industrial companies. The municipality has 2 specialized account managers for companies and offices (promotion and acquisition).

The topics energy/climate/sustainability are structural topics for the account managers and entrepreneurial organizations in Tilburg (BORT), and in ‘s Hertogenbosch the topics are becoming more important. In Eindhoven the topics are the least implemented. Eindhoven has only 1 account manager for the whole municipality. Eindhoven is implementing case management because they noticed companies want 1 window (1 case manager) where they can go to for all questions and to make sure everything goes to the right window. Tilburg is opening a climate bureau where inhabitants/companies can go to with their questions.

In Eindhoven en ‘s Hertogenbosch there is no official consultation for companies in the municipal energy and climate policy, but in ‘s Hertogenbosch there will be a voice for companies during the coming workshops. In Tilburg the consultation is already implemented in the climate community with the alliances.

All companies in the three municipalities want more communication e.g. park management or entrepreneurial organizations. For the companies in Eindhoven it is not clear what the municipality is doing and how. Improvement in communication about the specific plans is wanted. The companies in Eindhoven want to have a voice in the policy plans to talk about it and give their opinion. Eindhoven should keep informing the audience about the possibilities, because the unfamiliarity is still big. Also a clear window in Eindhoven is missing e.g. via an account manager. Finally in Eindhoven the relevant websites and windows (e.g. ‘meer-met-minder’ window) are not known. In Tilburg the communication works perfectly because
companies can go to 1 account manager who arranges everything. The contact goes much smoother than in Eindhoven. This can be explained that in Tilburg relatively more account managers are available for industrial companies than in Eindhoven.

In Tilburg a company whishes a newsletter e.g. via email, about specifically what’s happening on the business location itself in one glance like maintenance or activities taking place. Tilburg should be more taking the initiative instead of BORT and should provide more handles for companies. A better contact is needed between BORT and municipality of Tilburg concerning energy/climate/sustainability and more personal contact is whished about the municipal plans and policy in this field. Sometimes it is difficult the knowledge is limited in the municipality and they work as a hatch for the advisory bureaus. The activity, meetings and reflection toward companies from the climate community/alliances need to be intensified and more progress has to be made.

<table>
<thead>
<tr>
<th>MONITORING:</th>
<th>Relative ranking (1 = best)</th>
<th>1. Tilburg</th>
<th>2. 's Hertogenbosch</th>
<th>3. Eindhoven</th>
</tr>
</thead>
</table>

All three municipalities find it important to monitor their efforts. Eindhoven is not monitoring at this moment but is doing so in the future. 's Hertogenbosch is looking as much as possible to the results of their direct measures. Tilburg is a forerunner in monitoring and is also involved in a national pilot to think about monitoring. Tilburg finds it difficult to gain all necessary information (internal as well external) to monitor properly. According Tilburg, knowing everything exactly is less important than taking measures.

Not a single company has problems in showing the energy consumptions to the municipality. Especially not for monitoring in this field. One ambitious multinational company estimates there is a high chance of success if looking at how many energy companies consume and produce sustainable themselves, and connecting this with a reward in fiscal advantages/lower energy taxes, e.g. if they are 20% zero energy. A Municipal sustainable energy company can play a major role in this.

<table>
<thead>
<tr>
<th>REGENERATION VS. SUSTAINABILITY:</th>
<th>Relative ranking (1 = best)</th>
<th>1. 's Hertogenbosch</th>
<th>2. Tilburg</th>
<th>3. Eindhoven</th>
</tr>
</thead>
</table>

In all three municipalities in regenerating business locations the energy/climate topic has no top priority for Economic Affairs. For Tilburg and Eindhoven the reasons are the limited capacity, means/money and the focus on the upgrading, the improvement of accessibility, public quality, etc... Tilburg is still looking for opportunities for energy efficient buildings and explaining to companies the eventual savings in money and image improvement. In Eindhoven the BZW (a regional collective of entrepreneurial associations) is more focusing on these topics, and they think this works better and is more preferable to companies. Eindhoven finds regeneration a good moment to implement the moving scan (verhuisscan).
In ’s Hertogenbosch the municipality is discussing what to do in this energy-climate topic on business locations. But there is a commission group from the business location itself, in which someone from Economic Affairs is included, to look for opportunities. Every significant project goes always to the department of Environment for advice.

All companies in the three municipalities don’t have any knowledge about the regeneration, or only have basic knowledge something is/will be happening. Some companies would like to come in contact with the responsible organization to debate the best options and they want to have more information what will be happening to be able to anticipate as a company. Some companies don’t want any contact or only via the park management organization.

INTEGRAL (RE)BUILD:
This is not discussed with Eindhoven, but the municipalities of Tilburg and ’s Hertogenbosch see it as the responsibility of the client/entrepreneur itself, not the municipality to realize building in an integral manner. ’s Hertogenbosch mentions that the government should be more clear and consequent from the start e.g. zoning plan and communication, allocation, purchase agreement and actions have to be done on natural moments. Also a better alignment between departments on the topic of energy efficient building is needed. Tilburg sees a role for their account managers to instruct clients/entrepreneurs and referring them to the climate bureau. Most companies see it also as a responsibility for them. They find it important but many see also a role for the municipality to steer or inform about the advantages and opportunities.

MUNICIPALITY AS (BUILDING) ADVISOR:
The municipalities of Tilburg and ’s Hertogenbosch don’t see the municipality as a party in this. ’s Hertogenbosch mentions that the municipality needs to be clear and consistent and their role should be in stimulating and bringing parties into contact. They do that via ‘Bossche Bedrijven Besparen’. Eindhoven sees a role in this for the new municipal sustainable building advisor if he is specialized in industrial building, and Tilburg sees a role for the climate bureau as the knowledge node in the municipality for clients.

The opinions of the companies in this are much differentiated. The opinions differ from no advisor because it is not relevant in their business, too costly or want to do it their selves, towards approval for an advisor. But one says not by the municipality because of their limited knowledge, another wants to be the municipality as an initiator and another only wants an advisor if it’s free.
6.4.2 Small municipalities: Boxtel vs. Waalwijk vs. Geldrop-Mierlo

In this paragraph the following sub question will be answered:

Sub question 2.2: **What does the comparison look like of the current climate- and energy policy executions of certain small municipalities?**

### AMBITION:

|-----------------------------|-------------|-----------|-------------------|

All three municipalities have different goals. Waalwijk wants to be climate neutral in 2043, Boxtel has a 100 step strategy towards sustainability and strive towards co2-neutral managing and Geldrop-Mierlo doesn’t have a specific goal, but do have a fixed climate policy every 4 years, focused in reducing greenhouse gasses. All three municipalities are on track, but Waalwijk mentions the date is less important, it can be sooner but also later.

### ORGANIZATION:

|-----------------------------|-----------|-------------------|------------|

The organizational roots of the three municipalities for executing the energy- and climate policy are different but have similarities in the cooperation between other municipal departments. In Waalwijk there is an energy team (1,2FTE) with 1 project leader and a maximum team of 3 people. A shift is taking place towards involving more departments/sections that have to take up the topic themselves as part of their regular work. The energy team is stimulating municipal colleagues to take actions and have to report to the energy team.

In Boxtel two departments are involved and come together as a group to discuss about the topics. Individual building plans are viewed by both departments.

In Geldrop-Mierlo 1 program manager is responsible for the project executions. Projects are also outsourced or done internally and externally (SRE-Milieudienst).

### LEGAL INSTRUMENTS:

|-----------------------------|-----------|-------------------|------------|

In public law, all three municipalities mention the Environmental Law and Building regulations as public instrument.

In private law, Waalwijk and Boxtel use selling agreements. In Geldrop-Mierlo companies have to show their activities in sustainability or have to do (unenforceable) a sustainability scan if they want to establish on a business location with high ambitions in this field.
FINANCIAL INSTRUMENTS:

The municipalities of Boxtel and Waalwijk don't have the means to subsidize in this. Geldrop-Mierlo provides a sustainability scan with a discount of 50% and free if the companies take measures.

One company in Waalwijk is already fighting for 6 months to get a subsidy for using the residual heat of its dryers, but still got no respond.

COMMUNICATION:

All three municipalities have close contacts with the park management and/or entrepreneurial associations. In Waalwijk and Geldrop-Mierlo there is no structural possibility for companies to have a voice in the municipal energy- and climate policy. In Boxtel companies have a voice via the park management or individually, which will be more going from a reactive to a proactive voice in the future.

The municipalities of Boxtel and Geldrop-Mierlo use mass media e.g. special websites and newsletters, Waalwijk not. In Boxtel, individual companies that come to the city hall, are being informed. Waalwijk specially selects companies for a meeting and the municipality also acts sometimes as intermediary to bring companies into contact with each other. Geldrop-Mierlo has not the time to visit companies individually.

Most companies want more communication with the municipality about these topics. In Waalwijk a company mentions the municipality doesn't communicate about this topic in the entrepreneurial association and better communication is wanted about municipal goals and possibilities. Another company finds the communication bad.

In Boxtel one company has had good contacts and good experience with the municipality but want to intensify the contacts with the municipality about a voice in their energy- and climate plan. Another company wants more information collectively via the entrepreneurial association to stimulate and how can be worked with less energy. This company also doesn't know the relevant websites.

In Geldrop there is not much communication by the municipality about this, but the companies also have no needs for it. One company mentions better information via internet/mailing for bringing under attention.
The monitoring in all three municipalities is limited. In Waalwijk there is no monitoring and find it more important to grab chances, but should paying more attention to monitoring. Geldrop-Mierlo finds it really difficult to monitor and are waiting for a national tool. Boxtel monitors only via environmental permits. Waalwijk and Geldrop-Mierlo have no authority for getting insights in the company’s energy consumption for monitoring purposes.

Not a single company has problems in showing their energy consumption to the municipality. Most say that the municipality already has insights via the environmental permits.

In Geldrop-Mierlo there are no regeneration activities. In Waalwijk the topic sustainability is sadly not taken into account during regeneration because the regeneration itself is already a difficult process, but they are still searching for possibilities.

In Boxtel much is being done about sustainability in regeneration. It is taken into account in design and ground selling, discussions and cooperation takes place with entrepreneurs. The municipality sees the regeneration as a potential success.

For the companies in Boxtel, the regeneration is known. There is openness to have contact with the responsible organization. Regenerating Ladonk can have opportunities to implement residual heat of the Rabobank Datacenter. This is a task for the municipality.

In Waalwijk, the regeneration is also known. One company is not happy with the regeneration because the business location is defined as bevi-revi terrain, which makes permits more difficult and limits company’s developments. Also the bad accessibility of the terrain is a major bottleneck that needs to be solved. Both companies are not interested to come in contact with the responsible organization. One company finds there is no knowledge and support, another company finds the BOM should come into contact with building owners of deteriorated buildings to convince them to face-lift or demolish the buildings.
INTEGRAL (RE)BUILD:
All three municipalities see it as the client’s/entrepreneur’s responsibility. The municipality has to create the preconditions (facilitating role) or stimulating it. Waalwijk thinks it can help by informing early (e.g. selling brochure) about this possibility and showing successful and functional examples with the advantages.

The companies themselves see it also as their own responsibility, sometimes together with a contractor/architect.

MUNICIPALITY AS (BUILDING) ADVISOR:
All three municipalities don’t see it as their role. Waalwijk finds it difficult when in the process it should be done and the budget is limited. They acknowledge more communication towards companies is needed. Boxtel sees it as the entrepreneur’s responsibility. The municipality can only bring the possibilities under attention and providing the things they have, the entrepreneur has to decide how and what he uses. Geldrop-Mierlo thinks the introduction of the moving scan shortly will cover all possibilities, but they think connecting the moving scan to the current available subsidy can be a good idea. The opinions of the companies in this are much differentiated. The opinions differ from no advisor needed towards approval for an advisor. Those who approve find the high costs a problem.

6.4.3 Big vs. Small municipalities
In this paragraph the following sub question will be answered:
Sub question 2.3: What does the comparison look like between the big and small municipalities in their current climate- and energy policy execution?

This sub question might be interesting to see which differences and similarities there are between the big and the small municipalities, and what they can learn from each other. This sub question is also needed to investigate if a distinction has to be made between big and small municipalities in designing the model of this thesis.

AMBITION:
In general, the big municipalities have more specific targets (e.g. being energy or climate neutral in a certain year) than smaller municipalities. The small municipalities are more focusing in reducing emissions or generally being more sustainable by looking at the available opportunities.
ORGANIZATION:
Logically, the big municipalities have larger organizations to execute the energy- and climate policy but relatively the allocation of resources are comparable between big and small municipalities. Interesting to see is that the more municipalities are working together in their internal organization with other departments, the more successful they are in the execution.

LEGAL INSTRUMENTS:
In the legal instruments, no difference can be detected between small and big municipalities. Regarding public law, all municipalities mention only the environmental- and building permit to e.g. implement energy saving or being more sustainable. Regarding private law, most of the small and big municipalities use (selling) agreements but these are legally not enforceable and are more for creating awareness. Big municipalities do use more indirect measures, but this is mainly because more large-scale projects are being realized in these municipalities which makes indirect measures easier to implement like a sustainable infrastructure.

FINANCIAL INSTRUMENTS:
All municipalities don't subsidize, except 1 big and 1 small municipality, but rather on a small scale. There are no differences between small and big municipalities. The main reason for not subsidizing is the limited means/budget for municipalities.

COMMUNICATION:
All municipalities have close contacts with the entrepreneurial associations/park management and mostly all use mass media for communication e.g. about energy savings. It seems that the small municipalities have more personal contact with companies, but the big municipalities have account managers who work as an intermediary between municipality and companies.

MONITORING:
It is clear monitoring is a big problem in small as well in big municipalities and a specific difference between small and big municipalities cannot be detected. They find it all difficult to monitor and a proper national tool is wished but at the moment taking actions has more priority than monitoring exactly.

REGENERATION VS. SUSTAINABILITY:
Most of the big and small municipalities finds the energy- and climate topic in regeneration not a top priority because of the difficulty of the projects, limited capacity/means and because the focus is mainly on upgrading public terrain and improving accessibility of the business location. No major differences can be detected between small and big municipalities, although Boxtel shows that taking the energy- and climate topic in the regeneration is possible.
INTEGRAL (RE)BUILD:
No specific differences can be detected between the big and small municipalities. All 6 municipalities see integral (re)building as a role for the client/entrepreneur itself, which is also reinforced by the companies. The municipalities do see a facilitating role for themselves.

MUNICIPALITY AS (BUILDING) ADVISOR:
No specific differences can be detected between the big and small municipalities. Most municipalities don’t see it as a municipal role and the companies’ opinion is differentiated in the big as well as in the small municipalities. Although the big municipalities have in general more tools and possibilities that give companies advise than small municipalities.

6.4.4 Entrepreneurs’ general opinion and chances
In this paragraph the following sub question will be answered:
Sub question 2.4: What are the entrepreneurs’ general (non-municipal specific) opinions on the energy- and climate policy execution?

The numbers that are listed in the tables below, represent the amount that topic is being mentioned by the interviewed entrepreneurs.

For the interview results with the entrepreneurs, these aspects are:

- **Legal instruments**: This aspect describes the opinions of the companies about public and private law- and regulation without specific pointing to their municipality;
- **Financial instruments**: This aspect describes the opinions of the companies about financial incentives without specific pointing to their municipality;
- **Communication**: This aspect describes the opinions of the companies about (municipal) communication without specific pointing to their municipality;
- **Municipal involvement in building process**: This aspect describes the companies’ interest in municipal involvement in the building process;
- **Ownership building and land**: This aspect gives insights in how many companies have full capabilities in taking measures in their built environment;
- **Specific measures**: This aspect gives an indication why or why not companies have taken measures in their built environment in the field of energy saving and renewable energy;
- **Payback time**: This aspect indicates what the payback times need to be before companies take actual measures;
- **Available chances**: This aspect describes the chances that are still available but only need to be picked up by the company itself or third parties.
### Legal instruments
- In general contradictions and bad alignment in permits;
- Standard law and regulation wanted e.g. transporting of, and covering risk/claims in supplying residual heat;
- Municipality should relax procedures and permits, less regulation and more framework in which can be worked to be able to use all possible changes, especially for ambitious plans;
- Not possible to take directly green energy from external producer but has to go via more costly grid administrator.

### Financial instruments
- Subsidy or lowering taxes for accelerating taking measures and to lower the payback time (e.g. pipes for transporting residual heat, cleaning waste water, solar panels, etc.);
- The subsidies are too complex and too difficult to see which are available. This results in not using them or costing extra money because it has to be investigated internally or externally (advisory bureaus);
- No subsidy being used because of the high restrictions/bureaucracy/regulations and low flexibility in subsidies;
- The subsidy policy is unreliable by suddenly stopping. Looking at CO2-savings per invested Euro should be the norm.

### Communication
- Communication should be done by Senternovem, they have more knowledge;
- Communication should be more specified towards the right persons in the companies;
- Municipality should approach companies, bringing them into contact with each other and implementing possibilities;
- Starting a platform to share knowledge to gain good solutions, and rather sector oriented for better/focused information.

### Municipal involvement in building process
- Most of the companies think it is handy. Informing about the possibilities e.g. via checklist (measures, subsidies) or what is not possible in an early stage so it can lead to the best solutions and with the least delay.

### Ownership building and land
Yes for 9 companies, no for 2 companies and 1 partly owner and partly rented.
Those companies that have rented their buildings, didn't apply any measures in the built environment.

### Knowledge about energy, climate, co2-neutral, sustainability
- Extremely differentiated between the companies ranging from totally no knowledge to full understanding.

### Specific measures
- Companies mostly focusing on their process because the built environment is not significant enough, is being rented, long payback time, only has a functional role, or companies are focusing on their core-business;
- If activities have been done in the built environment, mostly in direct relationship with the process as reason (e.g. high insulation due to cooling activities or sensitive processes) or as specific strategy/image;
- Some ambitious measures could not be executed because of governmental/legal barriers.

### Payback time

<table>
<thead>
<tr>
<th>TIMES MENTIONED</th>
<th>1X small projects</th>
<th>1X big projects</th>
<th>2X projects</th>
<th>2X strategic investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAYBACK TIME (YEARS)</td>
<td>2.3</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>TIMES MENTIONED:</td>
<td>5X</td>
<td>2X</td>
<td>1X</td>
<td>1X</td>
</tr>
<tr>
<td>machines</td>
<td>building</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The reason for the short payback time is the uncertainty in the future.

Table 4: General (non-municipal) reflection on the municipal
Available chances if it is mentioned by at least 2 companies

- (10 X) Using roof for exploiting by external party;
- (8 X) Residual heat which can be used internally or externally;
- (8 X) Interest in taking collective measures (e.g. economies of scale, heat-exchange);
- (5 X) Relocation company if win-win situation lucrative;
- (5 X) Want to come in contact with similar entrepreneurs who are more successful in this;
- (3 X) Municipality or others should start an sustainable energy company;
- (3 X) More/better contact needed with entrepreneurs in neighborhood for taking measures and investigate possibilities;
- (2 X) Want to implement heat-cold storage or wind turbine;
- (2 X) Foundation of a special platform or bench market per sector to investigate possibilities;
- (2 X) Possibility of re-using waste (water) in a biogas installation;
- (2 X) Interest in participating in the municipal sustainable energy company;
- (2 X) Company offering to give presentations, demonstrations to bring the topic under attention/want to share knowledge.

Table 5: Available chances for industrial companies in taking measures.

6.4.5 Entrepreneurs' advantages, barriers and opportunities

In this paragraph the following sub question will be answered:

Sub question 2.5: What are the entrepreneurs' advantages, barriers and opportunities in taking measures for realizing 1-ZEB?

The numbers that are listed in the tables, represent the amount that topic is being mentioned by the interviewed entrepreneurs. The aspects, represented in the table below, are directly extracted from the literature study [Section: Theory, paragraph 3.5].

<table>
<thead>
<tr>
<th>ADVANTAGES INVESTING IN MEASURES</th>
<th>Place 1 (highest)</th>
<th>Place 2</th>
<th>Place 3</th>
<th>Place 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction exploitation cost</td>
<td>9 X</td>
<td>1 X</td>
<td>1 X</td>
<td>1 X</td>
</tr>
<tr>
<td>Reduction greenhouse gasses</td>
<td>2 X</td>
<td>4 X</td>
<td>3 X</td>
<td>2 X</td>
</tr>
<tr>
<td>Reduction dependency fossil fuel</td>
<td>1 X</td>
<td>6 X</td>
<td>4 X</td>
<td>3 X</td>
</tr>
<tr>
<td>Better &amp; healthier inner climate in building</td>
<td>1 X</td>
<td>7 X</td>
<td>1 X</td>
<td>3 X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BARRIERS INVESTING IN MEASURES</th>
<th>Place 1 (highest)</th>
<th>Place 2</th>
<th>Place 3</th>
<th>Place 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>High investment cost</td>
<td>6 X</td>
<td>4 X</td>
<td>1 X</td>
<td>2 X</td>
</tr>
<tr>
<td>No core-business</td>
<td>1 X</td>
<td>4 X</td>
<td>1 X</td>
<td>1 X</td>
</tr>
<tr>
<td>Used technologies insufficient developed &amp; integrated, seen as technical/financial risk</td>
<td>2 X</td>
<td>1 X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited demand and knowledge</td>
<td>1 X</td>
<td>1 X</td>
<td>1 X</td>
<td>1 X</td>
</tr>
<tr>
<td>Traditional building with focus on low risk and cost vs. value and quality</td>
<td>1 X</td>
<td>1 X</td>
<td>1 X</td>
<td></td>
</tr>
<tr>
<td>Not reaching theoretical energy performance due to bad monitoring</td>
<td>2 X</td>
<td>5 X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unreliable government by sudden stop subsidies</td>
<td>1 X</td>
<td>2 X</td>
<td>4 X</td>
<td></td>
</tr>
<tr>
<td>Trajectory permits too long and too costly</td>
<td>1 X</td>
<td>2 X</td>
<td>4 X</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPPORTUNITIES INVESTING IN MEASURES</th>
<th>Place 1 (highest)</th>
<th>Place 2</th>
<th>Place 3</th>
<th>Place 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image improvement (MVO)</td>
<td>8 X</td>
<td>3 X</td>
<td>2 X</td>
<td>3 X</td>
</tr>
<tr>
<td>Higher selling or rental value building</td>
<td>1 X</td>
<td>2 X</td>
<td>4 X</td>
<td></td>
</tr>
<tr>
<td>Stimulating innovation and employment in region</td>
<td>2 X</td>
<td>2 X</td>
<td>4 X</td>
<td></td>
</tr>
<tr>
<td>Using residual heat of production process in building</td>
<td>3 X</td>
<td>3 X</td>
<td>3 X</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Advantages, barriers and opportunities for industrial companies.
6.5 Conclusion

This chapter gave an answer on the sub questions 2.1, 2.2, 2.3, 2.4 and 2.5.

Sub question 2.1: What does the comparison look like of the current climate- and energy policy executions of certain big municipalities?

The big municipalities have different goals, which depend on their ambition. The success of realizing their energy- and climate ambition depends on the municipal organization. In the municipalities where this organization is focused on internal and external cooperation, the policy execution is successful. In executing the energy- and climate policy the municipalities have legal instruments, financial instruments and communication. The legal instruments that the municipalities can use are the Environmental law, building regulations, indirect measures and by using agreements. In big municipalities the budget of Economic Affairs is too limited to provide financial incentives.

Communication plays an important role in informing companies about energy savings. The big municipalities mostly communicate via mass media, the entrepreneurial organizations and by account managers. The companies find account managers a good medium by having one direct contact person for all their questions. In general the companies want more communication via park management or entrepreneurial organizations about the energy- and climate topics.

To gain insights in the progress of the municipal energy- and climate policies, monitoring is important. The big municipalities find it important, but monitoring is difficult. Not a single company has any objections to show its energy usage. This gives an opportunity for the municipalities to monitor better, more specific or even making a connection with fiscal advantages for companies who are e.g. 20% zero energy.

Implementing the energy and climate topic in regeneration plans for business locations is not a top priority of the big municipalities, although it becomes more important. An integral (re)building process is a necessity when realizing ZEBs. The municipalities and companies see this as the responsibility of the client/entrepreneur itself. The big municipalities don’t see a role for themselves in being a (building) advisor. The companies have mixed feelings if the municipality should have an advising role.

Sub question 2.2: What does the comparison look like of the current climate- and energy policy executions of certain small municipalities?

The small municipalities have different goals, which depend on their ambition. The success of realizing their energy- and climate ambition depends on the municipal organization. The more this organization is focused on internal cooperation, the more successful the policy execution. In executing the energy- and climate policy the municipalities have legal instruments, financial instruments and communication. The legal instruments the municipalities can use are the
Environmental law, building regulations and by using agreements. In the small municipalities the budget of Economic Affairs is too limited to provide significant financial incentives.

Communication plays an important role in informing companies about energy savings. The small municipalities mostly communicate via mass media and via the entrepreneurial organizations. In general the companies want more communication (e.g. associations or mass media) about the energy- and climate topics.

To gain insights in the progress of the municipal energy- and climate policies, monitoring is important. In the small municipalities, the monitoring is limited. Not a single company has any objections to show its energy usage. This gives an opportunity for the municipalities to monitor better, more specific or even making a connection with fiscal advantages for companies who are e.g. 20% zero energy.

Implementing the energy and climate topic in regeneration plans for business locations depends on the ambition level of the small municipality, although the municipalities find it all important. An integral (re)building process is a necessity when realizing I-ZEBs. The small municipalities and companies see this as the responsibility of the client/entrepreneur itself. The small municipalities don’t see a role for themselves in being a (building) advisor. The companies have mixed feelings if the municipality should have an advising role.

Sub question 2.3: What does the comparison look like between the big and small municipalities in their current climate- and energy policy execution?

The big municipalities have more specific targets than smaller municipalities. The sizes of the municipal organizations in executing the energy- and climate policies are relatively the same. For both small and big municipalities applies that better internal and external cooperation leads to a more successful policy execution. In communication it seems the small municipalities have some more personal contact with companies than the big companies. But otherwise, the big companies have account managers.

Based on this result, it is not needed to make a distinction between big and small municipalities in the model because the differences are too limited.

Sub question 2.4: What are the entrepreneurs’ general (non-municipal specific) opinions on the energy- and climate policy execution?

The companies indicate that many improvements can be made in the field of finance and law and regulation and they have several suggestions how to do it. The same applies for the communication about these energy- and climate topics. The companies find it helpful if the municipality will be more involved in the building process as soon as possible so the construction of the buildings can lead to the best solutions and with the least delay.
The industrial companies focus mainly on their production process in the field of energy savings, not on the building itself. If measures are taken, the payback time is mostly short (<5 yr.) because of the uncertainty in the future. Still there are many available chances which a municipality can pick up to eventually realize 1-ZEBs. For example many companies want to make their roofs available so that external parties can place installations for renewable energy generation.

Sub question 2.5: What are the entrepreneurs' advantages, barriers and opportunities in taking measures for realizing 1-ZEBs?

The companies see the reduction in exploitation cost as the biggest advantage if they invest in measures to save energy or generate renewable energy sources. The companies see the high investment cost, the unreliable government that stops subsidies suddenly, too long and too costly permit trajectory and the deviation from their core-business as the main barriers for taking measures. The companies mention image improvement and using residual heat as biggest opportunities for investing in measures.
SECTION 3:
REFLECTION, DESIGN AND CONCLUSIONS

This Section 3 shows the results of the previous two sections, Section 1: Theory and Section 2: Case Study. First a reflection takes place on both sections in which statements are being conducted. These statements will serve as preconditions for the model that will be designed next. This model is the answer on the main question:

How can the current municipal energy- and climate policy execution be improved so that it accelerates the realization of I-ZEBs?

After this model design, this section ends with the model validation, final conclusion and recommendations.

7 Reflection Theory vs. Case study

7.1 Introduction

This chapter shows the reflection on the previous two sections, Section 1: Theory and Section 2: Case Study. First of all, the insights, gained from the previous sections Section 1: Theory and Section 2: Case study, are being presented in separate overviews. Secondly, all the insights of both sections without exception are being put together if they have a comparable content. Based on their comparable content, statements from the viewpoint of the municipality, presented in italic, are being made that act as the preconditions for the model in the next chapter.

7.2 Insights Section 1: Theory & Section 2: Case study

7.2.1 Results Section 1: Theory (T)

(T1): definition of I-ZEB.
(T2): Fast implementation of I-ZEBs if: relative advantage (advantages vs. barriers), compatibility, complexity, trialability and observability are being fulfilled as good as possible.
(T3): In policy planning, focus on the content, in policy execution, focus on the process.
(T4): There has to be priority setting in policy processes. Policy makers should push for clear sustainability goals, with effective monitoring.
(T5): Realizing I-ZEB: first save energy, than making usage of renewable energy sources, finally using fossil fuels as efficient as possible.
(T6): Realizing buildings should be done by using an integral approach.
(T7): There need to be sufficient feedback mechanisms around I-ZEBs.
(T8): Fastest implementation of I-ZEBs when using authority, followed by a collective decision. Leaving the choice to the entity himself is the slowest.
(T9): Opinion leaders, and change agents in a more limited extent, can play an important role in influencing the behavior or attitude of entities or people to implement innovations.
Interpersonal communication has to be done by congeners to convince/persuade people to realize I-ZEBs. Mass media has to be done by non-congeners to create awareness of the existence of I-ZEBs. The less the people or entities are innovative, the more important is the interpersonal communication by congeners and vice versa.

7.2.2 Results Section 2: Case study

7.2.2.1 Results interview with municipalities (Cm)

(Cm1): Ambition levels are differentiated and the goals are political goals, reaching them is less important than actual taking measures according to several municipalities.

(Cm2): There are differences between the municipal organizations. Municipalities in which there is internal cooperation between the departments and externally with the industrial companies, the energy- and climate policy execution is successful.

(Cm3): The legal instruments that the municipalities can use are permits (public law), agreements and indirect measures (private law).

(Cm4): The municipalities have a too limited budget to subsidize.

(Cm5): The municipalities making usage of mass media and have close contacts with the entrepreneurial association or park management organization, but needs to be intensified according the industrial companies.

(Cm6): Most municipalities use Municipal account managers or sort like people as mediator towards industrial companies, who are highly appreciated by the companies.

(Cm7): Good monitoring is a problem for the municipalities, but the companies are willing to give insights in their energy consumptions for monitoring purposes.

(Cm8): For most municipalities the implementation of the energy- and climate topic in regeneration plans for business locations is not a top priority.

(Cm9): Integral (re)building is the responsibility of the client, although companies suggest information provision.

(Cm10): The municipalities don't see a role for them to be a (building) advisor, the companies have mixed feelings.

7.2.2.2 Results interview with industrial companies (Cic)

(Cic1): In the municipal legal instruments, the industrial companies face several barriers that prevent them to take measures on their location.

(Cic2): In the financial instruments, the industrial companies face several barriers that prevent them to make usage of the available subsidies.

(Cic3): Communication has to be done by more specific skilled people.

(Cic4): Communication has to be more specified towards the right persons in the company.

(Cic5): The municipality should approach companies, bringing them into contact with each other and implement possibilities.

(Cic6): Starting a platform to share knowledge, and rather sector oriented for better focus.

(Cic7): Handy to have municipal involvement in the building process to prevent delays.
(Cic8): The knowledge about sustainability or zero energy is differentiated among the companies.
(Cic9): Companies mostly focus on their process because investing in the built environment is not significant enough, is being rented, long payback time, governmental/legal barriers, has only a functional role, or the companies are focusing on their core-business.
(Cic10): Companies do take measures if they are in direct relationship with the industrial process or as part of the company’s strategy/image.
(Cic11): There are currently many available chances for taking measures that only have to be picked up by the companies themselves or third parties.
(Cic12): For companies the most important advantage of taking measures is the reduction in exploitation costs.
(Cic13): The most important barriers for the companies of taking measures are: the high investment costs, no core business, sudden stop of subsidies and permit trajectory that is too long and too costly.
(Cic14): The most important opportunities for companies to invest in measures are: image improvement and the (re)usage of residual heat.

7.3 Reflection and statements
(T1)+(Cic8)= (S1): The knowledge about 1-ZEBs should be promoted and distributed among industrial companies.

In the Section Theory the definition of 1-ZEBs is described, but the knowledge among the industrial companies about zero energy is differentiated. It is important the companies are becoming familiar about what 1-ZEBs are to create awareness. If they have never heard of 1-ZEBs, it is also impossible for them to realize these sorts of buildings.

(T2)+(Cm4)+(Cic1)+(Cic2)+(Cic12)+(Cic13)= (S2): The relative advantages of 1-ZEBs should be improved for industrial companies.

The relative advantages can be improved by reducing the barriers and enlarging the advantages. Increasing the relative advantages will result in a faster implementation of 1-ZEBs. The biggest advantage for companies to invest in measures is that it reduces the exploitation costs. But the companies are also facing many barriers, which are:

The internal barriers:
- The investments in measures are too high and in the built environment often not significant enough, which result in a too long payback time (should be between 2-5 years);
- Their buildings are being rented, so no concerns about the buildings;
- Companies focus on their core-business in which the building has a functional subordinate role, so limited interest in taking measures in the built environment;
The external (public) barriers:

- Permit trajectory is too long and too costly for non-conventional measures;
- Contradictions/bad alignment in and between permits;
- The subsidies are too complex and too difficult to see which are available;
- The subsidies are too bureaucratic, too high restrictions and not flexible enough;
- The subsidies are sometimes being stopped suddenly, which results in companies that are restrained to relay on subsidies;

For the municipalities it is difficult to solve or lower the barriers or improve the advantages, because many barriers have to deal with financial incentives and all municipalities don’t have any financial resources to stimulate. Besides, the existing barriers in subsidies do not fall under the responsibility of the municipalities because they don’t provide the subsidies themselves. Although the municipalities can solve or lower the barriers of the permits, because most of the time the municipality is the responsible authority.

\[ (T2) + (Cic9) + (Cic10) + (Cic14) = (S3) \]: The compatibility, complexity, trialability and observability of I-ZEBs should be improved for industrial companies.

Currently, the companies are mostly focused on their industrial activities/process, and do not take measures in the built environment because of the internal and external barriers. Companies do take measures if these are in direct relationship with their industrial activity or as part of the company’s strategy/image. The industrial companies see the re-usage of residual heat as an important opportunity. Also many companies see image improvement as a major opportunity. They are aware that image improvement becomes more and more important in the future as a marketing tool. These barriers and opportunities show that if improvements in the compatibility, complexity, trialability and observability are being made, this will result in a faster implementation of I-ZEBs.

\[ (T3) + (Cm2) = (S4) \]: There should be internal cooperation and external cooperation with the industrial companies about the municipal policy.

Several municipalities don’t involve companies during the planning and execution of their energy- and climate policy. But practice shows that in the municipalities in which there is cooperation between the internal municipal departments and externally with private parties, the energy- and climate policy execution is successful. It is important to focus in the policy planning on the actual content to prevent separation of processes and procedures. In the policy execution it is important to focus on the process to be able to let actors participate.

\[ (T4) + (Cm7) = (S5) \]: There should be a good detailed monitoring on individual industrial company level to see the effect of the municipal policy.

Good monitoring is important for municipalities to be able to see if their policies have any effect and if so, in what amount. Unfortunately monitoring is a problem for municipalities, but
all companies don't have any objection to show their energy consumption for monitoring purposes.

(T4)+(Cm1)= (S6): The municipal policy should have clear, realistic and consistent goals.

The ambition levels in the municipal energy- and climate policies are differentiated. Several municipalities define their targets as political goals. This means that actual realizing the targets is less important than taking measures. The municipalities therefore have to set priorities in their policy so that the energy-and climate topic is not left on the agenda without any further actions. Clear, realistic and consistent goals are needed.

(T4)+(Cm8)= (S7): The topic 'sustainability' should be (more) implemented in the municipal regeneration projects by external encouragement.

For most municipalities the implementation of the energy- and climate topic in regeneration plans for business locations is not a top priority. But as part of the stimulation of realizing I-ZEBs, this should be a top priority. Consequently, external encouragement from outside the municipality is necessary.

(T5)+(Cic9)+(Cic10)+(Cic11)= (S8): An environment should be created in which the industrial companies can apply the Trias Energetica.

Currently, the companies are mostly focused on their industrial activities/process, and do not take measures in the built environment because of the internal and external barriers. Companies do take measures if these are in direct relationship with their industrial activity or as part of the company's strategy/image. As a result of these barriers, still many chances are available at industrial companies that only have to be picked up by the companies themselves or third parties (applying Trias Energetica). The available chances (with the percentage of companies that have mentioned them) are:
- Using roof for exploiting by external party (83%);
- Re-using residual heat for internal or external use (67%);
- Relocation company if it results in a win-win situation (42%);
- Willing to implement wind turbines or Heat-Cold Storage on site (17%);
- Re-using waste (water) for renewable energy generation e.g. for biogas (17%).

(T6)+(Cm9)= (S9): The industrial companies should be informed about an integral building approach.

If companies want to realize I-ZEBs, they have to (re)build by using an integral approach in the process. In this way the goal is set early and the project team makes integrated decisions. The municipalities see this integral process as a responsibility of the client themselves, and the companies see it also as their own responsibility but suggest that the municipality can provide information about this way of building.
(T7)+(Cic6)+(Cic11)= (S10): Industrial companies should be provided with enough feedback mechanisms and a special platform should be established to share knowledge.

There needs to be a proper feedback of the advantages and opportunities of I-ZEBs in order to encourage and facilitate change towards realizing those types of buildings. Several industrial companies suggest a special platform or municipal/regional sustainable energy company to share knowledge or investigate the potential possibilities. There are even companies that want to participate in these platforms/sustainable energy companies.

(T8)+(Cm3)= (S11): To implement I-ZEBs the fastest way, all the municipal authority towards industrial companies should be used.

The municipalities only have limited authority to force companies to take action. The municipalities can only force companies via permits. Municipalities can also use indirect measures and (private) agreements, but these agreements are often legally unenforceable. Still, the municipality has to use as much of their public and private legal authority as possible to implement I-ZEBs in the fastest way.

(T8)+(Cic5)+(Cic11)= (S12): The focus should be on taking collective measures among industrial companies to implement I-ZEBs fast.

Second best option for the municipality to implement I-ZEBs is to put efforts in taking collective measures. Most of the companies are interested in collective measures because this will result e.g. in economies of scale. The industrial companies see also a role for the municipality to approach companies and bringing them into contact with each other to look for opportunities in taking these collective measures.

(T9)+(Cm6)+(Cic11)= (S13): Opinion leaders and change agents should be used.

Opinion leaders, and change agents in a more limited extent, can play an important role in influencing the behavior or attitude of the people that make the decision to realize I-ZEBs. Municipal account managers, or similar municipal officials, are highly appreciated mediators by the industrial companies. They can play an important role as change agent. Several industrial companies want to come in contact with similar entrepreneurs who are more successful in implementing measures in the field of I-ZEBs. Vice versa, there are also several companies that are offering to give presentations, and demonstrations to bring the topic of I-ZEBs under attention and to share knowledge. This indicates that ambitious companies can play an important role as opinion leader.

(T10)+(Cm5)+(Cic3)+(Cic4)+(Cic11)= (S14): The focus should be on mass media with enough intensity and toward the right people, interpersonal communication should be done by more specifically skilled people close related to the companies.
Interpersonal communication is important to realize I-ZEBs because people leave their choice dependent on personal subjective evaluations. Especially interpersonal communication with congeneres is important to convince or persuade people. Mass media is less important for actual realizing I-ZEBs, but this type of communication is more to create awareness of the existence of I-ZEBs or related topics. This indicates that the municipality should just focus on mass media because they are not that close related to industrial companies. Besides, the companies want the communication has to be done by more specifically skilled people, so not by municipal officials.

The companies want more/better contact with the entrepreneurs in the neighborhood for taking (collective) measures and to investigate potential possibilities. This indicates that interpersonal communication between industrial companies can play an important role.

\[(\text{Cm10})+(\text{Cic7})= (S15): \text{There should be municipal involvement in the building process to prevent delays and realize cost savings.}\]

The municipalities don’t see a role for themselves to be a (building) advisor towards industrial companies. But still, the industrial companies see a role for the municipality in the building process. The municipality can inform the companies in an early stage of the building process about what the possibilities are on that specific location, or what isn’t possible. This municipal involvement will lead in fewer delays in the permit trajectory and cost savings for both parties.
7.4 Conclusion

In this chapter a reflection is made on the previous two sections; Section 1: Theory and Section 2: Case study. This resulted in 15 statements, seen from the municipal’s point of view. These statements are summarized below and grouped around two themes to create a better overview, that is: Municipal policy related statements and 1-ZEB related statements.

MUNICIPAL POLICY RELATED STATEMENTS

S4: There should be internal cooperation and external cooperation with the industrial companies about the municipal policy.
S5: There should be a good detailed monitoring on individual industrial company level to see the effect of the municipal policy.
S6: The municipal policy should have clear, realistic and consistent goals.
S7: The topic 'sustainability' should be (more) implemented in the municipal regeneration projects by external encouragement.
S11: To implement 1-ZEBs the fastest way, all the municipal authority towards industrial companies should be used.

1-ZEB RELATED STATEMENTS

S1: The knowledge about 1-ZEBs should be promoted and distributed among industrial companies.
S2: The relative advantages of 1-ZEBs should be improved for industrial companies.
S3: The compatibility, complexity, trialability and observability of 1-ZEBs should be improved for industrial companies.
S8: An environment should be created in which the industrial companies can apply the Trias Energetica.
S9: The industrial companies should be informed about an integral building approach.
S10: Industrial companies should be provided with enough feedback mechanisms and a special platform should be established to share knowledge.
S12: The focus should be on taking collective measures among industrial companies to implement 1-ZEBs fast.
S13: Opinion leaders and change agents should be used toward industrial companies.
S14: The focus should be on mass media with enough intensity and toward the right people in the industrial companies, interpersonal communication should be done by more specifically skilled people close related to the industrial companies.
S15: There should be municipal involvement in the building process to prevent delays and realize cost savings.
8 Design

8.1 Introduction

This chapter presents the design of the model, based on the 15 statements of the previous chapter. These statements act as the preconditions that need to be fulfilled by the model. However, the statements need to be analyzed first to be able to determine how they can be fulfilled in the model in a proper manner.

Based on the analysis results, a model will be created that includes all the 15 statements. Consequently, this model gives an answer on the main question: How can the current municipal energy- and climate policy execution be improved so that it accelerates the realization of I-ZEBs?

8.2 Analyzing the statements

8.2.1 Analysis description

The 15 statements need to be fulfilled by the model. Unfortunately there is not a clear coherence between these statements, which makes designing difficult. Therefore the statements need to be analyzed to be able to have a proper starting point for designing the model.

This starting point will be created by asking the “how”-question for every statement. By asking this how-question repeatedly, eventually this results in a specific target for every statement where to focus on in designing the model. The analysis execution can be seen in the following paragraph, in which the specific targets are underlined for every statement.

8.2.2 Analysis execution

(S1) The knowledge about I-ZEBs should be promoted and distributed among industrial companies.
- informing via mass media

(S2) The relative advantages of I-ZEBs should be improved for industrial companies.
- improving advantages
  - lowering exploitation costs
    - subsidizing
    - Municipal lobby at subsidy grantors
      - creating an environment in which relevant actors collaborate
  - lowering barriers
    - lowering internal barriers
      - subsidizing
- Municipal lobby at subsidy grantors
  - Creating an environment in which relevant actors collaborate
- Improving compatibility
  - Making Social Responsible Management (MVO) important
    - Informing via interpersonal communication
    - Informing via mass media
  - Lowering external barriers
    - Better set-up of subsidy
      - Municipal lobby at subsidy grantors
        - Creating an environment in which relevant actors collaborate
    - Better set-up of permit granting
      - Interaction between the municipal departments
        - Creating an environment in which relevant actors collaborate

(S3) The compatibility, complexity, trialability and observability of I-ZEBs should be improved for industrial companies.
- Improving compatibility
  - Making Social Responsible Management (MVO) important
    - Informing via interpersonal communication
    - Informing via mass media
- Lowering complexity
  - Informing via interpersonal communication
- Enlarging trialability
  - Informing via interpersonal communication
- Enlarging observability
  - Making I-ZEB-related aspects visible
    - Making it part of the policy
      - Creating an environment in which relevant actors collaborate

(S4) There should be internal cooperation and external cooperation with the industrial companies about the municipal policy.
- Improving internal cooperation
  - Interaction between the municipal departments
    - Creating an environment in which relevant actors collaborate
- Improving external cooperation
  - Let companies participate in policy planning
    - Involving of ambitious companies in the policy planning
      - Creating an environment in which relevant actors collaborate
    - Giving companies a voice in the policy planning
      - Creating an environment in which relevant actors collaborate
Let companies participate in policy execution
  • Give companies a voice in policy execution
    • Creating an environment in which relevant actors collaborate

(S5) There should be a good detailed monitoring on individual industrial company level to see the effect of the municipal policy.
  • Monitoring by using data of individual companies
    o Using the information available via environmental permits
      • Creating an environment in which relevant actors collaborate

(S6) The municipal policy should have clear, realistic and consistent goals.
  • Separating the goals in short term targets and long term political goals
    o Fixing short term targets in the policy
      • Creating an environment in which relevant actors collaborate

(S7) The topic ‘sustainability’ should be (more) implemented in the municipal regeneration projects by external encouragement.
  • Making ‘sustainability’ a top priority in regeneration projects by external influence
    o Making the contribution of the BOM (BHB) dependent on the municipal measures
      • Creating an environment in which relevant actors collaborate

(S8) An environment should be created in which the industrial companies can apply the Trias Energetica.
  • Lowering barriers
    o Lowering internal barriers
      • Subsidizing
        • Municipal lobby at subsidy grantors
          o Creating an environment in which relevant actors collaborate
      • Improving compatibility
        • Making Social Responsible Management (MVO)important
          o informing via interpersonal communication
          o informing via mass media
    o Lowering external barriers
      • Better set-up of subsidy
        • Municipal lobby at subsidy grantors
          o Creating an environment in which relevant actors collaborate
      • Better set-up of permit granting
        • Interaction between the municipal departments
          o Creating an environment in which relevant actors collaborate
The industrial companies should be informed about an integral building approach.

- Informing via interpersonal communication

Industrial companies should be provided with enough feedback mechanisms and a special platform should be established to share knowledge.

- Informing via interpersonal communication
- Establishing a regional/municipal sustainable energy company

To implement 1-ZEBs the fastest way, all the municipal authority towards industrial companies should be used.

- Investigate all possibilities in permits
  - Interaction between the municipal departments
    - Creating an environment in which relevant actors collaborate
- Investigate all possibilities in indirect measures
  - Interaction between the municipal departments
    - Creating an environment in which relevant actors collaborate
- Investigate all possibilities in private agreements
  - Interaction between the municipal departments
    - Creating an environment in which relevant actors collaborate

The focus should be on taking collective measures among industrial companies to implement 1-ZEBs fast.

- Investigate interest and execute collective measures
  - Establishing a regional/municipal sustainable energy company

Opinion leaders and change agents should be used.

- Ambitious companies have to take the role of opinion leaders
  - Involving of ambitious companies in the policy execution
    - Creating an environment in which relevant actors collaborate
- Account managers have to take the role of change agents
  - Involving of account managers in the policy execution
    - Creating an environment in which relevant actors collaborate

The focus should be on mass media with enough intensity and towards the right people, interpersonal communication should be done by more specifically skilled people close related to the companies.

- Municipal communication via mass media
- Interpersonal communication via specifically skilled people/entities

There should be involvement in the building process to prevent delays and realize cost savings.

- Municipal participation in building process
  - Creating an environment in which relevant actors collaborate
8.2.3 Analysis result
As a result of the analysis in which for every statement the “how-question” is asked repeatedly, a proper starting point is realized for designing the model. Thanks to the similarities between the targets, this starting point consists of only three specific topics, which are:

- Establishing a collaborative environment in which the relevant actors can collaborate about a specific topic;
- Introducing the establishment of a Municipal/Regional Sustainable Energy Company
- Making the information provision important towards industrial companies by using mass media as well as interpersonal communication. The municipality should focus on mass media and leave the interpersonal communication to specifically skilled people/entities, close related to the companies.
8.3 Model

By using the analysis result of the previous paragraph as starting point, a model is created which covers all the 15 statements. As can be seen below, the model consists of actors, a collaborative environment and 8 specific topics that are combined into 4 themes.

The model below is only a small part of the total model, because every specific topic also has its own sub model. A full explanation about the actors, the collaborative environment and topics will be given in the following paragraphs.

![Diagram of the model]

**Figure 9: Main model**
8.4 Model explanation

**Province**: This is one of the three administrative layers of the Dutch polity. In this thesis’s setting about 1-ZEBs, the Provincial contribution in the model limits to the role of advisor and input providing client in the field of permits (e.g. Environment and Water) for the municipalities.

**Municipality**: This is one of the three administrative layers of the Dutch polity. Municipalities play a central role in this thesis’s setting because a solution will be given how municipalities can stimulate industrial companies to realize 1-ZEBs. Therefore also in the model, a key role is assigned to the municipalities.

Municipalities are not completely free to arrange their political organization. Several parts are prescribed by the Constitution (Grondwet) and Local Government act (Gemeentewet). Most important for this thesis are the obliged Council and the bench of Mayor & Aldermen who together form the local administration. The Council is directly elected by the municipal inhabitants, and is the highest official body in the municipal organization. The members of the Council also appoint the Aldermen. The Council sketches the outlines of the municipal policy and control the bench of Mayor & Aldermen. This bench of Mayor and Aldermen is in charge of the executive committee and executes the policy (ledema, R. et al., 2004).

The municipal organizational structure that is often used is the sectorial/departmental structure. This modern structure becomes more and more familiar, and therefore this structure will be used as basis in the model (ledema, R. et al., 2004). In this structure, the municipal organization is divided into several departments. Every department is controlled by a specific Alderman, who can also have to the responsibility of other departments.

For this thesis, the most important departments are those of Economic Affairs, Environment, Spatial Planning and Building & Housing, although these departments can differ in name and composition per municipality. These departments have their own specific tasks, resulting from the sketched outlines of the municipal policy by the Council. In this thesis’s setting about 1-ZEB, in general the Department of Environment is responsible for the Energy- & climate policy (planning & execution) and Environmental permits, the Department of Spatial Planning is responsible for the zoning plans (Wro), the Department of Building & Housing is responsible for the building permit and the Department of Economic Affairs is responsible for the entrepreneurship. One element of the Department of Economic Affairs are the Municipal Account Managers. These account managers are the main contact persons/window where companies can go for complains and whishes, and is in beginning responsible for advising (starting) companies and to help companies in granting subsidies and permits. As main contact person for industrial companies they can play an important role in stimulating the companies in realizing 1-ZEBs. Therefore also the municipal account managers are specific mentioned in the model.
Brabantse Ontwikkelings Maatschappij (BOM): The BOM, founded in 1983 by the Ministry of Economic Affairs and the Province of Noord-Brabant, has the task to play an active and stimulating role for the Brabant’s economy. Also other provinces/regions in the Netherlands have sort like organizations, and is therefore acceptable to implement in the model, including many of its divisions. Four divisions of the BOM are interesting to implement in the model for various reasons. First division that is included in the model is the BOM Business Parks. This division has the task in Noord-Brabant to regenerate 1000 hectare of obsolete business locations in 2011. To be able to do so, the BHB has a risk-bearing participation in regeneration projects. Thanks to this role, the BHB can put pressure on municipalities.

Second division that is included in the model is the BOM New Business Developments. This division of has the task to be an economy- and knowledge booster for the Province of Noord-Brabant. They also have specific knowledge in the field of (renewable) energy (e.g. via pilot projects) and have widespread network in this field. Third division that is included in the model is the BOM Foreign Investment Department. This division is responsible for the international acquisition and promotion of Noord-Brabant by actively attracting foreign companies and keeping them in the region. The final division that will be included in the model is the BOM Venture Capital. This division participates in high potential and innovative initiatives in Noord-Brabant and gives support in the search for financing. Also this division has an interesting wide network.

Entrepreneurial associations: This is an association that looks after the interests of its members, the (industrial) entrepreneurs in this case. This is mainly done on municipal level. As a social system, such associations play an important role. Various individual industrial companies are being represented in those associations. These companies can have high or low ambitions in the field of 1-ZEBs. In the model, this distinction is also made where needed because the model provides a solution to municipalities how they can stimulate industrial companies to realize 1-ZEBs. Both types play namely their own specific vital role in the total model in how to realize 1-ZEBs.

Collaborative environment: As can be seen in the analysis of the previous chapter, a collaborative environment is essential to be able to have an answer on many of the statements. Without a specific collaborative environment, collaboration between the actors is difficult due to different or even conflicting interest. With a collaborative environment is meant a formal (agreement) or informal relationship in which jointly is being worked with one or a limited number of others towards a common goal. In such an environment the parties share in the cost (e.g. effort, time, resources). In this thesis' setting, the goal of the collaborative environment is to bring relevant actors together who conjointly pick up (one of) the 8 topics in order to improve the municipal policy execution in such a way it accelerates the realization of 1-ZEBs. Therefore the Collaborative environment can be seen as a “booster” of the municipal energy- & climate policy execution towards realizing 1-ZEBs.

It is out of the scope of this thesis to elaborate about all the possible ways of formal and informal collaboration. The most important is the fact that the collaboration takes place, in what specific setting is less important. It is up to the parties themselves to determine how they
want to collaborate. Still one suggestion will be given, because this type of collaboration seems to be successful and can be applied in many of the topics that are mentioned in the coming paragraphs. This specific collaborative environment is the establishment of an energy- & climate Agency by the municipality.

This agency is an independent body of the municipality with its own Board and resources in which public and private parties collaborate. This Agency has a supporting and/or executing role for the municipality. In case of an energy- & climate Agency, such an Agency can support the municipality in their tasks, can provide continuance in policy execution and can pick up (collectively) many of the topics that are being mentioned below to be able to realize 1-ZEBs and in the future other environmental- and energy topics for other sectors like Industry, Farming and Traffic & Transport.

Themes & Topics: The topics are those subjects in which a specific way of collaboration is needed between the relevant actors. In total 8 topics have been created, combined into four themes. The themes and topics are:

1) Municipal policy:
   - Municipal energy- & climate policy planning
   - Municipal energy- & climate policy execution

2) Industrial Zero Energy Buildings (I-ZEBs):
   - Subsidy for I-ZEBs
   - Promotion of I-ZEBs
   - Persuasion to realize I-ZEBs
   - Participation in realizing I-ZEBs

3) Sustainable business parks:
   - Encouraging sustainable regeneration of business parks

4) Sustainable Energy Company:
   - Realization of a Municipal Energy Company (MSEC)

The themes and topics are the result of a selective procedure, based on the analysis of the previous paragraphs. In this procedure, topics have been chosen that cover in the best way the target(s) of every statement by looking specifically to the last-but-one ‘target(s)’ of every statement (see paragraph 8.2.2). Consequently this procedure resulted in the 8 topics as mentioned. In the collaborative environment each topic will be picked up by the relevant actors. The actors that have a leading role concerning a specific topic are responsible for the establishment of the Collaborative environment.
All 8 topics are related to the municipal energy- and climate policy execution. Consequently, these picked up topics provide each a part of the total answer on the main question. The topics will be further explained in the following paragraphs by making a distinction between the specific actors with their roles and tasks.

8.4.1 Theme: Municipal policy

8.4.1.1 Topic: Municipal energy- & climate policy planning

To be able to deal with the “Municipal energy- & climate policy planning” topic, at least the three mentioned municipal departments, the High ambitious industrial companies and the Entrepreneurial associations need to be involved. The three municipal departments work together on the set up of the energy- and climate policy planning by looking beyond their own well-delineated working area. In a collaborative manner, they formulate ideas for realistic short term targets and long term political goals for the industrial built environment. E.g. the realization of 10 industrial companies in the municipality by 2011 who are at least 50% zero energy by lowering tax, placing LED public lighting or wind turbines on business locations or new legislation in which the risk concerning the provision of residual heat is covered for the delivering industrial company.

The three municipal departments collaboratively investigate what the possibilities are in permits, public-private agreements and possibilities in indirect measures to stimulate industrial companies to realize I-ZEBs. E.g. in permits, the municipality can release the permit granting for I-ZEB related measures like pipes for the transportation of residual heat. E.g. in indirect measures, the municipality can lower taxes or realize a “heat net” on business locations. In this way, the companies are obliged to make use of this net. E.g. in public-private agreements, the municipality and an industrial company agree about the realization of heat-cold storage.

High ambitious industrial companies are invited in the process to participate in the discussion, in which they advice the departments in what can be done best, and what not to stimulate the realization of I-ZEBs.
After the investigations and the discussion with the High ambitious industrial companies, the departments determine the short term targets and long term political goals, including the belonging instruments/means, point in times and the division of tasks between the departments (who is doing what and when?).

Via the entrepreneurial associations, industrial companies are provided with a voice in the policy planning. With this voice, the companies give their opinion, wishes and barriers about the policy plans.

Finally, the short term targets are being fixed by making (binding) agreements with the Entrepreneurial associations. This ensures prioritization of the short term targets independent of the fluctuating municipal political environment.

By picking up this “Municipal energy- & climate policy planning” topic, the following statements are being covered:

S3: Via indirect measures the observability of I-ZEB-related aspects is enlarged.

S4 & S11: There exists internal cooperation between the municipal departments, which results in a better policy for industrial companies (S4), and a fast implementation of I-ZEBs by looking to the municipal authoritarian possibilities (S11).

S4: There exists external cooperation between the municipality and the industrial companies in policy planning, which results in a better policy and support for the policy.

S6: The municipal energy- & climate policy has clear, realistic and consistent goals thanks to the involvement of industrial companies and the fixing of the short term targets.

S2 & S8: The relative advantage of I-ZEBs for industrial companies is improved by lowering their external barriers, which is a better set-up of permit granting.

8.4.1.2 Topic: Municipal energy- & climate policy execution

![Figure 11: Sub model of Topic “Municipal energy- & climate policy execution”](image)
To be able to deal with the "Municipal energy- & climate policy execution" topic, at least the municipal departments, the Province and the Entrepreneurial associations need to be involved. The municipal departments are responsible for the actual execution of the energy- & climate plans, as determined in the policy planning. To be able to see if the policy execution is successful, good monitoring is essential.

The municipal departments work together on the set up of the monitoring in which they determine how the continuing monitoring has to take place and who is responsible. Most likely is to monitor by using the energy consumption data of individual industrial companies via so-called clever meter boxes or via the data of the environmental permit that has to be provided by the Province.

Via the Entrepreneurial associations, industrial companies are provided with a voice in the policy execution. With this voice, the companies give their opinion, wishes and barriers about this policy execution.

The information gathered from the monitoring and Entrepreneurial associations is collected and analyzed by the responsible municipal department(s).

If needed, the municipality adjusts its energy- & climate policy to be able to realize the short term targets and the long term political goals in the best possible way (improvement in policy effectiveness and efficiency).

By picking up this "Municipal energy- & climate policy execution" topic, the following statements are being covered:
S4: There exists external cooperation between the municipality and the industrial companies in policy execution, which results in a better policy execution and support for the policy.
S5: There is detailed monitoring on individual industrial company level to see if and in what amount the policy execution is successful for industrial companies.
8.4.2 Theme: Industrial Zero Energy Buildings (I-ZEBs)

8.4.2.1 Topic: Subsidy for I-ZEBs

To be able to deal with the "Subsidy for I-ZEBs" topic, at least the BOM and the Municipal departments of Environment and Economic Affairs including their Municipal account managers need to be involved. The Dep. Environment is responsible for assigning specific tasks to the Municipal account managers (directing), the Dep. Economic Affairs is responsible for bringing in and controlling the account managers.

Controlled by the Dep. Economic Affairs, the Municipal account managers investigate for industrial companies the subsidy wishes and barriers in the field of I-ZEBs by visiting them at least once per year. These visits can be done in a collective manner via the entrepreneurial associations or by having individual company visits. Practice shows that at least 1 municipal account manager for every 180-200 industrial companies is sufficient.

The account managers collect the data and transfer this data to the BOM who has a close relationship with the subsidy grantors. This data transfer only takes place if enough relevant data is collected. Industrial companies have mentioned several suggestions what can be improved (see appendix). Examples are:

- Connecting subsidies to energy/sustainability scans;
- Providing subsidy that is based on the energy/co2-reduction per invested Euro;
- Providing subsidy for pipes to transport residual heat between companies.

After receiving enough relevant data of the Municipal account managers, the BOM lobbies toward the subsidy grantors (Provincial & State government) to fulfill the industrial company wishes and reducing the barriers concerning subsidy to realize I-ZEBs and asks for feedback. The BOM transfers this subsidy grantors' feedback to the municipality.
By picking up this "subsidy for I-ZEBs" topic, the following statements are being covered:

S2: Improving relative advantage of I-ZEBs for industrial companies
- Reduction in exploitation costs via additional subsidy.

S2+S8: Lowering internal barriers of I-ZEBs for industrial companies
- Lowering payback time via additional subsidy.

S2+S8: Lowering external barriers of I-ZEBs for industrial companies
- Better set-up of subsidy by making them less complex, providing better insights which are available, making them less bureaucratic with high restrictions and low flexibility, and making the subsidy granting consistent over time.

8.4.2.2 Topic: Promotion of I-ZEBs

To be able to deal with the "Promotion of I-ZEBs" topic, at least the municipal departments Environment and Economic Affairs need to be involved. By collaboration, both departments determine which specific I-ZEB-related aspects have to be promoted and how often. Most obvious is the indirect promotion by making Social Responsible Management important (e.g. by giving awards, free media attention) and creating knowledge acquisition about I-ZEBs (e.g. by adding I-ZEBs in the selling/promoting brochures for business parks with explanation about its advantages).

After deciding what exactly will be promoted, the municipal departments determine by collaboration how the promotion should be done. Interesting is the fact that the Dep. Economic Affairs has close contacts with the industrial companies in the municipality. Consequently, the promotion activities can be done via these already existing communicative instruments like newsletters, websites, brochures and so on. In addition, the promoting activities have the most effect with the least effort if the promotion by the municipality takes place via mass media.

After determining who’s responsible for the execution of the promotion activities, the promotion takes place towards the industrial companies.
By picking up this "Promotion of I-ZEBs" topic, the following statements are being covered:

S1: Promotion and distribution of knowledge about I-ZEBs among industrial companies.

S2+S3+S8: The relative advantage of I-ZEBs for industrial companies is improved by lowering their internal barriers, which is the improvement of the compatibility by making Social Responsible Management important.

S14: Focus of the municipality on the usage of mass media.

8.4.2.3 Topic: Persuasion to realize I-ZEBs

To be able to deal with the "Persuasion to realize I-ZEBs" topic, at least the municipal departments Environment & Economic Affairs, the Municipal account managers and the High ambitious industrial companies need to be involved. By collaboration, both departments determine what specific persuasion activities and other relevant activities will be executed and how often.

The Dep. Environment is responsible for assigning specific tasks to the Municipal account managers and the High ambitious industrial companies (directing), the Dep. Economic Affairs is responsible for bringing in and controlling the account managers as responsible authority.

After receiving their tasks under the responsibility of the Department Environment, the municipal account managers and the High ambitious industrial companies start with their persuasion activities towards industrial company to realize I-ZEBs.

Controlled by the Dep. Economic Affairs, the Municipal account managers bring at least once per year a personal informal visit with the entrepreneurs of every industrial company in the municipality. Practice shows that at least 1 municipal account manager for every 180-200
industrial companies is sufficient. The Municipal account managers also have interpersonal meetings with the industrial entrepreneurs during natural moments (e.g. in their role as municipal window). During these meetings and visits, the Municipal account managers provide:

- Personal feedback about I-ZEBs (e.g. explaining advantages)
- Explain the usefulness of realizing building in an integral manner (higher price-quality ratio)
- Persuade the entrepreneurs to realize I-ZEBs by explaining the increasing importance of Social Responsible Management as marketing tool.

The High ambitious industrial companies visit/meet the industrial companies in a formal or informal manner during natural moments (e.g. in the Entrepreneurial association or as part of the regular entrepreneurial activities). During these meetings, the high ambitious industrial companies provide:

- Personal feedback about I-ZEBs (e.g. own experiences, advantages and chances)
- Explain the usefulness of realizing buildings in an integral manner (higher price-quality ratio)
- Persuade the entrepreneurs to realize I-ZEBs by explaining the increasing importance of Social Responsible Management as marketing tool, by lowering the complexity of I-ZEBs (e.g. own experience, barriers, advantages and good info provision) and by enlarging the trialability of I-ZEBs (e.g. conducted tour around the High ambitious company).

By picking up this “Persuasion to realize I-ZEBs” topic, the following statements are being covered:

- **S2+S3+S8:** The relative advantage of I-ZEBs for industrial companies is improved by lowering their internal barriers, which is the improvement of the compatibility by making Social Responsible Management important.
- **S3:** The complexity of I-ZEB is lowered and the trialability of I-ZEBs is enlarged.
- **S9:** The industrial companies are being informed about an integral building approach.
- **S10:** The industrial companies are being provided with enough feedback mechanisms about the advantages and opportunities of I-ZEBs.
- **S13:** High ambitious ind. companies as opinion leaders and municipal account managers as change agents.
- **S14:** Interpersonal communication done by more specifically skilled people close related to the companies themselves.
8.4.2.4 Topic: Participation in realizing 1-ZEBs

To be able to deal with the “Participation in realizing 1-ZEBs” topic, at least the municipal departments in general, the Department Economic Affairs in special, the Municipal account managers and the Province need to be involved. The Dep. Economic Affairs is responsible for bringing in and controlling the account managers, and the Municipal departments jointly are responsible for assigning specific tasks to the account managers (directing).

Controlled by the Dep. Economic Affairs, the Municipal account managers bring at least once per year a personal informal visit with the entrepreneurs of every industrial company in the municipality. Practice shows that at least 1 municipal account manager for every 180-200 industrial companies is sufficient. During these informal visits, the Municipal account managers inform the entrepreneurs about the possibility of having municipal support in the (re)building process for ambitious projects (e.g. realizing 1-ZEBs in combination with wind turbines or heat-cold storage).

The Municipal account managers also have interpersonal meetings with the industrial entrepreneurs during natural moments (e.g. in their role as municipal window). During these formal or informal meetings, the Municipal account managers investigate if municipal support is wanted at this moment or in the future and what type of support should be provided.

The information of every meeting is being collected by the account managers and if relevant transferred as soon as possible to the Municipal departments.

By collaboration, the Municipal departments analyze the specific information and decide how the industrial companies can be supported (e.g. helping to speed up the permit granting, looking for a perfect location to realize heat-cold storage) and who should provide this support in the Municipality. Where needed, also help form the Province is asked (e.g.
Environmental/Water permit). After deciding to provide support to the industrial company in its (re)developing process, the participation activity takes place.

An additional suggestion towards the Municipalities is to let every apply for a building permit be investigated not only by the Dep. Building and Housing but also by the Dep. Environment to advice the entrepreneur about taking additional measures (e.g. by providing a checklist or giving specific suggestions).

By picking up this “Participation in realizing 1-ZEBs” topic, the following statements are being covered:

S15: Delays in the building process are shortened/prevented, cost savings are realized and the result is improved by having municipal involvement in the (re)building process of an industrial company in an as earliest phase as possible.

S2+S8: The relative advantage of 1-ZEBs for industrial companies is improved by lowering their external barriers, which is a better set-up of permit granting.

8.4.3 Theme: Sustainable business parks

8.4.3.1 Topic: Encouraging sustainable regeneration of business parks

To be able to deal with the “Encouraging sustainable regeneration of business parks” topic, at least the municipal departments in general, the BOM New Business Developments and BOM Business Parks need to be involved.

For every new regeneration project of a business park, the BOM BP and BOM NBD collaborate and inventory what the sustainability possibilities are at that park. Based on this investigation, the BOM BP sets demands for the Municipal departments about the amount of sustainable measures in the field of energy that need to be realized on that specific business park (e.g.
implementing LED public lighting, wind turbines, forced cooperation in renewable energy pilot projects).

The Municipal departments have to accept the sustainability demands that are set by BOM BP, because otherwise the BOM will not financially support the regeneration project. This Municipal acceptance is enforced in a legally binding agreement between the BOM and the Municipality which includes the specific sustainability demands.

After signing the agreement and before the actual implementation, the Municipal departments collaborate about what specific measures they can implement and how to do it. If needed, the BOM NBD provides advice.

By picking up this “Encouraging sustainable regeneration of business parks” topic, the following statements are being covered:

S7: The topic ‘sustainability’ with the focus on energy is implemented in municipal regeneration projects by external encouragement.

S3: By implementing sustainability with the focus on energy in regeneration projects of business parks, more L-ZEB-related aspects become visible, which improves the observability of L-ZEBs.

8.4.4 Theme: Sustainable Energy Company

8.4.4.1 Topic: Realization of a Municipal Sustainable Energy Company (MSEC)

Figure 17: Sub model of Topic: “Realization of a Municipal Sustainable Energy Company (MSEC)”
To be able to deal with the “Realization of a Municipal Sustainable Energy Company” topic, at least the Municipal departments, the BOM Venture Capital (VC), BOM Foreign Investment (FID) and BOM New Business Developments (NBD) need to be involved.

By collaboration, the Municipal departments investigate the feasibility of a Municipal Sustainable Energy Company (MSEC) by writing a business plan with help from BOM NBD (helping with content) & BOM VC (helping with plan set up).

The BOM VC provides a starting capital for the MSEC in trade for an equity interest if the business plan satisfies. The Municipal departments together with BOM FID lobby toward interested companies/parties to participate in the MSEC (as input provider/client, member or shareholder).

The Municipality, and possible together with the participating companies/parties resulting from the lobby, establishes the MSEC further and participates in it.

With input from the BOM NBD (e.g. inventory of regional chances) and participating companies/parties (e.g. providing residual heat, waste for biomass or renting their roof for installing solar panels), the MSEC starts producing and selling renewable energy (e.g. installing heat nets or installing & exploiting solar energy) on local scale and starts selling energy saving products and services (e.g. insulating of industrial buildings).

One of the advantages of such a MSEC is that it accelerates the production of sustainable energy and the utilization of energy saving measures by anticipating on local chances. It also gives an impulse for the local economy because of its small scale (BuildDesk, 2009). By letting companies/parties and public servants with specific knowledge participate, this energy company can function as a knowledge and information centre towards industrial companies and other parties in the municipality (e.g. supporting industrial companies to realize I-ZEBs or investigating and initiating collective measures with industrial companies).

Because this MSEC works independently from the municipality and on the long run finances itself, its functioning is secured and insensitive to the political environment. This sustainable energy company also relieves the municipalities from several tasks so that municipal officials can spend more time in other tasks.
By picking up this “Realization of a Municipal Sustainable Energy Company” topic, the following statements are being covered:

**S8:** An environment is created in which the industrial companies can apply the Trias Energetica. Many of the available chances at industrial companies can be picked up by the MSEC, which are:

- Using roof for exploiting by external party (83%);
- Re-using residual heat for internal or external use (67%);
- Willing to implement wind turbines or Heat-Cold Storage on site (17%);
- Re-using waste (water) for renewable energy generation e.g. for biogas (17%).

**S10:** The municipality fulfils the wishes of the industrial companies by establishing a MSEC.

**S12:** Collective measures are being taken which results in a fast implementation of I-ZEBs.
8.5 Conclusion

In this chapter, a model has been created that is based on the 15 statements of the previous chapter.

First of all, the model consists of actors. These are the Province, Municipality, BOM and the Entrepreneurial associations, including their divisions where relevant.

Secondly, the model consists of a Collaborative environment in which relevant actors are being brought together who jointly work toward a common goal. This goal is to accelerate the realization of I-ZEBs. The actors that have a leading role are responsible for the establishment of this Collaborative environment. Most of the time, it is the municipality who has this responsibility. This establishment can be done in the form of an energy- & climate Agency.

Finally, the model consists of 8 topics that are related to the municipal energy- and climate policy execution. These topics are:

- Municipal energy- & climate policy planning
- Municipal energy- & climate policy execution
- Subsidy for I-ZEBs
- Promotion of I-ZEBs
- Persuasion to realize I-ZEBs
- Participation in realizing I-ZEBs
- Encouraging sustainable regeneration of business parks
- Realization of a Municipal Energy Company (MSEC)

These topics are being picked up via the collaborative environment in which relevant actors collaborate with each other. For every specific topic, this Collaborative environment setting is displayed in separate sub models. These sub models show which specific actors participate and what roles and tasks they have. These tasks are placed in order of time with connecting in- and outputs to be able to see the procedure how to deal with this specific topic.

By picking up these 8 topics, the energy- and climate policy execution of the municipality is being improved in such a way it accelerates the realization of I-ZEBs. Therefore the Collaborative environment can be seen as a “booster” of the municipal energy- & climate policy execution towards realizing industrial zero energy buildings (I-ZEBs).
9 Expert validation, final conclusion & recommendations

9.1 Expert validation
A previous model has been sent to the interviewed municipal officials of all six municipalities. Two municipal officials of Waalwijk and Geldrop-Mierlo have provided feedback. Their summarized feedback is as followed:

Waalwijk:
- Clear advice and a nice approach;
- Most of the recommendations are agreed, not all;
- The recommendations are too abstract, difficult to use in practice, examples are needed.

Geldrop-Mierlo:
- Several recommendations will be implemented (e.g. promoting Social Responsible Management), and several not (e.g. realizing Municipal Sustainable Energy Company);
- Additional explanation necessary about integral building and type of permits;
- Examples are needed to become more specific.

This feedback of the municipalities resulted in adjustments in the model by providing examples and additional information if possible. These adjustments are included in the current model as shown in the previous chapter.

9.2 Final conclusion
This paragraph contains the final conclusion of this thesis. In here, the main question is being answered. To be able to do that, this main question is divided into several sub questions. These sub questions are all solved in the previous chapters by using a literature study and interviews.

To recall, the main question of this thesis is: How can the current municipal energy- and climate policy execution be improved so that it accelerates the realization of I-ZEBs?

To be able to answer this main question, a model has been designed. In this model the establishment of a Collaborative environment plays a fundamental role in which relevant actors are being brought together who conjointly work toward a common goal. This goal is to accelerate the realization of I-ZEBs.
Most of the time, it is the municipality as leading actor who is responsible for establishing this Collaborative environment. In the Collaborative environment the relevant actors pick up one or more specifically defined topics. The topics accelerate the realization of I-ZEBs in their own specific way. These topics are:

- Municipal energy- & climate policy planning
- Municipal energy- & climate policy execution
- Subsidy for I-ZEBs
- Promotion of I-ZEBs
- Persuasion to realize I-ZEBs
- Participation in realizing I-ZEBs
- Encouraging sustainable regeneration of business parks
- Realization of a Municipal Sustainable Energy Company (MSEC)

All 8 topics are related to the municipal energy- and climate policy execution. Consequently, by picking up these 8 topics via the Collaborative environment, indeed the energy- and climate policy execution of the municipality is being improved in such a way it accelerates the realization of Industrial zero energy buildings (I-ZEBs). Therefore this model answers directly on the main question.

The mentioned 8 topics deal with all the concerns of the industrial companies that are related to the realization of I-ZEBs. If all the mentioned suggestions and improvements in the model are taken into account, the industrial companies are more willing to (re)build their industrial buildings into I-ZEBs. Therefore the hypothesis of this thesis is validated:

*By having insight in how the current municipal energy- and climate policy execution can be improved, the municipal officials are be able to accelerate the realization of I-ZEBs.*
9.3 Recommendations

This thesis would not have been possible without making some assumptions to have a clear focus. Thanks to this focus, there are some recommendations for further research.

1. In this thesis the focus was directed on ambitious municipalities, which resulted in improvements for them about how to accelerate the realization of I-ZEBs. These improvements can also be used for less ambitious municipalities to improve their policy. But still it would be interesting to also look specifically at less ambitious municipalities and to investigate why their ambitions are low, how ambitious municipalities can help and what can be done to improve their energy- and climate policy with the least effort.

2. In this thesis the focus was mainly on the interaction between municipalities and industrial companies. Interesting would be to focus more on the municipal organization itself. For example how the cooperation in the energy- and climate policy can be improved in the internal organization. As concluded, a good cooperation will lead to a better policy execution. But more in-depth interviews with municipal officials are necessary to provide even better and more specific advice.

3. This thesis was mainly a qualitative research. It would be interesting to do a quantitative research by using statistics to see which of the 8 topics would contribute the most in accelerating the realization of I-ZEBs. By applying a sensitivity analysis it can be seen which topic has to most influence and consequently should have the top priority in improving the execution of the municipal energy- and climate policy.

4. One of the topics of the model suggested an establishment of a regional/municipal sustainable energy company. Unfortunately, there is still no finalized business plan for such a company at this moment. Although several municipalities like Tilburg, Amsterdam and Apeldoorn are investigating such a company. This would be a nice opportunity for further research to make a universal or regional specific business plan for a municipal sustainable energy company.
10 References


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• DeRoo Metaalindustrie, Geldrop: Marc van den Acker, CEO;
• Distillery Cooymans, Tilburg: Mr Van den Hoven, Manager quality check, environment and process technology;
• FrieslandCampina, Eindhoven: Huub te Poel, head Technical Service, including energy and environment;
• FUJIFILM Manufacturing Europe B.V., Tilburg: ing. (Jef) Verboven, Sustainable Environment Technologist Energy;
• King Cuisine BV, Tilburg: Hans Scheffers, location manager;
• NABER Plastics, Waalwijk: Wim Naber, CEO;
• Oerlemans Foods, Waalwijk: Gerard Busser, Manager Manufacturing Service (permits, investments, vision, production, etc.);
• RABOBANK Datacenter, Boxtel: Eric Stevenaar, Facility manager;
• Rivusol, Eindhoven: Wilbert Neijmeijer, CEO;
• SMULDERS GROEP B.V., Mierlo: Paul van de Wiel, Welding Engineer and KAM-coördinator;
• STRAALBEDRIJF BOXTEL B.V., Boxtel: Mr Van de Heuvel, CEO.
Interview Municipal officials:

- Boxtel: Miranda Wolf, Contact person companies for entrepreneurs on business locations and ZZP-ers;
- Eindhoven: Vanessa Silvertand, program manager Sustainability & Climate policy, and Peter Vloet, Senior policy employee Economic Affairs & Account manager companies and business locations;
- Geldrop-Mierlo: Anke Kerkels, policy employee Spatial Planning, cluster Environment & employee SRE Milieudienst, and Fanny van Breugel Contact person companies at Economic Affairs;
- 's-Hertogenbosch: ir. Erwin Bosch, Coördinator energy and climate program;
- Tilburg: ing. Pieter Biemans, program manager energy and climate, and Jody Broeders, policy employee at team Economy;
- Waalwijk: drs. Titus Drijkoningen, Senior policy employee section Environment, responsible for energy policy, and Esther van Dijk, policy employee section Economic Affairs.

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