

Challenges of the energy transition

A case study on the city of Eindhoven



Knecht de, S. (n.d.). Als cartoon getekende architectuur, stadsbeelden en fictieve steden [Illustration] Retrieved from <https://www.schetsontwerp.com/stad-architectuur>

Gijs Sebregts, 1014619
Supervisor: Cebuan Bliss
Radboud University
Nijmegen School of Management
Geography, Spatial Planning and Environment
August 2020
Word count: 16,857

Preface

Dear reader,

In front of you, you find my bachelor thesis about the challenges of the energy transition for the city of Eindhoven. This thesis is my final assignment before I finish my bachelor's in Geography, Spatial Planning, and Environment. In this thesis, all the abilities, skills, and knowledge that I have acquired during my bachelor period will be combined, and the results will be shown in the next few chapters. It was a pleasure to work on this self-chosen topic, which, in my opinion, will play a very prominent role in society over the next decades, and it is interesting to dive into this at the starting point of this transition.

The last four months were very difficult and overwhelming due to the Coronavirus. This pandemic has also affected my working process, but that is relatively small compared to the global implications. Hopefully, we will be facing better times soon!

I want to thank my supervisor Cebuan Bliss for her support and useful feedback during this process.

Enjoy reading this,

Gijs Sebregts

Abstract

Climate change one of the biggest challenges that humanity is facing in the next few decades. Although climate change has always existed, the human influence on it has never been so large as now and this can have a big impact on humanity in the form of flooding, drought, extreme precipitation and drastic changes in temperature.

Cities appear as one of the bigger pollutants. With all the city activity, such as mobility, construction and industry do they have a big impact on this climate change. This is because of the fossil fuel based economy and therefore a transition to more sustainable energies is needed. This is also the case in Eindhoven. Eindhoven is the fifth city in the Netherlands and it is dealing with the energy transition as well. Supported by the Green Deal, the Dutch Climate Agreement and the Regional Energy Strategy is it about to start the energy transition towards the two Climate Goals that have been set by the United Nations: 55 percent reduction of CO₂ in 2030 emissions and 100 percent reduction of CO₂ emissions in 2050. Eindhoven was behind on a few topics, as appeared in the Natuur & Milieu (2018) report and also a local councillor said in the local newspaper (Eindhovens Dagblad, 2019) that more help and financials are needed. With this speech he aimed on the government, the EU, the Technological University of Eindhoven and the High Tech Campus, which is a highly technological campus in Eindhoven with a lot of high tech companies.

The main question of this research will be:

- How is the city of Eindhoven dealing with the energy transition, and what are the future challenges?

The following research questions have been set up to answer the main question:

- What are the problems for policy-making towards the energy transition?
- What developments are going to accelerate the energy transition?

To picture the energy transition as a whole there has been chosen for a conceptual model that shows three main influences from society where the municipality has to deal with regarding the energy transition. These three elements are the citizens, the businesses and the technological innovations. The citizens form a challenge as they have to be on board of this challenge. The same does count for companies. Technological innovations can be seen as an opportunity that can form a solution for the municipality of Eindhoven on the energy transition.

A qualitative approach has been used. This helps to create a deeper understanding of the materials and to analyse reports and papers that are written about the topic in general and about the context of Eindhoven. Because of the specific case that Eindhoven is, has been chosen for a single case study. With the presence of a technological university and the appearance of 'the smartest square kilometre' in the world (High Tech Campus, N.D.) does Eindhoven have a lot of possibilities regarding technology and it is also aiming on using these possibilities.

For Eindhoven it is important to create clear a long-term framework where every party in the municipality can rely on. This involves social support and synergy between municipality, businesses, the citizens and educational institutions. New agreements such as the Green

Deal (EU, 2020) and the Dutch Climate Agreement (2019) will create more guidelines to form this framework. Among citizens clear education is needed where every citizens gets an offer they can rely on. The municipality has to show decisiveness and leadership to get each party aboard. Then it should also strictly compliance the policy it has set. Right now Eindhoven is already trying to tackle the existing problems that occurred relating to energy. Implementation of this new framework will help Eindhoven reaching the Climate Goals of fifty-five percent reduction in 2030 and ninety-five percent reduction in 2050 that have been set by the government (Climate Agreement, 2019).

Table of contents

Preface.....	2
Abstract.....	3
Table of contents.....	5
1 Introduction.....	7
1.1 Outline.....	7
1.2 Objectives.....	11
1.2.1 Social relevance.....	11
1.2.2 Scientific relevance.....	12
1.3 Research questions.....	13
2 Theoretical framework.....	14
2.1 Rotmans about the energy transition.....	14
2.2 Policy instruments.....	15
2.3 Innovation policy for the Dutch energy transition.....	16
2.4 Economic growth.....	16
2.5 Constraints.....	17
2.6 Empirical examples of the energy transition in Europe.....	18
3 Methodology.....	19
3.1 Research strategy.....	19
3.2 Research material and processing.....	19
3.2.1 Conceptual model.....	20
3.2.2 Local councillor.....	21
3.2.3 Academic from the TU/e.....	21
3.2.4 Professional from investment company.....	22
3.2.5 Academic from the University of Applied Sciences.....	22
3.2.6 Student entrepreneur.....	22
4 Results.....	24
4.1 What are the problems for policy-making towards the energy transition?.....	24
4.1.1 Dissent.....	24
4.1.2 Distributed control.....	26
4.1.3 Determination of short-term steps.....	27
4.1.4 Danger of lock-in.....	28
4.1.5 Political myopia.....	29
4.2 What developments are going to accelerate the energy transition?.....	30
4.2.1 Technological innovation.....	31

4.2.2	Financial opportunities	32
4.2.3	Educational institutions	33
5	Conclusion	35
5.1	What are the challenges for the city of Eindhoven during the energy transition? ...	35
5.2	Recommendations	36
5.3	Reflection.....	36
6	Reference list.....	38

1 Introduction

1.1 Outline

Sustainability is one of the most important themes in modern times and nowadays every company, university or government acknowledges its importance. Due to climate change, the earth is warming and immediate action is needed to stop or reduce this. Different global parties have set targets for the next few decades to protect the earth from further warming with all its disastrous consequences. These targets were set in Rio de Janeiro in 1992, there was the Kyoto protocol in 1997 and long-term targets were set in Paris in 2015. Countries that have committed themselves to this Paris agreement have the duty to reduce emissions in 2030 by 40 percent (Paris Agreement, 2015). The Netherlands was even more ambitious, by striving for a 55 percent reduction in 2030. In 2050, this reduction should even be at least 95 percent (Dutch Government, N.D.). The underlying meaning of this agreement is to stop further global warming and keep the warming under 2 degrees Celsius and if possible, under 1,5 degrees Celsius (Paris Agreement, 2016). An energy transition is needed to achieve these targets. Fossil fuels have to be banned within a few years, and everyone has to become reliant on renewable energy. These developments will minimize CO₂ emissions, which will stop further global warming (IPCC, 2016). To transform a whole economy from fossil fuel to renewable energy is a vast operation and this leads to a lot of constraints and struggles and maybe even to a whole different organization of the society. National and local governments have to implement new policies that should help to achieve the new targets. Sometimes this will conflict with other ideas the political parties already had, and sometimes not every citizen can be satisfied, but the underlying idea is that this should help in the long-term to achieve the climate targets and preserve the planet.

In the Netherlands, there is much discussion on how and to what extent to the country must implement climate measures. The government presented an agreement to provide some guidance through this process (Klimaatakkoord, 2019). The Climate Agreement is a package of measures that should help to reach the 2030 climate goals. These measures will probably affect all Dutch citizens. The aim is to reduce carbon dioxide emissions by 49 percent relative to 1990 emissions levels before 2030. At the moment, the government is making significant efforts to achieve these goals, and some progression is already noted. However, more effort is needed to reach the 2030 goals. The Climate Agreement is not about adaptation to climate change, but only for preventing more emissions that lead to higher temperatures, so it is a more mitigating approach. It forms a crucial building block in further climate policy.

This Dutch Climate Agreement is a goal set by the Dutch government, but it is part of the Paris Agreement, which has as a target to limit global temperature rise to two degrees, and if possible, 1,5 degrees. Together with 195 other countries, the Netherlands committed to this agreement, and the Dutch Climate Agreement forms guidelines to reach this goal. Besides the Climate Agreement, the Dutch also have the Climate Law. This law endorses the 30 percent CO₂ reduction before 2030 and the 95 percent reduction before 2050 goals, and the Dutch government has committed itself to this law. Despite the extended set of measures, it still depends on many factors whether the targets of 2030 will be reached. For example, the involved parties have to implement plans to work towards these climate goals. However, they also have other priorities, and sometimes these do not match with the Climate Goals. Therefore, strict compliance is needed. Otherwise, there is a chance that the Climate Goals

will not be achieved. The next few years will require a significant transition, and this gives the government a lot of choices and dilemmas, which makes it hard to give an accurate prediction for 2030. The expectation is that, with these measures, the 2030 targets will be accomplished, but the government is cautious because of the many insecurities that are still left. The Netherlands expect the costs of this transition to stay under 0,5 percent of the Gross Domestic Product (GDP), so the government thinks that it should be able to afford this transition, which will be paid for by the society, companies, and the citizens (Klimaatakkoord, 2019).

As a result of the Climate Agreement, the Dutch government invented a new strategy for municipalities to meet its climate targets. This strategy is the Regional Energy Strategy (RES). The RES has a target for each of the thirty energy regions to find a suitable location within its region to produce sustainable energy, but heat networks could also be used to make neighbourhoods gas-free. The task is to determine whether there is space to develop renewables and how much space there is. These findings have to be documented in the Regional Energy Strategy (National Program RES, 2019). The concept of the RES for Eindhoven and its surrounding municipalities, together called the Metropool region Eindhoven, has been released. It is still in its early phase, and it will be interesting to see how this strategy will develop after implementation.

Climate change and the deterioration of the environment form an enormous threat to Europe and the world. Europe needs a new growth strategy to fight this, which would make the EU a modern, resource-efficient, and competing economy that reduces greenhouse emissions to zero in 2050 and achieves economic growth with regard to the well-being of every human being in this region. The European Green Deal, which is about to be launched, is meant to be the pathway for Europe towards a sustainable economy. This deal will only succeed if every policy area is willing to tackle each climate or environmental problem to make the transition just and inclusive for every person in the EU (EU, N.D.). The European Green Deal should form a pathway to make the use of resources more efficient by switching to a clean circular economy and recovering biodiversity by reducing pollution. It is about to make investments in financial instruments to achieve an inclusive and fair transition. The European Union has to be climate neutral in 2050. In that perspective, it has proposed a climate law that converts this political commitment into a legal obligation to invest in sustainability.

Each economic sector has to cooperate in this deal. They have to

- Invest in environmentally friendly technologies
- Help companies to innovate
- Arrange a clean, cheap, and healthy form of private and public transport
- Create a carbon-free energy sector
- Produce bigger energy-efficient buildings
- Cooperate with international partners to improve global environmental norms

The EU will arrange financial and technical support for people, companies, and regions who struggle to transition towards a green economy. This mechanism should create a just transition that makes 1000 billion euros available for the countries that are mostly affected by the transition between 2021 and 2027 (EU, N.D.). The Green Deal is a framework for Europe as a whole, and for the Netherlands, it forms an addition to the already presented Climate Agreement. This Green Deal gives, hierarchically speaking, more pressure, even

legal requirements, and this helps to accelerate the energy transition in the Netherlands as it leaves no more room for excuses.

The government also has to monitor the progression of these climate targets. This progression is being shown in the Climate and Energy Scout (KEV, 2019). This report monitors the actual progress that is being made towards the climate targets. This report, which was launched in 2019, is meant for politicians, policymakers, and other interested people and has two important messages. First, significant extra effort has to be made to reach the goals of 2030. Figures showed that in 2018, carbon dioxide emissions were reduced by 15 percent compared to the 1990 levels. This reduction is some improvement, but it also means that in the next ten years before 2030, three times as much emission reduction has to be accomplished to reach the 2030 goals. It also shows what the current climate measures will lead to in 2030, and needless to say, this will not be enough to reach the goals. Second, the implementation of climate policy is challenging, and the 2020 targets for greenhouse gas reduction, renewable energy, and saving are not likely to be reached (KEV, 2019).

Cities, in particular, are very vulnerable to climate change. Many cities all over the world are located in coastal areas or near rivers, and globally, more than 50 percent of the population lives in cities. Seventy-five percent of the European population lives in cities, which makes cities responsible for 80 percent of the global economy and the fact that these cities are often located in coastal areas makes them more vulnerable to flooding (Reckien et al. 2018). In the Netherlands, this has happened as well. The four biggest cities in the Netherlands are below sea level. The Dutch set up some measures and projects to protect these cities and to enforce the Dutch defence against the water. As a result of these measures, the estimated risk of flooding, for the four biggest cities Amsterdam, Rotterdam, The Hague and Utrecht, has decreased to only one event in ten thousand years (Dutch government, N.D.). Cities have two main responses to climate change: adaptation and mitigation. Mitigation means trying to reduce or soften the impact of climate change on society, for example, by reducing carbon dioxide emissions to reduce the risk of further temperature rise. These responses can be done at the city level, for example, by deploying more public transport and reducing the facilitation for private transport. Adaptation means adjusting to the new situation, for example, by giving more space to water when sea-level rise occurs (Reckien et al. 2018). An example of giving more space to water has happened in the area of Nijmegen. In the last decade of the previous century, there was a very high water level in the Waal river due to weather circumstances, which led to a higher flooding risk. An extra side channel has been constructed as a flood catchment area to prevent this and now this area can adapt more easily to high water levels (Ruimte voor de Waal, N.D.).

In this research Eindhoven will be used as a case study. Eindhoven has a rich history and with about 235.000 citizens, it is the fifth-largest city of the Netherlands (Municipality Eindhoven, 2020). Philips, one of the biggest electronic companies in the world, was founded in this city and several other large Dutch companies such as VDL, ASML, and Jumbo are located in or around this area. The city is famous for its technology. Eindhoven has a prestigious Technological University, but the most innovative part of this city is probably the High-Tech Campus. This Campus is a cluster of technology companies that form a hotspot of technological development in the Netherlands and attract expats from all over the world. It is known as the smartest square kilometre of Europe, with more than 200

companies and about 12.000 researchers (High Tech Campus, N.D.). Transition, creativity, innovation, technology, design, and knowledge are terms that the city uses to identify itself (This is Eindhoven, N.D.). Besides that Eindhoven does also have strong growth ambitions (Coalition Agreement, 2018). Therefore, it is all the more remarkable that the Municipality of Eindhoven is behind in meeting its climate targets, and this will be the focus of this research. A city with a global image as a centre of technology and innovation could have a pioneering role. How did this situation occur, and what can be done about it?

Eindhoven is one of the Regional Energy Strategy regions and has the task to work out its first concept before the first of June 2020. It divided the problem into different aspects and different workgroups. Working groups are groups that discuss with stakeholders about certain aspects, gather information about the aspect they are dealing with and they are in touch with the citizens. By doing this they combine social support with the available knowledge about a specific part of the Regional Energy Strategy (RES, 2020). By differentiating the subject, they try to have a more focused and suitable solution. The ultimate goal is 100 percent sustainable energy in 2050 (Metropoolregio Eindhoven, 2019).

Eindhoven is a region that is booming. In 2017, it had an economic growth of 4,9%, the highest in the Netherlands, in which the average was 3,2%. It is a region with many employment opportunities and much economic activity. With the presence of knowledge, innovation, and education, is this region known as the Brainport. Since 2018 it is even one of the three main ports in the Netherlands, next to the Port of Rotterdam and Amsterdam Airport Schiphol. The High-Tech Campus Eindhoven is even a player on world level with its innovations and developments. (Coalition Agreement, 2018).

Eindhoven even got called the most inventive area in the Netherlands. According to the European Patent Office are Dutch companies on top of the world regarding the application of new inventions (EPO, 2019). This can be showed by the number of patents that got allocated to Dutch companies. Also the number of Dutch patent application is one of the highest in Europe. A great part of these inventions from companies that want patents are from technical companies in the area of Eindhoven. Philips, ASML, signify, but also smaller companies are responsible for this large share.

Those companies on the High Tech Campus are working on research and development. Spokeswoman of the High Tech Campus even calls world class in the area of innovation and with 40 to 50 percent of the Dutch patent application it is the innovation hotspot from the Netherlands. The proximity of other high tech companies stimulates the ingenuity and cooperation (Trouw, 2019). This leads to more development.

Eindhoven, with its status as a main port that is specialized in technology and innovation, is a very developed area. Despite that it is not on track to meet its climate goals. In February 2018, just before the municipal elections, Natuur & Milieu published a report about sustainability in the 42 biggest municipalities in the Netherlands. Natuur & Milieu is an independent organization that strives for a more sustainable and cleaner environment. In this report, it tested the 42 biggest municipalities, among which Eindhoven, by 12 factors, which are all related to sustainability, and this gave an outcome to what extent these municipalities were sustainable already. This report was based on sources published by the government, and it had quite a disappointing outcome for Eindhoven. For each area, there were three

possible outcomes, namely green (good), yellow (mediocre), and red (bad). The city had a good score on relative car use but had poor scores on the energy labelling of buildings, pollution by traffic, and the participation in programs that strive for cities with zero-emission and neighbourhoods free of natural gas. Eindhoven was behind on cities like Amsterdam and Utrecht and that means that it has to undertake action (Natuur & Milieu, 2018).

In September 2019, Eindhoven councillor Rik Thijs from the political green, left-wing party GroenLinks said that Eindhoven would need help from either the Technological University or businesses in the area for the city to achieve the Climate Targets. He also asked for more subsidies from the government and the European Union. Eindhoven is aiming for a car-free city-centre, it is trying to make multiple neighbourhoods gas-free, and it is trying to develop solar panel parks or wind farms. According to the councillor, these ambitious ideas are not achievable without external help, including financial help from higher governmental institutions. Furthermore, it is crucial to create support among the citizens for implementing these measures, and this can be done by good provision of information and transparency (Eindhovens Dagblad, 2019). The fact that Eindhoven is technological hotspot with the ambition growth, in combination with the 'rattling' climate policy makes Eindhoven a unique case to research. It has a lot of possibilities to improve regarding sustainability and energy, but until now it did not make much use of it. What is the underlying reason for this and will it improve?

1.2 Objectives

In this research, the aim is to explain how cities deal with the challenge of the energy transition. What is the current situation in Eindhoven regarding the energy transition, and what were the important constraints in the past regarding achieving these targets? Is there a lack of support for sustainable measures among the citizens, or is there just a lack of resolution from the local government, or are there other reasons explaining this situation? It is important to find out which actors are involved and which measures could be implemented in the future. Therefore, the role of the University and the High-Tech Campus is interesting. These are Technological hotspots with a reputation all over the world. How could they contribute to Eindhoven's efforts to meet its climate targets? Recently, a councillor in Eindhoven asked for help from different parties, including the Technological university and the High-Tech Campus. He hoped that their innovations could help accelerate the CO₂ reducing process. Besides that, he sought more subsidies from the Dutch government and the EU (Eindhovens Dagblad, 2019). Where will this lead to, and what are the connections between the council and these parties?

1.2.1 Social relevance

In the last few years, society has become more aware of the urgency of climate change and the seriousness of this change. There were reports from institutions like the Intergovernmental Panel on Climate Change (IPCC), prominent universities, such as Harvard University (Harvard University, N.D.), and other respectable organizations, such as the European Union (EU, N.D.) and the United Nations (UN, N.D.). These parties underline the urgency of climate change adaptation or mitigation. The World Health Organization states that climate change is one of the biggest threats human beings will face in the next few years (WHO, 2020). This problem requires an integrated collaborative approach on the national level, but also on the local level. The Dutch government and the EU set climate

goals for 2030 and 2050, and it is of huge importance to meet these to prevent a further decline of the planet. As mentioned, this also requires an approach at the city level. Some cities are doing this quite well already. There are, for example, the C40 cities who are leading the way in climate adaptation. C40 is a network of the world's megacities committed to addressing climate change. C40 supports cities collaborating effectively, sharing knowledge, and driving meaningful, measurable, and sustainable action on climate change (C40.org, N.D.).

This research will analyse the problems or constraints that cities face to form a clear overview. In this research, an outline will be made about a city and the problems it faces regarding meeting its climate targets. In this case, it will be about Eindhoven, a very lively city that is doing very well economically and that has a global image regarding technology, with the presence of Eindhoven University of Technology (TU/e, N.D.) and the High Tech Campus (High Tech Campus, N.D.). In 2018, a paper by Natuur & Milieu specified four points on which Eindhoven could improve sustainability: energy labels in buildings, green deal zero-emission city logistics, green deal natural gas free neighbourhoods, and particulates emission by road traffic (Natuur&Milieu, 2018). In September 2019, a councillor of the city mentioned that without help, Eindhoven would not be able to meet its targets, which are specified in the Dutch Climate Agreement (2019). These issues are likely occurring in many contexts (TNO, 2020), and therefore, this paper is socially relevant. Eindhoven is used as a case study, and this research aims to explain the problems that should be addressed and how this can be done. In Eindhoven there is a huge challenge for the next few decades. As mentioned before, they are behind for its Climate Goals, and this means that there is a lot of work to do in the next few decades. The fact that Eindhoven has a lot of resources that can support them in this challenge, such as the university and the Brainport, makes it very interesting to see how they will manage this transition in the next few decades and if they could make good use of those available resources.

1.2.2 Scientific relevance

Climate change is a problem that has been going on for decades, but in recent years, people have become more aware of it. In the last few years, international agreements have been made (Paris Agreement, 2016), and sustainable measures are being implemented, although researchers mentioned this situation decades ago. In 1972, John Sawyer summarized all papers about the Greenhouse effect and human-made carbon dioxide (Sawyer, 1972). More recently, Al Gore warned the public about this in his movie 'An inconvenient truth' (Gore, 2006). Recently, it has been shown that cities struggle with these targets. On the one hand, they want to keep their citizens satisfied, and forcing them to make costs for a problem that sounds vague to them will lead to resistance (Leach, 1992). On the other hand, there is the urgency of undertaking action based on scientific evidence and governmental agreements (IPCC, 2016; Paris Agreement, 2015). This topic has been researched for decades, and this research could form a clear overview from a scientific perspective on what the problems are in a city like Eindhoven. This thesis will be just one case study, so generalizing is difficult. However, when combined with similar studies, certain patterns of behaviour can be discovered, which can be an early stage of a new behavioural theory about this subject. It is also interesting to apply scientific theories to this context.

1.3 Research questions

This research is focused on describing the challenges regarding the energy transition for the city of Eindhoven. Based on the earlier reviewed literature, some circumstances have a significant influence on this transition. With these questions, the aim is to try describing the current and future challenges regarding the energy transition. This main question will be answered by describing the factors that are relevant in this transition. It appeared that social support, businesses and technological innovation play an important role in this process, so their contribution will be analysed. The connection will be made with the municipality and how it translates this into a strategy towards the Climate Goals. Also the role of the higher governmental institutions will be discussed.

Main Question

- How is the city of Eindhoven dealing with the energy transition, and what are the future challenges?

Sub-questions

- What are the problems for policy-making towards the energy transition?
- What developments are going to accelerate the energy transition?

2 Theoretical framework

Because of the relevance of this topic, much literature has already been written. The energy transition is something that will be part of almost every policy issue in the future, which is a big challenge to face. According to the IPCC report (IPCC, 2014), there will be a temperature increase related to the vast amount of air pollution produced by human society. This pollution can have negative consequences for the earth and human society, and thus, drastic measures need to be taken. There will be effects like water scarcity, floods, drought, landslides, sea-level rise failing agriculture, and heatwaves (EU, N.D.). A big transition has to be made with radical measures to tackle these effects. How are these measures going to be implemented, and what consequences does this have on the world and its society?

2.1 Rotmans about the energy transition

Dutch professor Jan Rotmans is an expert in the area of transitions and transition management at the Erasmus University in Rotterdam. In his day-to-day operations, he tries to translate theoretical transition sciences into specific actions and advice for all kinds of parties. He has written many articles about it and is a key figure in the Dutch discourse about this subject. In a recent essay, he analysed the concept of energy transition (Rotmans, 2019). He wrote about the enormous task that the Netherlands is facing in the next few decades, in which all existing houses must become gas free (Klimaatakkoord, 2019). An operation he compared to the reconstruction of this country after World War 2. He says that it is important to tell the story about this transition from two perspectives, a small and a large one.

The small perspective translates this enormous task to the daily lives of individuals to make it less difficult, but rather motivating and stimulating to cooperate. He pictures this huge reconstruction as small scale reconstructions on the household level. From this perspective, the transition is decentralised to make it more tangible and give municipalities and neighbourhoods the means to start with this operation. The large perspective is meant to underline the urgency. While the local perspective is meant to activate the individuals and make it more practical, the large story accentuates the seriousness of the situation and enables the creation of a long-term vision (Rotmans, 2019).

Rotmans splits up the concept energy transition in his essay. The first word, energy, is the word that gets the most attention in the discourse about this topic, and Rotmans argued that this often resulted in some technical discussion. However, the second word, transition, gets less attention even though it is just as important. He described it as a fundamental turning point of thinking, acting, and organizing. So, a transition is not just a normal change but a fundamental irreversible one. It requires a different way of thinking. Transitions, Rotmans continues, never exist out of a broad support system, for that would lead to too many conflicting interests. A transition comes forth from a small deep support system that can slowly be extended, starting with the pioneers (maximal 10 percent of the population). Those are the people who are willing and able to transform. Afterwards, the people who are willing but not able or vice versa join (maximal 70 percent of the population). The last group that will follow is those who are not willing and not able to transition. This shows that transitions are long processes that occur in phases. The answer to this transition is not a clear one. Many technologies, techniques, sources, and innovations are possible, but none of these inventions are perfect, said Rotmans. Every technique will be needed, and a lot depends on

the context of the specific situation. Another point is that current implementations can be outdated in ten years. The key will be the way how the stakeholders will organize this. It has to be smart and fast but also strategic and controlled so that no precious time will be wasted.

Rotmans was not very positive about the climate agreement. He stated that the pace of this transition is set by parties from umbrella organizations who are already doubting the feasibility of the targets and are already demanding more money. The real innovative parties, such as middle and small enterprises and start-ups, do not get the space they need to scale up. Also, a top-down structure will not work as this will miss too many citizens and municipalities. Rotmans argued for an integrated approach that combines top-down with bottom-up structures. Strict leadership from the government, but with plenty of possibilities to participate from the bottom-up with more responsibilities for local municipalities (Rotmans, 2019). With this paper Rotmans tries to define the concept of the energy transition and that makes it a relevant paper to include.

2.2 Policy instruments

As long as the necessary technologies are not there yet, for example, if they still need to be scaled-up, implemented, or even invented, climate policy is needed. Climate policy and the involved restrictions are something new, and people have to get used to it. Some things that were part of people's everyday lives are not allowed anymore. Examples are emission zones where diesel cars are not allowed anymore, nitrogen restrictions for the farming and the construction industry and the restrictions on pipelines for natural gas in new buildings. These different ways of policy-making with policy instruments can influence the way people behave towards the environment. These measures are being implemented and can force people to change their attitude or way of doing things. These actions are called policy instruments. In environmental management, four types of policy instruments can be identified:

- Advisory: This instrument works to change behaviour and attitudes through the provision of information. This information can be spread through advice, leaflets, and help-lines labelling, and it is mostly aimed at risky or environmentally damaging behaviour in this context.
- Market-based instruments: These are interventions that seek corrections when the market fails to protect the environment. Through financial incentives, they try to make people behave in their own best interest, which is in the best interest of society and causes minimal environmental damage. Examples are environmental taxation, trading schemes, and environmental subsidies.
- Regulation: This is legislation to 'command-and-control' and is mostly in response to problems. It provides more certainty than the other two instruments as it can limit or prevent actions while the other two instruments are merely guiding.
- Behavioural: This type of instrument is also called nudging. It tries to alter people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives (Thaler et al., 2012).

Whatever the chosen instrument is, it should be effective. It has to resolve the problem it was introduced to address. It also has to be efficient. It has to minimize both the direct compliance costs borne by the subjects who are regulated and other indirect costs borne by the public (OECD, 2006). Policy instruments are a way to influence people their behaviour and it is interesting to see if does Eindhoven does use them and how.

2.3 Innovation policy for the Dutch energy transition

In 2004 Loorbach and Kemp wrote an article about the operationalization of the national environmental policy plan (NMP4, 2001). This is an addition on Transition Management (Rotmans, 2001) and it provides a policy approach for the societal problems that will occur in the future, such as climate change, biodiversity loss and overexploitation of resources. In the NMP4, the Dutch selected the energy supply, mobility, agriculture and the use of biodiversity and natural resources as priorities for developing transition management activities. National the ministry of Economic affairs and Climate are responsible for this energy transition and they have the task to attract the multiple actors in this transition. By this they wanted to see how the ministry fostered the energy transition with the underlying reasons. The management of this transition with the involved stakeholders and policies will be described. In the paper they use a multi-level, multi-phase transition framework in which they analyze the approach of the Dutch ministry in terms of content and process. By this they want to distinguish visions, experiments, actors and instruments. They also looked at the prospects of this transition (Loorbach & Kemp, 2005).

In the paper they discuss a few aspects of the energy transition. First the need for an alternative way of governance. Sustainable development has been described as a 'redirection of trajectories in ways that combine economic wealth, environmental protection with social cohesion. In the remaining of this paper the way a transition will be formed in the Netherlands. It is interesting to say how this transition is being shaped in Eindhoven and what the similarities and the differences are.

They distinguished five main problems during policy-making for sustainable development:

- Dissent
- Distributed control
- Determination of short-term steps
- Danger of lock-in
- Political myopia

It is interesting to translate this paper to this a modern context to measure to what extent these problems are still applicable on the energy transition. This paper also helps to describe the situation on Eindhoven.

2.4 Economic growth

In most countries in the western world, there was economic growth until the outbreak of COVID-19. However, due to the ongoing climate change, a radical change of the system is needed. Maybe, this is the moment to make this radical change. This radical change is a situation that makes people anxious, because why would we refurbish the whole economy for something like climate change? It will be a costly operation and will cost some people their job, mainly jobs in the fossil energy sector. In new renewable economies, these jobs would no longer exist. On the other hand, the sustainable transformation of a country could also create new opportunities and new jobs, for example, jobs in the sustainable energy sector, which will expand because of this transition (Fankhaeser et al., 2008). A few countries and companies, like the Middle East and, for example, Shell or KLM/Air France, will have a hard time, while countries leading in sustainability, such as Switzerland or

Norway and companies like Tesla, will take advantage of this situation. The energy transition will have winners and losers economically, but the most important aspect of the energy transition is that the Climate Targets of 2030 and 2050 will be achieved and that further global warming will be stopped.

In 2016, Irena (International Renewable Energy Agency) did some research on this phenomenon. It tries to measure the socio-economic footprint of the energy transition. It argues that the energy transition could not be studied without taking the broader socio-economic system into account. There must be integration between this transition and the wider economy. It also argued, as mentioned in this research, that some countries will do better than others. Highly fossil-fuel dependent countries with a non-diversified supply chain will face many problems during this transition. Countries with a diversified non-fossil fuel dependent supply chain will face fewer difficulties. The next step is to implement and integrate renewable energy technologies in materials and human resources. Overall, good integration and collaboration between all stakeholders are necessary to make this transition a successful one. For the countries that are behind in renewable energy and have a weak domestic supply chain, it is important to start developing their industries based on renewable energy. A good industrial policy framework could help these countries take the economic opportunities that the energy transition offers (Irena, 2016). A radical change is needed, but with good adaptation and good governance, it also creates many possibilities.

2.5 Constraints

In this transition to sustainability, there are many constraints that negatively affect the process. One of these constraints is climate change scepticism. American president Donald Trump is an example of that. He is the most powerful man in the world but denies the scientific consensus regarding climate change, and with that attitude, he hinders the development of new sustainable policies. In the Netherlands, a similar movement is happening, although it is much more under the radar and less prominent. Two Dutch parties, PVV and FVD, are very sceptical about climate change, and they claim that there is no significant anthropogenic influence on climate change. They even do not see the global increase in CO₂ as a huge problem that should be tackled. Unlike the USA, the Dutch have a 'poldermodel' which means that every relevant party can be involved in the policy-making process. This model means that all parties have to opportunity to spread their ideas in real life and in the media, which has its effects on society. Nowadays, they have a lot of sympathizers, which is not good for creating societal support for climate measures (Camfferman, 2018).

In forums, weblogs, and other channels, many people are able to spread their sceptical thoughts. This group gets, despite its limited amount of people, a big platform, and this is because of the attention it gets from the mainstream media. This attention enables some of its leaders to debate their ideas on TV, where they tried to argue their points mostly by advocating other irrelevant scientific explanations or by showing incomplete figures. So, the big platform this group received from the media combined with the Dutch parliamentary system in which every relevant party has a platform to speak and get involved makes this group a serious threat to further climate policy (Camfferman, 2018).

Another constraint could be political disagreement. There are a few parties in the Netherlands, like D66 and GroenLinks, that currently focus almost entirely on climate change, but there are also many parties that have other important ideals. Liberal parties, for example, argue that they are aware of the urgency of climate change, but they also want a lot of other things, which are not always easily combined with climate policies. Think about the tax tariff that big companies pay in the Netherlands. These taxes could be much higher, and, according to left-wing parties, they should be, to make sure that these parties pay for their pollution but also to help finance the Dutch government. Liberal parties want these companies to keep their advantages to ensure that they stay in the Netherlands and to keep the Netherlands competitive as a trading country. These are different insights that occur in Dutch politics, and that forms an obstruction to effective climate policy. This overview of the Dutch political landscape and all its forces and visions is very interesting to include in this research as it also applicable on the context of Eindhoven.

2.6 Empirical examples of the energy transition in Europe

In Copenhagen in Denmark, local governments are experimenting with the implementation of low-carbon initiatives. These initiatives could help in the energy transition. In such cities, there is a lot of good and feasible low-carbon initiatives from citizens, and in this study, it will be explained how a local government can support such an initiative during the scaling-up process (Van Doren et al., 2020), which is relevant for almost every other city in transition. Small initiatives from local people could be innovative and sustainable, and that could form an ideal pathway so a more sustainable and less polluting city. These small initiatives could also be interesting to research in Eindhoven. There are low-scale initiatives that require more attention or support, and there are possibilities to scale these ideas up to make them successful within the limits of a city. Expanding and promoting public transport is a topic with which many cities are dealing. Cities want the transport in their cities to be cleaner, which can be achieved by using private electric vehicles but also by promoting public transport. This has been done in, for example, Utrecht, in its action plan clean transport (Actieplan schoon Vervoer Utrecht). It expanded its train station and other public transport facilities, but It also promoted the use of electric vehicles, which do not produce emissions (Municipality Utrecht, 2015). Another, even more rigorous, example is Tallinn. Tallinn is the first and one of the biggest cities in Europe that offers fare-free public transport (FFPT). It started this as a pilot in 2013, and it worked out so well that currently, it is still going on in the Estonian capital. Before the implementation of the FFPT, ticket prices were already covering only one-third of the total costs due to other discounts for certain population groups as elderly, disabled people, and kids. FFPT was just the next step in which all citizens of Tallinn were allowed to use free public transport. After a referendum, the citizens of Tallinn chose for the FFPT system. These are interesting alternatives that could be an example for the city of Eindhoven.

3 Methodology

3.1 Research strategy

This research aims to explain the process of the energy transition in cities through an embedded single case study in Eindhoven. Thus, this research will have a qualitative approach. A qualitative approach will help to create a more thorough understanding of the subject, and it enables getting more information about the specific case of Eindhoven. Eindhoven is a special and worldwide-known TechHub, and this is something very interesting to explore. What can these technology companies and institutions contribute to cities regarding energy, sustainability, or climate change? Are there new technical innovations that can form a useful implementation, and can this help Eindhoven to achieve its targets? Eindhoven has a successful business sector and a large society, and it is relevant to see its attitude towards the energy transition. Due to the presence of these institutions, Eindhoven is quite a unique case, and that is why it has been chosen for an embedded single case study. Eindhoven is quite a unique case, and this makes it difficult to compare it with other cities because other cities cannot rely on the same resources, such as a High-Tech Campus, a Technological University, or multinational companies. For those reasons, an embedded single case study has been chosen (Vennix, 2016).

Five in-depth interviews have been conducted with different stakeholders on this issue aiming to create insight into the situation from that person's perspective. There were questions about that person's role in the transition and that person's view of the situation as a whole. The aim was for the interview to be like a real conversation in which each stakeholder could elaborate on the topics as much as he or she wanted to, and this also led to interesting insights that were not mentioned in the theoretical framework. Even though the approach is single-based in the case of Eindhoven, important findings could still be applicable to other cities. Each of the respondents had a different, diverse background, which was not always based on Eindhoven. As a result, the interviews were not specifically about Eindhoven all the time. It was also about certain ideas, concepts, or experiences that could be applicable to Eindhoven, but also other cities. Because of this, the outcome of this research could also be generalized and applied to other cities.

3.2 Research material and processing

There will be two ways of information gathering. The first way is 'desk research.' In the first part of this research, relevant academic papers, local policy documents, reports, local newspapers, and other additional sources have been collected to help to describe the setting. The second way of information gathering was the collecting of primary resources through face-to-face interviews. Because of the current circumstances regarding the Coronavirus, the interviews were held online. In-depth interviews are useful because they give more insight into the situation, and it enables responding to the reactions of the respondents. The research material is transcribed, and the parts that were useful to answer the research questions are processed in the results section.

This method helped provide a clear overview of the case of Eindhoven and what possible solutions or implementations could be. The interview outputs are compared to each other to determine if policymakers give consistent answers and compare their responses to the literature. Finally, the results have been discussed, and this enabled answering the main questions and form a conclusion of this research about the energy transition in Eindhoven.

3.2.1 Conceptual model

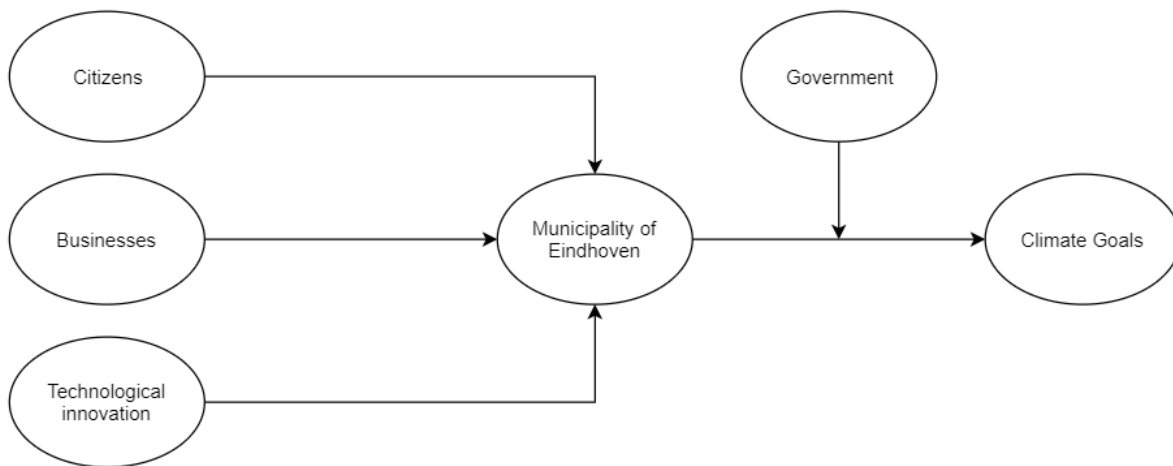


Figure 1 Conceptual model

This conceptual model shows the relations and links that are going to be investigated in this research. The municipality is the central actor in this model. It has to deal with several incoming societal influences, which are simplified into three types: citizens, businesses, and technological innovations. The job of the municipality is to manage these forces of society towards the Climate Goals. It has to get society onboard for the energy transition, and in this research, it will be investigated how this social support can be achieved. Furthermore, the municipality has the duty to implement policies aimed at the achievement of the Climate goals. Also, the role of the government is relevant to discuss. With this, I refer to the (inter)governmental institutions above the municipality level. These (inter)governmental institutions can vary from the Paris Agreement to the United Nations or the Brabantse Ontwikkelingsmaatschappij (BOM), which has been set up by the provincial government to accelerate the energy transition in Brabant. With its policies and agreements, it sets the framework for the municipality to develop its own policy. Furthermore, the role of educational institutions such as the Technological University, Fontys University of Applied Sciences, and Summa is going to be discussed.

In this research, the aim is to determine the challenges regarding the energy transition for Eindhoven. These will be divided into different indicators that influence the way the energy transition towards an emission-free city should be implemented in Eindhoven. The problems for Eindhoven's energy transition will be identified through the literature review and interviews. The literature review has given an overview of general problems regarding the implementation of the energy transition in a society. Afterwards, this information will be tested in the city of Eindhoven. The aim is to find out what the issues are in Eindhoven and why these problems occur. The research will also analyse possible solutions, and which actors that are involved in this situation. In the end, there will be an overview of the challenges for Eindhoven, currently and in the future.

For this research, five people have been interviewed. Each of them has a different position, background, and view on the situation, and this made the final data very diverse and

comprehensive, but with regard to the underlying research and the questions that have been set. The topics were the same, but each respondent's view on it was different, making it interesting to analyse. The interviews have been held in Dutch and the used quotes have been translated as accurate as possible to make the message the same. Because of the relevance and the accurateness of the quotes has been chosen not to paraphrase them, but to show them how it has been said during the interviews. Because of the wish of some of the respondent to do some statements anonymous has been chosen to give each respondent a fictive name to maintain the consistency. The next table shows briefly what each respondents function is, further there will be elaboration about each respondent its background.

ROLE	RESPONDENT	DATE
LOCAL COUNCILLOR	Piet-Hein Bartels	April 8th 12:30 MS Teams
ACADEMIC TU/E	Claudia Freriks	May 8th 10:00 Zoom
PROFESSIONAL	Barbara van Laaren	May 15th 10:30 MS Teams
ACADEMIC FONTYS	Jessica Bovendam	May 19th 10:30 MS Teams
STUDENT	Jean-Paul Duivenbode	May 25th 15:15 MS Teams

Table 1

3.2.2 Local councillor

The first interview respondent is a local politician in Eindhoven. He is involved in the topics of energy and climate, and this is why he is an interesting respondent to talk to about this local energy transition. In the results section, this person will be referred to as Piet-Hein Bartels, and the transcript can be found in Appendix A. In the local coalition agreement (Coalition Agreement, 2018), the Regional Energy Strategy (Regional Energy Strategy, 2020) and the media (Eindhovens Dagblad, 2019) mentioned that there is a big challenge in realizing sustainability in the next few years in Eindhoven. In these aforementioned documents, the city has already addressed a few projects to start with as soon as possible, such as a car-free city centre in 2025, disconnecting neighbourhoods from gas resources, and introducing more sustainable sources, such as biomass and biogas. Furthermore, they is trying to find new locations to install solar parks and wind farms in Eindhoven and the surrounding municipalities, known as the Metropool region Eindhoven. These measures will lead to an estimated reduction of 30 percent, while 55 percent is needed. This reduction is a huge task that the Municipality of Eindhoven cannot complete by itself. The city is negotiating with partners and looking for extra financial support to help them reach these targets. Piet-Hein Bartels is currently trying to set up a long-term framework to guide Eindhoven through this transition.

3.2.3 Academic from the TU/e

The second interview respondent is an academic from the Eindhoven University of Technology with an impressive track record in the area of energy. From this perspective, she can provide some interesting insights from both business and academic views. In the results section, this person will be referred to as Claudia Freriks, and the transcript can be found in Appendix B. She is active at the area energy at TU/e, and she also has a solid track record in the profit world in themes related to energy. She also took part in the negotiations for the, in 2019 launched, Climate Agreement, and she is in the external safety commission of the

nuclear plant in Borsele. She has much experience in the area of energy, and that makes her an interesting respondent for this research.

3.2.4 Professional from investment company

The third interview respondent was someone from an investment company who invests in sustainable energy projects. By doing this, it tries to accelerate the local energy transition. In the results section, this person will be referred to as Barbara van Laaren, and the transcript can be found in Appendix C. Barbara van Laaren is an employee of BOM (Brabantse Ontwikkeling Maatschappij), which stands for the Brabant's Development Agency. This company was founded in 1983 to boost the economy in Brabant by investing in companies and projects. BOM does this in four areas. The respondent works in the renewable energy area. It is formed out of a specific demand from the provincial council to boost the energy transition, and it invests primarily in projects concerning the energy transition. Renewable energy focusses on three main categories - first, energy savings and energy generation in the built environment, meaning all types of property. The second category is a large-scale energy generation. These are projects like solar fields and wind parks, but recently it has also been looking into the generation of energy in treatment plants. These themes make regular use of citizen participation who could invest in these projects. The last category is investment projects in big companies with high energy use. This category is a different because of the customization that most big companies require for this theme. BOM is a very interesting company in this transition, as it helps to accelerate it by setting up new projects and investing in companies and ecosystems. Institutions like this can help municipalities by investing in specific projects that are sustainable and relevant. It wants to improve Brabant's excellent competitive position in a sustainable way.

3.2.5 Academic from the University of Applied Sciences

This respondent is part of the Fontys University of Applied Sciences and takes part in its energy platform. Besides that, she has a background in behavioural psychology. In the result section, this person will be referred to as Jessica Bovendam, and the transcript can be found in Appendix D. Jessica Bovendam is an academic in the field of Applied Psychology. This background made it very interesting to discuss the underlying behaviour of people towards energy and sustainability. She is also the intern programme manager at FEECT, which stands for Fontys Expertisecentrum (Fontys Expertise Centre). This new platform has been founded last January. Due to the Corona issues and a staff change at the municipality of Eindhoven, the program is still in its early phase. The aim is to initiate studies to varying themes relating to sustainability. It wants to focus on the circular economy, the energy transition, and transition to a circular economy for medium- and small-sized enterprises in the areas in which Fontys is active. It will also cooperate with the municipalities and other institutions, such as housing associations. The final objective is to create a platform that forms the knowledge centre about this subject in the region of Eindhoven. The aim is to do research and distribute the results to accelerate the energy transition and the circular economy. Based on her psychological background and her function in the expertise centre of Fontys, she is a very interesting respondent.

3.2.6 Student entrepreneur

This is a student from the Eindhoven University of Technology, who set up a student team that is building an innovative house that is climate neutral. In the result section, this person

will be referred to as Jean-Paul Duivenbode, and the transcript in Appendix E. He did a study in Physics at the TU/e. During his period at the TU/e, he discovered many houses with, for example, a lack of a heat pump or a lack of solar panels. This situation was something he thought could be improved, and he founded student team CASA. CASA is a student team from the TU/e, who are designing a comfortable, affordable, and sustainable house. The aim is to set new standards for housing in terms of sustainability, health, and costs. The first fully sustainable house is almost ready, and if this works, this project could be developed on a larger scale. Technological innovations like this one are very interesting to follow, and it is interesting to hear his vision on his project and the energy transition.

4 Results

4.1 What are the problems for policy-making towards the energy transition?

Currently, Eindhoven is on a turning point in the transition towards an emission-free city. A few years ago, people were talking about a ‘rattling’ climate policy (Eindhovens Dagblad, 2017). There was no real vision towards sustainability or energy, and a new kind of policy had to be constructed to make it more tangible, more specific, and targeted. This has changed in the last few years. Supported by higher governmental decisions, such as the Paris Agreement (2015), the Climate Agreement (2019), and the decision to implement a Regional Energy Strategy, which recently has been released, Eindhoven has been able to form a vision towards sustainability and energy.

Local politician Piet-Hein Bartels: “the aim is to create a long term vision towards the Climate Goals for 2030 and 2050, with a framework that creates clarity and on which each involved party can rely” (Personal communication, April 8th, 2020).

In their paper Kemp and Loorbach (2005) identified five central problems that occur during policy-making towards sustainable development related to the energy transition: Dissent, Distributed control, Determination of short-term steps, Lock-in and Political myopia. Through this perspective the problems in Eindhoven will be identified.

4.1.1 Dissent

Complex problems lead to a lot of dissent on goals and means. Each person has a different perspective on the nature of the problem and the preferred solution (Kemp, 2005). In current society there is a lot of polarization on this topic, this leads to criticism. Not every person is convinced about the urgency of climate policy or people are worried about the financing of the whole transition and this forms a barrier for the current policy-makers in charge. Something that hinders the current policy is the influence of populist political parties questioning scientific research on climate change, as Camfferman described (2018). Piet-Hein Bartels: “We let ourselves be hijacked by 1 percent of the so-called researchers, that thinks that there is no anthropogenic influence on climate change” (Personal communication, April 8th, 2020). This influence is something that disables the current policymakers, also in the rest of the world, to make policies about this topic. This group of people is against climate policy because, according to them, it will not make any significant difference. In the Dutch ‘poldermodel’ (Camfferman, 2018), it is common that each opposing party can give its opinion, including these parties. For policymakers, this is a huge constraint as they do not only oppose them, but they also have a large group of supporters in society, leading to polarization on this topic. Each individual is allowed to have its own opinion, but people who reject scientific research are very difficult to get on board on these kinds of topics.

Next to the criticism about the transition as a whole there is also discussion about the alternative energy sources that society should rely on in the future. Piet-Hein Bartels and Claudia Freriks mention the paralyzing effects of nuclear and hydrogen energy in the energy debate. Many people think that this has much potential, so much so that it would be the solution to the energy problem. That leads to companies not willing to invest right now, because, in the future, hydrogen and nuclear energy will be the solution, and then this investment would have been useless. The fact remains that these solutions are not available

now, making it irrelevant for the short term, while immediate action is needed. On the long term nuclear energy could be the solution, as it does not release any CO₂ and it is able to cover a great part of the energy demand (Brook et al., 2014). Fact is that it is not operationalizable soon and that makes it not relevant right now. Kramer (2017) thought that nuclear energy would not be the solution at all as it is very difficult and expensive.

As mentioned, social support is needed to make this transition successful. People want to be involved, and they want a policy that they can support. With issues like climate policy, this tends to be difficult as there is division among people about this topic. Jessica Bovendam said that a change of behaviour is needed to make this transition a good one, which includes customization because not every person is as far in this process as others.

Jessica Bovendam: "There is a group of people who is aware of climate change and who does have the financial resources to act on it. Those people do only need facilitation. There is another group that likes their lives the way it is, and they do not want any change. They do not see any personal advantages in the energy transition, and for them, there is no reason to participate. They also question if we are going to save the climate with this. This makes it very hard for people to intrinsically motivate themselves to make the investment to switch to sustainable energy." (Personal communication, 19th may, 2020)

This statement has common grounds with the theory of Rotmans (2019). Rotmans described a similar pattern in which a small group starts a transition. Afterwards, the other groups will gradually follow as soon as they are ready. Jessica Bovendam added that those people need empathy, patience, and understanding. Their support is needed as well when a neighbourhood needs a sustainable renovation. Because of the insecurity of the outcome, people tend not to make investments to make their houses sustainable. As long as other people make investments, their decision not to invest will not make any difference. This idea shows that this energy transition has a strong discrepancy between collective and individual interests. Individually people take the disadvantages in the short term when they invest, while the collective advantages are uncertain and long-term. This discrepancy corresponds with the tragedy of the commons (Atzema et al., 2012), in which the collective rationality clashes with individual rationality. If everyone thinks like this, nothing will be accomplished. People are not against acting more climate-friendly, but they want to be sure that everyone else will do it as well, and they do not want to make any unnecessary costs. It would be helpful if the energy transition could be linked to some individual advantages that are more certain, for example, in the costs.

Another problem is that education about the costs can be difficult to understand for some people and that people tend to drop out because of that. Furthermore, the mistrust of big institutions is relevant. Big companies or governmental organisations offer funds for possible renovations, but this is often not taken well. What could help is an independent unbiased party that can educate people about this topic. This person could also be someone from the neighbourhood, who is known in this area. If this person renovates their house and passes the knowledge on, they could encourage the rest of the neighbourhood to follow their example (Personal communication, May 19th, 2020). Claudia Freriks and Jessica Bovendam said that this idea could be applied to issues like solar panels and electric cars. When people see that their neighbour has purchased solar panels or an electric car, they are more likely to ask for information and find out if that could be an interesting option for them as well. With

regard to Eindhoven, Jessica Bovendam mentioned that there should be more balance between the stakeholders. Everyone has its own interest, and the challenge is to get that in balance. In the energy transition, different parties are waiting for each other, due to the uncertainty and the lack of urgency. For people, such a transition does not feel like the standard yet, and so they do not feel like they have to act. More exemplary projects will accelerate awareness and acceptance among people, and therefore, it will accelerate the energy transition. The Corona crisis shows how much is possible in a short time. Everyone changes its behaviour, and this had its effects. People feel like there is a threat, so they are willing to change. This example shows that the urgency of climate change is not acutely enough. Getting large groups of people to change their behaviour is difficult when the possible impacts are not clear yet, Jessica Bovendam concluded.

The different visions on climate change and the solution for it leads to a lot of dissent on this topic. People are not convinced about the urgency or the human influence at all and if they are they are not happy with the proposed solution. These forms of dissent form society hinders policy-makers who try to get everyone aboard of the transition, so for politicians it is important to reduce those critical noises by making good decisions, where everyone can agree with.

4.1.2 Distributed control

In this pluriform society control cannot be exercised from the top. It is distributed over different stakeholders with their own opinions, interest and resources. There are multiple actors and that makes a unitary action almost impossible because of the many different interests (Kemp & Loorbach, 2005). This energy transition challenge will not be an easy one, as Piet-Hein Bartels acknowledges that it is currently not on track to achieve these goals, so this is a huge challenge in the next decades. The Regional Energy Strategy (RES, 2020) is a programme that is meant to form the pathway for sustainable energy over the next few decades. It is a strategy that has been set by the Metropool Region Eindhoven, which consists of Eindhoven and the surrounding municipalities, and together, they have formed this strategy. This is a programme that has been set up by the Dutch government to give more responsibility to the municipalities in the Netherlands and it enables them to design their own energy strategy. Right now, just before the implementation of the RES, there is more a top-down situation where the municipality has more power in the energy strategy. With all these different actors and influences this is very difficult to manage for a municipality. With the RES they want to attract the citizens more and more to this process of the energy transition.

Furthermore, accelerating the energy transition requires social support from the citizens. According to Piet-Hein Bartels, Eindhoven does not actively try to gain support by changing people's behaviour or correcting them, but more by facilitating the discussion. This way, the municipality can observe what the citizens are thinking, and it does not have to participate in the discussion themselves. It leads to more power to the people. When people discuss relevant topics, interesting solutions can be found. The intention was to organize public meetings and debates where people could exchange ideas, but the Coronavirus made this impossible. Nonetheless, it was an interesting time to discuss ideas with the implementation of the Regional Energy Strategy in mind. It found a good solution and organized several online meetings. One of these meetings was on the fourth of June 2020, and this meant for

each interested citizen. This meeting was organized and held on Microsoft Teams. It enabled the municipalities to present their ideas, and it enabled the citizens to give their opinions, which led to interesting discussions on the topic of energy. The RES is also designed to enable citizens to come up with their own initiatives related to energy. This bottom-up model leads to a more diversified field of actors. More power to the citizens with a facilitating role for the governmental organization (RES, 2020).

4.1.3 Determination of short-term steps

The long-term targets have been set but the pathway towards these targets contains a lot of short-term steps. This forms a problem for policy makers as there exists very little theory on this, which makes it difficult to determine these steps (Kemp and Loorbach, 2005). Both Claudia Freriks and Barbara van Laaren see the Climate Goals as a relevant and clear target. It provides a thinking perspective for the parties involved, and it provides a mutual 'point on the horizon.' The issue for a lot of the parties involved is that the long term perspective is clear, but that they do not know what to do in the next few years, and what will be expected from them. 2030 and 2050 seem far away, and that makes it unrealistic.

Claudia Freriks: "There is a lack of intermediate steps, and that makes 2030 look more unrealistic. People do not take it seriously right now. The government or the municipality should create a pathway with realistic intermediate steps. This will gain more support from society, and it makes these goals more tangible. If people see that you are working in a certain direction, they will start to believe this pathway" (Personal communication, May 8th, 2020).

According to Claudia Freriks, companies generally have a clear idea of what they have to do and the constraints regarding this transition. For smaller companies, it is more difficult because they do not even know where to start. There is an asymmetry in information between big and small companies. Big companies know what they have to do to become more sustainable, but what they have to do is difficult and expensive, so they are unwilling to do this. They need a subsidy on which they can rely for multiple years, which will help them undertake measures. On the other hand, some sort of penalty system can help if companies know that they will get fined when they do not take action soon enough (OECD, 2006). This penalty has to be high enough that companies are almost forced to change, and this also helps to justify their actions to their stakeholders. Also financing is not the problem for big companies. Investments in sustainability are seen as 'shaky,' and that makes it riskier for stakeholders, which is what keeps a lot of big companies from taking action. Shaky investments with governmental support will not be seen as very reliable by stakeholders. They have the resources, but they do not want to use them for this if it is not mandatory (Personal communication, May 8th, 2020).

Barbara van Laaren had conversations with a few big French companies regarding sustainability, and they described the Dutch CO₂ reduction as a form of risk management as a result of the total unawareness about future CO₂ taxations. When these CO₂ prices rise, businesses that did not do enough about CO₂ reduction will collapse because they cannot afford the rising CO₂ taxes. Some companies are intrinsically motivated, but others reduce emissions out of risk management. However, this is not a good situation as it is not fair when some companies invest, and others do not. The same goes for citizens who are freeriding on the investments of others. This is something that should be clear in the legislation for all

companies. That is why the Green Deal will be a great addition as it will legally force companies to make these investments. It will also help companies to justify their costs to their stakeholders, and it reduces freeriding behaviour (EU, N.D.). For the middle- and small-sized companies, this is more difficult. They do not have endless financial resources, and making big investments is quite a risk. With the new legislation, they are forced to make the switch, but they could use financial help from the government and advice from companies like BOM or the Fontys Expertise centre to help them make this energy transition successful. Big companies have more possibilities to test new technics, they can hire extra people to focus on this, or they organise a project group that is going to figure out what the possibilities are regarding renewable energy. For smaller companies, this is a huge task that they often cannot afford to do next to their primary activities. They see the urgency because they know they will fall behind if they refuse to adjust to the new situation, but it is a huge demand. Good support and education can help these businesses through the transition (Personal communication, May 19th, 2020).

As mentioned before the Regional Energy Strategy is the concept that should form the long-term framework for Eindhoven. Like other regions, Eindhoven designed a strategy that should guide them through this energy transition. The concept version has just been presented, and this is a step until further implementation can be realized through the Metropol Region Eindhoven. In this concept version, the intentions have been presented, and in the next phase, the aim is to concretize this into a real plan. Based on this concept plan, a new plan will be formed to show the environmental effects of a generation of sustainable energy. Based on the first RES 1.0, spatial, economic, social, and political/administrative considerations will be considered. This concept will be based on consultation from stakeholders and citizens. The RES 1.0, which will be the first concrete plan, will be launched before July 2021, and this final strategy will be reconsidered every two years to keep it up to date (Metropol Region Eindhoven, N.D.). With this plan more clarity on the short-term will be provided to society.

Another issue is that possible further economic growth will make it more difficult to reduce emissions compared to 1990 levels. More economic growth leads to more industrial activity and, thus, more emissions. With the Coronavirus, the growth has temporarily stopped, but with our economy, that is based on growth, the growth will eventually start again. This growth is something that has to be taken into account as it makes reducing emissions more difficult. Jessica Bovendam adds that technically the 2030 goal is not impossible, but crucial is support, innovation, and change of behaviour. The technological innovations and business plans are not the problem. Social innovation will depend on the success of the energy transition. People have to be willing to participate in this transition. As Rotmans (2017) described, most of these transitions occur based on small, sincere support from people who are willing and able to participate. These people will be the pioneers, and in the long term, other people will follow. This shows that also conviction of citizens is a process that contains a few steps until everyone is aboard.

4.1.4 Danger of lock-in

For policy-makers this is a difficult issue. They are about to make policy for the long term and try to keep each option open as long as possible to reduce the danger of lock-in, which happens when they choose for a solution that is not good for the longer term (Kemp & Loorbach, 2005). The vision and the ambitions are clear, but in this pathway towards an

emission-free city, there are many constraints starting with the insecurity about the decisions it has to make. Climate change is urgent and requires an immediate response. This urgency means that the municipality has the duty to undertake measures to tackle this. The insecurity is about the effect of the measures. In about fifteen years, it can estimate if it made the right decisions, which leads to extra pressure, as it is about such an important topic. Besides that also the different visions, opinions and possible solutions make it difficult to commit to one final approach, and this forms a dilemma for policy-makers. Piet-Hein Bartels mentioned that only in the end we can tell if they made the right decision or not. For a lot of policy-makers this is the reason that they keep their options open as long as possible (Kemp & Loorbach, 2005).

4.1.5 Political myopia

Political myopia forms also an important factor in a transition. The politicians have to make the decisions and different visions or ambitions can conflict with the long term transition plans. Transitions are not processes that change within one generation so it needs long term vision and commitment and that is something that does not always happen (Kemp & Loorbach, 2005).

Claudia Freriks: “The vision of the government contains a few conflicting elements, which are just a lack of exploring in the topic. Another issue is that it is not willing to spend much money if it is unnecessary. The government wants to keep the costs as low as possible, and this does not always lead to the best solution. Also, governments often act too softly. If it strictly forces companies to make more savings, these savings would have been made, and then people would take the government more seriously. I do not know to what extent policymakers do research about the policy or decisions they are about to make. If they ask experts, such as universities, if their policy is possible and what their opinions are. That is something I miss sometimes, and if they do, the decision has already been made. This is also applicable to the climate goal for 2030. They set the goal for a 50 percent reduction, but did they really research if this is even possible? And maybe if they look at data, it turns out that 32 percent is more realistic. At the moment, there is nobody who really has the courage to say that a 50 percent CO2 reduction is just not possible. They have to take charge and just acknowledge that the goals that has been set by the Dutch government are not possible for multiple reasons. We have some restrictions, which makes it very hard, we are going to set up some new heat projects, and then we are going to reduce as much as possible, based on actual data that show what is possible before 2030. And then there should be the confidence and the trust that Eindhoven is definitely going to reach 2050 with zero emissions. There has to be someone who is just honest about this, but that is all about politics, and nobody wants to jeopardise their own position” (Personal communication, April 8th, 2020).

Governmental organizations have the task of making decisions that contain a broad range of disciplines, and in each of these disciplines, it has to make the best decision. Making these decisions is very difficult, but in that situation, institutions or companies who are experienced in this topic can help them to make the right decision. Asking for help is something that governmental organizations could do more often. When they do this, the best solution will appear, and then the governmental organization can decide which decision they are about to take, while financials in mind. The last part of Freriks’ quote shows that the government

should act more like a leader who tells the people what the perspective is for the next few years and how it will do that. Policy instruments could help the government maintain the policies it implemented strictly, which helps the government to control these measures (OECD, 2006).

In this transition, governmental organizations can form a barrier for effective energy policies. The main reasons are the earlier mentioned poldermodel (Camfferman, 2018), and the fact that government organizations are quite bureaucratic and slow in making their decisions (Willemson, 2017). This barrier is also something that Rotmans (2017) observed in the people from the big institutions who decide the pace of the transition. These organizations often contain people who do not believe in the Climate Goals and are already asking for more money. Lack of vision is something that Claudia Freriks mentioned as well.

Financial implications are one of the main barriers for parties to get involved in the energy transitions. The good intentions are there, but there is a lack of financial possibilities to get this transition started in some areas. This lack of funds is also a problem for the municipality of Eindhoven. The costs are enormous and diverse, making it very difficult for the municipality to come up with the necessary funds. That is why they were looking for more support from the government to accelerate the transition (Eindhovens Dagblad, 2019). Piet-Hein Bartels says there should be a more proportional distribution of financial sources. At this time, the government allocates the same amount of money to each municipality, which is not fair. A municipality with 600 inhabitants gets the same amount of money as the fifth-largest city in the country. A fair distribution of resources based on the size and the impact of a municipality would be a fairer distribution, and this would shape the transition in a better way. Furthermore, a financial incentive to stimulate innovation, but also offering citizens a fair deal to renovate their houses, is something that could help the transition in Eindhoven. This could result in a structural concept that supports these innovations. Right now, Eindhoven cannot afford this, but in the future, after implementation of the new Green Deal, this could improve, and then, such investments and structures could be possible. The Green Deal would be a great addition. It will force companies and other parties to switch to renewables in the future and it facilitates actors to invest in other kinds of sustainable measures such as innovations and carbon-free alternatives. It converts good intentions into duties, and this way, it will make a great impact on the transition (EU, N.D.).

4.2 What developments are going to accelerate the energy transition?

The Natuur & Milieu report (2018), which has been discussed, showed that Eindhoven had four main points on which it was not performing very well. These were energy labels in buildings, Green Deal Zero Emission City Logistics, Green Deal Natural Gas-Free Neighbourhoods, and the particulates emission by road traffic.

Piet-Hein Bartels said that Eindhoven is doing a lot to accelerate the transition. With new technics for the use of data, it is experimenting in two neighbourhoods to get them off natural gas: de Generalenbuurt and 't Ven. These are pilot neighbourhoods, and possible successful innovations can be scaled-up and used in other cities, which is part of the image of Eindhoven as an innovative and creative city. Companies in Eindhoven are called 'the Brainport' as they want to excel in technology and innovation (Municipality Eindhoven, N.D.).

Another important task for Eindhoven is mobility, a significant issue in which some improvements can be made. Eindhoven endeavours a car-free city by 2025 (Coalition Agreement, 2018). The city is facilitating this with more high-quality public transport, and there is the ambition to create more housing in the city-centre to reduce the transport streams (Eindhoven. Like Utrecht (2017), Eindhoven is creating plans for a car-free and, thus, more emission-free city-centre. The issue Green Deal Zero Emission City Logistics, another indicator on which Eindhoven had a bad score, is also improving. A few months after the report, Eindhoven committed itself to a programme with TLN, which stands for the Transport and Logistics in the Netherlands. In this programme, Eindhoven and TLN are actively pursuing a strategy regarding logistics towards an emission-free city in 2025. This programme contains issues like the size of the emission-free zones, the way of supplying catering and stores in the city-centre, the accessibility of the centre, the possibilities for a transition phase for old vehicles, and financial support for the purchase of sustainable vehicles (TNO, 2018). These plans show that Eindhoven is actively trying to reduce the particulates emission by road traffic, emission by logistics, and neighbourhoods depending on gas, so in those areas, it are improving compared to the situation in 2018 (Natuur & Milieu, 2018).

4.2.1 Technological innovation

Claudia Freriks mentioned that she has more trust in technology than in people. People are not willing to decrease their consumption or comfort, so new technologies have to fill this gap. People want devices and products that are superior. If people see something new, they immediately want to buy it. They see others with something, and people want it for themselves. Moreover, people do not have the idea that their actions will influence the world, and so they just move on and do what they always did. As Kramer described in his paper, people only want to change their behaviour if there is a good alternative. He mentioned the speech of president Bush in 1992. Bush said that there is no negotiation about the American way of life. This statement shows that as long as there are no sufficient technological alternatives, no one will voluntarily change their behaviour (Kramer, 2017).

Jessica Bovendam: "If we want to maintain our standard of living, we should develop technological innovations. People cannot be told that they cannot use energy anymore, so technology is the condition. The technology is already quite far along. The point is that whenever you install something new, for example, solar panels, there is already a newer, better innovation, and people tend to purchase the best product, which leads to a lot of waste. Such devices are difficult to recycle, and these issues make the energy transition and the circular economy very hard to combine. I think that it is important from a technological point of view to make the energy supply as circular as possible" (Personal Communication, 19th May 2020).

Circularity is a very relevant topic, but currently, Eindhoven is not actively pursuing a strategy towards this as it does towards the energy transition. In its Coalition Agreement (2018), Eindhoven addressed it shortly, and, in this Agreement, it said it wants to reduce residual waste, and it wants to focus on circular purchasing, which means that no raw materials will be used for these purchases. Policy towards circularity is something that will be intensified in the future. Currently, Eindhoven has started a few projects, but it is still very much in its early phase. Fontys University of Applied Sciences can be a good partner in this as it started its expertise centre on circularity this year (Fontys, N.D.).

Eindhoven is a smart, creative city (Eindhoven municipality, N.D.) with a technological university and many high-tech companies. There are many possibilities. Technological innovation is a very interesting and relevant solution for the energy problem. New techniques, applications, and inventions can give the energy transition a significant boost and as Kramer (2017) described it can form the solution on the existing environmental problems. Many things are developing, such as heat storage, energy savings, and CO2 filtering, and good development could make a significant difference. Technological innovation is very important, and Barbara van Laaren was very satisfied with the focus on innovation in the new coalition agreement of Brabant. There are many opportunities and possibilities that are still at a very early stage. However, it is also important to look abroad because a country does not have to invent everything. A country should invest in the things it is good at and buy the products that other countries are good at. By doing this, every country progresses, and this brings each country closer to the climate goals (Irena, 2016). On a lower scale, this can also be said about the municipalities. During her activities for investment company BOM, Barbara van Laaren discovers a lack of cooperation between the municipalities. The Regional Energy Strategy (2020) is an example of good cooperation between different municipalities. However, usually, municipalities tend to invent the same things separately, which is not very efficient as cooperation and learning from each other its strengths could be more successful. This way, when everyone focuses on the thing that it is good at, comparative advantages can be gained (Ricardo, 1817), which is relevant on international, national, and local level.

If technologies improve and get integrated into society, this can form a good alternative, but this takes time. There is just a small group that is actively changing their behaviour to be more environmentally friendly, which shows that the degrowth theory (Kallis et al., 2018) will not be a serious possibility in the near future. People are not willing to downscale their consumption for issues like climate change. However, the Corona lockdown showed that a degrowth theory could have its effects because of the low economic activity that led to lower emissions. However, Eindhoven is not pursuing a strategy in that direction (Coalition Agreement, 2018).

4.2.2 Financial opportunities

Companies like BOM (Brabantse OntwikkelingsMaatschappij), where Barbara van Laaren works, try to help parties who are struggling by providing them financial support and advice in sustainable projects. For many companies, this transition is a huge operation, especially when it hits their core business. BOM does this by creating new projects, and when those projects reach a market and create revenue, BOM withdraws itself, and the project will be given back to market parties. In the earlier phase of the project, the market cannot run the project, but after a few years and with the help of the extra finances, BOM believes that the market can continue this project. In that respect, it is looking for new scalable projects aimed at reducing CO2 emissions, and it tries to boost these projects with their investments (BOM, N.D.). BOM has no profit motive, but employees are being held accountable for their performances, so each investment has to be explainable and bad investment has to be compensated by better investment. Thus, BOM can be seen as a company. Barbara van Laaren considered that as one of the strengths of BOM. It is not just a governmental institution that has a tax-paying society behind it. It is a company supported by the government, and that enables them to call less strict demands towards companies and act more like a social partner. BOM has received a 60 million fund from which it could finance these projects.

According to Barbara van Laaren, getting solar panels right now is a very good investment. There is a netting rule, and the VAT will be refunded after your investment. These are a few measures that the government made to encourage people to get solar panels. An issue faced by parties like BOM is that gas is not very expensive in the Netherlands. Compared to countries like Denmark, gas is quite cheap in the Netherlands. Electricity in the Netherlands is also cheaper than in Denmark, although the Dutch government is actively trying to increase the gas prices through taxes to get neighbourhoods off the gas (energiervergelijk.nl, 2019). The cheap alternative makes it more challenging to make an offer for solar panels profitable. That is why it is much easier to convince citizens in countries like Denmark.

BOM is also working on a participation fund. With this project, people living close to a wind park receive a share of the revenue of that park, and from that money, they can make their houses more sustainable. The aim is to make sustainability not only a possibility for the rich but for everyone living close to such wind farms. BOM can help to set up this project, but it would result in people participating in their own wind farm from which they share in the revenues (BOM, N.D.). The main barrier seems to be unfamiliarity with this concept, and according to Barbara van Laaren, the education on this topic is not very good. If you compare the potential revenues with the interest that people can get on a bank account, she describes it as a "no-brainer."

Barbara van Laaren: "I think that returns and the several risks from those investments are not being pictured very well. With renewables, you can produce your own energy which makes you personally independent, but we, as a country, are also less dependent on certain eastern countries, which you do not want to be depending on. This is, geopolitically speaking, much more beneficial" (Personal communication, May 15th, 2020).

The aim of the Renewable Energy sector of BOM is to convince parties to take part in their projects to accelerate the energy transition in Brabant. Barbara van Laaren said that there are multiple reasons for companies to participate. In the beginning, they closed a few deals with some big frontrunner companies, and they hoped that other companies would follow. With entrepreneurs, the aim is to create a knock-on effect. Bom is starting with a few leaders who try to get everyone else on board. If a few pioneers start with solar panels and wind farms and encourage others to do this because of all the beneficial effects, the transition will be accelerated (Personal communication, May 15th, 2020).

4.2.3 Educational institutions

Since 2015 the Technological University of Eindhoven and the municipality have established a partnership with the covenant 'Uploading the Smart city'. This partnership is mainly established to tackle the existing social challenges in society. TU/e already this by setting three main strategic areas: Energy, Health and Smart Mobility. These areas should help providing social support to society, by facilitating concrete products and applications (Ven, 2017). Piet-Hein Bartels valued the relationships with the local educational institutions. The TU/e is a well-known institution in the Netherlands specialized in technology, and with its technological innovations and ambitious students, it can play a big role in this transition. Besides the TU/e, there is the University of Applied Sciences that is forming a new expertise centrum in the area and a Secondary Vocational Education Institution (MBO in Dutch),

Summa that he mentioned. He talked about their inputs on different levels. On the one hand, there are the people at TU/e who invent new things, but on the other hand, there are the people, for example, from Summa, who help with the implementation of all these social and technological innovations that are just as important. Because of the importance and the growing attention for sustainability and energy, this topic will be very relevant in the next few decades. In the future, this can lead to some very interesting jobs, just as Fankheuser (2008) described. Environmentally unfriendly jobs will disappear, and new sustainability-based jobs will appear in future society. It is about attracting young people during their school period who want to be part of this development. Right now, sustainability is becoming a more highly technical discipline that may engage future generations. Also, the discussion about renewable energy will disappear. Then, renewables will just be the standard (Personal communication, May 15th, 2020).

The three main functions of a university that are specified in law are education, research and valorisation, which means bringing the knowledge to society. Everything can be researched and discovered at universities, but in the end it is also important that this knowledge finds its environment and the citizens. With the earlier mentioned partnership the city of Eindhoven can help the university implementing their findings by providing space, neighbourhoods and roads to test new technologies as an extension of their laboratories (Ven, 2017). About the relation between, businesses, TU/e and the municipality Claudia Freriks mentioned the following. "Parties are familiar with each other and lines between them are short. For TU/e this is a good thing because that makes the relation with the municipality close. They know they can rely on each other. Claudia Freriks does not like the unrealistic expectations that people, especially from the municipality, have from the university.

Claudia Freriks: "This is a mismatch. The TU/e's primary goal is providing students with an education, and that is what people tend to forget. Some people think that the TU/e can provide lots of students for every project offered, but the fact is that students are not always interested. An example is a consultant who was complaining about the university for not understanding that the transition is happening right now, while the university tends to focus too much on the future. I said that this is exactly what a university does. It is not focussed on solving a short-term lack of information. Other educational institutions are much more aware of that, but universities are thinking about the longer term. If we, as a university, would only focus on today, we would still be wearing animal hides" (Personal communication, May 8th, 2020).

Scale-ups, like Team CASA, are a good example of how a university can support the energy transition. This project is a student initiative. This team is a start-up with the ambition, when everything works out well in the next period, to scale up and form a very significant part of the local energy transition and even beyond. Team CASA, a start-up organized by a university, is also very interesting, as a university has lots of connections with both profit and non-profit parties. For the students, it is a very good educational experience what will help them in the rest of their career, while for companies and municipalities, it is a great opportunity to learn from them and even apply the methods Team CASA uses on its activities (Personal communication, May 24th, 2020).

5 Conclusion

5.1 What are the challenges for the city of Eindhoven during the energy transition?

Eindhoven is actively pursuing a strategy towards an emission free city. It does this by creating a long-term pathway towards the climate goals. With this pathway, it has to show ambition and decisiveness, and it has to provide clarity for the stakeholders involved. It is important to provide those stakeholders, such as companies, with some sub-objectives. For many parties, 2030 still seems far away, and this leads to a lack of action. With sub-objectives towards 2030, intermediate steps will be provided, making it easier and clearer for those parties to cooperate. The RES (2020) is something that could grow into this, but that is too early to say, although the ambitions are hopeful. Also the implementation of the Dutch Climate Agreement and the Green Deal (EU, 2020) will give the municipality more options to pursue policy towards a long-term framework.

The municipality has to show leadership towards the citizens to make this pathway credible and powerful. This means supervision after the implementation of this pathway that rewards good behaviour and punishes bad behaviour. Also, clear education about the many other advantages besides saving the climate, such as energy independence, geopolitical advantages, financial support, and the benefits of having control over your own energy supply, is necessary.

Eindhoven shows that it is actively trying to tackle the existing problems, by renovating neighbourhoods, reducing transport emissions in the city and trying to design the transport flows in a more sustainable way.

Sustainability requires the social support of citizens. A significant part of society is already in, but another part is still sceptical towards climate change. They need understanding and consultation from parties they can trust and a good education about the advantages that energy transition could bring them. Eindhoven is trying to involve citizens more in the process, and by doing this they try to gain more social support. Citizens also require better education. This means not only the costs and the possible outcomes, but a more concrete plan with clear scenarios and more certainty about what is going to happen. An offer the citizens can rely on.

Businesses often require a more personal approach. While big companies, who have the sources to switch to renewables, need a supervising municipality that forces them towards renewable energy, small- and medium-sized businesses need more help in this. When small businesses have to make the transition, it is costly, and it hits their core business. They do not have the sources to experiment or set up a project group to test this, so it requires a lot from them. Parties like BOM and the FECT support them, but a more personalized approach from the municipality could help. This support would lead to customization and a bigger movement towards a CO2 free city.

Technological innovation is essential in this energy transition. People have their living standards and do not want to give that up, is the general attitude (Kramer, 2017). Therefore, the solution could be new technologies. New technologies can replace existing polluting, without declining of the comfort people are used to, but with less emissions. For that matter

the municipality of Eindhoven has, with the presence of the Brainport and the University, an ideal location for the implementation of technology and they could even appear as an example for other cities in the area of energy. Many initiatives and new techniques are already there, but they need further development and scaling-up to make the difference. This change will require time and support.

In this transition a clear synergy between municipality, businesses, citizens and educational institutions is needed. Everyone is involved with the subjects and is willing to cooperate, but the division of tasks is not totally clear. A government sets up the earlier mentioned framework and does supervise, businesses run their business with regard for the emission goals and schools provide the required knowledge and expertise about subjects. When this synergy is clear, each party knows what to do and a more efficient and effective energy transition could be the result.

5.2 Recommendations

Based on this research both a practical as an theoretical recommendation can be made. The practical recommendation is about the role of the government in this transition. It has the leading role in this transition and it could take this role more actively and show that it is really committed to this. This can be done in words and actions. In words in creating this long-time framework in combination with the implementation of the Green Deal. This shows what its plans are for the future and it provides a thinking perspective for the involved parties. In actions it can underline this by actively acting towards it. This means adherence to the implemented policy, supporting positive influences such as technological innovation and citizens participation.

The theoretical recommendation is about the way the future energy transition will be shaped. Lots of innovations, whether social or technological, have to be made and to decide which measure or technology to implement requires research. This is a task for the municipality of Eindhoven to make a scientific outline about how and which measures to implement to accelerate the energy transition. When a scientific research about this topic will be made, ideas could be generalized and applied to other cities. This could form a valuable addition to the energy transition in the next few decades.

The municipality, the educational institutions and the businesses should create a synergy together regarding the energy transition where each party knows what to do and that creates an efficient and effective programme for the future.

5.3 Reflection

The proposal of this research was a difficult part of the process. It is about quite a broad subject and it is difficult to decide which elements to include and which elements not. Sometimes this led to doubts and thoughts about this and I had to exclude a few interesting topics to keep it organized. I made the decision to use a qualitative approach as it enables to me to make an in-depth study of this, which I thought would be more suitable in this context. There was the consideration about making it a single or a multiple case study and because of the specific situation of Eindhoven which I explained in the paper has been chosen to make it a single case study, but with a multiple case study there could be more comparing between the different cases and then generalizations could be made easier.

Another constraint were the Corona circumstances. Because of this each interview has been held online and as this makes the information gathering different than during face-to-face interviews. In face-to-face interviews there is plenty of room to discuss, to interrupt and to elaborate and it enables to notice other signs than just the things the respondent says. During Zoom or Microsoft Teams meetings there is often a delay and the earlier mentioned things that happen during a face-to-face interview are more difficult. The overall process was due to the Corona implications not ideal as well. Normally on the Campus there is plenty of space to discuss either with your supervisor or fellow students, but now I was, despite a few video calls and e-mail contact, appointed on my own and that was though sometimes.

Something that I had planned, but what did not work out this well, was the searching for respondents. I had five very interesting interviews, but I also tried to speak to someone who could provide me some insights about citizen initiatives and the role they can play in the transition. This still got covered in the other interviews, but an interview could have formed a great addition to this research.

Despite this it was a pleasure to work on this interesting and very relevant topic. I learnt more about the practical implications of such transitions and I got really engaged with the ongoing process in Eindhoven. The knowledge I acquired during this period can be very important in my further career and maybe it can help me to contribute in the energy transition as well in the next decades. Thank you!

6 Reference list

Atzema, O., & Lambooy, J. (2012). *Ruimtelijke economische dynamiek* (3rd ed.). Coutinho.

BOM. (n.d.). *Samen met ondernemers bouwen aan een toekomstbestendige Brabantseconomie* | De Brabantse Ontwikkelings Maatschappij. Retrieved 21 June 2020, from <https://www.bom.nl/over-bom>

Brainport Smart District. (n.d.). *Brainport Smart District*. Retrieved 22 June 2020, from <https://brainportsmartdistrict.nl/particulieren/>

Brook, B. W., Alonso, A., Meneley, D. A., Misak, J., Bles, T., & van Erp, J. B. (2014). Why nuclear energy is sustainable and has to be part of the energy mix. *Sustainable Materials and Technologies*, 1–2, 8–16. <https://doi.org/10.1016/j.susmat.2014.11.001>

C40. (n.d.). C40. Retrieved 26 February 2020, from <https://www.c40.org/>

Cats, O., Susilo, Y. O., & Reimal, T. (2016). The prospects of fare-free public transport: evidence from Tallinn. *Transportation*, 44(5), 1083–1104. <https://doi.org/10.1007/s11116-016-9695-5>

de Knecht, S. (n.d.). *Als cartoon getekende architectuur, stadsbeelden en fictieve steden* [Illustration]. Schetsontwerp. Retrieved from <https://www.schetsontwerp.com/stad-architectuur>

Dutch Government. (2019). *Nationaal Programma Regionale Energie Strategie*. <https://www.regionale-energiestrategie.nl/default.aspx>

Dutch Government. (2019). *Het Klimaatakkoord*. <https://www.klimaatakkoord.nl/klimaatakkoord/documenten/publicaties/2019/06/28/klimaatakkoord>

Eindhoven University of Technology. (n.d.). *Eindhoven University of Technology*. Retrieved 16 June 2020, from <https://www.tue.nl/en/>

European Union. (2017, February 16). *Climate change and you*. https://ec.europa.eu/clima/citizens/eu_en

European Union. (2019, October 12). *Een Europese Green Deal*. Europese Commissie - European Commission. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_nl

Fankhaeser, S., Sehleier, F., & Stern, N. (2008). Climate change, innovation and jobs. *Climate Policy*, 8(4), 421–429. <https://doi.org/10.3763/cpol.2008.0513>

Gore, A. (2006). *An Inconvenient Truth*. Adfo Books.

Harvard University. (n.d.). *Climate Change*. Retrieved 16 June 2020, from <https://climatechange.environment.harvard.edu/>

High Tech Campus. (n.d.). *Home - High Tech Campus Eindhoven*. Retrieved 25 February 2020, from <https://www.hightechcampus.nl/>

Intergovernmental Panel on Climate Change. (2014). *Climate Change 2014*. <https://www.ipcc.ch/report/ar5/syr/>

Irena. (2016). *Measuring the socio-economic footprint of the energy transition: The role of supply chains*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_-_Measuring_socio-economic_footprint_2019_summary.pdf?la=en&hash=98F94BCC01598931E91BF49A47969B97ABD374B5

Jonkman, S. N., Kok, M., van Ledden, M., & Vrijling, J. K. (2009). Risk-based design of flood defence systems: a preliminary analysis of the optimal protection level for the New Orleans metropolitan area. *Journal of Flood Risk Management*, 2(3), 170–181. <https://doi.org/10.1111/j.1753-318x.2009.01036.x>

Kallis, G., Kostakis, V., Lange, S., Muraca, B., Paulson, S., & Schmelzer, M. (2018). Research On Degrowth. *Annual Review of Environment and Resources*, 43(1), 291–316. <https://doi.org/10.1146/annurev-environ-102017-025941>

Kramer, G. J. (2017, September). *De ontdekking van de toekomst*. <https://edepot.wur.nl/423128>

Leach, G. (1992). The energy transition. *Energy Policy*, 20(2), 116–123. [https://doi.org/10.1016/0301-4215\(92\)90105-b](https://doi.org/10.1016/0301-4215(92)90105-b)

Loorbach, D., & Kemp, R. (2005). Innovation policy for the Dutch energy transition Operationalising transition management? *Research Gate*, 2–9. https://www.researchgate.net/publication/254774308_Innovation_policy_for_the_Dutch_energy_transition_Operationalising_transition_management

Metropol Region Eindhoven. (n.d.). *Een excellente regio waar het leven goed is!* Copyright 2020 Triptic (Http://Www.Triptic.Nl). All Rights Reserved. Retrieved 28 February 2020, from <https://metropoolregioeindhoven.nl/>

Municipality of Eindhoven. (n.d.). *The Official Guide to Eindhoven*. This Is Eindhoven. Retrieved 27 February 2020, from <https://www.thisiseindhoven.com/en>

Municipality of Eindhoven. (2018). *Coalitieakkoord: Evenwicht & Energie*. https://www.eindhoven.nl/sites/default/files/2018-05/Coalitie%20magazine_0.pdf

Municipality of Utrecht. (2015). *Actieplan Schoon Vervoer*. <https://www.utrecht.nl/wonen-en-leven/duurzame-stad/elektrisch-vervoer/actieplan-schoon-vervoer/>

Natuur & Milieu. (2018). *Quickscan duurzaamheid Nederlandse Gemeenten*. <https://www.natuurenmilieu.nl/wp-content/uploads/2018/02/180222-Rapport-Quickscan-gemeenten.pdf>

OECD. (2006). *Alternatives to traditional regulation*. <https://www.oecd.org/gov/regulatory-policy/42245468.pdf>

Pieterse, W. (2017, March 20). *De organisatie van de overheid | iBestuur*. IBestuur. <https://ibestuur.nl/weblog/de-organisatie-van-de-overheid>

Planbureau voor de Leefomgeving. (2019, October). *Klimaat- en Energieverkenning*. <https://www.pbl.nl/publicaties/klimaat-en-energieverkenning-2019>

Ricardo, D. (1817). *The principles of political Economy and Taxation* (1st ed.). John Murray.

Rotmans, J. (2019, December). *Een transitie aanpak voor Aardgasvrije Wijken*. <https://www.omgevingsweb.nl/wp-content/uploads/po-assets/290236.pdf>

Ruimte voor de Waal. (n.d.). *Projectinformatie - Ruimte voor de Waal*. Retrieved 16 June 2020, from <http://www.ruimtevoordewaal.nl/nl/het-project/projectinformatie>

Sawyer, J. S. (1972). Man-made Carbon Dioxide and the “Greenhouse” Effect. *Nature*, 239(5366), 23–26. <https://doi.org/10.1038/239023a0>

Team CASA. (n.d.). *Team CASA – Comfortable, Affordable, Sustainable Alternative for houses in the Netherlands*. Retrieved 22 June 2020, from <https://teamcasa.nl>

Thaler, R. H., & Sunstein, C. R. (2012). *Nudge* (2nd ed.). Adfo Books.

TNO. (2020, March). *Financing of the energy transition in the Netherlands: The important role of institutional investors* (No. 1). <https://www.tno.nl/nl/aandachtsgebieden/energietransitie/roadmaps/naar-een-breed-gedragen-energietransitie/financiering-van-de-energietransitie/>

Transport en Logistiek Nederland. (2018, June 1). *Eindhoven maakt werk van schone stadsdistributie*. <https://www.tln.nl/nieuws/eindhoven-maakt-werk-van-schone-stadsdistributie/>

United Nations. (n.d.). *Climate Change*. Retrieved 16 June 2020, from <https://www.un.org/en/sections/issues-depth/climate-change/>

Utrecht University, & Camfferman, G. (2018). *Climate change is a hoax, they say*. <https://dspace.library.uu.nl/handle/1874/367000>

van Doren, D., Driessen, P. P. J., Runhaar, H. A. C., & Giezen, M. (2020). Learning within local government to promote the scaling-up of low-carbon initiatives: A case study in the City of Copenhagen. *Energy Policy*, 136, 111030. <https://doi.org/10.1016/j.enpol.2019.111030>

Velzen, J. (2018, July 6). Eindhoven bloeit dankzij techbranche én het technisch onderwijs. *Trouw*. <https://www.trouw.nl>

Ven, M. (2017, October 27). *TU/e en gemeente samen op weg naar slimme stad*. Cursor. <https://www.cursor.tue.nl/nieuws/2015/juli/tue-en-gemeente-samen-op-weg-naar-slimme-stad/>

Vermeeren, H. (2019, September 19). Eindhoven wil klimaatdoelen halen, maar kan dat niet zonder TU/e, Den Haag en Brussel. *Eindhovens Dagblad*. <https://www.ed.nl>

World Health Organization. (2020, January 13). *Urgent health challenges for the next decade*. https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health-challenges-for-the-next-decade?utm_source=STAT+Newsletters&utm_campaign=1931cb646b-MR_COPY_02&utm_medium=email&utm_term=0_8cab1d7961-1931cb646b-150708293