



**Sustainable redevelopment at the neighbourhood
 level and the role of various actors**
 Drawing lessons from local energy initiatives



Colophon

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Preface

With the submission of this thesis I have managed the final step towards finishing my master Environmental & Infrastructure Planning at the University of Groningen. Moreover, I hereby finish my time as a student. I am very happy with finishing this era in my life and I am happy to set the step toward the next. Moreover, I feel proud that I have finished this thesis, which is something I have done mostly by myself. However, there are two persons who have helped me during this process which I would like to thank.

Firstly, I would like to thank Ferry, my supervisor from the University who helped my creating ideas and helped gaining insights but most off all was someone to talk to and to express the problems I stumbled upon along the way while drinking coffee together. This was very helpful, and my thesis would not have looked the way it does now without such guidance and help.

Secondly, I would like to thank Michelle, my supervisor from Witteveen + Bos. She also helped me digging up ideas, but she also put a lot of time and effort in helping me structuring the thesis. Furthermore, she offered nice companionship in the office where I wrote my thesis, as did everyone else from the company and I am very thankful for that since it makes writing much easier.

Lastly, I would like to thank the people who decided I could do a Key-note on the Graduate Research Day. This was something I really enjoyed, and it really marked the end of the thesis period.

Harjen Vrijs - 26 February 2018

Abstract

Energy has become one of the most vital elements of modern day society; we use it to heat houses or for appliances. However, the need to redevelop the current energy landscape becomes more apparent almost every day with the continuous request to lower the gas extraction in Groningen. This necessity is beginning to gain a foothold in the Netherlands, therefore certain agreements on energy regulations have been made, however, to achieve energy neutrality of the Netherlands in 2050 it is necessary to redevelop urban areas so that renewable energy is not only being produced but also utilized in neighbourhoods. At the moment, this change to enable usage of renewable energy sources within neighbourhoods is not happening fast enough to reach the targets by 2050. Governmental organizations try to stimulate more sustainable development and redevelopment in various ways with differing success.

This research tries to come up with recommendations that can help and stimulate energy efficient housing renovation on a neighbourhood level. This is done via interview with cases active with sustainable neighbourhood redevelopment, governmental organizations involved in them or involved in policy and supportive parties who are also involved in sustainable neighbourhood redevelopment. To be able to implement this, a long-term vision and hence opportunity for actors to create innovations should be set up. This enables risk taking activity and thereby enables learning from these practical cases. Furthermore, the success of this transition depends on stimulating strategies and the different approaches taken by multiple actors in practice. Also, the different roles of those various actors are essential, it became clear from the results that governmental organizations should try to work towards a more active approach. Currently there is a mismatch in their attitude and their practical approach. Via active and context specific help from governmental organizations local energy initiatives become more successful and create an opportunity for upscaling sustainable neighbourhood redevelopment. It is very important however to gain proper understanding of the needs of the local energy initiatives in order to help them with these specific needs. Furthermore, consensus creation can help creating a sense of urgency and aid in enabling sustainable renovation to evolve on a neighbourhood level.

Moreover, consensus creation can be helpful in setting up local organizational structures which can act as an entity to set up local energy initiatives, hence stimulating the organization of local people can be beneficial, namely it could mitigate the number of individual actors and hence mitigate the complex adaptive system that is otherwise present. Furthermore, the active stimulation of these local initiatives helps in creating a network and knowledge which is very important for their success. The stimulation of such local actors can be done via different ways, it could be that sustainability needs to be 'sold' hence focussing on comfort improvement or financial changes can be beneficial. It is always important to take these individual aspects into account. Moreover, when multiple larger actors are involved it is important that there is a certain amount of commitment and understanding between parties which can help creating an environment in which risks are being taken. Hence there are many ways via which sustainable neighbourhood redevelopment can be stimulated either by changing roles of actors, changing regulations or approaches to sustainable neighbourhood redevelopment.

Keywords: Sustainable redevelopment, Energy transition, Local Energy Initiatives, Sustainable Governance, Complexity, Barriers, Opportunities

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1. The need for sustainable neighbourhood redevelopment

This chapter dissects the problem this research revolves around. It tries to create understanding on the different ideas on sustainability and the urgency of a more sustainable society. Furthermore, this chapter helps gaining insight in necessity of sustainable neighbourhood redevelopment by showing housing stock figures. Furthermore, the chapter shows the main research question and decomposes it into multiple questions that need to be answered in order to give answer to the main research question. Lastly this chapter provides the reader with an overview of what they can expect in the following chapters.

1.1 Backdrop of the problem

Given the amount of attention around climate change in the formation of the Dutch cabinet (NOS, 2017a; NOS 2017b), but also the increase of votes on party's who have climate as big issue, the Paris agreement and the choice of the president of the United States of America to step out of the Paris agreement (NOS, 2017c), one could state that there is increased debate about climate change and potential routes for a solution. Therefore, it would be sensible if the government Netherlands keeps their promises made in the Paris agreement. And one could say that the Netherlands is indeed trying to keep these agreements. Investments in sustainable energy are increasing and the amount of renewable energy sources in the Netherlands is also growing (REN21). Furthermore, the amount of sustainable energy worldwide is growing (NOS, 2017d).

However, only being able to produce green energy is not enough to reach the agreements of the climate agreement. To really be able to use the new energy that is being produced, we must be able to utilize these types of energy in our society. Eventually these new types of energy should be able to take over the current main energy sources. Most of these new types of energy production, such as windmills or PV panels produce electricity. For a household in the Netherlands in 2014, the percentage of the total direct energy consumption that was not electricity was more than 70%; hence 70% of the energy need is something else than is being produced by most new energy production methods. These direct energy sources where 31% fuel for cars and 42% energy in the form of gas, primarily to heat houses (Gerdes et al., 2016). These energy sources are fossil fuels and hence emit carbon dioxide, a greenhouse gas which further worsens the problems with climate change according to the Intergovernmental Panel on Climate Change (IPCC) (2015). Climate change is associated with problems such as sea level rise, loss of biodiversity and problems regarding food production (IPCC, 2015) therefore it is good practice to combat climate change. Not only to preserve nature but also for our own good. When sea level rises occur the safety of a country like the Netherlands could be at risk and therefore new investments in protection have to be made which mean high investment and maintenance costs.

Moreover, since gas is a fossil fuel, we cannot keep relying on it since it will simply run out sooner or later. The exact moment when gas will be depleted is being argued, Bentley (2002) has stated that the global peak in conventional gas

I do acknowledge that sentences such as 'energy production' do not comply with the laws of Thermodynamics. To be more precise, the first law of thermodynamics state that energy cannot be produced since the amount within a system always remains equal (Van Kann, 2015). However, since such sentences are used in common practise and language I have also chosen to use such words in order to achieve a better readable text. Furthermore, I don't think this hampers the effectiveness of this research since this is not the research focus. Therefore sentences such as energy production or usage can be seen throughout this research, however I do acknowledge that this is strictly wrong. Therefore when this research discusses energy production, it is in fact about energy conversion.

production would lie somewhere in 2022. Aleklett & Cambell (2003) on the other hand estimate it only by 2040. Lewis (2007) estimates that we still have gas supplies between 2067 and 2183. Furthermore, to make things more complicated, Aleklett et al. (2010) states that the amount of gas is overestimated when looking to the amount of energy it supplies per unit. So, there is no consensus on when our fossil fuels will run out, however, among scientist, the depletion of natural gas itself is not being argued upon. Moreover, there is an increasing amount of dissatisfaction with the exploitation of gas fields in Groningen especially since the recent earthquakes (NOS, 2018). Additionally, if we won't act we remain dependant on the usage of gas, given the dissatisfaction with the exploitation and the fact that natural gas will run out, there is quite some urgency to enable the usage of renewable energy resources. Therefore, it is better to speed up the development of ways to use alternative energy sources instead of fossil fuels. And to really start redeveloping neighbourhoods in a way that enables the usage of such energy sources.

1.2 Understanding the necessity

The necessity to change from fossil fuels as energy supply to a more sustainable energy supply hence is clear. And it's also recognized by the Netherlands Environmental Assessment Agency (PBL). They state that it should be the ambition of the Netherlands to transform all existing buildings into energy neutral or emission free housing (PBL, 2016). Also, the government of the Netherlands understands that change is needed and has decided that in 2050 no house in the Netherlands may be heated by gas (NOS, 2016a). Sustainable redevelopment of existing housing is even said to get the highest priority in the new government agreement (Doodeman et al., 2017). The question of how to do this remains very important however (Van Belzen, 2017b). However, the techniques to achieve sustainable redevelopment are available and the affordability for them is increasing (Van Belzen, 2017a). Also, there are already examples of neighbourhoods that are being built all electric (Van Belzen, 2017a). Developments of all-electric neighbourhoods open up chances for heating through sustainable energy sources such as energy from wind farms and solar panels, since those sources are mostly suited to produce electricity as energy carrier.

Hence, one could say that the Netherlands is going in a forward direction. However, there is still a large problem with heating in the Netherlands. Namely, 85% of all the households in the Netherlands work on a central heating that is powered by gas and only 6.3% is gasless. Also, 91.5% of all houses have their own gas connection (Gerdes et al., 2016). Considering the number of houses in the Netherlands in august 2017 was more than 7.7 million, this means that more than 6.55 million houses are still heated by gas, and more than 7 million still have a gas connection. So only focussing on creating new neighbourhoods that work on other sources of heat than gas is not enough, to start creating a sustainable society these existing houses also need to be redeveloped. This need to focus on existing housing and office stock is also ventilated by Urgenda (2014). They state that the big step towards a sustainable future is not by building new sustainable housing since this is already in the proposed plans of 2020. Instead the biggest steps ought to be made through redeveloping existing built up area. This is the case since at least the half of the current housing stock will still be standing by 2050 (Wang et al., 2017). However, policy on renewable heat sources in the Netherlands is currently lacking (CBS, 2016).

Changes in policy and stimulation measures are not only necessary to make sure that other produced types of energy are accommodated, and gas is no longer used, there are also changes necessary to the energy consumption of a house to get heated. Namely the quality of the energy and the total heat that comes from sustainable energy sources can differ in many ways from conventional gas. This can be explained by using exergy. Exergy can be described as the "...maximum possible useful work that a system can deliver when it undergoes a reversible process from the initial state to the state of its environment, the dead state" (Wu & Zmeureanu, 2011, p390). Through exergy diverse sources of

energy can be compared to each other. Exergy hence is in short, a measurement of quality of the energy (Rosen & Dincer, 2001). The exergy of different energy sources differs, therefore different energy sources have different effects on the heat they produce. Hence it can be an important measurement that can be used as a tool to create better energy policy (Dincer, 2002). Some sources, such as shallow geothermal energy are better suited for low temperature heating (RVO, 2015), however many existing houses with bad Insulation are not suitable for these heat source options since they are adapted to high temperature gas heating systems. Since such houses must be gasless in 2050 (Van Belzen, 2017a), these older houses need to be adapted to be able to accommodate heating by sustainable resources.

There are technical innovations such as solar panels, using urban and geothermic heat and creating insulation in old houses already available. However, neighbourhoods are not being redeveloped into sustainable neighbourhoods on a large scale, so the techniques are not being implemented on a large scale. This is a challenge for the sustainable future of the Netherlands, especially when considering that more than 6 million houses are more than 20 years old, and more than 5 million are 30 years or older (CBS, 2017a). According to Tigchelaar & Leidelmeijer (2013) there is a strong relation to the energy label and the year the dwelling our house has been built. The energy label is an indication of the energy quality of a dwelling and hence is an indication of the amount of energy is necessary for the occupant in the house to heat and electrify it. These labels are a result of technical qualities such as amount and quality of insulation. The labels run from A, which means that the house needs the least amount energy, all the way to G, which means the house uses the most amount of energy. When looking at the data especially the housing stock that was built before 1980 still has a lot of houses with label D or worse (Tigchelaar & Leidelmeijer, 2013). This means that these dwellings are the buildings with less than average insulation and hence have a high energy. Even the houses built after 1996 often don't have A as energy label, so even in relatively new housing stock a step towards sustainability can be made. So, investments in existing housing are not only necessary, they also are likely to have the largest impact on energy consumption of the Netherlands.

Wijngaard et al., (2014) propose an investment plan to achieve a climate neutral housing stock in 2050, this means that the housing stock does not emit any carbon dioxides or compensate the emissions through other sectors. Wijngaard et al. (2014) talk about houses in the future still being able to be heated by gas and then compensate this through other energy producing measures. However, in new regulation, houses cannot be heated by gas in 2050, this shows that large steps are being made in policy, however in practice these steps are lacking. This report shows the urgency to indeed reach a sustainable society in the Netherlands. A potential investment plan as shown in the report of the PBL (2016) could be an indication on how to shape this research. It also brings up the question, if the PBL in 2016 saw that steps needed to be taken, why aren't these steps being applied?

1.3 Goal of the research

Why existing neighbourhoods are not getting redeveloped, or at least not that fast, is a question this research evolves around. This research tries to come up with recommendations that can help professionals and governments actively with energy efficient housing renovation on a neighbourhood level. What barriers to sustainable neighbourhood redevelopment can be seen by different stakeholders and how can these recognized barriers be removed or mitigated? The main research question therefore is as follows: How can net real fossil emission free neighbourhood redevelopment in the Netherlands get stimulated within 33 years by activities from multiple actors, policy changes and changes in behaviour from involved actors? This research is looking for answers to this question and come up with recommendations that enable governments and other parties to successfully enhance redevelopment of neighbourhoods.

To answer this question, it is necessary to answer multiple other questions that could aid in answering the main question. Firstly, it is necessary to gain understanding of sustainable redevelopment and their interlinked concepts to understand what sustainable redevelopment really means. Secondly it is necessary to gain insight in the current state of existing neighbourhoods in order to gain insight in the urgency. Also, it is useful to gain understanding of the proposed approaches mentioned by different authors that can act as a guide for a transition towards more sustainable neighbourhood redevelopment. Furthermore, the role of stakeholders within such sustainable redevelopment projects is interesting, since these stakeholders all add to the complexity of a project, also gaining insight in the effect of complexity on projects is important. Additionally, it is good to gain insight in potential technologies and techniques that can enable sustainable redevelopment. It is also useful to gain understanding of their potential and limitations. Also, it is important to gain insight in the existing barriers and opportunities connected to local initiatives that are trying to redevelop a neighbourhood into a sustainable neighbourhood. This will help gaining understanding in potential bottlenecks and chances for local energy initiatives.

Since this research is looking for stimulation measures within and between different layers of governments and local initiatives, there is quite a focus on comparison between and among scales. Since many problems in the field of planning are dealing with problems within and between such layers, it can be argued that it is a good idea that such a question will be answered by someone familiar with and active in the field of planning. Since the author of this research has enjoyed education within this field it makes sense to tackle a problem as described. Also, since the field of planning is closely intertwined with approaches to multi-scalar levels it is appropriate to take such an approach as basis.

Since this research takes transition management and multiscale approaches as basis, this means this could also aid the theoretical debates around these themes. The main addition to the theoretical debate is the implementation of such concepts. It is good to gain insight in the applicability and effectiveness of theories in the real world. This does not only lead to added knowledge about the applicability of the concepts in real life. It could also create understanding of the meaning of such theories in the real world and how they are used and interpreted.

For planning professionals, the added value of this research lies in the link of the theory with their practice. Also, it helps gaining insight in effectiveness of current policy or practices and thereby could create guidance for planning professionals who seek to stimulate or enhance sustainable neighbourhood redevelopment. Lastly this research helps gaining insight in the different roles different actors can take within sustainable redevelopment and the effects of said roles. Therefore, it creates a framework that can aid planning professionals in taking the most appropriate place within projects. This could guide them in making the most appropriate decisions and adds to the effectiveness of their organizations.

1.4 Reading guide

Transition management can act as a basis for the research since this could provide understanding of the processes needed to achieve a transition as described above. However, to firstly be able to grasp the complexity of sustainable neighbourhood redevelopment it is necessary to gain understanding of the different concepts regarding sustainability, redevelopment and the ways different authors approach sustainable redevelopment. Such concepts, their effectiveness and approaches to them will be explored in the next chapter. Chapter two provides this basis and looks at theoretical ways to implement the concepts within sustainable neighbourhood redevelopment. Also, the chapter takes a critical look at the current energy state of neighbourhoods to create insight in the urgency and need for sustainable redevelopment, but also adds to the understanding of current practices. Moreover, the chapter decomposes the true meaning of redevelopment and thereby sustainable redevelopment.

Additionally, chapter two describes a framework for planning-oriented action with the degree of complexity as a condition for the choice on a planning approach. Furthermore, it adds insight in the different roles taken by parties or persons and it also adds insight in the theoretical approaches to sustainable neighbourhood redevelopment.

Chapter three explores the different techniques that exist which could aid sustainable neighbourhood redevelopment. This can be energy saving or production techniques which can be implemented in individual housing or in a collective manner. Furthermore, ways to practically implement these techniques will be discussed on the basis of transition management literature. Based on these theoretical insights, there are various barriers and opportunities listed that could either hamper or stimulate sustainable neighbourhood redevelopment. Chapter four discusses the method used to gather data and analyse them to gain insight and answers to the main question. Moreover, it discusses the research strategy that has been applied. Furthermore, a selection of participants is given with an explanation for each of them why they have been selected.

Chapter five discusses the analysis of the data found in the interviews. This chapter discusses the different barriers and opportunities found within the data and it tries to link this to concrete lessons that could aid in achieving sustainable neighbourhood redevelopment. Also, the findings are briefly discussed and linked to the literature findings in chapters two and three, this helps gaining insight in both the usefulness and applicability of the found theories.

In chapter six the final conclusions are drawn; the most important lessons are summarized here and the most important of unexpected links to the literature are described here. Furthermore, a short reflection on the effectiveness of the approaches used in this research is given and recommendations for future research are mentioned. Chapter seven shows a list of literature used in this research and appendix one, which is filed in separately, shows the raw data used for chapter five.

2. Theoretical framework

To be able to give answer to the main research question we first have to define what concepts are connected to the sustainability debate and what these concepts mean to gain understanding of the debate and the potential problems related to the usage of the concepts. First, this chapter shall discuss the multiple concepts used in the sustainability debate to understand the basic principles that are connected to the discussion, but also to better understand potential problems when applying such concepts in practice. Second, the meaning of the used concepts will be dissected to gain insight in the different advantages and disadvantages of the use of the concepts. Third, the current energy state of existing neighbourhoods is described and analysed to gain understanding of the necessity and urgency of sustainable neighbourhood redevelopment. Fourth, multiple aspects such as the role of different actors and the importance of the contextual situation is mentioned and discussed so that a clear understanding of the factors of interest can arise. Fifth, connected to this, a framework for planning-oriented action with complexity as condition for the choice of the approach is explained. Lastly theoretical approaches that are proposed to stimulate or guide sustainable neighbourhood redevelopment are discussed to gain insight in the theoretical insights on how such a transition ought to happen.

2.1 Defining and discussing important concepts in the sustainability discussion

There are many words and definitions that are being used intertwining when talking about a sustainable neighbourhood. A large part of the literature is about sustainability and sustainable development which are often used abreast such as in Hopwood et al. (2005) or Holden et al. (2016). These are concepts that this research is also using as a guide towards a sustainable neighbourhood and hence is important to gain understanding of. The concept of sustainable development however is not precise but vague and hence can provoke many different ideas and responses. According to the United Nations (2016) sustainability consists of three main dimensions, the economic, the social and the environmental dimension. Holden et al., (2016) suggest a model for sustainable development on three moral imperatives, satisfying human needs, ensuring social equity and respecting environmental limits. The model of Holden et al. (2016) is different from the three pillars of the United Nations (2016). It namely doesn't state that there is a balance between the three targets. In contrast Holden et al. (2016) state that sustainable development creates a set of constraints on human behaviour, they include constraints on economic activity as well. The constraints that are mentioned form the 'sustainable development space'. Sustainable development hence, is a concept to combine the growing concern about a range of environmental issues with socio-economic issues (Hopwood et al., 2005).

According to the Brundtland report (WCED, 1987, p41):

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

This definition is seen by many scholars as a starting point for understanding sustainable development. According to Wheeler (2013, p30):

“Sustainable development is development that improves the long-term health of human and ecological system”

Holden et al. (2016, p215) state that:

“Sustainable development is a normative value system, on par with human rights, democracy and freedom (and it is closely interlinked with all these systems). Thus sustainable development is essentially a strong ethical, or moral, pronouncement as to what should be done”.

Hence sustainable development and sustainability can be seen as ensuring equality between generations on earth or even trying to improve the situation for future generations. Furthermore, sustainable development can be seen as something that is desirable in general consensus. Hence it is generally accepted within society that a sustainable development route or path that ought to be taken. The three pillars or constraints in the form of societal equity, economic satisfaction and environmental preservation seem to come back in many definitions in one way or the other. Therefore, sustainable development is a very inclusive and broad concept. This could lead to multiple interpretations or individual preferences which could make sustainable development quite a fuzzy concept. One could argue that a communicative approach to planning as described by De Roo (2003), which can deal with fuzzy planning problems could be an appropriate approach. Accepting uncertainty would be a very important first step (De Roo, 2003). This is explored in more detail in 2.4.1.

Sustainable neighbourhood design or sustainable neighbourhood planning is closely related to sustainable development and hence takes many of the ideals and transforms it into a planning perspective. Sustainable neighbourhood design has received much attention of scholars. According to Egan (2004, p7) there is an important social aspect in sustainable neighbourhood design and hence he states that:

“Sustainable communities meet the diverse needs of existing and future residents, their children and other users, contribute to a high quality of life and provide opportunity and choice. They achieve this in ways that make effective use of natural resources, enhance the environment, promote social cohesion and inclusion and strengthen economic prosperity”

According to Holden et al. (2016) the ‘planet boundary approach’ is a promising view regarding the respect for the environment. Holden et al. (2016) identify nine boundaries to the earth’s system. Among others these are climate change and rate of biodiversity loss. Yigitcanlar & Teriman (2015) state that sustainable urban development is seen to minimise externalities such as degradation of natural habitats, the simplification of species composition and the disruption of energy flows and nutrient cycles. This could be perceived as improving the quality of life in an area without leaving a burden. Urban development processes should operate within the limits of the ecosystem boundary in order to achieve sustainability in the long run. To achieve this there an integration of planning, development and ecosystem sustainability is necessary (Yigitcanlar & Teriman (2015). However, according to Hopwood et al. (2005) other facets of sustainability such as access to good health, equality and possibility to make political and economic choices are equally important for sustainable design. This clearly shows that the scope of sustainable neighbourhood design contains more than only environmental aspects. Sustainability is indeed a broad and unclear concept.

That the concept is broad indeed is emphasized by Larco (2016), he has compared lists of concepts and elements that the different authors use to define and explain sustainable urban design. The most striking and common element in his review of the literature and also listed in most papers is compactness, the closer buildings are situated, the fewer transport kilometres have to be travelled by humans, products but also water and electricity can be transported less (Jabareen, 2006; Kenworthy, 2006; Ritchie & Thomas, 2009; Jepson jr. & Edwards, 2010).

These concepts and ideas are all valid approaches to create sustainable urban forms. However, they are not suited for the goals pursued by this research, since this research focus is on built environment that already exist. Therefore there is a limit to what can be changed to the neighbourhood. The far-reaching changes that adding compactness would create in practice when applied to existing urban

area is too big. Hence these concepts can be of importance to study, however within this research it is chosen not to take that into account because the problems in the practice related to this research are too large. The literature focusses for instance on adding emphasis on sustainable transport such as railway or cycling, however such large-scale changes fall outside of the scope that is used in this research. We do not seek to totally overhaul the existing fabric. Instead, this research tries to come up with recommendations that can help and stimulate energy efficient housing renovation on a neighbourhood level.

This can only be achieved by using the existing fabric as starting point for potential adaptations. Furthermore, the ideals of equity and economic prosperity are of less importance for the goal this research has stipulated. This research focuses on the local neighbourhood level as boundary and it also has more focus on sustainable energy in that area instead of focussing on the broad concept that sustainability is. The indication for the broadness of sustainable urban design proposed by Larco (2016) who has created a framework based on these concepts could still be useful however since it creates insight in the concepts related to sustainability. Hence it is a good starting point for setting the focus of this research. Here we start with this broad concept and try to funnel it into a concept that has potential to base the research around. Larco (2016) has accumulated all the concepts and created five focus areas, these are:

1. Energy use and GHG emissions
2. Water quality and recharge
3. Habitat and ecological quality
4. Energy use and production
5. Equity and health

The primary focus of this research is not on equity. However health issues actually could be an important element or argument for people to invest in their homes so that sustainable redevelopment occurs. The other elements are all interesting, but the habitat preservation is more of interest in creating new neighbourhoods, within existing neighbourhoods there can be made hardly any adaptations to preserve habitats. Also, an important focus of this body of literature lies in trying to have a small impact on the existing nature. Moreover, sustainable development encompasses elements for finding sustainable building materials to build the neighbourhood (Luederitz et al., 2013), in the case of existing areas, this is of less importance since the harm to the pre-existing nature has already been done and the materials for the buildings already have been selected and used. Focussing on building materials is therefore not present in this research since we assume that most building materials have already been applied in the existing buildings and hence focussing on materials for renovation is only a small element. Also, nature that pre-existed in the area has already been replaced mostly and hence there is little meaning in focussing on preserving it. The importance on flood design is more an element that has to be applied as a consequence of climate change and hence is not of main interest in answering my research question. Another important element that reduces the usability of sustainable development as a concept in this research is the fact that sustainable urban development literature states that the neighbourhood should be a closed system and hence cannot consume energy from outside the area (Luederitz et al., 2013). Or as Farreny et al. (2011) state, the premise of a sustainable neighbourhood should be self-sufficiency. However, when this would be applied as strict as stated, many areas cannot be sustainable in the best way possible since there is just too limited space to produce the energy needed, or the housing is not suitable. For instance, if a city centre of one of the larger cities in the Netherlands has to produce their own energy, this wouldn't be feasible since there is no room for enough solar panels or wind turbines in the city centre to facilitate the area and mostly these houses are poorly isolated. However, when neighbourhoods could 'import' sustainable energy from the local proximity that has potential to create more sustainable energy than the neighbourhood consumes, then this would be feasible. Hence, I would argue that looking for real fossil emission free neighbourhoods by linking multiple scales and combining weaknesses and strengths of

areas is more important and that this could help create sustainability across the whole of the Netherlands. Hence this research considers sustainable neighbourhood development as to strict to be able to apply it to the situation in the Netherlands; instead a holistic approach should be taken.

When talking about sustainable urban design and a more sustainable future in the Netherlands, creating houses that are gasless is mentioned quite a lot. Many municipalities are formulating their goals around creating gasless housing, see for instance Hellinga-Oving (2017) or Gemeente Dalfsen (2017). Constructors of new housing are eager to get started with all electric houses, this is one way to create gasless housing (Van Belzen, 2017a). Thereby they might abandon natural gas as heating source. This is the case since the government of the Netherlands has decided that heating of houses through natural gas will be prohibited by 2050 and hence gasless is becoming more interesting and popular in the whole of the Netherlands (Van Belzen, 2017a).

However, when one would have gasless as a goal or focal point in the search to sustainability, there are a few problems. This research argues that gasless is not really a goal, instead it is a means to achieve sustainable neighbourhoods. One could redevelop a neighbourhood with all electric housing, however if the electricity is then being produced by fossil fuels such as coal, then the whole idea of all electric becomes flawed. Then, all electric is not a step forward in heating of houses, instead it is a step backwards. Furthermore, when all gas for heating of houses is prohibited, this also means that there is no gas connection anymore in those houses. This research argues that this might also be the wrong choice since there are also ways to create gas that is carbon-neutral and hence removing the gas connection might be capital loss that is not necessary. For instance, gas that is produced through faeces of animals combined with other rest products in the agricultural sector. According to Weiland (2010) bioenergy will be the most significant renewable energy source in the next few decades since it offers economical attractive alternatives to fossil fuels. Also, since there is already an extensive gas network in the Netherlands, biogas can be implemented quite easily since the infrastructure is already there. However, since biogas is produced with things as fruits and vegetables or maize, it could well be that biogas production directly competes with food production and animal food production. Also, technical challenges could be a challenge (Herrmann, 2013). Moreover, conflicts with other environmental goals can be a challenge (Herrmann, 2013). Also, the nutrients coming from the biogas plants need to be managed properly to prevent nutrient imbalances for plants (Herrmann, 2013). Hence biogas might also not be the best answer.

This shows that the problem where this research is based around is quite complex since there is no simple substitute for the natural gas that is currently used. There are many potential renewable energy carriers that could all be applied in the search for a net CO₂ net neutral society. The above-mentioned problems with applying concepts to individual houses also show that it is not a good idea to look at houses individually. Instead, it is a problem that should be solved in an integral way. This can be done by combining different energy sources and different levels of energy consumption and production at different scales in order to create the best solution overall, hence taking a multi-scalar approach. Furthermore, the energy network must be seen as integral part of an area and hence must be approached with that specific context in mind. The linking of scales will be crucial to create opportunities and mitigate barriers that can be found on our route towards a sustainable society. When there are barriers at a certain location, it would be good to mitigate them by making a connection with locations that do not have them, thereby fully utilizing the potential that could present itself. For instance, it might be more beneficial to fully renovate house A and install twenty solar panels on its roof and the energy produced can be transported to house B, instead of fully renovating both houses and installing ten solar panels on both. Hence such holistic and integral approaches should be considered.

This research argues that by having gasless as a goal, immediately a large potential energy carrier that could be used as a direct carbon neutral replacement of gas is being denied. This is a missed

opportunity; hence the goal for neighbourhoods in the Netherlands should not be gasless but net real fossil emission free. This means that no fossil fuel should be used as energy carrier. In this way, interesting and promising techniques are still utilized. This is the best option since this would lead to the most amount of potential options for the energy mix in the Netherlands.

One can see that small nuances within concepts in the discussion on sustainability could have big implications in the end result. For instance, the difference between energy neutral or sustainable development can have major implications on what is taken into account when discussing about or acting according to that specific concept. Hence, I think it is important to gain understanding of the different concepts, the consequences of those concepts and the different choices that can be made. This will be discussed in the next section; the discussion could lead to a whole new balance within the discussion. This is beneficial to truly understand the problems and to find answers to the problems mentioned. Sustainability and gasless are already mentioned so we continue from here.

2.1.1 Combining elements in concepts to create a more applicable concept

Urgenda states that self-sufficiency on the individual parcel should be the goal to aim for (Urgenda, n.d.). Self-sufficiency is about the ability to supply the individual house with all the local resources at the level at which it is used (Farreny et al., 2011). Resource flows however may occur according to Farreny et al. (2011). This seems odd since self-sufficient actually is defined as “*Able to provide everything you need, especially food, for yourself without the help of other people*” (Cambridge Dictionary, 2017). Therefore, self-sufficiency basically means that everything should be produced within the own lot. When linking this to energy element of self-sufficiency, this means that one should produce the energy one consumes. Or as Melchert (2007) states, in principle a self-sufficient house should be able to be disconnected from existing networks. Since Farreny et al. (2011) think otherwise, it shows that there is no consensus on whether self-sufficient should mean being able to get disconnected or not, hence the term is difficult to use consistently. The central argument of producing energy that one consumes is very closely related to energy neutral housing. The main difference is that self-sufficient means that one should produce each different energy source such as gas and electricity at their own house since one should be able to produce everything they consume. While energy neutral means that the amount of energy consumed at each lot, should also be sustainably produced at that lot (Urgenda, 2014). It does not matter what type of energy is used or produced, as long as it is at least the same amount. So, when a house used a certain total amount of energy in the form of electricity and gas, it can be energy neutral as long as it produces the same amount of renewable energy, in what shape or form doesn't matter. In terms of exergy, this means that the total amount of usable energy should be the same as the amount of energy consumed. This also means that a house that uses gas for its heating, but produces enough electricity to compensate it, the house is in principle energy neutral. However, since it still uses gas as heating source, the house still contributes to the amount of CO₂ emissions. Urgenda (2014) later states that collective production can be applied, but it is described as the last thing to do, furthermore, this does not coincide with their definition of energy neutral. Hence, they take a definition and then later seek to find an escape for cases that do not fit their definition. This research therefore state that the definition of energy neutral simply is a limiting idea since it would exclude many sources for renewable energy. Also, since the definition is not used as strict as the organisation states, this shows that the concept is simply to limiting and therefore not practical in achieving a large-scale energy transition. One could argue that energy neutrality is more a strategy or means in a specific location to reach the end goal which is no longer using fossil energy sources.

Carbon neutral is also relevant to consider since it seems closely related to energy neutral housing, however it focuses on the output of CO₂ that is contributing to climate change rather than the energy that is used. However, it does not differ that much from energy neutral housing since with carbon neutral housing, the building energy use is compensated on a yearly basis by carbon neutral renewable

energy generated within the community. Which differs from renewable energy since that could be not carbon neutral for instance when wood is burned, it still is renewable, but it also creates carbon emissions. Furthermore, the exact type of energy used does not matter when calculating the amount and type of energy produced at the local lot (Janssens et al., 2016). Therefore, it practically uses the same principles as energy neutrality. Interestingly, also the household electricity use of the individual households is not taken into account (Janssens et al., 2016). The main difference is that carbon neutral looks at the amounts of CO₂ that should be compensated and not necessarily the amount of energy. Dahal & Niemelä (2016) state that carbon neutral refers to balancing artificial carbon emissions by certain emission cutting actions and sustainable energy production methods. Therefore, this definition still doesn't tackle emissions as such. Instead it looks for ways that can compensate the CO₂ emitted. The main problem hence still is that a house can be heated by gas and thus emits CO₂, but it could be called CO₂ neutral when it produces renewable green energy.

Another interesting concept to consider is a net zero-energy building (ZEB) which is mentioned by Torcellini et al. (2006). A ZEB is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. Torcellini et al. (2006) identify four groups of definitions of ZEB that have pluses and minuses in usage. The basis however is the idea that buildings can meet all their energy requirements from low-cost, locally available, non-polluting, renewable sources (Torcellini et al., 2006). This research only takes the annual balance of the ZEB into account and does not incorporate the energy needed in the production as others mention (Marszal et al., 2011). This choice is made since the research focuses on existing buildings and hence the building materials mostly will be largely already used in the creation of the building. Of the identified definitions of ZEB, the most strict level of ZEB is when this energy is produced on site. However renewable energy sources from outside of the building could also be used to achieve a ZEB. Torcellini et al. (2006) however make a distinction from a regular ZEB and hence call such a building as "off-site ZEB". Torcellini et al. (2006) identify multiple definitions within the ZEB concept, these are listed in table 1.

Type ZEB	Definition
Net Zero Site	A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site. Hence it is neutral over a given amount of time, hence compensation is possible.
Net Zero Source Energy	A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy on the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.
Net Zero Energy Costs	In a cost ZEB, the amount of money the utility pays the building wonders for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services an energy used last year.
Net Zero Energy Emissions	A net-zero emission building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.

Table 1: Types of ZEB derived from Torcellini et al. (2006)

Torcellini et al. (2006) state that this type of ZEB can be achieved in multiple ways. It could produce emission free renewable energy to compensate for the emission producing energy source it uses. Also, if all energy comes from an off-site zero emissions source then it also falls into this category without producing its own energy. Since this definition leaves room for off-site generated green energy makes

that this idea fits well within the goal this research has in mind. The only thing that this research does not incorporate is the compensation measures for fossil fuel usage. The problems that this definition produces will be dealt with later. The Net Zero Site is of course also of interest since it produces its own energy on site a could put the excess of energy onto the national grid which could be even used to compensate with other buildings. This could then for instance be used for Net Zero Energy Emission buildings. The same goes for the Net Zero Source Energy.

The Net Zero Site and Net Zero Source Energy are closely linked to a full sustainable house since they produce energy on site (Torcellini et al., 2006). However, by not ruling out Net Zero Energy Emission buildings and even connecting them to one grid to spread the available energy it could be suited for an energy transition in the Netherlands since this creates opportunity for the energy that is produced to be used in sites that can use it. Therefore, it allows for transfer of energy among buildings. The only thing is that these sites should eventually also be heated by emission free sources. The Net Zero Energy Costs is of minor interest since the goal of this research is not to change cost structures, the central point of equal payment for and from consumers and utility networks is important however to get incentive to give energy back to the energy system. Corvacho et al. (2016) add to this Net Zero Energy Community which takes into account a whole area or neighbourhood, this is closely related to the concept this research wants to stimulate. Corvacho et al. (2016) state that taking into account a larger area is more cost effective and offer economies of scale. Furthermore, applying the concept to the urban scale creates opportunities for seasonal storage, implementation of smart grids for power sharing between housing units, and controlling peak energy production and demand. Also design flexibility and increased surface area can be seen as an advantage. This research states that net real fossil emission free neighbourhoods should be the goal to look for. The main difference is adding the word real, hence eventually ruling out all fossil fuels needed for energy. The advantages of the large-scale approach of Net Zero Energy Communities are also considered by this definition. The upscaling look towards a neighbourhood creates opportunities to use the economies of scale, smart grid, storage and power sharing as mentioned by Corvacho et al. (2016).

2.1.2 Consequences of different concepts

In the section above, we have discussed multiple concepts that are used in the discussion about sustainable redevelopment or sustainability of the housing stock in general. These terms are often used intertwiningly without proper understanding of the consequences of using that concept. Some concepts are very broad and inclusive which makes it hard to achieve goals, objectives or targets. Therefore, they could be difficult to use since it will make the eventual end goal seem diffuse and fuzzy. Other concepts on the other hand are very strict in what they incorporate in ‘their way’ to achieve a kind of sustainable housing stock. Therefore, these concepts might be unachievable to reach and therefore act as a barrier to achieve a sustainable housing stock across the Netherlands. In table 2 the discussed concepts are listed and linked to consequences that comes with the concept. In the following paragraphs the consequences are explained a bit more extensively.

Goals are more visionary and direction setting, objectives are more short term goals and targets are specific desired outcomes that support the goals and objectives.

Concept	Meaning	Consequences
Sustainable development/design	<i>“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p41)</i>	Very inclusive broad and vague concept. Therefore, it is hard to understand the true meaning of it or adhere to all the ‘requirements’. Every aspect of the neighbourhood should be incorporated into the

		neighbourhood design, hence sustainable redevelopment will be hard to achieve. At the same time, it is hard to operationalize sustainability, hence it will be hard to set goals and objectives.
Gasless housing	Housing that can no longer have a connection to the gas network, proposed by the government by 2050.	The idea is that by prohibiting the usage of gas, the CO ₂ emissions of housing decreases. However, it also ignores the potential of biogas which could be very beneficial in heating houses that can only be insulated to a certain degree. Therefore, it could prohibit the development of a promising heat source. When natural gasless housing is meant it can also be seen more as one approach instead of a goal. Hence natural gasless housing is also unsuitable to use as goal.
Self-sufficient housing	A house should create enough energy to sustain their own energy needs. The energy used should be produced within the boundaries of the parcel the house is standing on.	When self-sufficiency becomes the norm or goal to aim for within urban redevelopment. One cannot use communal energy sources such as large windfarms at sea or large amount of solar panels on the roof or farms as energy source to create energy for certain areas since they would not be energy production facilities at the lot. Therefore, some very promising ways of energy production may not be used. Furthermore, some houses such as in city centres can hardly meet such requirements because they simply don't have enough room to produce the energy which may lead to inefficiency.
Energy neutral housing	The total amount of energy consumed in a house should be produced at the same lot, the type of energy does not matter	When energy neutral housing becomes the norm or goal to aim for within urban redevelopment. One cannot use communal energy sources such as large windfarms at sea or large amount of solar panels on the roof or farms as energy source to heat housing in certain areas since they would not heat their house with energy produced at their own lot. Therefore, some very promising ways of energy production may not be used.

		Furthermore, some houses such as in city centres or high-rise cannot meet such requirements because they simply don't have enough room to produce the energy. Furthermore, since there is no distinction made between type of energy the house still could use gas and hence still emit CO ₂ .
Carbon neutral housing	The building energy use is covered or compensated on a yearly basis by carbon neutral renewable energy generated within the community.	When carbon neutral housing becomes the norm or goal to aim for within urban redevelopment. One cannot use communal energy sources such as large windfarms at sea or large number of solar panels on the roof or farms as energy source to heat housing in certain areas since they would not heat their house with energy produced at their own lot. Therefore, some very promising ways of energy production may not be used. Furthermore, some houses such as in city centres cannot meet such requirements because they simply don't have enough room to produce the energy. Furthermore, since there is no distinction made between type of energy the house still could use gas and hence still emit CO ₂ , it only compensates for this.
Zero Energy Building (ZEB)	A ZEB is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies	There are multiple forms of ZEB each coming with their own strictness. Either only energy produced at the own lot can be used, or energy produced at the own lot can be used to compensate for the energy used. Thereby it is either to strict and thus not suitable for different sources of off-site energy generation. Or it enables CO ₂ emitting energy sources for which can be compensated and hence it is still contributing to the total amount of CO ₂ emissions.

Table 2: Different concepts used in sustainable redevelopment discussion, their meaning and consequences

Table 2 shows different concepts that are used in the discussion about sustainable development and redevelopment, their meaning is shown and the consequences of the usage of each concept is also listed. As shown in the table 2, each concept that used in the literature has some consequences connected to it.

Sustainability has some drawbacks to its usage, the main problem with this concept is that it is too inclusive which could lead to differing viewpoints on sustainability (De Roo, 2003). For a redevelopment project to be truly sustainable, the building materials have to be renewable and sustainable as well (Luederitz et al., 2013). Furthermore, the whole layout of the neighbourhood should then be in compliance with the sustainability principles. It should be facilitating more sustainable ways of travel such as walking and biking (Kenworthy, 2006). Also, sustainability is about the social aspect of the neighbourhood, or community in this case. Sustainability then also focuses on economic prosperity and social inclusion (Egan, 2004). Lastly, self-sufficiency is also widely used when talking about sustainability (Farreny et al., 2011). Hence sustainability takes into account a lot of aspects and is at the same time quite strict in what counts as sustainable. Hence it is a concept that is hard to use in research and hard to achieve when redeveloping a neighbourhood.

Gasless as a concept of housing that is said to be enforced by 2050 by the national government surpasses the potential energy source of biogas (Van Belzen, 2017a). The concept is proposed with good intentions but it comes with certain drawbacks and problems. Firstly, the idea that houses can no longer be heated through gas is more of a means to achieve sustainability of the housing stock. Therefore, it is weird to use it as a goal per se, if for instance it prohibits the usage of biogas or green gas which could be used to heat houses. Such biogas or green gas is renewable and could be very well used in housing that simply cannot be insulated as thoroughly and therefore need an energy source that can effectively be heated to high temperatures. Gasless hence, is quite unsuitable as a goal since it is merely a means to achieve sustainable, energy neutral or carbon neutral housing and therefore if gasless is indeed a goal, then a whole array of measures become unusable.

Self-sufficiency in housing creates other problems. Self-sufficiency namely has the premise that each individual entity should be able to produce all the resources that it needs. This means that all the energy that is used in a house should also be produced at the lot of the house. This concept comes with multiple problems, firstly, some houses simply don't have enough space to be able to produce enough energy for their consumption, for instance apartments on the ground floor have no room for solar panels and hence can face difficulties in producing energy. One could argue that the whole apartment should be taken as entity to achieve self-sufficiency, this is a choice of scale and does not solve the problems with the definition itself. Furthermore, self-sufficiency does not incorporate renewable CO₂ neutral energy sources such as large windfarms. Therefore, it excludes promising ways of energy supply on a large scale. Lastly, when all house owners should strive for self-sufficiency, there is a large potential efficiency loss. Namely, this means that all houses as individual entity should be producing their own energy. This could lead to a situation where housing with unfavourably situated roofs could have a whole lot of solar panels on their roof to barely achieve self-sufficiency. While houses with very favourable situated houses only have a few since they can easily be self-sufficient. It would then be more efficient and hence cheaper, when looking at the problem holistically, to put more solar panels on the favourable situated houses and just use that energy on housing that is not favourable situated. However, when self-sufficiency is the goal, such arrangements are not facilitated. Furthermore, there is no incentive for the person in the favourable situated house to overproduce energy and then redistribute it through the network. Therefore, self-sufficiency is not a concept that should on its own be used to achieve sustainable neighbourhoods, it can be one of the means to do so.

Energy and carbon neutral housing are very closely related and broadly mean the same thing. The only difference is that they take the amount of energy or emitted carbon as taken as entity to which the concept is applied. Therefore, the problems related to both concepts are very closely related and sometimes the same. The main problem of seeing a house as production/consumption entity, or shifting the system border to the specific lot, is the same as self-sufficiency. Namely energy neutral housing should also produce the same amount of energy it consumes. Therefore, the same problems such as neglecting windfarms as energy source or reducing incentive to create overcapacity which are

mentioned above also count for energy and carbon neutral housing. With these two concepts there is another problem however. These concepts only state that the amount of energy used, or carbon emitted should be equal to the amount of energy produced. They do not state what sources of this energy should be. This could create the situation where a total energy neutral or carbon neutral house is totally heated by gas, but it still counts as energy neutral since it produces the same amount of energy with solar panels for instance. The logic behind this is that the house also could use the energy produced by the solar panels and hence does not use energy or emit carbon. However, since the energy that is used to heat the house is still a fossil fuel it still adds to the total emission of carbon into the atmosphere. Therefore, this research argues that although such concepts could be a route in between the final goal of energy neutral neighbourhoods, it should not be the goal. The goal should be namely housing that can be heated with such renewable energy. The produced energy should not be able to 'compensate' for the fossil sources the house uses.

Zero Energy Building is a concept that can take shape of multiple forms as already stated. This creates a problem in itself since it is not clear what exactly is meant by a ZEB. Furthermore, the problem with ZEB's goes two ways, first it also uses a certain compensation logic. Therefore, the problems mentioned above for energy and carbon neutral housing is also applicable for ZEB. Secondly certain ZEB's are very strict and therefore neglect potential energy sources such as wind farms and biogas.

The previous section mainly focussed on consequences of using the concepts. As discussed, all concepts seem not to fit the goal of this research. Due to the discussion being very fuzzy and diffuse, these concepts are sometimes used differently in different articles. The general meaning is often quite similar, however the differences between the usage of them is sometimes stark. For this research to truly be able to answer the main question it is good to create a definition that is clear, but also applicable. The next paragraphs will try to decompose the goals that are the core of the discussion, what do we actually want to achieve. What can aid in achieving this goal and what can act as a barrier.

The central point of sustainability is making sure that the planet is still inhabitable and full of opportunities for future generations to come. The concepts of gasless housing, self-sufficiency or ZEB all try to contribute to this by focussing on one aspect that the future generation also needs. These central elements can be distilled to energy and climate. The current society is largely based around energy and it is likely that this will be the same in the future, therefore energy is a core element that should be available for the future generations. The other important element climate dictates the way we currently are living, it enables or prohibits farming and it even dictates where we can live. Therefore, it would be good if we try to keep climate change as limited as possible, we can do this by reducing the amount of greenhouse gasses. The central end goal would then be to reduce the amount of fossil fuels we use because they will eventually run out and hence cannot deliver energy for future generations and since they emit greenhouse gasses. Another central element is to enable the production of renewable carbon emission free energy and to facilitate the use of this energy.

These goals could be achieved by taking into account multiple scales. The concepts of self-sufficiency and energy neutrality focus on individual housing on which the concept has to be achieved. This research wants to argue that this is not the only scale to achieve such goals. The different scales from national to local are all connected, and this is where the solution should be sought. By taking a larger scale, we do not limit ourselves to opportunities at the local lot or parcel which is likely limited. Furthermore, when looking at a larger scale, windfarms and large acres of solar panels come into the realm of the opportunities, which is likely beneficial for success. Secondly, by taking a larger scale trans local opportunities that otherwise were not considered can be used (Connolly et al., 2014). A plant that produces residual heat can be implemented in a local heat plan. Farms that produce excess manure could utilize it to produce biogas that could be used to heat small villages in the surrounding. This could mean that local gas networks could be slightly adapted and then continue to be utilized. This potentially saves money since it not only makes changing the energy network superfluous, it also

saves insulation costs since the exergy of gas is higher than electricity. Such different applications are very context dependent however. The main argument hence is that when taking multiple scales into account, we will not only create opportunities that would otherwise be neglected, it also enables more effective energy production, transport and consumption allocation (Connolly et al., 2014).

This research hence looks for a situation that leaves opportunities for heating with sources such as biogas or energy that is received from large windfarms, but on the other does not limit the energy production to the own parcel the house stands on. Due to the explained boundaries to which energy can be produced at the own parcel, an energy neutral housing at the individual level is not the chosen direction. Hence this research thinks carbon emissions are an appropriate measure since it focuses on the problem of emitting greenhouse gasses and does not punish house owners who live in an apartment or flat and thereby cannot produce enough energy. In the meantime, having an energy production facility at the parcel should still be stimulated. This could be achieved by changing prices for energy or making policy that stimulates having energy producing sources at the plot.

The situation this research strives for is a housing stock that is net real fossil emission free. This means that the housing stock does not necessarily have to produce as much energy as it consumes, nor can it compensate by energy production for fossil fuel consumption. It means that the house should be powered by renewable carbon free energy, whether this is produced at the lot or somewhere else. This does not mean that houses cannot produce their own energy, in fact it could save them from costs of buying the energy. The only real commitment that applies is no heating by fossil fuels. Hence ruling out oil, gas and coal powered heating or electricity stations. However still leaving options to implement different techniques such as collective thermal heat, windfarms or biogas open. Therefore, this basically focuses on transitioning housing from the current usage of fossil fuel heating systems to systems that enable usage of renewable energy sources for heating. This option was chosen since it leaves leeway to implement different techniques in different contexts that require different approaches to reach energy neutrality.

Important to note is that this research does not look at projects or examples of neighbourhood renovation or redevelopment into net real fossil emission free housing. This might sound odd but the redevelopment projects this research looks at are projects that reduce the energy consumption in such a way that it enables net real fossil emission free neighbourhoods. This choice was made since it is very hard to find projects that are truly net real fossil emission free. It is already difficult enough to create less energy consuming neighbourhoods on larger scale. Therefore, be of importance to the energy transition goals of the Netherlands it is first necessary to create neighbourhoods that at least are able to facilitate energy neutrality by enabling different heating sources. To explain this point, it is first necessary to look at exergy since that can be used to explain the consequences of different energy carrier on heating methods and hence it can be the explanation of the choice to look at energy consumption reducing projects. Milieu Central (n.d.) states that in order to be able to become energy neutral, the amount of energy a house consumes should be as low as possible to be able to produce the energy needed by yourself. The lower the energy consumption, the easier one can become energy neutral. This logic lies at the basis of the choice to look at developments where existing housing is renovated as energy thrifty as possible.

2.1.3 Exergy as guide to gain understanding of the problems and opportunities

To add to the understanding of the difficulties of implementing such systems, it is necessary that the concept exergy is explained shortly. We will use it as a guide to find answers to potential problems or difficulties. According to Van Kann (2015) the laws of thermodynamics form a solid starting point. The first one means in its core that, whatever happens, all energy remains equal. The second is about the potential to transform a certain amount of energy of a certain form into another form. This is necessary

to make the eventual labour possible. Furthermore, there can be made a division between three energy forms. The forms consist of unlimited convertible energy forms such as electricity, limited convertible energy forms such as heat and non-convertible forms such as internal energy in equilibrium with its surrounding. The limited convertibility of energy can be explained by the second main law, according to which not all processes can be possible spontaneous and there has to be a certain direction of the ending of a process that is prescribed naturally (Van Kann, 2015). This can be called the difference between reversible and irreversible processes. All unlimited convertible energy forms consist totally of exergy. Exergy can be described as the quality of energy. Or it can explain the quality of the stock of labour that energy can accomplish or the durability of the stock. Van Kann (2015) makes a link to food that can decay fast, he argues that one should eat this food first. The same goes for energy in his view and this research shares that idea. He argues that we should consume energy that can get lost quickly, by this he means that excess heat that comes from all sorts of industrial processes could be granted priority in sequence of usage, thereby saving an energy source that is more durable. One of the most durable energy sources is natural gas according to Van Kann (2015), therefore we should use this the least and only when really needed, not for heating a house. He has this opinion since he explains that natural gas is an energy source that can reach very high temperatures of which only a few degrees would be enough. Therefore, a whole lot of the energy in natural gases get wasted. This means that usage of natural gas has a very low exergy efficiency. This research agrees and even thinks that natural gas should not be used at all eventually. To gain understanding of the opportunities and problems with different energy producing solutions on a regional scale, it is important to take exergy efficiency as a tool to gain better understanding of different options and (im)possibilities. Exergy can hence be used to gain understanding of potential inefficiencies in the total network and thereby to find answers to these inefficiencies. The main point of this is that exergy can be helpful in gaining understanding of the quality of certain energy sources, thereby gaining understanding of the usefulness of certain energy carriers.

As Van Kann (2015) states, it could be beneficial to use any type of high exergetic gas only for processes that need such a high exergetic type of energy. For lower exergetic energy processes, such as the heating of houses, low exergetic energy sources could greatly increase the exergy efficiency. Van Kann suggest a system of heat cascading, this is only possible with the appropriate amount of compactness however. Heat cascading basically means that the same energy gets used multiple times. This could increase efficiency of exergy immensely. Planning hence can be an important addition to such concepts. Especially integration on a larger more local or regional scale will be beneficial (Van Kann, 2015). Therefore, integrative planning will be beneficial for the transition towards sustainable energy usage. Also using exergy as basis of analysis on an energy system can show the potential of bioenergy, much of these energy bearers namely have a high exergetic quality and hence can replace fossil fuels in a better way in the locations where high exergetic energy is required. Exergy hence can serve as a concept to grasp the shortcomings of certain locations and to better use different energy sources effective. Therefore, it is a good idea to look at multiple scales when looking at sustainable redevelopment to allocate the appropriate energy bearer at the appropriate location while making use of smart energy transport opportunities.

2.2 Current energy state of existing neighbourhoods

Sustainable neighbourhood design, gasless initiatives and Zero Emission Buildings have received much attention in scholarly articles, a large focus is on newly built neighbourhoods. This literature is not consistent however since the definitions used differ and therefore the proposals within the literature are differently embedded. Moreover, not much is being stated about redevelopment of existing neighbourhoods even though most of the housing stock that is present in the Netherlands now is relatively old and will be probably present also in the future. As expected, more than half or even three quarters of the current housing stock will still stand by 2050 (Wang et al., 2017). Of the current housing

stock more than 5 million houses are 30 years or older (CBS, 2017a). Housing stock that was built before 1980 still has a large percentage of housing that has an energy label D or worse and even buildings built after 1996 do sometimes have a B or C label (Tigchelaar & Leidelmeijer, 2013). The labels mentioned here are meant to enhance the insight into the thriftiness of houses for house buyers and renters (Energietabel.nl, n.d.). The labels go from A to G, the closer to A, the less CO² that house emits. However currently there are even houses that have A++. Therefore, label C or D is quite low. Furthermore, of all the existing housing stock, 85% is still heated by gas through central heating (Gerdes et al., 2016). This means that more than 6.4 million houses are heated by gas. Hence, the existing housing stock is not energy fossil emission free. By far the largest part is heated with fossil fuels and many of the existing stock is not thrifty in its energy consumption. Hence a large part of the existing housing stock is far from being able to be emission free. Furthermore, the steps towards better energy labels Tigchelaar & Leidelmeijer (2013) seen over the years is mostly caused by demolished older buildings and hence is not the effect of real improvement of existing housing stock even though these houses are built to last.

Tigchelaar & Leidelmeijer (2013) show, when insulation measures are taken, the quality of the labels tend to go up, hence there lays a first opportunity for sustainable redevelopment. A strong relation is visible in the type of ventilation, the worse the energy label, the worse the ventilation, mostly these are natural ventilation instead of mechanical ventilation. Another important reason why older buildings are less thrifty and sustainable is the fact that these older buildings are not as well insulated as newer buildings. Hence there is much potential when such older neighbourhoods could be redeveloped. Especially insulation in the floor and façade is missing in older housing (Tigchelaar & Leidelmeijer, 2013). The insulation in private rental housing is especially lagging compared to other housing types. So, these older buildings are not very thrifty due to bad insulation and non-mechanical ventilation. Good ventilation is important since it could prevent heating air being unwantedly transported outside or it mitigates unwanted effects on humidity which will lead to higher energy usage. Furthermore, better ventilation is beneficial for health issues (Carrer et al., 2015), this issue could create an incentive for house owners. Therefore, health benefits are worth mentioning the amount of gas used per household differs due to size of the building, the energetical quality of the house and the behaviour in usage in heating of the inhabitants. However, 25% of the gas usage could be explained by a bad energy label. Therefore, improving the energy label of existing houses could be a good way to reduce gas usage. The difference in gas usage between an A label and a G label is 95%, so this is quite a strong difference. The households that use the most gas is for 80% older houses that have been bought, not rented.

The potential to decrease the amount of gas needed to heat houses is large due to the potential technologies that can aid this cause. The investments needed to reach a higher energy label are not that big and could also save money on energy in the long term. Therefore, such investments could be quite beneficial. In fact, 42% of the whole primary energy consumption could be saved by implementing measures that make a house thriftier and hence consume less energy for heating. Especially a heat pump that does not work on gas but on electricity is an effective measure to reduce gas consumption, however the usefulness of the heat pump is dependent on the total thriftiness of the house, a heat pump uses warmth from the surrounding and electricity (Tigchelaar & Leidelmeijer, 2013).

Hence, older houses indeed use more energy for heating, furthermore they tend to get heated by natural gas. Therefore, these houses in existing neighbourhoods have good opportunities for improvement, should redeveloped into energy efficient and zero emission houses occur. This is the case since they have a very large negative impact on energy consumption of housing in the Netherlands. As stated before, the transformation of the energy-based society should take place on neighbourhood level, however the different measures should also be applied to a certain extent to the individual houses. There is hence an integration of multiple scales necessary where multiple levels are

taken into account in an integrated way. Furthermore, willingness to implement such adaptations to the houses should be present within the owners (Tigchelaar & Leidelmeijer, 2013). According to Urgenda (2014) this transformation is urgent since CO₂ will stack for longer times and hence time is of the essence to reduce CO₂ emissions.

2.3 What is sustainable redevelopment

We have concluded that the discussion about sustainable redevelopment or development is very unclear and fuzzy. Furthermore, we have gained understanding of the consequences that these specific concepts have when one chooses to use them. Then we have established that these consequences are not very clear within the users of them and therefore are used intertwiningly. Also, this research has established that the goal should be eventually net real fossil emission free neighbourhoods. Furthermore, we have seen that there is no abundance of clear projects where redevelopment or renovation takes place and therefore it is good to a look at what renovation exactly is, what makes it a difficult process and what can a sustainable component add to it.

According to Thuvander et al. (2012), there is no general definition to describe renovation, instead they state that there is a large variety of overlapping terms and concepts in use. These are among others, renovation, alteration or retrofitting. The use of different terms comes from the varied type and scale of buildings, reasons and range of actions. The core however that a renovation is an intervention to preserve the building or (Thuvander et al., 2012). According to Jensen and Maslesa (2015), building renovation is the process of fixing or replacing existing parts of the building to improve its performance, either to its original state or better.

We choose to set the focus of this research on relatively large changes to a building and alteration of the way the building looks and functions in terms of energy usage. Hence, we use the term renovation or redevelopment. Sustainable redevelopment then takes this basis and adds sustainability dimensions, this means that the goal is then fulfilling environmental, social and economic sustainability in changes to the building. This research will only focus on the environmental aspect and hence focuses on the energy component of renovation of buildings.

Thuvander et al. (2012) states also that in Sweden, the regulations regarding energy efficiency regarding the altered part of a building, that his altered part should be the same as a newly built building, hence equal energy efficient. In the Netherlands this is more or less the same (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2013). The 'Bouwbesluit' states the term remodelling which is an element of the renovation typology. It is stated that a remodelling is the total or partly alteration or change of an existing construction. Furthermore, partly renewal is also mentioned, this happens when a construction will be stripped to the core and rebuilt, or when one or multiple parts of the construction get changed. When the contours of the construction remain the same, this is called as alteration.

According to Thuvander et al. (2012) energy conservation actions, which are an important aspect of sustainable renovation, are often influenced by municipal policy and economic return. Furthermore, the energy improvements are seldom the main motivation for initiating a major renovation. Rather, they are one of the several coinciding needs (Thuvander et al., 2012). Furthermore, much of the current renovations are done without considering the energy efficiency, hence it is important to come up with a strategy that aids in the adoption of such alterations. When energy improvements are done, improving of comfort levels is the main driver.

The longevity of renovations is also important to consider, according to Meyer et al. (2014), such renovations can last up to 60 years and therefore it is important to make sure that renovation

standards should be quite high since the 'consequences' will be apparent for a very long time. This furthermore shows the importance of energy improvement happening now, since the alterations will probably be still present in 2050 and hence the closer to a net real fossil emission free neighbourhood, the easier the target will be met. Or in other words, the better the insulation and renewable energy measures taken now, the higher the chance we reach energy neutrality in 2050. The alterations that are being undertaken now, will be present in 2050 and hence will be beneficial then. Therefore, we should try to reach net real fossil emission free neighbourhoods now, since they are still present in the future. This is not only beneficial by 2050 but also now since it avoids overinvestments in supply systems and it can aid in synchronizing with technologies such as heat pumps and solar panels. Also, since people live for 70% within buildings (Jensen & Maslesa, 2015), a good climate within them should be of importance to us.

Hence sustainable redevelopment is seen in this research as an alteration to a building that can aid to an increase in energy level performance. However, we focus on more large-scale renovation projects and hence individual alterations to an individual building are not treated as case. The research looks at projects that clear the way to reach net real fossil emission free neighbourhoods. As Corvacho et al. (2016) state, focusing on large urban units may present some scale advantages and may create an opportunity to change the area in a smart energy way that would not be possible when looking at individual houses. Therefore, the scope of this research is much more focused on getting an area, neighbourhood ready to implement energy solutions that enable net real fossil emission free neighbourhoods.

2.4 Taking context into account

According to Khan (2005) environmental projects are contextually based in space and hence context specific factors should be taken into account since they affect project design and project management. Khan (2005) states that differences between projects are not only dependent on the type of project in question but that these also differ due to context specific factors. Projects namely are dependent on external reality. The specific contexts create the backdrop for a project and could alter the outcome, since contexts will invariably differ from one place to another. The context of that project will probably differ as well. Therefore, the approach to the projects probably should be adapted to the context in order to be successful. The context in this research is also of importance since the context in which the different neighbourhoods are placed will also differ quite strongly. The different contexts will be a basis for the different opportunities that are present in the specific area.

The notion of context can also be seen as the importance to take into account the specific place of a project and the people living within neighbourhoods who will value their neighbourhood in various ways. With renovation projects, the existing material structures that exist in an area will remain the same as shown above. Therefore, the meaning infused within them will also remain. The local context therefore will remain largely the same. Therefore, taking local context into account is essential for successful sustainable neighbourhood renovation.

Furthermore, especially since renovating is about taking the existing urban fabric as a base, it is clear that certain urban areas or neighbourhoods are more convenient to renovate the area into a more sustainable neighbourhood than others. This is due to the fact that the specific housing stock per area will differ. Heiskanen & Matschoss (2017) state that the physical building stock has an effect on building-scale renewable energy solution. For instance, certain neighbourhoods cannot become net real fossil emission free, while others might even produce more sustainable energy than they use. However, when both look at their own area individually, some areas have no incentive to start renovating. Also, as Corvacho et al. (2016) show, it is important to specify specialities of areas since it can make a difference to the optimal solution. Simply because the existing fabric differs per area,

therefore the local context is highly important to consider. Also, this means that net real fossil emission free should be sought sometimes on a larger scale to enable compensation between areas. Corvacho et al. (2016) name this a Net Zero Energy Community (NZEC), which closely resembles net real fossil emission free neighbourhood or area. The scope depends on the chosen scale level. The addition of the word real simply reduces opportunities to simply compensate fossil energy usage. Instead it tries to move away from fossil fuel energy consumption, thereby it stimulates the use of sustainable energy sources.

Moreover, the national policy regime can also be seen as contextual factor since it can have an influence on the uptake of sustainable renovation and also national investment plans have a certain influence. Furthermore, local supportive networks and structures such as good technicians and financial adaptations have an important role within the diffusion of different technologies (Heiskanen & Matschoss, 2017). These are however more complementary services for a more stable market, local initiatives and innovative solutions can help create an upsurge of such markets (Heiskanen & Matschoss, 2017). Lastly also more social factors such as age, education, access to capital and home ownership are important factors to consider. However, since these social factors are mostly fixed, it is especially interesting to gain insight in ways to use them to stimulate sustainable renovation.

The importance of the context is also recognized by de Roo (2003) in fact he makes the point that the different issues arise from the complex context. This notion of complexity also came across previous sectors a few times. The viewpoints of de Roo could well be a guiding framework or frame to which different outcomes can be framed. The following section briefly discusses his ideas and the application of them for this research.

2.5 Complexity as guidance for understanding

Of the book 'Environmental Planning in the Netherlands: Too good to be true' especially chapter four is of interest for this section. In this chapter de Roo (2003) attempts to construct a model that can accommodate issues of varying complexity. The issues that his model is concerned with are most important for this research are the level on which certain decisions must be taken, who will take them and whether this leads to central or decentral policy.

An important notion is that the context of local environmental issues is becoming increasingly important and even determines the solution to a great extent (De Roo, 2003). Figure 1 shows the interplay of a planning object and the context. In the case of neighbourhood redevelopment, the object can be seen as that specific neighbourhood while the parts can be individual people living in that neighbourhood. The interplay with contextual factors could be very important for the success of such a project. The context may differ very much per planning object. Simple projects such as a traffic light build on a road is still affected by the context, however there are fewer parts involved, the environment gets changed less and the difference in scale is not that important, in such case the individual parts are more important. More difficult projects such as sustainable neighbourhood redevelopment is influenced much more by different stakeholders interested in that specific project. Also, with that the influence of contextual

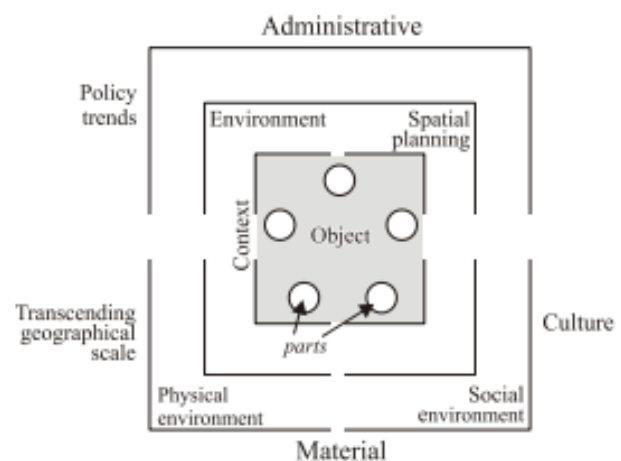


Figure 1: Context of the objective (De Roo, 2003)

factors such as the environment, culture or material trends also become more connected to the project making it more complex (De Roo, 2003).

Figure 2 shows a framework in which or projects can be situated on the basis of their complexity. The more complex a project, the more goals should be achieved, and these goals can be dependent on each other (De Roo, 2003), furthermore, it is likely that a more participative approach where interaction among stakeholders is central becomes more important. The simpler projects can be dealt with by central guidance, also mostly there is a single and fixed goal (De Roo, 2003).

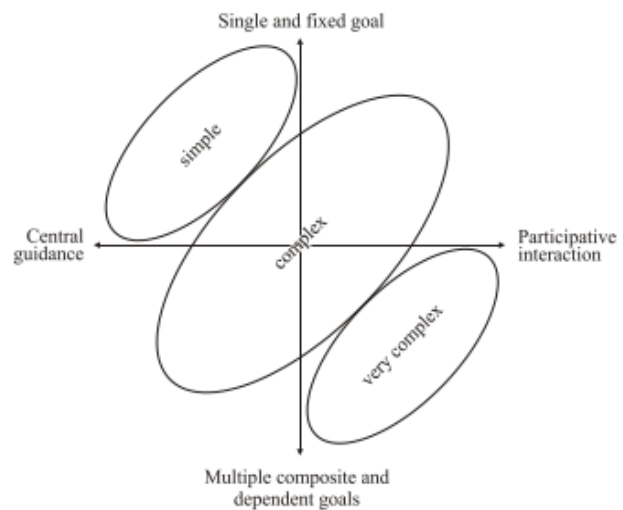


Figure 2: Framework for planning-oriented action (De Roo, 2003)

When looking at neighbourhood redevelopment we would suggest that it fits within the complex section. There needs to be some form of central guidance

within the whole neighbourhood, otherwise it would be all individual people within their own project. On the other hand, there are multiple stakeholders with all their own interest in such projects. Furthermore, within such a neighbourhood there would be multiple potential goals since energy is not the only aspect of living in that neighbourhood, hence there are multiple goals which could be interconnected. When housing corporations would redevelop their housing, there exists much more central guidance due to the fact that such project are mostly initiated by a single actor. They have to deal with multiple actors but still have quite some say within such projects.

Hence the approach in the more complex cases where home owners are present to a large degree will probably require a different approach than more central oriented projects. In fact, in complex cases multiple cases are reality and cannot be ignored and, in such cases, uncertainty is a fact (De Roo & Porter, 2007). When there is such a complex case at hand it is increasingly important to involve the different actors that can have an impact on the project (De Roo & Porter, 2007).

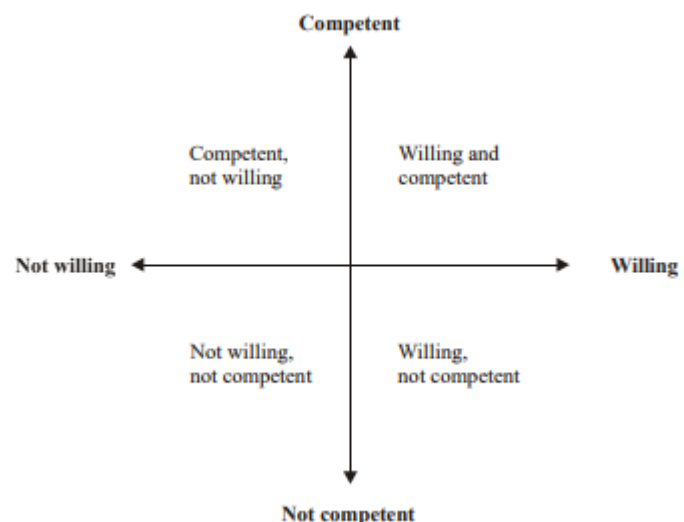


Figure 3: Willingness and competence of actors (De Roo & Porter, 2007)

These actors have their own opinions, value judgement, prejudices and should be taken seriously within the planning arena. Problems with such multiple actors, multiple perspectives, conflicting interest and key uncertainties mostly need communicative approaches, hence involving actors (De Roo & Porter, 2007). Figure 3 shows the influence actors can express by either not willing to join the project, or not being able to since they are not competent to do so. Actors can hence have an important role within sustainable neighbourhood projects, hence it is good to take a closer look at the role of multiple actors.

2.6 Role of various actors

Within neighbourhood renovation projects there can be multiple actors present that influence and shape the success of such renovation projects. It is important to gain understanding of the different actors within such renovation projects since stakeholders can play an important role in determining the type and extent of any redevelopment measure (Menassa & Baer, 2014). As stated above the physical components and social elements in a neighbourhood are important to consider, however the social component is important to. Sanders (2014) investigates the importance of social cohesion among citizens for local energy initiatives, he states that among like-minded people group formation can take place more easily.

Furthermore, Sanders (2014) states that sustainability initiatives do not give direct reason for groups to form. However, the activities related to sustainability initiatives do stimulate social cohesion. For such local initiatives there is increasingly more room and shape empowerment. These initiatives are mostly organized by frontrunners and people tend to prefer organisation formats that do not have many obligations (Sanders, 2014). Also, interestingly, according to Sanders (2014) citizens are not in favour or against sustainable actions, this lead however to the fact that it is highly unlikely that they behave sustainable of oneself. Hence this could be an indication that there must be created incentive for people to behave in a sustainable manner. Interestingly also is that pull factors are more likely to be guiding towards sustainable renovation projects instead of push factors since people need to be persuaded.

Menassa & Baer (2014) state that other stakeholders in renovation projects can include anyone who has, directly or indirectly a vested interest in the building, the operation, or the outcome of a future renovation project. Besides the owner these can be tenants, investor, building operator but also designer. There are even more stakeholders, and all these can have different interests in such projects, Berardi (2013) names public governments for instance as an added stakeholder. Hence it is interesting to gain insight in the stakeholder relations recognized within sustainable initiatives investigated in this research and to gain insight in their roles within the different projects, both negative and positive.

2.7 Application of sustainable renovation in theory

What are the potential routes to achieve sustainable redevelopment or renovation then one might ask. Conci & Schneider (2017) state that the original route for reducing the energy consumption of the building stock was an incremental route. They argue that a district approach would be more effective. This approach focuses on a whole district instead of individual housing. This focus is chosen to effectively exploit stochastic and synergetic potential of an efficient local energy generation and distribution system (Conci & Schneider, 2017). Or as Conci & Schneider (2017) state:

“The developed approach combines interventions to reduce the energy demand of the current building stock with its physical and operational connection within a local heat network and power micro-grid equipped with energy generation and storage technologies” (Conci & Schneider, 2017, p2).

There is an energy-management system used in this approach that optimizes energy flows through a control strategy. Buildings with different thermal qualities can be connected within a district heating distribution system. These buildings work effectively on different temperatures, by heat cascading renovation necessity can be minimized, or the effectiveness of the renovation optimized. Coupling of energy generation, storage and distribution at the district level has a higher impact on lowering the primary energy need compared with the renovation for building envelopes (Conci & Schneider, 2017). Sağlam et al. (2017) also propose a solution where envelope improvements are combined with energy

system retrofits and renewable energy usage. So, an integrated solution with both sources and energy savings solution is probably necessary as Østergaard et al. (2010) also state.

Palumbo et al. (2017) also discuss potential strategies to achieve such net zero energy renovation at the neighbourhood level. They state that incentive and policies for energy measures have proven to not be sufficient to motivate citizens to start renovating. The authors state that too complex procedures add to this. They argue that a combination of bottom up and top down strategies are necessary. The municipalities become in this way proposer and facilitator to mobilize citizen engagement and community resources. The importance and involvement of stakeholders is also mentioned by Jensen (2017).

Connolly et al. (2014) argue that district heating could be implemented in the EU energy system to decarbonise it. The benefit in this is that expensive heat saving technologies don't have to be implemented at such a high level. A combination of both local and national governmental policies is necessary. An advantage of adding such a heat system is that other heat sources could be used across the EU to heat housing (Connolly et al., 2014). However, policies to create incentive for the start of such a system must be developed first.

Governmental policies also can enhance the adoption of decentralized energy sources, which are energy sources that produce energy very local, so on the plot level (Van Aerschot, 2013), hence the government could play an active role for energy efficient renovation of the existing housing stock. According to Baek & Park (2012) policy systems such as energy performance certificates can aid in overcoming the barrier of limited incentive to renovate into energy efficient buildings. Furthermore, subsidies can aid in lack of resources for redevelopment and information can limit the lack of knowledge. And lastly stricter building regulations can create a mandatory renovation scheme among existing house owners (Baek & Park, 2012), however one could argue this option is too harsh. In rental housing the landlord/tenant dilemma could be solved by adding a new budget allocation structure into contracts which would mean that the owner no longer solely pays for the improvement. In this case the tenant pays for it as well since he also benefits from the renovation. Another incentive could be the potential addition of increased rentable floor area with the refurbishment which could create opportunities for owners to earn their investments back (Greco et al., 2017). Wilson et al. (2015) state that renovation from individual home owners is hard to stimulate. Financial incentives are only attractive when they already decided to renovate, and energy assessments are mostly just ignored. A potential way to stimulate it is by changing the policies into more day to day examples. Interestingly however is that Wilson et al. (2015) recognize that renovation is mostly not totally context specific and hence not unique for each house. Therefore, a more generic approach could be appropriate. However, the literature does not give answers on how to stimulate such renovation and retrofitting on a more local level. This is a shame since it would create an opportunity for larger steps towards sustainability as a route becomes an option.

The literature lacks in applied approaches toward energy efficient renovation on a scale such as the neighbourhood level incorporating social incentives. Therefore, literature lacks in applied methods in energy efficient renovation. There are ideas about the techniques that are available for retrofitting of houses, and how this could be done theoretically however there is no clear image on how to govern or stimulate such transitions. This research tries to come up with recommendations that can help and stimulate energy efficient housing renovation on a neighbourhood level. What barriers hamper different stakeholders and how can these barriers be taken away by other stakeholders or by the stakeholders who recognize the barriers themselves. However, since one stakeholder recognizes a barrier it will be more logical that this can only be mitigated by other stakeholders since the stakeholder recognizing the barrier themselves probably already has tried to mitigate it.

To give answer to this question we have to first gain insight in what possibilities there are for sustainable neighbourhood redevelopment we have to look at the different technologies that exist and that can aid such renovation. Also, it is good to gain insight in different routes multiple authors have suggested to understand what framework already exists. Lastly, we have to gain insight in the barriers and opportunities and barriers actually exist in order to be able to mitigate them. The next chapter covers all these things.

3. Application to redevelopment of existing neighbourhoods in practice

This chapter discusses practical solutions that can be implemented to achieve sustainable neighbourhood redevelopment. In order to do so this chapter discusses multiple technologies that can be used and implemented to achieve sustainable neighbourhood redevelopment. Furthermore, a notion of transition management theory (Rotmans et al., 2001) is mentioned since this can give theoretical guidance in the implementation of such technologies. Lastly the different barriers that can restrain sustainable neighbourhood redevelopment and the opportunities that could be utilized to create the highest potential for sustainable neighbourhood redevelopment are discussed and listed. These barriers and opportunities form a basic framework for the methodology and data gathering.

From the previous chapters it becomes clear that existing neighbourhoods should be redeveloped into net real fossil emission free neighbourhoods since fossil fuels are running out and they contribute to climate change. According to Urgenda (2014) there are three steps that have to be applied to achieve sustainability and get rid of fossil fuels within the existing built environment. Energy consumption should be reduced to the minimum by using thrifty devices and by reducing heat loss and therefore the amount of energy needed for heating by implementing good insulating measures. Also, the energy that is still needed should be produced within the own terrain for instance through solar panels, thermal heat, wind energy or biomass. And if there is no opportunity to produce energy on own terrain, then sustainable energy should be bought from collective windfarms or sustainable energy bought from outside the Netherlands (Urgenda, 2014). As already established, this fits within our view on net real fossil emission free neighbourhoods.

For such redevelopment different techniques should be applied to facilitate new energy sources and make sure that these are used effectively. Therefore, the first part will discuss the potential technologies that are available to improve thriftiness of housing in energy consumption and potential alterations to use emission free renewable heating sources instead of natural gas. The application of them are a very important first step towards fossil emission free neighbourhoods. Important to note is that these techniques can be applied both individually and on a larger scale, the larger scale will help increase overall effectiveness and hence can mean larger steps towards the end goal. Individual application of techniques is most of the times also a requisite to achieve larger scale energy efficiency since many of the future heating sources could be interlinked (Van Kann, 2015).

3.1 Techniques available to save energy consumption in housing

The simplest techniques such as stand-by killers, LED-Lighting and more conscious behaviour could already save 10 to 20 % in energy consumption. Furthermore, there are many techniques such as a heat pumps, Infrared panels, and heat storage installations (Urgenda, 2014).

According to the RVO (2014a), most energy neutral housing concepts are currently focussing or using at heat pumps as a concept for heating the houses. New improvements to the heat pumping such as flash-injection, two stage compression cycle and the invert technology make it possible to achieve all electric living (RVO, 2014a). These techniques create the possibility to use air from outdoors while maintaining an efficient production. For individual projects these heat pumps get connected to gas, which could be biogas in the case of energy emission free housing renovation. Also, such hybrids of these heat pumps could be used in collective concepts where heat pumps cover the base load and gas only is being used at peak times. New types of heat pumps that can reach high temperatures are also being developed so maybe gas is not even necessary (RVO, 2014a). Especially the fact that air can be used as a source is promising for the Netherlands since it means that there has not longer have to be a source in the ground. This saves costs and a hassle for renovation projects (RVO, 2014a). Furthermore, heat pumps can be four times more efficient than conventional heating and they can

also produce coolness in the summer (Belmans et al., 2016). However, for such heat pumps to be successful, other elements such as source, building, installations, and delivery system have to be intertwined.

Another interesting technology that could be useful in existing housing is a ceramic fuel cell, such cells produce electricity or energy from natural gas (RVO, 2014a). However, when biogas is available, the natural gas can be replaced by biogas. One of these cells could power four to five houses and due to the fact that biogas could be used it means a good alternative for heating and electricity (RVO, 2014a). An advantage of this is that the existing infrastructure of the gas pipes does not have to be replaced. Therefore, especially in existing housing renovation such a technology could be effective (RVO, 214). Mechanical ventilation or ventilation with heat return systems could be helpful in achieving a good air quality while maintaining thermal comfort and keeping energy consumption in check. There are also other techniques to achieve this. The central element is that the heat lost by ventilation will be returned in the house, thereby minimising heat loss due to ventilation (RVO, 2014a). Also heat from shower water can for approximately 60% be returned with a heat exchange system (RVO, 2014a).

The delivery systems that are important for the efficiency of other techniques can also be seen as a category of systems to achieve energy emission free housing. Traditionally heat is generated through radiators. However, with the rise of low temperature heating, floor and wall heating is increasingly being implemented. Also, air can be used as delivery system for heat, this is mostly done where balanced ventilation is applied (RVO, 2014a). Low heat radiators in combination with balanced ventilation systems could be interesting for renovation solutions since it minimises the costs of transforming the floor (RVO, 2014a). A new trend is the application of fast and efficient electrical heat delivery systems. These can generate fast locally high comfort levels. An example is heat through infrared heating (RVO, 2014a).

A technique that is important for combination with renewable emission free energy sources is a heat storage system. The storage is important to compensate for the fluctuations in supply and demand (RVO, 2014a). The storage of heat or cold can be applied in individual projects or in a wider collective area. Furthermore, storage is necessary to prevent loss of energy in peak production. Tangible heat will mostly be stored in a water holding container. Phase Change Materials such as salt hydrates are being used to store latent heat. This could be used to prevent rooms becoming too hot and hence saves the need to cool (RVO, 2014a). The most developments of heat storage focus on creating smaller storage solutions (RVO, 2014).

Also, insulation measures are common in renovation programmes. This will save heat loss and thereby energy loss which makes other techniques more efficient and easier to achieve. When the insulating factor is higher, smaller components can be used (RVO, 2014a). Also limiting the amount of air permeability is a regular technique applied. This could be done by closing seams on frames. Walls could be finished with elastic closed cell band (RVO, 2014a). Furthermore, optimizing the insulating quality of windows is a very important element in gaining insulating progress. There are multiple options to do this, multiple layers of glass with different gasses, foils or even a vacuum within, these can make windows opaque or a different colour when the temperature changes. This could mean heat or cold is not getting through the window as much, hence meaning less energy is needed for cooling or heating (RVO, 2017).

Also, climate active build elements could be applied to buildings. This combines all the different elements into one integrated concept (RVO, 2014a). Such element can act dynamically to the present conditions and hence change the energy consumption of a house. Climate façades can have positive effects on discomfort mitigation and energy consumption. A second skin façade is an active façade that uses two glass surfaces. This enables better insulation in the winter and summer for cold a heat. Solar passive design is also a good option to reduce energy consumption (RVO, 2014a), however since this

research focuses on existing buildings, the orientation of houses cannot be changed, and hence solar passive design will be hardly feasible. In the end, such bad orientation of housing could be even seen as a criterion to not renovate but instead demolish the building.

3.1.1 Techniques available for renewable energy production on site

Net zero energy emission housing cannot only be completed by applying energy saving measures in housing initiatives, there must be a source of energy. This could be ideally produced on the lot or house. However as already explained we do not see this as a requisite, we look at the net zero emission. This means that houses may be heated by sources some distance from the house, as long as it is a sustainable source. One of the most common ways to produce energy at your own lot is solar energy using solar panels. Also, wind turbines can be used (RVO, 2014a). Wind turbines can have both vertical or horizontal axes. Vertical turbines are more efficient in the built environment since they are always in the 'right' position (RVO, 2017). Another advantage of solar panel usage is that the excess energy can be given back to the energy network when it is connected to a grid. Panels oriented between south east and south west are the most effective. Solar panels could be built separately onto existing buildings and hence can be applied onto existing housing. However integrated cells are also an option in both new and existing housing (RVO, 2014a).

Smart converters are necessary to be able to create collective renewable emission free energy in existing neighbourhoods where all the roofs are oriented in a way that does not give a high yield. However, the total production of solar power, both on and off site, and production of electricity and passive heat is only four percent (CBS, 2016). The amount of this is increasing very rapidly since 2010 there is a surge in megawatts produced by solar energy (CBS, 2016). Hence solar energy cannot be underestimated as a source. Another common technology is the solar water heater, this means that solar energy can provide for a large part in the heating need. Special vacuum collectors can generate up to 300 degrees Celsius (RVO, 2014a).

Thermal heat is another option that can be used on site, this technique uses the warmth of the inner earth to create heat, these individual holes can be used on site for different projects. Thermal heat currently consists of 5% of the total amount of renewable energy sources (CBS, 2016). Groundwater can also be used for heat and cold storage that work with heat pumps to create thermal energy (CBS, 2016). Outside air could also be counted as renewable resource since it can also be used in heat pumps, although energy is still needed to heat the air it adds 2% to the total of renewable energy (CBS, 2016). Heating of companies by burning biomass is also a common practice, 7% of the total usage of renewable energy sources comes from this practice. In households, one-sixth of the total usage of renewable energy sources comes from burning of biomass in the house (CBS, 2016).

3.1.2 Techniques available for renewable energy production off site

Considering the goal of this research, namely developing insights in how to stimulate redevelopment of older existing housing that is heated by gas into housing that is heated and electrified totally by net zero energy emission sources. We should also look at different techniques that produce energy without CO₂ emissions. Since we still need energy, therefore this energy also needs to be produced, and as already explained, this can be at a different location than the specific neighbourhood. Already mentioned are solar energy and wind energy, these are sources that can be applied at the lot itself. These two energy sources can also be located on special wind or solar farms that produce energy that then could be used in housing environment. There are already quite some windmills in the Netherlands both individual as in the form of a farm (NOS, 2016b). Although windfarms are very visible in the land, the amount of energy produced by windmills and windfarms has steadily been increasing from the

1990's onward. Currently wind energy sits at more than a fifth of the total renewable energy supply in the Netherlands (CBS, 2016). Hydro power could also be a source for net zero emission energy production, however in the Netherlands the amount of waterpower is not that abundant (CBS, 2016) and hence might not be the best option for large scale power supply.

Another important source for energy is biomass, biomass can take many forms however. The total amount of energy produced by biomass is 68% of the total renewable energy (CBS, 2016). 17% of the total renewable energy production comes from waste incineration plants. 7% of the total comes from the burning of renewable sources such as wood in coal plants. And another 5% comes from burning of biomass for electricity in specialized power plants (CBS, 2016). One could argue however that such sources are not completely renewable at the rate of consumption. Furthermore, since much of the energy comes from burning, these still emit CO₂. However, biogas is different since those emissions would have ended up in the air one way or the other. By creating gas however, the gas is being used and hence adds a certain amount of value and productivity. Bulk gas is gas that comes from landfills. The most gas that is caught is being used to produce electricity, however the gas can also be converted to be able to use instead of natural gas, it adds only 0.3 percent to the total of renewable energy however (CBS, 2016). Biogas can also be won from sewage treatment plants, this adds 2 percent to the total of renewable energy (CBS, 2016). Furthermore, biogas can be created in so called co-fermentation. This is fermentation of faeces from animal manure. This adds 4% to the total renewable energy and hence is the biggest contributor to biogas. The amount of energy produced by such fermentation processes could increase since a large dairy producer wants to help in 2020 a thousand dairy farmers with installations from which they could create electricity. Besides adding to the electricity supply, such fermenters lower the amount of greenhouse gas emissions. With such fermenters, the farms can become climate neutral and even deliver electricity to the energy network (Morel, 2016), this energy then could be used in a nearby village or neighbourhood, hence it could be included into the neighbourhood. Considering the total amount of manure of more than 78 billion kg (CBS, 2017b) this could lead to quite a large amount of energy. According to van Soest et al., (2014) it could mean that biogas will have the equivalent of 2.2 billion m³ natural gas in 2030. Considering the average usage of 1430 m³ natural gas per household in 2016 (CBS, 2017c). This means that more than 1.5 million households could be theoretically heated through biogas. Therefore, this research sees biogas as a very promising source for future redevelopment schemes of existing neighbourhood. A main advantage being the already present gas pipelines. Lastly, energy can be won from biogas that comes from waste water that is produced and uses in the food industry (CBS, 2016).

So, there are many technological options that can be implemented in houses or neighbourhoods that can aid in achieving sustainable neighbourhood redevelopment. However, for such technologies to be implemented within neighbourhoods there must be created incentive for people to do so and ways to guide or stimulate this as government. It is useful to gain insight in the different approaches mentioned within scientific literature that propose ways of doing so. Therefore, the next section will briefly mention transition management as an approach to sustainable redevelopment. Furthermore, different barriers and opportunities for the implementation of sustainable redevelopment measures are described and translated to specific barrier and opportunity categories. These for a basis for the interviews that are going to be conducted.

3.2 How to stimulate sustainable redevelopment

In this part of the study the practical application of net real fossil emission free neighbourhoods is being discussed. It links the theoretical insights and the possible technologies with the practical application. This part further links the analysis of the routes such application can take place as discussed in the previous sections, what difficulties can be found and what opportunities are apparent. These difficulties and opportunities will form the basis for gaining insight in potential problems for the application of said approaches and technologies for sustainable renovation.

Development of net real fossil emission free neighbourhoods can be described as a difficult process that will take time to be practiced. This research wants to argue that such development and redevelopment will probably be a slow process. Therefore, it is interesting to apply transition management as it can be helpful in understanding the processes going on and positioning the method used here against a theoretical background. Also, it is helpful to gain insight in why and how barriers are used as a framework to identify the problems with potential routes and technologies.

3.2.1 Transition management

Loorbach (2010) states that transition management can be used as a new governance approach for sustainable development. Transition management is explicitly useful in managing complex long-term processes that need structural change. The transition to a sustainable society, for which net real fossil emission free neighbourhoods are necessary, is exactly such a process. Therefore, the choice to use transition management as a back drop for the interview framework was made. According to Loorbach (2010), long-term thinking is a framework for shaping short term policy. This research tries to develop regulations that can help making the short-term decisions easier. Also, participation from and interaction between stakeholders is necessary to reach long term transitions, therefore this research looks at multiple stakeholders in the process of creating net real fossil emission free neighbourhoods.

Rotmans et al. (2001) describe transitions as transformation processes in which society changes in a fundamental way over a generation or more. This research also deals with a transition since the change needs to take place within 33 years and hence is a generation or more. The different phases that occur during such a transition can be seen in Figure 4. Furthermore, there is a fundamental change at hand since the transformation means that we are going to change the whole societal system of gas as heating source, which we have known for many years. Rotmans et al. (2001) state that governments can play an important role in bringing about such structural changes.

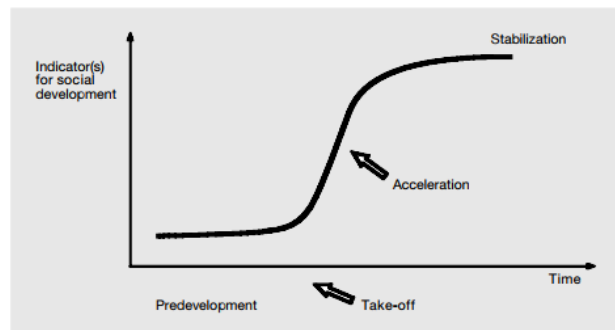


Figure 4: Transition phases (Rotmans et al., 2001)

Important is that a transition is the result of a development in different domains, a transition is hence a set of connected changes which reinforce each other (Rotmans et al., 2001). The redevelopment of existing neighbourhoods into net real fossil emission free neighbourhoods is one of these domains within the energy transition. When looking at the phases that Rotmans et al. (2001) describe as part of a transition, it makes sense to put this research in the acceleration phase since it consists of upscaling the smaller projects that are going on. Also, it is about making structural changes that take place through the accumulation of socio-cultural, economic, ecological, and institutional changes that interact (Rotmans et al., 2001). Basically, this research tries to find answers on how to help the

redevelopment of neighbourhoods to gain speed and get out the take-off phase into the acceleration phase. Of the multiple levels Rotmans et al. (2001) uses, namely micro, meso and macro we suggest that all levels have important potential impact. The micro level is about individual actors, the meso level comprises communities and networks and lastly the macro level is about nations or large organizations. The macro shapes the backdrop for both the micro and meso levels while at the same time the individual micro levels shapes the meso networks and organizations. According to Rotmans et al. (2001) the macro level or regime can act inhibiting in the early stages of a transition and that micro changes can act as catalyst for changes on meso and micro levels. It is interesting to gain insight whether such interchanges are indeed taking place, furthermore it is useful to gain deeper insight in such interactions in practice.

Rotmans et al. (2001) state that transition management is based on a different, more process-orientated philosophy that balances coherence with uncertainty and complexity. They state that there are four characteristics that shape the core of transition management. Transition management is about long term thinking to shape short term policy. It has a focus on learning by doing and doing by learning. It tries to bring about system innovation alongside system improvement. And lastly it keeps many options open. A difficulty with transition management is according to Rotmans et al. (2001) the fact that the fruits of current policy will be mostly visible in the current or near future. Therefore, long term plans can be hard to achieve since the eventual effects are far less visible. Therefore Rotmans et al. (2001) list steps that can be undertaken to manage a transition well. Firstly, a transition objective which still leaves leeway for the future has to be set. As important side note the state that risk in certain targets cannot be easily recognised or qualified. Then a long-term vision has to be set which acts as framework for formulating short term objectives and evaluating existing policy. Then also interim objectives that lie between the present and the future vision have to be listed (Rotmans et al., 2001). Moreover, there are development rounds where is evaluated where what has been achieved in terms of content, process, or knowledge. It is important that lessons are drawn from experiences with such approaches in practise in order to gain understanding of its value and problems. This research can be seen in that light as important for the learning of lessons. Lastly public support for the transition has to be developed. Both top-down and bottom-up techniques are important to exploit developments at the micro level and be able to allow collective learning. It is interesting to gain insight whether these insights are applied in policy and if so, how these are applied and also whether these insights actually are helpful. Shove & Walker (2007) namely have questions about the successfulness of such transition management strategies. Or to be more precise, the question whether steering of events in the desired direction is even possible, they argue that this might be too complex.

An important characteristic of transition management of which this research also thinks is essential in reaching success, is creating a gradual structural change that adapts to bottlenecks that come along the road (Rotmans et al., 2001). Rotmans et al. (2001) state that these bottlenecks will be inevitable which then stimulate the development of new concepts, ideas, insights, methods, and techniques. The research will therefore also focus on such bottlenecks or barriers since the mitigation of these can be an important step in the transition process. Also, Rotmans et al. (2001) state that different actors and governments have an important role to play within a transition, therefore this research focuses on the role of different actors via interviews. Governments need to look what their role should be in the transition towards net real fossil energy emission free neighbourhoods. Therefore, this research tries to gain insight in the effectiveness in the actions of governments. Also, governments have to stimulate learning as much as possible and hence the government has a plural role according to Rotmans et al. (2001). However, political landscape and constraints create limitations for the role of a government.

Loorbach (2010) mentions four governance activities that are important for societal transitions, strategic, tactical, operational, and reflexive. These activities have been put in a figure called the transition management cycle which can be seen in figure 5. For strategic activities Loorbach (2010) mentions vision development, strategic discussion, long term goal formulation, collective goal and norm setting and finally long-term anticipation. For tactical activities he identifies steering activities that are interest driven and relate to the regime, these include all established patterns such as rules and regulations, institutions, organizations, networks, and routines. For operational activities he mentions activities, experiments, and actions with a short-term horizon. Reflexive activities are more about monitoring, assessing, and evaluating.

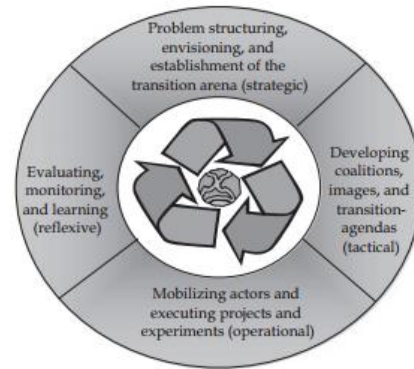


Figure 5: Transition Management Cycle (Loorbach, 2010)

In these types of activity, Loorbach (2010) identifies barriers that can constrain the implementation of transition management. He identifies institutional fragmentation as a barrier for strategic activities. Regulatory, institutional, and economic conditions but also consumer routines, physical infrastructure and specific technology can act as barrier for tactical activities. Different other authors (Risholt & Berker, 2013; Meijer et al., 2009; Baek & Park, 2012; Olsson et al., 2015; Berardi, 2013; Van Bueren & Priemus, 2002; Tuominen et al., 2012; Painuly, 2001; Ástmarsson et al., 2013; Hunt & Rogers, 2005; Winston, 2010; Jakob, 2007; Cattano et al., 2013; Williams & Dair, 2007; Thuvander et al., 2012; Hauge et al., 2013; Risholt et al., 2013; Alberini et al., 2013) also mention different barriers and opportunities for implementing sustainable development or redevelopment principles in housing. These barriers form the framework for the interviews that will be held. Some of them are mentioned in 3.2.3, 3.2.4 and are summarized in 3.2.5. The two tables in this last section form an overview. This is also used to gain overview of the different barriers that exist and the ways to overcome them. Furthermore, it forms a basis for the conduction of the interviews. This is useful to gain insight in potential ways to stimulate sustainable neighbourhood redevelopment.

3.2.2 Barriers to sustainable redevelopment

The following sections will focus on both barriers for sustainable redevelopment, the barriers and opportunities will be put in a table and divided among different categories of barriers. This table can then be used to analyse the data that comes from the different interviews. This should lead to gaining insight in the occurrence of each category type. Furthermore, the cases where sustainable redevelopment has happened have overcome such barriers and hence the interview with the stakeholders of the specific positive cases could lead to added insight in how to mitigate the barriers that currently are present. In the next section some of the most interesting barriers are explained in more detail.

The lack of sustainable construction has also been recognized by van Bueren & Priemus (2002) already, they state that this could be due to the multiple decision phases and makers that all have to make a positive decision. In present times there are still multiple decision makers involved in the process, hence such a barrier could still exist. Furthermore, they state that in the building sector many companies fear that the extra costs or activities they have to undertake will cost them because competitors don't do the same. According to Hunt & Rogers (2005) the most important consideration in redevelopment are economic considerations. When sustainable redevelopment is more expensive

than non-sustainable redevelopment, this can be an important barrier for sustainable redevelopment to happen.

Ástmarsson et al. (2013) write about the so-called landlord/tenant dilemma, this arises when the interest of landlords and tenants misalign. They state that this is one of the biggest barriers for sustainable renovation of residential buildings in Europe (Ástmarsson et al., 2013). The landlord/tenant dilemma occurs when both parties cannot agree upon a strategy for energy-efficiency improvement of a property. Since the tenant mostly pays for the energy used and the landlord does not, the landlord has few incentives to invest in the property. This could be solved by an increase in rent for the tenant which means they finance the retrofitting. However, one could ask whether this is fair since the landlord also benefits from the renovation. This is a financial barrier, more informal barriers include lack in political consciousness, lack of overview and common direction among stakeholders. Furthermore, new projects seem more exciting than renovation projects (Ástmarsson et al., 2013). Meijer et al. (2009) state that the most important barrier for sustainable redevelopment is a lack of knowledge and problems with the costs and benefit are important. The most difficult thing is that the investor sometimes receives no benefit from renovation and hence they have no incentive. Another important barrier is the fact that much of the products that enable sustainable housing are more geared towards new construction. Also, a lack of experience and only few examples of best practices act as a barrier (Meijer et al., 2009). For owner-occupants, important barriers consist of high investment costs, low payback time and other investment priorities.

Baek & Park (2012) state that the awareness of the energy performance of houses is low, even if such renovations are carried out, the effects are sometimes hardly felt. The financial barrier is also mentioned by Baek & Park (2012), they add to this that the inhabitants with houses that have the biggest potential for renovation mostly have to make the highest costs and have the least amount of income. Hence this imbalance acts as a strong barrier. Also, the lack of information can act as a barrier. Furthermore, some stakeholders simply forget to apply sustainable measures when no regulatory exists (Williams & Dair, 2007). According to Jakob (2007) the economic viability has not to be a barrier to undertaking energy efficient renovations, home-owners must however assume long-term benefits and have forward-looking considerations. Baek & Park (2012) furthermore mention the absence of regulatory frameworks on existing buildings as potential barrier, although it acts more as a bump that has to be overcome. The incentive to adjust the existing housing is not being regulated so to renovate houses without these regulations means that this initiative fully depends on the owners' willingness to do so. Risholt & Berker (2013) state that low energy prices can act as a barrier, this is of course intertwined with financial barriers. Additionally, a lack of attractive products and services, a different priority and insufficient coordination of initiatives, incentives and regulations can act as barrier. Furthermore, due to lack of knowledge or information, people can perceive energy efficiency can be seen as a potential risk or uncertainty and hence decide not to implement energy efficient measures (Risholt & Berker, 2013). Another interesting barrier is the craftsman that is hired, when he has a lack of knowledge or skill he can act as a barrier, this could be due to the fact that he cannot make money on energy saving investments (Risholt & Berker, 2013). Painuly (2001) mentions the following categories: cost-effectiveness, technical barriers, market, institutional, political, regulatory, social, and environmental barriers. More concrete barriers can be complex building regulations, limited investment incentive, historical preservation priority and technical limitations (Conci & Schneider, 2017).

These and other barriers have been combined and merged them into five distinct barrier categories which can be seen as important barrier categories that could reduce the chance for success of sustainable renovation. The first category is the **complex decision system**, by this we mean that there are many stakeholders on both the demand and supply side and that all these actors have to make a positive decision about sustainable renovation, in order for sustainable renovation to occur. Because of these different stakeholders, power relations and communication problems a complex decision

system occurs. The second category is about **financial or economic considerations**. Within this category everything from the landlord/tenant dilemma to competition between builders is considered. Also, high investment costs or the lack of a price on negative externalities can be called a financial barrier. The third barrier category is the system or **regulatory barrier** category. Within this category more political barriers are apparent, the frequent changes in regulations is for instance one of the barrier as well as problems with the lack of regulations that should guide sustainable renovation initiatives. The fourth category is the category that is about the lack of knowledge from many actor groups such as consumers, suppliers, and governmental organisations. **The lack of knowledge** can be about specific technologies, processes, or financial options. The last category is about the **lack of experience** with similar projects. This can lead to products and procedures being less geared towards renovation projects, also this leads to a higher perceived risk for sustainable renovation projects.

3.2.3 Opportunities and incentives for sustainable redevelopment

So, there are many barriers to sustainable or energy efficient renovation of current existing buildings, what can be done to take these barriers away or mitigate them or to stimulate sustainable renovation. In other words, what are opportunities and incentives for sustainable redevelopment. According to Painuly (2001), governmental intervention is a must to make sure that energy efficient measures can be taken on a large scale. The government should actively try to mitigate barrier effects, build human and institutional capacity, and enable and create a favourable investment environment. Also, information provision should be done by the government, however if there is a lack of knowledge within governmental organizations this would be very difficult.

Another important element could be the creation of a guaranteed market for renewable energy (Painuly, 2001). Also, financial, and economic incentives could be applied through tax advantages to create incentive for energy efficient renovation. Also, standards and regulatory measures could boost sustainable renovation (Painuly, 2001).

Hauge et al. (2013) state that a good way to affect environmental attitudes and behaviour is emphasizing exemplary projects as role model. Also, individual projects within a neighbourhood can create such a boost. Such an example project can also take away the barrier of lack of information due to the fact that people can see it with their own eyes and thereby gain information on how such renovation methods work. Furthermore, such examples can change the societal norm on what is 'right'. Authorities should aid pioneers who can create such examples (Hauge et al., 2013). Also, ambitious and strict regulation towards sustainable energy renovation is important since many actors who aren't pioneers will look for the easiest a cheapest renovation option. When there are certain requirements applied then the lowest level of renovation will also go up since it will become more mandatory (Hauge et al., 2013; Ástmarsson et al., 2013). According to Risholt et al. (2013) the homeowners' priorities are very important for sustainable renovation.

Meijer et al. (2009) explain that natural renovation moments provide cost effective opportunities that have to be taken to make the step towards sustainable redevelopment. Also creating a policy framework to create better pricing for sustainable energy is important to get both energy companies and inhabitant's support (Meijer et al., 2009). Also, governments pushing for energy targets and creating legislative adaptations to practical problems can be very helpful in the search for sustainable redevelopment (Meijer et al., 2009). The main driver behind renovation however remains comfort improvement, so when the market can convince residents that sustainable renovation measure can enhance comfort, then such measures are more likely to be implemented (Meijer et al., 2009).

These and other opportunities are combined into five distinct opportunities categories which can be seen as potential categories in which for solutions needs to be sought to stimulate sustainable

renovation as government or other organization. The first category is about giving **information** or showing an example of potential solutions. This can be done by setting up information channels or stimulating a case that can act as an example. Also, a ‘dwelling passport’ (Meijer et al., 2009) could be introduced which should enlarge the amount of information on a specific house and thereby make renovation easier. The second category is about **mitigating financial barriers** and thereby creating opportunity. This could be done by creating a tax advantage or create a guaranteed market. Also using natural restructuring moments can mitigate the high cost of sustainable renovation. The third category is about **creating regulation that is better in stimulating sustainable renovation**, this can be done by creating regulations that prevent actors choosing the cheapest or easiest way. Also, the creation of a mandatory framework that could be implemented when renovation is started is an option. The fourth category is about **creating consensus**. This can be done by showing examples of what the renovation is going to mean for the people and thereby creating consensus on the positive effects of sustainable renovation or by communication and thereby creating consensus. The last category is about **approaches to sustainable redevelopment**, this is about how the renovation project should be approached, maybe a shift away from the technical focus could be helpful and could prove to be an opportunity. Instead a shift towards benefits that appeal more to the users and home owners could be a promising route.

3.2.4 Overview of barriers and opportunities

In the previous section, we have identified that there are multiple barriers that can constrain the redevelopment or renovation of existing neighbourhoods into more sustainable net real fossil emission free neighbourhoods. However, there are also opportunities that benefit the redevelopment or renovation of existing neighbourhoods into more sustainable net real fossil emission free neighbourhoods. These barriers and opportunities form the basis for my interviews since the cases that I will interview probably have experience with these barriers, but they have overcome them. The experience of these cases in this process can be useful to gain insight in the potential ways to deal with such barriers. And eventually it can help gaining insight in how to stimulate net real fossil emission free neighbourhood renovation. This could then act as a guidance and give handles to the stimulation of the redevelopment of existing neighbourhoods into net real fossil emission free neighbourhoods.

Barrier category	Specific barrier
Complex decision systems	All actors involved have to pick the ‘positive’ option for sustainable redevelopment, if one actor in the link doesn’t do this, then sustainable redevelopment will not occur (Van Bueren & Priemus, 2002).
	Multiple home-owners all have an opinion and hence create difficulties for large scale renovation (Meijer et al., 2009).
	Lack of power within actors to enforce best practices (Williams & Dair, 2007).
	Limited tenant involvement (Olsson et al., 2015).
	The instability, temporality, and fragmentation of stakeholders in the construction process can act as a barrier to the adoption of new technologies (Berardi, 2013).
	Contrasting priorities among stakeholders (Berardi, 2013).
	Lack of cooperation in supply chain (Berardi, 2013).
	Problems with communication and coordination among actors (Tuominen et al., 2012).
Economic/Financial considerations	Building companies do not want to pay more than necessary when other companies don’t do this, could lead to less optimal solutions (Van Bueren & Priemus, 2002).

	The person that builds for homeowner has no real incentive to implement sustainable structures, it only is more difficult and thereby takes more effort and time (Risholt & Berker, 2013).
	Sustainable redevelopment more expensive than regular sustainable redevelopment (Hunt & Rogers, 2005).
	Landlord / tenant dilemma, who pays and who benefits (Ástmarsson et al., 2013).
	No good cost benefit relation for the investor, investor does not always profit (Meijer et al., 2009).
	Current financial structure not good for energy companies and the support from inhabitants for them. More specific examples of organizational and financial solutions than are currently available are necessary (Meijer et al., 2009).
	For owner-occupants: high investment costs up front, long payback time and other competing investment priorities (Meijer et al., 2009).
	Increase energy performance hard to recognize and difficult to demonstrate higher market value (Baek & Park, 2012).
	Large differences when evaluating economic and technical aspects of renovation measures (Olsson et al., 2015).
	Negative externalities of pollution caused by traditional forms of heating are not included in prices for energy (Tuominen et al., 2012).
	Marginal considerations do not justify investments in energy saving (Jakob, 2007).
Informal or system barriers / regulatory	Little political consciousness, lack of overview and common direction among the main stakeholders and lack of overview of the potential for energy renovations and where to prioritize (Ástmarsson et al., 2013).
	New construction is seen as more exiting and hence receive more attention (Ástmarsson et al., 2013).
	Energy performance perceived as unimportant (Baek & Park, 2012).
	No real regulatory system around existing housing (Baek & Park, 2012).
	Focus on demolishing of housing rather than renovation (Winston, 2010).
	Lack of support for project manager to pursue sustainability measures (Olsson et al., 2015)
	Limited inspection and evaluation of indoor environmental aspects (Olsson et al., 2015).
	Uncertainty about changing laws and regulations (Berardi, 2013).
	Lack of ambitious regulatory frameworks or enforcement or framework (Tuominen et al., 2012).
	Lack of involvement of stakeholders can create wrong priorities (Painuly, 2001).
	Problem with distance to neighbours, monument, city centre façade (Jakob, 2007).
	Potential risk to large renovation due to more strict restrictions when this gets done (Jakob, 2007).
	Frequent changes in regulations (Berardi, 2013).
	Highly controlled energy sector (Painuly, 2001).
Lack of knowledge / Information	Lack of knowledge about centralized heating systems (Meijer et al., 2009).
	Individual contractors have not enough knowledge about energy saving solutions (Meijer et al., 2009).

	Limited information on energy efficiency details of the house (Baek & Park, 2012).
	Potential of risk of new technology; i.e. will energy saving be achieved (Risholt & Berker, 2013).
	Lack of detailed analysis of energy performance in early stages (Olsson et al., 2015).
	Limited and to general follow-up of environmental improvements and energy use (Olsson et al., 2015).
	Lack of overarching guidelines for input data to economic evaluation (Olsson et al., 2015).
	No in-depth questionnaire to identify problems with indoor environment prior to renovation project (Olsson et al., 2015).
	Lack of information about financing options (Tuominen et al., 2012).
	Lack of precise site condition information beforehand (Cattano et al., 2013). (risk)
Lack of experience	Products to save energy and create more sustainable living more geared towards new construction (Meijer et al., 2009).
	No much experience with sustainable redevelopment on larger scale (Meijer et al., 2009)
	Due to lack of experience, few examples that can aid understanding (Meijer et al., 2009).
	Lack of procedures, checklists etc. to manage sustainability aspects throughout renovation process (Olsson et al., 2015).
	Lack of energy, environmental or sustainability objectives in maintenance plans (Olsson et al., 2015).
	Lack of experience can lead to uncertainties about prices for technologies (Jakob, 2007).
	Limited environmental expertise to support project team or manager throughout renovation process (Olsson et al., 2015).
	Limited engagement or skill of project manager may greatly affect sustainability aspects in project (Olsson et al., 2015).
	Unfounded trust in 'experts' leads to less investigation of home owners, thereby missing information (Risholt & Berker, 2013).
	Sustainable measures not considered by stakeholders (Williams & Dair, 2007).
	Sustainable measures not required by client (Williams & Dair, 2007).
	Condition of house perceived as good, no need to renovate (Jakob, 2007).
	Renovation processes are complex and more uncertain in terms of decision-making, planning and execution than the process of new construction (Thuvander et al., 2012).

Table 3: Overview of barriers

Opportunity / incentive category	Specific opportunity or incentive
Information / Example	Government should set up canals and methods to distribute information (Painuly, 2001).
	Stimulate or create cases that can act as an example or role model (Hauge et al., 2013).

	Information dissemination along the lines of publicity campaigns (Meijer et al., 2015).
	Provide 'dwelling passport' to potential purchasers to induce action from new owner (Meijer et al., 2015).
Financial	Create a guaranteed market for renewable energy that would help shortening payback period and create incentive to invest in renewable energy sources (Painuly, 2001).
	Apply tax advantages in favour of renewable emission free energy (Painuly, 2001)
	Apply tax on energy sources that create negative externalities such as pollution, this way the real price of such energy can create incentive to use other heat sources (Tuominen et al., 2012).
	Use natural renovation moments to lower the cost of energy renovation measures (Meijer et al., 2009).
	Need for government subsidies (Olsson et al., 2015).
	New business models that value environmental aspects higher (Olsson et al., 2015).
	Marginal cost of electricity should go up to justify investments in energy saving investments (Jakob, 2007).
	'Window of opportunity' when renovation already had to be conducted (Jakob, 2007).
	Increase financial opportunities by enabling a volume increase when renovating (Berardi, 2013).
Regulatory	Create regulatory measures that create a solid basis for implementation of sustainable renovation (Painuly, 2001).
	Create strict regulations to prevent actors from choosing the cheapest or easiest way (Hauge et al., 2013).
	Create a mandatory framework that could be implemented when renovation is started (Ástmarsson et al., 2013).
	Adapt building regulations to promote energy efficiency (Meijer et al., 2015).
Consensus creation	By creating an example case, consensus that it works and that it is a good thing to do can be created (Hauge et al., 2013).
	Try to steer the priority towards energy when renovating or redeveloping (Risholt et al., 2013).
	Show people that with such renovations the comfort of their house increases and thereby create consensus in the positive aspects of sustainable renovation (Meijer et al., 2009).
	Free riding: People do invest in their house because of their heightened awareness of a program in the area although they do not use the program (Alberini et al., 2013)
Approach	Renovation should be considered more as a service-minded process instead of a technical one (Thuvander et al., 2012).
	Show people that with such renovations the comfort of their house increases and thereby create consensus in the positive aspects of sustainable renovation (Meijer et al., 2009).

Table 4: Overview of opportunities

3.2.5 Translation to conceptual model

The discussion about transition management and the barriers found in the literature form the basis for the conceptual model for the research. This model can be seen in figure 6. The explanation of this model will be discussed in this section.

The opportunities and barriers as listed above are present and visible for each individual actor, so also in the neighbourhood. All found barriers and opportunities are represented by the red and green elements of the model. These barriers and opportunities can change dynamically due to changes in the neighbourhood, policy, or belief systems of people. The opportunities create incentive for the start of an energy initiative to start a project or initiative to sustainable neighbourhood redevelopment while the barriers impede this. When there is a positive balance between the opportunities and barriers as is visible in the bottom left corner where the green square is larger than the red one, an initiative is more likely to be started. When the balance is negative, this is less likely. The initiative can be started by any actor that would like to redevelop a neighbourhood into a net real fossil energy emission free neighbourhood. So, this could be a local inhabitant or a government. At the same time and on a continuous base the macro, meso and micro levels as described in transition management theory all have influence on such initiative, the whole cycle of that initiative is thereby influenced by these scales. For instance, regulations at the macro scale change the context or regulations and hence change the balance between opportunities and barriers. Or an innovation on the micro scale is developed which lowers the necessary costs, hence lowering financial barriers. Hence the actors active in all these scales have some influence on the barriers and opportunities perceived by the actor(s) that starts an initiative.

When the initiative is started, the initiative moves into the neighbourhood sphere since it is going to involve the neighbourhood in order to create net real fossil energy emission free neighbourhood redevelopment. Here the barriers and opportunities remain and keep changing dynamically, also the different actors that can be or have to be involved in the project start to have more influence. The actors within that neighbourhood have a direct positive or negative impact on the project by having different priorities or stances. Furthermore, the actors in the context and on the different scalar levels have influence on the barriers and opportunities. Therefore, the dynamic of the present opportunities and barriers within the project might shift. Therefore, the changes of the barriers and opportunities within the project sphere might shift dynamically. But also, by individual changes of people active in the project and their mind set. Also, personal changes within the other actors such as a change in government structure after an election or a change of person in charge in a specific company might alter the opportunities and barriers significantly.

The project might be continued over a certain amount of time regardless the changes of opportunities, also there can be a period when the opportunities are greater and then seized while at times when the barriers are greater the project might be moving a bit slower. Hence the effectiveness and rapidness of the project might go up and down with the change in opportunities and barriers changing. However, eventually when the project wants to be a success, it is necessary that the opportunity and barriers keep a positive balance overall. The role of different actors can aid these circumstances. The opportunities need to 'break through' the existing barriers to achieve a success. However, if the time in the neighbourhood project sphere is quite long and the barriers continue to outweigh the opportunities then the project will not be able to really take off and slowly diminishes activity and hence can be seen as failure.

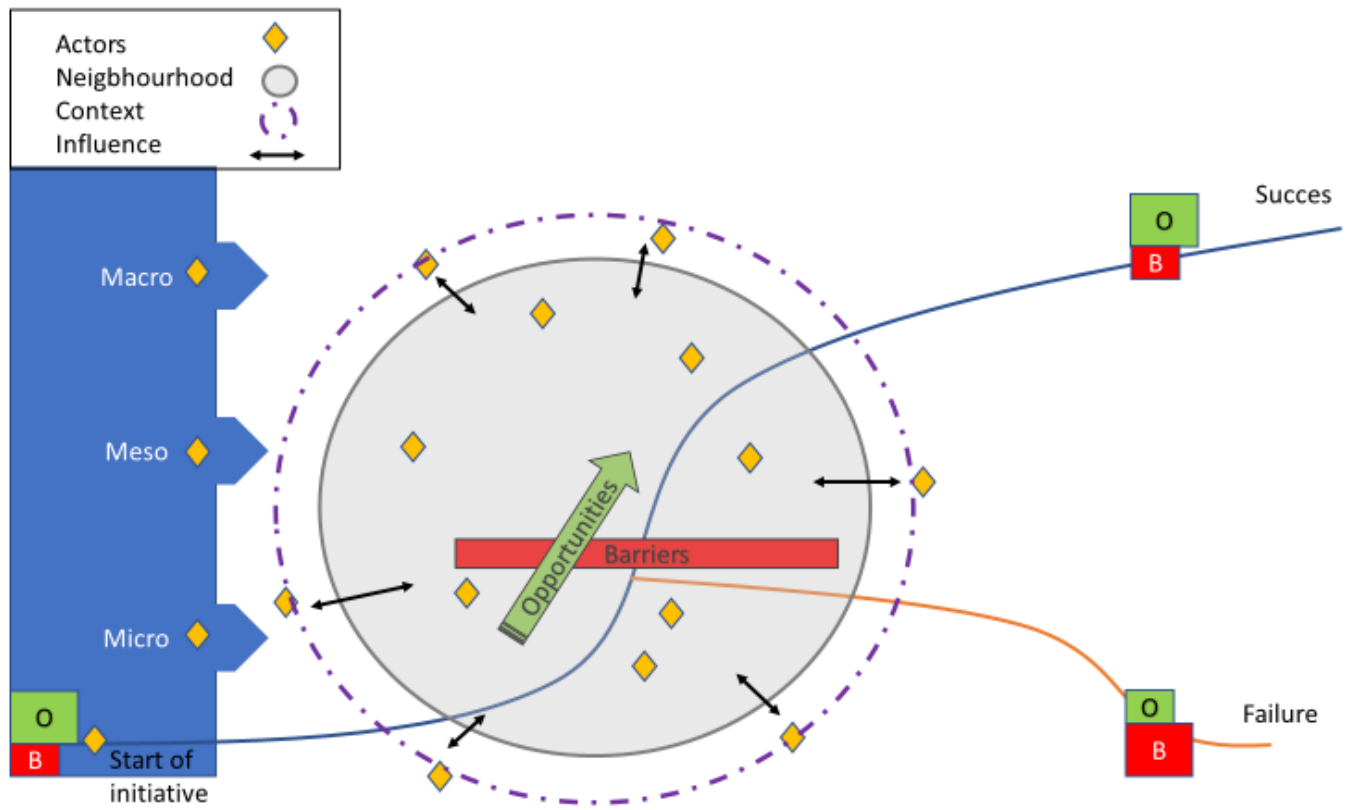


Figure 6: Conceptual model (Author, 2018)

4. Methodology

This chapter describes the method that has been utilized to gather the different data. Furthermore it justifies the selected method and describes the different choices that have been made in order to select the appropriate method. Additionally, this chapter gives a description of the different participants that have been selected for the research. This chapter explains why they have been selected and how they can be seen relatively to each other. Also, the chapter discusses the different ethical questions related to the method and the selected approach to enable an ethical valid research.

4.1 Choice of research method

From the previous chapters it becomes clear that the problem this research deals with is quite complex. In the light of figure two one could argue that a participative approach will be most fitting. Furthermore, there seems to be no clear route to achieve sustainable neighbourhood redevelopment that has proven to be a success or failure. Therefore, there is a lot of unclarity regarding the topic. Hence, to find answers to the main question it is necessary to gain detailed information about the barriers and opportunities. Since it is mostly unknown how important these are, what they mean and how they affect sustainable neighbourhood redevelopment is necessary to gain deep understanding of the problem and not ruling out potential barriers not found in the literature. For this research hence is chosen to shape it as a qualitative research. For such research it is can be useful to do a questionnaire to gain more insight among more stakeholders. However, since this research focuses on different roles of stakeholders but also on barriers they recognize it could well be that there are roles or barriers that have an important impact although they are not directly recognized from the literature study. It is interesting to gain deeper insight in these underlying roles or barriers, however since a questionnaire will be mostly a static document handed out to people, it is hard to implement ways to gain deeper understanding of these previously unknown factors. Hence, this research will be conducted on the basis of interviews of multiple parties linked to sustainable redevelopment and also specific project cases who have experience with sustainable neighbourhood redevelopment. More precisely, the research will be based around a comparative qualitative case study design. This means that the research focuses on a small number of cases (Lieberman, 2005).

4.1.1 Selection of cases

For this research the cases consist of the individual neighbourhoods where a sustainable redevelopment or renovation has taken place and the different governments in which such projects have taken place. Supportive parties involved in the cases and other governmental organizations not directly involved with the cases. Especially the policy of governments directly related to a case is important. All interviewed parties can be seen as stakeholders to sustainable neighbourhood renovation and each stakeholder will add different insights to the final recommendations that should help gaining insights in the potential to stimulate sustainable redevelopment. Important to note is that although I have noted in previous chapters that the main focus is about net real fossil emission free neighbourhoods, the cases could differentiate from this definition simply because cases that are redeveloped exactly according to these principles are very hard to find. Or because the case is interesting to interview nonetheless. The cases resemble renovation projects that have all made steps towards net real fossil emission free neighbourhoods, but possibly not yet achieved this. The selected cases will however closely resemble the aforementioned concept. The method of qualitative case study is chosen since it offers tools to study complex phenomena within their context (Baxter & Jack, 2008). The reason why we have chosen to compare across cases is due to the importance of context for our study. By limiting us to a single case, the author argues that we do not take the different contexts into account enough. Furthermore, this research wants to argue that by understanding the

individual cases, the comparative case-oriented method can eventually create a potential for generalized concepts that are interlinked with the literature (Ragin, 2013).

Moreover, some interviews are shaped around interviews with individual experts from different governmental organizations and also with experts who were involved with specific cases. Hence the interviews do not represent the stances of the whole organization, but for the sake of clarity I shall refer to them as the interview with that specific organization. The interviews of governmental organizations could form the basis for case selection since they are mostly involved with these cases and can thereby give insight in the usefulness of the different cases in their area. This is the case since the governmental organizations could have insight in the specific problems that have occurred around each case and also have insight in potential policy related to this. The interview with a governmental organization hence will be the starting point for the interviews. This is a deliberate research strategy since it could lead to the most insightful respondents and it utilizes the network of the governmental organization.

4.1.2 Content of the interviews

Important to note is that the table 3 of potential barriers and incentives or solutions form a framework and thereby form the basis for the interviews. The barriers that became clear from the literature review form the basis for the questions for each interview partner. The different interviews will be analysed and hence an overview of barriers found in the cases can be recognized. This could give insight in the justification of the different barriers in the literature. Also, the potential opportunities will be analysed and compared to the tables and also the barriers that are present. The solutions to the specific barriers that arise for the interviews form the basis for recommendations.

By combining the barriers and solutions found in literature together with those mentioned by different interviewees it could become clear how a potential guidance framework can be created to achieve net real fossil emission free neighbourhoods. Furthermore, by comparing the mentioned barriers and solutions also barriers that are hard to be solved can be identified and this could form the basis of further research.

Furthermore, I will look for certain positive criteria or elements within each case that has been redeveloped, I am interested in how they helped to reach the sustainable renovation. Therefore, there could be multiple criteria that have a positive or negative impact on the success for renovation projects. These criteria will be linked and then could help in formulating recommendations that could aid in stimulating sustainable renovation and redevelopment. The literature research conducted forms the basis for my interviews. The outcome of these interviews will be linked to the literature and hence form insights of positive and negative elements for stimulating sustainable redevelopment. This would then help to gain insights in the proper choices to make for different situations and this could then help to create the best atmosphere for each individual case to create the highest potential for sustainable redevelopment. The outcome of the different interviews sometimes leads to a reinvestigation off the different literature elements in my research. This is a recurrent process and hence the specific focus of the interviews can change over time.

This is also one of the main reasons why I have chosen to interview the respondents not in a specific order from provinces to municipalities and then cases. Instead I have chosen to interview different types of interviewees in an intertwiningly way. This creates opportunity to take insights gained from one interview to alter the interview of other interview partners. This could lead to better insights. Since I have chosen to interview different categories intertwiningly I can also take insights from different type of categories to the interview of the other categories. Hence the seemingly randomness of the interview sequence is chosen deliberately.

4.1.3 Processing method for the data & method of analysis

The interviews held with the multiple parties which are described below have been transcribed in atlas.ti version 7. This forms the raw data for the research and can be seen in appendix 1. Since some of the interviews stated that they thought their anonymity was important, and that the interviews could give some clues on which interviewee said what. I have decided to deliver the appendix in a separate document since the interviewees are very important for this research I want to treat them with the most respect I can. The whole coded text is not included in the appendix since it adds no direct value, however the most important and interesting codes is being shown in the regular text. The results coming from the coding are the basis of the analysis. How I came to a specific code is explained in the text box on the right side. This is an example of one code and the different quotations that have been selected to count towards the total number of quotes assigned to that code.

The data that comes from the interview will be analysed through multiple ways. On the one hand general findings that were reoccurring throughout the interview will be mentioned, discussed, and enforced by showing quotes from different interviewees. For the anecdotal evidence I shall mainly stick to general examples, opinions, policies, or roles in such a way that they are hard to link directly to a specific interviewee. Also, specific codes have been created and linked to a specific section of text. The codes have been chosen based on the literature, but also on insights that were gained during the conduction of interviews. When it became apparent that a specific role, policy, or viewpoint was essential for success a code was designed and assigned to the specific quote or part of the text. The codes have been designed in such a way that they give a clear insight in their meaning. There have been created a total of 105 codes hence the list of codes as such is not very insightful. Instead in the analysis of the data I shall briefly explain the meaning of that code. Then, based on the insights gained by the author, the most important or remarkable data of specific code allocations shall be discussed by the author. This will then shortly be analysed and given meaning through either individual quotes or generalized findings. Many of the codes represent small differences or nuances to properly represent the results from the interviews. The sheer amount of codes assigned already hints to the fact that the problem of sustainable renovation of existing neighbourhoods is extremely complex. Especially since the present codes even do not represent the nuanced explanation that is present in the interviews. There have been made four categories, namely: provinces, municipalities, cases, and supportive parties. Three categories

The code [Hassle] is related to the fact that there is a certain hassle connected to initiating a local energy initiative or renovating a house. There are five quotes linked to this code, they are the following:

“The unfamiliarity with these things for people is an often heard comment, that they do not know, how do to deal with something like that. Also there are a lot of regulation such as requesting offers. They find that a lot of hassle, so unburdening is very important.” (Ma)

“I think it comes down to a few things, finances, information and hassle.” (Ma)

“In other words, more hours needed to invest in technology, more hours for hiring a mechanic. And then the misery starts, because mechanics do not have all the needed knowledge and we do not have enough. So I do not know if insulation and improved new technology will increase my comfort. That will also happen at home, I will soon have a maintenance contract for my boiler and for my Hybrid heat pump.” (Cb)

“People say: I have to put all kinds of signatures on papers. While in reality it is not that bad.”(Mb)

“What obstacles are there then, that is sometimes knowledge, sometimes financing and sometimes hassle.”(Mb)

From the previous quotes it becomes directly clear why they fall in the hassle category. They all are about a certain hassle with either signatures or the word has been directly mentioned. All of my coding has been conducted via the same method. However important to note is that there will always remain a certain amount of subjectivity to the assigning of the codes.

consist of three interviews, only the category supportive which consist of two interviews. Most of the time I shall differ between provinces, municipalities, cases, and supportive parties, when necessary I shall dissect between individual interviewees.

4.2 Justification of research method

The data for this research will be collected through semi-structured interviews. This method has been chosen deliberately due to the versatile nature of this type of data collection. According to Clifford et al. (2010), a semi-structured interview is a verbal interchange where one person attempts to elicit information from another person by asking questions. For such an interview questions are prepared, but semi-structured interviews can unfold in a conversational manner offering participants the chance to explore issues. Also, according to Rabionet (2011) an interview is a powerful tool to gain insight in those experiences. The opportunity to explain the points made that is vested in an interview is of crucial importance since these explanations are the basis for creating a stimulating framework for stakeholders. The choice for a semi-structured interview format can further be explained by the points that Gill et al. (2008) make, it gives guidance on the specific topic, the link with literature is very important here, but it also leaves room to explore and gain depth and insights that need explanation. Which is necessary for such a complex topic.

The selection of the participants in a semi-structured interview is very important according to Clifford et al. (2010). The participants are usually chosen based on their experience regarding the subject. The participants that are selected in this interview are also chosen based on their experience. The validation of the chosen participants is given in section 4.2. Also snowballing is being used as a method for participant selection. This means that interviews with one person could lead to interviews with others due to their contacts. In my research this means that interviews with provinces could lead to a connection with different contacts from the province that can be a potential interesting stakeholder and therefore could interviewed.

4.3 Ethical deliberations

Important to note is that the interviews will take place within the offices of the different provinces and companies or at the homes of different stakeholders. This choice has been made deliberately in order to make the participants feel comfortable in their own surroundings. According to Clifford et al. (2010) this could be beneficial for the data that can be collected in the interviews. Also, participants will be asked about the privacy of the information given hence they can choose whether they want to remain anonymous or not. Furthermore, the content of the interview will be sent to the participants after the interview has been conducted. This way the participants can rectify the interview and agree with the written transcription, furthermore they have the right to make changes when they feel the urge to do so. Also, participants have the right to withdraw from the interview when they feel the need, also a break can be taken whenever the participants want. In this way I am hoping to make the respondents feel as comfortable as possible and hence get the best results from the interviews.

Additionally, interviewees were given a choice on where to have the interview, this way there was little effort involved regarding traveling on the side of the interviewees. This choice was made deliberately to relief pressure on participant regarding time constraints. Since the subject is quite complex it was essential to be able to discuss every element into detail. In total there were held 11 interviews, the different interview partners can be allocated into the aforementioned different categories. The number of interviews was determined after recognizing the fact that not much new information was obtained from interviews, hence there was a feeling that the most important information was gathered. Three interviews were held with municipalities, three with provinces and three with different cases. The cases were both rental and home-owners areas. Furthermore, both

area's in a city and a village where undertaken in order to get a full picture of the different problems within each context. Lastly an interview was conducted with an advisory organ that wants to help local energy initiatives and an interview was held with an organization that can be seen as a representative of the building sector in the Netherlands.

As said, the interviews were conducted in a semi-structured way, this had two main advantages for my research. First I was able to let the interviewees speak freely. This is important since insights of the interviewees that were not recognized in the literature review could lead to important insights for the research. Secondly, when I wanted to know a bit more about a specific topic within the interview I was able to ask for more detail. This was also due to the fact that I have prepared myself thoroughly for each interview by reading policy documents and information on websites. Most questions were formed on interests I gained by reading this information. This also led to the fact that none of the interview questions were completely the same, however they were generally about more or less the same topic. Furthermore, I wanted the interviews to be more of a conversation to make the interviewee feel more comfortable. This all led to the fact that not every question was asked if the interviewee had already given answer to my questions on paper. Central elements in all interviews were, the definition of sustainability, the role of different parties within sustainable renovation of existing neighbourhoods, existing barriers, and opportunities and lastly ways to mitigate the barriers or exploit opportunities. This way I tried to gain the best insights on how to stimulate renovation in net real fossil emission free neighbourhoods. The interviews that have been conducted can be seen in a separate appendix, called appendix 1.

4.4 Selection of participants

In this section the different participants within the interviews are discussed, here will be discussed why they are chosen as participants. Why they could be a good interview partner for my research and how they can add value to my research. The different interview partners are selected on the basis of short literature research and also the interviews that are being conducted can lead to new insights and potential new interview partners. The interview partners can be parties that are involved in a specific case or project or parties that are involved in policy making or are overarching associations. The sequence of the selection of interviews presented below have no implication connected to them, instead they are listed according to the date at which the interviews were held. Hence the order below is chronological. As stated before this was a deliberate choice to be able to use insights across different categories to bring the interview to a higher level. The transcripts of the interviews can be seen in the separate appendix, appendix 1, the same chronological order is used here. Important to note is that the interviews are conducted with one or two specific persons working for the mentioned organization. Therefore, they do not represent the stance of the total organization, however an interview with every person at such organizations is not possible in the time span I have for the research. Therefore, these persons represent their organization the best way they can. Important also is that the persons selected have a representative role for their respective organizations.

4.4.1 Province of Drenthe

The province of Drenthe has been selected as a governmental organization to interview. This choice was made after conducting policy analysis. The province of Drenthe already was exploring the policy field in 2013 (Provincie Drenthe, 2013). Also, a special energy agenda has been made for the period between 2016 and 2020 (Provincie Drenthe, n.d.). Furthermore, since 2016 it has begun with a so-called energy expedition (Provincie Drenthe, 2017). The goal of this expedition is finding a so-called route to the destination that is making Drenthe energy neutral by 2040. In other words, it is a process of trial and error in which different projects are started, worked out, evaluated, and potentially getting upscaled. It is the starting point for the energy transition of the province and hence it is interesting to

gain understanding of the working process of the expedition in order to draw lessons for other governments. Also, it is interesting to see how Drenthe is dealing with the problems that occur along the way. Therefore, the province of Drenthe seems to be a good organization to talk to a help my research advance. However, since the province of Drenthe is quite active in the field, it is interesting to see that the success is relatively small. Hence the province could prove to be useful to gain insight in the different barriers and the problems that exist within such a transition. Furthermore, since there are a few interesting cases nested within the province, the decision was made to contact the province. The contact of the province with those individual cases could lead to a snowballing potential of different cases that could be interesting for this interview. The interview with the province of Drenthe was conducted with the expedition leader. He is the person in charge of the expedition and can hence be seen as one of the most important persons of the energy transition in the province of Drenthe.

The interview was conducted on 27 October 2017.

4.4.2 Municipality of Groningen

The municipality of the city of Groningen has been selected as governmental participant for interviews. This choice was made after a short policy analysis. The municipality has a program called 'Groningen geeft energie' (Gemeente Groningen, n.d.). Some of the interview questions will be based on this program. The respondent for this interview will be a policy maker of the municipality that is involved with the policy connected to the program. Furthermore, this municipality has been selected since one of the cases that I also interview is located in the municipality, hence it is interesting to find out what the role is of the municipality in such local initiatives. The insights that the municipality takes from the different projects and approaches within the municipality could be very useful for the research that has been conducted. Especially a focus will be on the different strategic choices the municipality has to make and their role in local initiatives. Furthermore, a part of the interview will be about the success of different approaches the municipality takes.

The interview was conducted on 22 November 2017.

4.4.3 Stichting Samen Energie Neutraal

The Stichting Samen Energieneutraal (SEN) has been selected as a participant for an interview. The SEN can be seen as an organisation that advises local energy initiatives. The organisation has been selected since it is an advisory organ for two of the cases that are interviewed in this research. Hence it is interesting to find out what the influence of such an advisory organ is for the local initiatives. Furthermore, it is useful to gain insights in the role of different governments for such advisory organs. The main goal of SEN is to create energy neutral villages and neighbourhoods while making use of initiatives already present in the area (SEN, n.d. a). This means that in individual dwellings and also in the specific neighbourhood investments and changes have to be made. Both insulation measures and also changes to the generation of energy have to be made. The core of the success lies in the ownership of local citizens, it is interesting to find out what this means and how this approach can help gain understanding in the potential of stimulation to create more sustainable neighbourhoods. The people who have founded SEN have a very different background (SEN, n.d. b). Hence it will be interesting to gain understanding in how these different roles of such experts can be utilized in setting up local energy initiatives and thereby aid in stimulating the creation of more sustainable Neighbourhoods in the Netherlands. One of the founders is the interview partner for SEN.

The interview was conducted on 22 November 2017.

4.4.4 Province of Overijssel

The province of Overijssel has been selected as governmental participant for interviews. This choice was made after conducting policy analysis. The province of Overijssel namely has multiple projects that try to redevelop existing neighbourhoods and there are multiple projects under the umbrella of Duurzaam Ontwikkelen Overijssel (Overijssel, 2015). Furthermore, an interesting approach to renovation or redeveloping existing housing is the so called Overijsselse Aanpak. I think this policy is interesting since the program is a collaboration between 30 parties that work together to enhance the sustainable redevelopment of 45% of the existing housing that is owned by the occupant. Furthermore, as is stated in the Blok voor Blok evaluation document (RVO, 2014b) Overijssel was the most successful and active province within the program. Since this project was a test case for large scale energy saving measures, Overijssel is one of the most interesting province to draw lessons from. Hence the choice to interview Overijssel was made. The main goal of the program is to have at least label B before 2020. Interesting to see why is chosen for an intermediate option where the housing is not redevelopment or renovated towards net real fossil emission free housing. Also, it is interesting to see why they have chosen such a short time span. The core of the program has been twofold, firstly individuals who own houses to implement energy saving measures by subsidies and sustainable loans for people who don't have the money to buy it for themselves. Secondly it is about activating the market to stimulate market parties to get active on this market. This is chosen so the government parties can be less active in the long term (RVO, n.d. a). The active neighbourhood approach was about municipalities who work together with municipalities who go into the neighbourhoods together. The goal was to achieve sustainable renovation of 10.000 houses, one hundred companies where involved. So, with this special approach it is interesting to have the province of Overijssel as participant. Furthermore, of the projects concerning sustainable redevelopment in the Netherlands, many of them are located in the Overijssel province. Hence, we could see the province as quite successful, therefore it would be an interesting partner to interview. The interview will be held with the project leader of the Overijsselse Aanpak and hence can be seen as one of the most important persons of the energy transition of Overijssel.

The interview was conducted on 23 November 2017.

4.4.5 Housing Corporation Openbaar Belang

The housing Corporation Openbaar Belang has been selected as participant for interviews. The choice has been made after conducting a short search about different projects that are put in the database for Energy thrifty build environment by the RVO (RVO, n.d. b). From the multiple projects that were present in the database it was clear that Openbaar Belang was a very active Housing Corporation when looking at creating more sustainable housing. Including a case in which rental houses where being made more sustainable seemed interesting, hence the choice for Openbaar Belang was made. It is interesting to see how this case with rental houses differs from the cases which concern local energy initiatives or owner occupant structures. Furthermore, it is interesting to gain understanding in the process of creating more sustainable housing when a Housing Corporation is involved. The interview will be mostly about the specific projects that can be found on the RVO website. Also, it is interesting to see what role governments play in the rental housing sector and how the Housing Corporation sees this role. The interview was conducted with the project manager that was involved with one of the specific projects.

The interview was conducted on 24 November 2017.

4.4.6 Noorderplantsoenbuurt Groningen

The Noorderplantsoenbuurt in Groningen has been chosen as a participant for this research since it has a very ambitious goal of becoming energy neutral in 2024. Furthermore, since it is in an urban context it is interesting to see how this bottom up approach tries to connect people and achieve their goals together. The urban context of the project is interesting since the other case has a more rural context. There are certain pilot houses that are being created and the lessons that are learned here could be used in the other parts of the neighbourhood. Furthermore, interesting is that the neighbourhood is a very mixed bag of different types of housing and hence the approach they take could create valuable insight for the rest of the Netherlands. Also, the use of creative producers, innovation coaches and neighbourhood evenings are interesting to gain insight and draw lessons from. The idea that specific persons are utilized to help the people living in the area is interesting especially the same thing was mentioned by the province of Drenthe. The fact that this insight is already mentioned shows the usefulness of the sequences of the interviews. The interview was conducted with one of the founders of the energy cooperation.

The interview was conducted on 27 November 2017.

4.4.7 Bouwend Nederland district Noord

The Northern district of branch organization Bouwend Nederland has been selected as an interview participant. They were selected since they can be seen as good point of contact for the building industry. The building industry also plays an important role within the transformation of neighbourhoods into sustainable neighbourhoods. The section north of Bouwend Nederland is also contact organization that acts between the builders and the government, hence they have an important part to play in connections with provinces and municipalities. Therefore, it is interesting to see their role and also the role of more building companies. The interview was conducted with the region manager.

The interview was conducted on 28 November 2017.

4.4.8 Ansen

The village of Ansen has been selected as a case for an interview. The village has been called one of the most successful local initiatives in the Northern part of the Netherlands by the province of Drenthe, SEN and Bouwend Nederland. Some people in the village have founded a local energy cooperation called EnergieKansen and the goal of the cooperation is to be able to produce the total energy consumption of the village with renewable energy sources by 2020 (EnergieKansen, 2015). Furthermore, on a longer term they also want to be able to compensate for the heat consumption in their village. And lastly, when they have succeeded in their goals they want to disconnect from the national networks and create a truly net energy emission free village. Hence it is very interesting to gain understanding in the successful factors in such local initiatives. Furthermore, it is interesting to gain understanding in the role of multiple components that are present in such a case that could be an argument for success. Lastly it is interesting to gain understanding in the role of government it is located in, namely the province of Drenthe and municipality De Wolden, but also the role of SEN in such projects could provide insight. The interview has been conducted with the chairmen and the secretary of the cooperation. Also, the difference compared to the other cases could be interesting to gain understanding in potential success factors and also gain understanding in ways to stimulate local initiatives.

The interview was conducted on 29 November 2017.

4.4.9 Province of Groningen

The province of Groningen has been selected as governmental organisation for an interview. This choice was based on a short policy analysis. They have an energy transition program for 2016-2019. This is called 'Vol ambitie op weg naar transitie' (Provincie Groningen, 2016) The province uses three action lines in this program, saving energy, sustainable energy, and the energy system. It is interesting to find out how these different action lines work out in concrete policy. Furthermore, it is useful to gain insight in the success of the policy, the goals that are achieved. For the goals that are not achieved it is interesting to find out what measures the province is taking. Lastly it is interesting to find out how the problems with gas extraction influence the renovation of houses into more sustainable housing. It is interesting to gain insight in the usage of the role of the province of Groningen within the energy transition. The interview will be held with someone of the province who is active with local energy initiatives, therefore it is interesting to see how the province handles such initiatives and what the role of the province is within such project. Lastly it is interesting to gain insight in the success of such activities for the individual projects. Hence the province of Groningen is an interesting partner for an interview.

The interview was conducted on 30 November 2017.

4.4.10 Municipality of Zwolle

The municipality of Zwolle has been selected as decentral governmental organization for an interview. The choice was made after conducting a short policy analysis, based on the presence of the case within the municipality and after a connection made by a previous interview. The municipality of Zwolle is part of the province of Overijssel and hence is part of one of the frontrunners within the energy transition and renovation to net real fossil emission free neighbourhoods. The municipality has an agenda sustainability that is said to show the road for a future proof Zwolle (Gemeente Zwolle, 2015). In the policy there are certain actions, goals, and measures, it is interesting to gain insight in the success of such actions and measures. Furthermore, it is good to gain insight in the achievement of the goals within the policy. Also, there is in the policy a section about so-called accelerator which is a person that is said to try and accelerate local energy initiatives. Interestingly, from the policy investigation it seems that this closely resembles a potential opportunity put forward by another interviewee, therefore it is interesting to gain insight in the success of these so-called accelerators. Furthermore, the policy is much about creating networks and connecting business with local people, hence it is useful to gain insight in this process and the potential successes of this. The interview will be held with a civil servant working on the field of the energy transition of the municipality.

The interview was conducted on 12 December 2017.

4.4.11 Municipality of Assen

The municipality of Assen has been selected as a governmental interview partner. The selection was based on a short policy analysis, furthermore the municipality has developed an interesting financial construction which could be of interest for the research. The municipality of Assen has an energy potency map. Furthermore, they have a so called 'Duurzaamheidsvisie' (Gemeente Assen, 2009). However, the most recent vision that can be accessed online only runs until 2015, it is interesting to gain insight whether there is a more recent version. Furthermore, it is interesting to gain insight in the role of the municipality within the energy expedition of the province. Also, it is interesting to gain insight in the role of the municipality in the local initiatives within the municipality. Lastly, it is useful to gain insight in the approach of the municipality. The interview will be held with a policy expert on sustainability.

The interview was conducted on 19 December 2017.

4.4.12 Actors that where not selected

Aside from the different interviewees mentioned above there are also actors that could have been interesting to interview but that eventually did not get interviewed. This was mostly due to lack of time or lack of response of that specific actor. There have been made multiple contacts whit other municipalities and advisory organs, mostly there was a lack of response, or the response was quite late hence leading to problems for the time management of the research.

5. Analysis of the problems with sustainable neighbourhood redevelopment and the proposition of potential solutions based on data analysis

This chapter analyses the data that has been gathered during the interviews. The data gathered via the interviews has been given meaning through the designation of codes to specific sections of text as explained in chapter four. Furthermore, specific quotes of the interviews add value to the understanding on their own via anecdotal evidence. The choice to combine both anecdotal evidence with codes is due to the fact that the interviews that were conducted are quite long and complex. By this I mean that there is a high level of nuance added to the specific answers of the interviewees which cannot be properly represented by mentioning codes. The analysis tries to make sense of the data by recognizing patterns and insights gained during the interviews. These are then connected to potential recommendations or lessons that can be drawn from the analysis. The last section of this chapter shall discuss the meaning and importance of these recommendations.

Since coding only can represent general concepts and viewpoints discussed in the interview, they will only be able to represent general conclusions. Hence, the combination of anecdotal evidence will strengthen and nuance the results represented by the coding. Also, the insights that I gained during the conduction of the interviews can help represent the data gained during the interviews. Furthermore, although some specific text elements cannot be assigned to a certain code does not mean that they are not insightful and hence must be taken into account to get a complete image. Certain points that appear to be of interest both from a literature perspective but also after conducting the interviews will be shortly discussed. These points will be shown on the basis of data stemming from the coding process and then will be linked to examples of anecdotal evidence from the interviews. Important to note about the codes is that the number that is shown in tables is the time a party mentions a specific code. Hence it could be that the code mentioned by one party consists of one hundred words while the other code only consists a few words. I have chosen this method since it can well be that the interviewee talks a lot about the same topic without adding extra meaning to that specific code, hence over representing that specific code. Therefore, I have tried to only code texts that add value to the specific code. This is quite subjective however and I am aware of that, therefore it is not useful to do statistical or correlation tests since these will not be based on objective measurements. Also, some of the results mentioned can be assigned to codes such as the mentioned barriers but fit another code more, therefore there is a large amount of codes that have direct and indirect links with others, hence the choice to combine this with anecdotal evidence. I will however compare the numbers of codes in a basic manner since I have gained a lot of insights during the interviews and hence can give a good representation of the meaning of the codes mentioned in the interview. This does sometimes mean that a code might only be mentioned a few times, however this does still imply an important difference between interviews in my opinion since a code mentioned once can be about a large part of the interview.

An important element of the analysis is linked to the designation of the codes. Namely a very important element of the analysis exists of recognizing patterns among different categories and between interviews. The exact amount of a code linked to a specific interview does not really mean anything due to the fact that the number are not objective. However, the relative amount of codes assigned to interviews or categories might hint on a relation. For instance, if a specific code gets linked 20 times to the municipalities while they are 0 times linked to the cases than this could indeed hint to a difference between the different categories. The recognition of different patterns shall form an important element of the analysis, the next sections will work on such a basis.

The different individual parties when mentioned are also coded they are coded such a way: Ma: Municipality a, Mb: Municipality b, Mc: Municipality c. For provinces the codes Pa, Pb and Pc exist, for Cases there are Ca, Cb and Cc and lastly for Supportive parties Sa and Sb exist.

5.1 Different roles and insights

To dissect problems regarding net real fossil emission free neighbourhood redevelopment, it is necessary to gain insight in different facets that could hamper this. The next sections look at the different roles actors play but also the different viewpoints and stances are investigated. The effects of the different roles and insights is then analysed. First the different taken roles are investigated, it is interesting to see whether the roles that are taken by parties actually match the expected role for them by other parties.

5.1.1 Roles of the actors

Table 5 shows points made by cases about the activity of governments. Interesting to see is that in every category the consensus seems to be that the government should be more active, the viewpoint that the government should do less is only mentioned once. Also interesting is that the provinces mention the viewpoint that governmental organisations should be more active more often than municipalities. The difference between governments having the activity stimulating or facilitating is also quite interesting, stimulating is a more active way of handling and facilitating is more passive. It can be seen that the cases would like to have a more stimulating government or experience a stimulating government while both the provinces and municipalities seem to be much more passive and facilitate more. Hence the governmental role should be shifted towards a more active role. Namely, the cases that have been interviewed can be seen as successful and since they experience a stimulating and active role of the government, this hints toward an active role of governmental organizations have a positive effect.

	Government should be more active	Government should do less	Role government: facilitating	Role government: stimulating	Role government: strategic choices
Cases	8	1	1	6	1
Municipalities	4	0	5	1	1
Provinces	7	0	6	2	2
Supportive	3	0	0	1	0

Table 5: Insights in activity government

The viewpoint that governments should be more active is for instance stated by one of the interviewees at the province Pa who states that *“The lead should be at the municipality, if they only have a facilitating role one could assume not much is going to happen”*. However, one of the measures a municipality mentions as their activity is creating the availability of meeting rooms or print facilities for local initiatives. Hence, one could argue that this is not really a leading role, instead it is quite passive. One could argue hence that there is also a mismatch between preferences of different governmental organisations.

When looking at table 6 below the same issues come to the forefront. Although both provinces and municipalities both have active attitudes and approaches and they state to have an active role, many of their approaches can be described as passive. So, although there might be indeed a mentality shift towards more active approaches, governmental organizations still seem to be quite passive in the approaches they undertake.

	Active approach	Active attitude	Active role government	Passive approach
Cases	2	7	2	0
Municipalities	0	4	3	21
Provinces	4	7	0	14
Supportive	2	1	0	0

Table 6: Insights in activity interviewees

The difference between an active approach and an active attitude is that the active attitude is more about a mind-set while an active approach is an already existing approach which can be defined as active towards initiative takers. Although the differences are quite small, what is most interesting is that the passive approach is very much present at the governmental levels. This passive approach mostly comes from the fact that some governments have initiated a certain organisation such as an energy desk and then they state that local initiative should come to these desks them. Hence the only real activity is setting up such desk and then they wait. Also, meetings are organized by governmental organizations, but these are quite passive since the governments only organize them and then invite the project initiators to come to the governmental organization. Hence there is a step from local people required in order to have success.

More active approaches consist of actively designating a person working at a governmental organization who is responsible for local energy initiatives. These approaches are more active towards the local projects and individuals. Important however is that such persons are directly linked to a project and don't have a general place within the organization. Also, when talking about Local Energy Initiatives, many governments state that they just appear and hence don't have to stimulate them and hence act quite passive. So, governments do act but they either expect the people or projects to come to them or they have actively initiated a platform but thereby are then passively involved themselves. An example of an active approach is mentioned by one of the provinces who states that would like to send a bus into the neighbourhood and hence cater to people in an active way, hence the attitude is active, but they do not act active yet. Another example is mentioned by one of the supportive parties who advises local energy initiatives and strives to have one person at every meeting of the initiative. In these ways the initiative does not have to be active towards the other party since they will come to the energy initiative.

In general, we can see that organizations in all categories seem to agree that there should be a government who takes an active role and approach, however they seem to rely mostly on passive approaches, it is interesting to see whether differences between the individual interviewed governments can be seen. In table 7 below the activeness of governmental organisations is shown for each individual province and municipality. To not show a direct link to the individual to the interviewees the provinces are shown by a P with a small letter to keep track of the different provinces, with the municipalities the same is done with an M. Since I have interviewed municipalities that all lie within a province that has also been interviewed, I have given the municipalities that lie within that specific province the same colours as the province to show a potential relation between the governmental layers.

	Active approach	Active attitude	Active role government	Government should be more active	Passive approach	Role government: facilitating	Role government: stimulating	Role government: strategic choices
Pa	3	3	0	0	5	5	1	0
Pb	1	4	0	4	1	0	1	1
Pc	0	0	0	3	8	1	0	1
Ma	0	0	0	0	13	4	1	1
Mb	0	1	1	4	3	0	0	0
Mc	0	3	2	0	5	1	0	0

Table 7: Activeness per governmental case

As can be seen from table 7 above there is no obvious connection between the activeness of different governments, their viewpoint, and their roles. However interestingly is that Ma shows a high amount of passive approaches and indeed has as most prominent role stated that they are facilitating, which is also more passive than stimulating. The same is can be seen when looking at Pc, although the relationship is less strong, moreover they have stated that government should be more active. Interestingly, the municipality Ma lies within the province Pc. This could show that there is a link with the activeness of the province on the municipality or vice versa. This is also shown by the municipality Mc with quite much passive approaches which corresponds with that of Pa. However, both the province and municipality seem to have a more active attitude, the province already translated this into active approaches while the municipality takes active roles in projects. Hence, we could argue that the level of activeness or passiveness between the province and corresponding municipalities seems to be related to one another.

The relation to this activity and the success of sustainable renovation of existing neighbourhoods is hard to examine since there are no clear numbers on this. However, during the interviews with the cases as well as the supportive parties there was a clear trend that where the role of the government was seen as active and positive, there has been achieved larger amounts of success than the case where the statement was made that governments where activity of a governmental organisation was very small or not present. The more successful case Cc stated that almost 20% of the houses in their area could be energy neutral while the less successful case Cb only achieved the instalment of a few solar panels. This case focuses more on self-reliance and hence wanted less involvement of governmental agencies. Since they are less successful, this could be an indication that an active government is indeed beneficial for success of a local energy initiative. Such an indication is also given by the province Pc. In that province there are six local energy initiatives that are being supported by someone from the province who acts as a contact person who helps them with application to subsidies and grants them a network. In the words of the interviewee of Pc, those initiatives “...have been put on a cushion...” and also “... it is a bit easier for them because we have our network behind us, we know who they should talk to, we can ask things for them or we can help them to get the right people at the table.”. In other words, due to the active involvement of someone of the province, such projects get started more easily. Moreover, the interviewee also states that such cases are indeed being called successes.

One could ask why governmental parties do not take a more active role, this comes from the fact that they sometimes do not necessarily see it as ‘their’ role. The interviewee from Pc stated that they do not see the build-up area and that of houses not as their core business. Hence the focus of the people working at the province are not stimulated to help local energy initiatives or more top down initiatives in the existing built environment. This could lead to a lack in an active approach of such provinces.

The next section takes different insights from the different actors as described above into account in order to better understand different roles taken and different preferred paths by the different actors. When these misalign, it could hamper net real energy emission free neighbourhood redevelopment.

5.1.2. Different insights

The problem of contrasting viewpoints is mentioned ten times during the interviews. In fact, both Mb and Mc as well as the supportive party Sb indicated something in that direction. There was a conversation about a project in Mb where windmills would be placed, which was an initiative from local parties which ended in failure. The problem was that the municipality was not totally into windmills and therefore remained quite neutral about the initiative. Civil servants of the municipality expected that due to the fact that the project was initiated from within local parties there would be enough force to create enthusiasm among the people and eventually the council. However due to the fact that the council of the municipality remained neutral and did not want to say yes to the project, the local parties were uncertain about continuation of the project.

Also, the local parties also did not do much to persuade the council, they put this task into the hands of the civil servants. However, without the support of local parties their argument to continue was suddenly undermined and hence the project did not continue. So, the expectation of civil servants towards the other parties to be active proved not correct, there was also misalignment in expectation from the parties to the municipality council and from the municipality council to the civil servants. Hence a lesson that can be drawn is that prior to a project there must be made clear agreements about what role every actor should take and how to act.

A comparable statement is made by Mb who speaks about a sustainable redevelopment project on a neighbourhood level which failed due to the fact that *"...we did not have a clear picture of what we really could do there."* Furthermore: *"There were too few market parties that already came up with ideas, so we did not know the possibilities. Also, at that time, we had not yet analysed the neighbourhood well enough to find the best scenario"*. Furthermore, it was stated that *"expectations were different from the start of the project"*. The lesson that could be learned is similar to what we have found already above. In fact, the municipality even, states that *"As a lesson we have learned that as a municipality, you have to have a clear picture as a municipality where do you want to go..."*.

Another problem which was stated was that the idea for plan was created together, but that the initiative was eventually pushed greatly towards the municipality. The municipality did not expect this and therefore lacked capacity. Furthermore, the plan was not really made together it was mostly agreed upon which led to the misalignment of expectations. The lesson which is also recognized during the interview is that such a plan should be made together from the start. The same conclusion was ventilated by Sb. Who states that expectation management is a crucial element in such a project to keep the understanding and expectations among parties clear. Due to the fact that the expectations were not managed well one of the parties lost trust in the project. The conclusion that multiple parties should be involved from the beginning is also mentioned by Sb: *"So we say, if you ask a lot of market parties. Then involve them at the beginning, so you can also ask for commitment"*. Hence it is important that at the start of a project or initiative there is agreement between and among the different parties about the role each should play, what their expectations are towards other organizations and how this corresponds with their own view on their role. Furthermore, a lesson that can be drawn is that there should be a clear idea or picture where one wants to go as a municipality, however this probably also counts for other parties involved to create synergy in the ambition in the end goal.

5.1.3 Different approaches

Another element that could limit is the way parties approach the energy transition. However, when looking at difference between the categories in table 8 there is not striking evidence that there is much difference in approach. Only maybe that the provinces mention a combination of a top down & bottom up approach often, but this might be due to their scale. Also interesting is the fact that the cases mention the individual approaches or a combination with a collective approach much more often. Therefore, it is interesting to dissect this element between the cases.

	Bottom up	Collective approach	Combine individual and collective	Individual approach	Integral approach	Sectoral approach	Top down	Top down & Bottom up	Top down necessary
Cases	2	2	4	6	0	0	0	0	1
Municipalities	2	3	0	3	3	3	2	2	1
Provinces	3	2	0	1	4	1	1	7	1
Supportive	0	6	3	1	5	2	0	3	0

Table 8: Top down or bottom up approaches

When looking at the differences between the cases there is however no real clear picture that can show where the differences come from. For instance, interview of Ca which was on rental housing, even that interviewee clearly focusses on an individual approach. Hence in a collective approach there is always a necessity for an individual approach to persuade people. According to the interviewee this was mainly about involving people individually: *“Involving each individual individually in the intervention that you are going to do may make more sense to ultimately limit these CO2 emissions.”* Hence this is also an element that can be linked to consensus creation. Therefore, a lesson that can be drawn is that individual involvement in a collective approach is important.

	Collective approach	Combine individual and collective	Individual approach
Ca	0	2	4
Cb	2	1	2
Cc	0	1	0

Table 9: Collectivism of cases

This combination is also mentioned by Cc who states that they are *“...a collective of individuals who like the neighbourhood to be a better neighbourhood and greener neighbourhood.”* Hence the link between the individual and the collective is important. Furthermore, individual

	Scale benefits	Scale cons
Cases	14	3
Municipalities	10	1
Provinces	15	0
Supportive	10	0

Table 10: Scale benefits or cons

preferences or limitations should not be a limiting factor for a collective project as Cc states: *“Perhaps we should set the ambition to be energy-neutral, but if someone wants to go half-way, we should also agree on that.”* So, the importance is to appeal to individual preference but without limiting the advantages of a more collective approach. This is quite important since as can be seen in table 10, all interview categories seem to agree that there are indeed favourable benefits to an approach that adds scale to a renovation project.

Other contrasting viewpoints but that are not as strongly recognized are for instance that some people see the financial considerations as one of the main barriers. Sb states for instance that: *“...the financial aspect is the biggest barrier we now know.”* While at the same time Cb states: *“I believe that people should want it themselves and that they should not be helped at all, they have enough money,*

especially now that money is so cheap.”. These contrasting viewpoints could change policy in such a way that the focus shifts away from the real problem. Another example is the idea about disinvestment. Some state that you should not invest in things now that might be not the best in a few years and hence should wait: *“And you wait a few years with doing things because a lot of new techniques come to us.: (Cb).* While others state that: *“Then you're doing an investment for 30 years now, nobody can look that far ahead. We already know that you think within 15 years that you should have done it differently. But if you do nothing now nothing will move, and nothing gets done.” (Mc).* A lesson that could be drawn is that you have to create consensus and understanding among actors to ensure that activities of multiple parties are synergetic.

Another interesting differentiation in viewpoint is the ideas about social cohesion or social pressure. As seen below, although cases Cb and Cc state that the social bond is important. They also specifically stated that this must not be overestimated, while this is not recognized by any other governmental or supportive party. This is especially interesting since these both cases have statements that show that there is a strong social cohesion or at least a reason to think that there is. Cb namely states that it is *“... a village in the City that has very specific characteristics.”.* And Cc states that the case is successful *“... because the case can be overseen, the lines are short, and we know everyone.”.* I am not sure why this is the case, this is an interesting element to gain further insight in in future research.

	Pa	Ma	Sa	Pb	Ca	Cb	Sb	Cc	Pb	Mb	Mc
Social bond important	0	0	1	4	2	4	3	2	1	2	0
Social cohesion not overestimating	0	0	0	0	0	1	0	2	0	0	0
Social pressure	1	0	0	2	2	1	1	3	0	0	1

Table 11: Importance of social bond

Lastly an interesting difference in insight is that there are different opinions on whether subsidies are good or bad. Provinces feel that they are always bad since they can mess up the market of certain energy technologies, thereby hindering the innovation and application. The municipalities and cases think they are good because they can lift financial considerations and thereby stimulate energy initiatives.

5.2 Recognizing barriers and uncovering new barriers

When looking at the literature, we have identified five categories of barriers that could prevent sustainable renovation on a relatively large scale. It is interesting to find out to what extent the barriers that are found are also recognized by the interviewees. Also, it is useful to gain insight in barriers not found in the literature but stated during interviews

5.2.1 Recognizing barriers

What becomes clear from table 12 is that indeed all the barriers are recognized by the interviewees, however some are mentioned more than others. The lack of experience seems to be recognized very scarce, this is mostly due to the fact that many interviewees are very active with projects and that gives them experience, hence this could be an overrepresentation of the total experience.

	Complex decision system	Financial considerations	Lack of experience	Lack of Knowledge	System and regulatory barriers	Total
Cases	8	16	1	7	12	44
Municipalities	10	9	3	7	11	40
Provinces	4	2	3	2	15	26
Supportive	4	11	1	4	3	23
Total	26	38	8	20	41	

Table 12: Recognizing barriers

Another interesting finding is that the Complex decision system is especially mentioned by municipalities and cases. The fact that these are mentioned by cases comes from the fact that one of the cases mentions difficulties of collective approaches quite often and hence could over represent the category in that type of organization. It is mentioned a lot by the municipalities and this mostly acts as an explanation for not being able to setup large scale renovations projects or local energy initiatives.

An example is made by a municipality who explains that all the different types of housing and owner constructions prevent a central agreement to occur. Which could of course be true. But mentions from the specific case the statement made actually was about could mitigate these problems. This case had created eight general home-owner categories, hence generic but

	Collective approach	Combine individual and collective	Generic/Specific solution
Cases	2	4	2
Municipalities	3	0	2
Provinces	2	0	1
Supportive	6	3	9

Table 13: Generic/specific solutions and collective or individual approach

still relative specific solution for each resident profile. What is interesting is that exactly this case state that collective approaches are difficult to implement. That seems strange since they do work with a collective approach to the individual people in the area. A lesson drawn could be that a generic/specific solution is helpful in both collective and individual energy initiatives in order to gain a better understanding of the area and hence create an opportunity for collective approaches, but that these solutions are not always recognized. Such generic specific/specific solutions are also mentioned by all categories of interviews as can be seen in table 13. By far the most such approaches are mentioned by the supportive parties which comes from the fact that these are mostly busy with collective approaches that can benefit from such generic/specific solutions. As an example of the relatedness of generic and specific solutions one of the supportive parties mentions that even when applying a generic concept onto multiple houses, specific differences still have to be taken into account since there are most likely differences in measures already taken. Also, in the same type of house the measurements can differ sometimes quite a bit. Therefore, it is a good idea to combine both generic and specific solutions in order to create advantages of scale but still keep an effective solution due to an applied approach that is specific enough.

The complex decision system probably will be the most difficult barrier to mitigate since this barrier stems from the fact that every person is an individual in their own right and hence can be hard to assemble. Also, many individual barriers consist to the complex decision system, some of these are not directly linked to this during the interview but have an indirect connection towards it. One of these is uncertainty which is mentioned a total of 27 times as can be seen in table 14. Some people see this as just uncertainty of what is going to happen in the future or what is the best technology. However, one of the cases mentions uncertainty that exist within the people themselves because they don't understand what is going to happen when they invest in an energy innovation, one could state that

this is an element of limited tenant involvement. Hence this shows that some codes are very much intertwined and more complex than meets the eye and especially the complex decision system has stronger and weaker links to some of the other codes.

An example which is connected to learning and the complex decision system is mentioned by one of the supportive parties who state that innovation can only happen if market parties are given trust and time to earn back their made investments. Not doing this resembles closely what Berardi (2013) stated, namely that the instability, temporality, and fragmentation of stakeholders in the construction process would be a barrier for adopting new technologies. Hence a lesson that can be drawn is that multiple parties should be more committing to each other in order to create opportunities for the creation of innovative ideas.

One of the most recognized and mentioned barriers are the financial considerations, these are mostly mentioned by the cases which is logical since they are the ones who have to invest in their renovation projects. The provinces mention this not quite as often as municipalities, this might come from the fact that they have more of an overview point of view and hence are not so closely related to individual projects. The interviewees that do indeed mention financial considerations mostly talk about the fact that the investments of sustainable renovation are quite high and that these are hard to earn back. However, as one interviewee states, financial considerations are also the easiest argument not to try to renovate houses in a sustainable manner. Another party mentions that the investment for market parties and the potential to earn this investment back is also the main reason to either accept the project or not as such a market party. Also, the fact that certain home owners do not pay for the energy bill and renters do is mentioned, this also creates a complex decision system on top of the financial considerations.

The barrier category that is mentioned most often is the system and regulatory barrier category. One element that was interesting was that it was recognized that politicians have a much shorter time frame that would be necessary for the energy initiatives to evolve, this was mentioned so often that I even describe it as an individual barrier in the next section. The regulatory barriers are indeed recognized quite literally by Pa: *"... then you come back into the corner of the legal rules."* Also, barriers in this category that fit more in the scope of how things are done fall in this category. One interviewee for instance stated that the building sector simply runs the way as it always does and that is not very suited for energy initiatives. However, it is simply how it's done so the way that system works also acts as barrier. Also, the differences by what has been stated and what is mandatory according to the law is an important barrier as Mb states: *"If it is even happening because it is nowhere specified in a law. In that sense, such a target as a municipality for 2050 we will be energy-neutral, it says very little and it certainly does not create sense of urgency."*

The lack of knowledge or information is mentioned less. This barrier is for instance about the lack of knowledge vested in people in an area to start up a local energy initiative, however supportive organizations could be helpful in sharing or giving knowledge. The sharing or giving of knowledge namely is mentioned also quite often, therefore it is interesting to see that still certain knowledge does not seem to reach the right person. The lack of experience is not mentioned as often, this might be due to the fact that I have interviewed parties already working on such projects and hence acquainted with projects present.

5.2.2 Finding unknown barriers

After conducting the interviews not only the barriers that were already found in the literature can be recognized. There were also some mentions of barriers which have not been mentioned in the literature. However as explained already, some of them have very close relationships with the barriers already found. Table 14 shows the newly found barriers, it is clear from reading the different codes

that some of them have overlapping meaning with some of the existing barriers. However, due to either explicit mentioning by interviewees or a strong belief of importance I have mentioned them as their own barriers. Below table 14 I shortly explain the most important meanings attached to the most interesting new barriers. The first argument that can already be made is that there is quite a high number of barriers that were not recognized in literature, hence suggesting towards the fact that the problem is indeed quite complex.

	Cases	Municipalities	Provinces	Supportive	Total
Contrasting benefiting policies	3	0	1	0	4
Contrasting role ideas	0	7	4	2	13
Contrasting time scales	0	2	4	1	7
Contrasting viewpoints	2	3	2	3	10
Government takes no risk	0	2	2	2	6
Hassle	1	2	2	0	5
Lack of people	2	3	3	2	10
Lack of time	0	2	2	1	5
Ministerial responsibility	0	1	4	0	5
Multiple parties	1	6	5	4	16
Personal problems	3	1	1	1	6
Uncertainty	9	13	3	2	27
Unclear role	1	4	6	1	12
Will to act not present	1	2	1	1	5

Table 14: Newly found barriers

The first barrier is about policy that is contradictory, it can be that policy is stimulating sustainable redevelopment while at the same time reducing funds for such investments. Or subsidies switching from one technology to another. This barrier could well be fitted within the regulatory barrier category. The second is about contrasting role ideas, this stems from different expectations of one organizations to the role of other organizations, this can lead to an anticipative attitude in a project. This means that the different stakeholders and parties involved with the project don't take initiative but expect the other actors to do so.

The fact that there are multiple parties involved within the energy transition to which local energy initiatives could go to gain knowledge or subsidy, can create ambiguity on what their role exactly is. Another element is that persons do not always know what organization have what role, hence people do sometimes not know to what organization they need to go in order to start a project. However, the fact that there are such multiple parties is not necessarily a problem. However, some parties seem to state that this is a problem and thereby state that a so called central or hourglass person should be created to funnel all the knowledge of the existing parties towards local energy initiatives. However, this is almost not mentioned by the cases, only once out of the seventeen times of total mentions of such a solution comes from a case. Mostly it is mentioned by the provinces who are already starting such a central party that can funnel all knowledge. However, also as seen above, the cases do not seem to recognize the multiple party and unclear role problem. Hence starting up such an hourglass party which is meant for local energy initiatives might not be as useful as expected.

The third barrier is about contrasting time scales which basically is about the energy transition being a long slow transition while the political leaders are concerned with a four-year time period before election as discussed before. Closely related is the ministerial responsibility which is about any of the people responsible for policy on any political level, due to the fact that they want to achieve something.

It is more tempting for them to invest in short or large-scale projects which has nothing to do mostly with sustainable renovation.

Contrasting viewpoints is about different parties having different ideas about the 'right' way, this impedes collaboration. The viewpoint that governments take no risk is impeding initiatives. This is not mentioned by the cases; however, one case mentions that the involved municipality indeed states that they felt uncertain or tense about the project, however after a concrete plan was created by the initiative the government felt more confident. This was helpful for collaboration according to the case and hence it shows that taking a risk can indeed be seen as good for starting up such local energy initiatives. Hence the lesson drawn could be that governments should try and take more risks, however the uncertainty that is mentioned also in table 14 contributes to this fear of risk. Uncertainty was a very often mentioned barrier. Due to the fact that the parties do not know what technology will be the best, they fear to invest in something that will be eventually not the right investment. However, according to one of the parties we should not want to know things for certain because we simply cannot know. Furthermore, this uncertainty leads according to an interviewee to a stalemate in innovation because if we do not try to do things, we can also not learn. This closely resembles the learning necessity mentioned by Rotmans et al. (2001) A lesson drawn could be that we should use the certainty we have and adapt to future changes. This enables innovation, learning and start-up of projects. Hence a flexible or adaptive policy strategy could be beneficial.

Other barriers are a lack of people or time either at governments or the local people to start up a local energy initiative. This leads to the fact that either there are no people to stimulate or start an initiative Also the hassle of subsidies and regulations in implementing sustainable renovation is seen as a barrier for large scale sustainable energy renovations. Hence projects are not getting started due to the hassle involved with it either for the people who need to organize energy initiatives or for people who could join such an energy initiative.

5.3 Overcoming the problem seizing opportunities

When looking at the literature, we have identified five categories of opportunities that existed and that could stimulate sustainable renovation on a relatively large scale. It is interesting to find out to what extent the opportunities that are found are also recognized by the interviewees. Also, it is useful to gain insight in opportunities not found in the literature but apparent in the interviews.

5.3.1 Recognizing opportunities

What becomes clear from table 15 is that indeed all the opportunities were recognized by the interviews. What is also interesting is that these opportunities could act as a counterweight for certain barriers. The financial considerations can be countered by financial benefits, system or regulatory problems by regulatory benefits or changes. The lack of knowledge can be countered by giving information or examples. The complex decision system can be mitigated by the creation of consensus. The one opportunity that remains then is the approach to sustainable redevelopment which has no direct counter in the barrier categories.

It is interesting to see that the total amount of barrier is not met by ways to counter these. For instance, the system and regulatory barrier was found more than forty times while the opportunities to counter them by new regulation changes are only mentioned fourteen times. The lack of knowledge and information is found 28 times while the giving of examples and information is only named 18 times, however this difference is not so strong and could be due to the fact that information and experience can be named quite often together. Also, I did not get the sense after the interviews that there was a very big problem in this category. Interesting to see is that consensus creation is found more than the

complex decision system, but in the interviews, there was a tendency that the complex decision system was seen as an insurmountable problem.

	Approach to S R	Consensus Creation	Financial benefits	Information/example	Regulatory benefits
Cases	13	11	8	4	4
Municipality	8	7	12	3	2
Provinces	7	8	10	10	8
Supportive	9	7	3	1	0
Total	36	33	33	18	14

Table 15: Recognizing opportunities

The approach to sustainable redevelopment (S R) mostly is about how governments or cases felt the need to ‘sell’ the sustainable renovation measures. The interviewees felt this need because for instance: “Actually if you want to sell sustainability, then you should not sell it as such because that is not sexy...” (Sb). Also: “That is also packaging, but you have to design your project this way because otherwise there is absolutely no urgency.” (Mb). Hence the problem that there is no urgency or selling potential meant that actors tried to package sustainability by mentioning an increase in comfort level or a positive change in monthly costs. Another example is that there sometimes needs to be a service linked to a project in order to mitigate a very specific barrier which otherwise would not be thought of. As Mb states: “people did not insulate because their attic was full of junk. When they added a moving service, insulation suddenly got going”. A lesson that could be drawn is that sustainability should be approached via a different way that can persuade people. However, as is stated by the interviewee of Mb, such an approach could ask for an integral viewpoint, for instance by using water problem solutions in a neighbourhood to gain trust or a foothold. And then after that program is finished one can begin talking about sustainable renovation. This is mostly hard to do because of the sectoral organization structure in governmental agencies. Interesting is that the approach to sustainable renovation opportunity is especially mentioned by cases, which feel the need to sell sustainability to their neighbours.

Also, consensus creation is mentioned often by the cases, this could come

	Gaining Knowledge	Knowledge giving	Sharing Knowledge
Cases	8	4	8
Municipalities	1	6	5
Provinces	0	5	4
Supportive	0	3	0

Table 16: Amount of knowledge gained, shared, and given

from the fact that the cases mostly where local people who tried to persuade other people in their area to join them or to start an initiative on their own. Therefore, it is logical that these cases rely on the creation on consensus in their area, especially because they stated that they needed to sell sustainability, creating consensus can be seen as adding to that selling potential. Sharing knowledge as seen in table 16 also adds to understanding and hence to consensus creation. The cases seem to share a lot of knowledge, also they gain the most knowledge, this is probably due to the fact that they are not professionals and hence need knowledge from others in order to succeed. The other categories seem indeed to be more focused on knowledge giving.

The financial benefits are mostly mentioned by the municipalities and the provinces, but also by the cases. Financial benefits are seen as an incentive to start local initiatives. Also, it is similar to the amount of financial considerations mentioned by the different categories in the previous part. Also, the financial benefits mostly come from the municipalities or the provinces, hence they have the most

knowledge about such benefits and could be more exposed to them, hence naming them more often. Therefore, they might feel that the financial considerations are less of an issue than the other parties who might not have the same knowledge about existing financial structures. As was stated by Pc already before, the help of a province to local energy initiatives towards subsidy structures can be highly beneficial. Hence one of the lessons drawn is that there could be a mismatch in the knowledge about current financial options for local energy initiatives.

The benefits of giving information and examples is by far the most mentioned by provinces, in fact more than half the times they mention it. The idea of these opportunities are mostly examples of local people who have redeveloped their house and can show this to their neighbours. The idea behind this ideology is that the neighbours trust each other more than they trust external parties. This viewpoint could well come from the idea where provinces state that social bonds are important for success, however as we have seen this is less supported by the cases. Also interesting is that the importance of trust is mentioned the fewest by the provinces. Also, the lack in trust from actors to their specific organization is mentioned only once by a municipality and twice by a case, however this was mentioned by the housing corporation, hence creating more logic behind that statement.

The regulatory benefits are mentioned mostly by the provinces and municipalities, which is logical since they are the ones who can influence such regulatory benefits. The cases also mention them, but this mostly comes from the case of the housing corporation where there used to be regulatory benefits for the housing corporations. Interesting however is that the regulatory benefits are mentioned far less than their barrier counterpart. This comes mostly from the fact that the regulatory barriers are perceived as very hard to change. Especially for the cases and supportive parties it is logical that they perceive it this way since they only have a small role to play within that area. However, the governmental parties state that such regulatory changes need to be made by the state or that there are rules for financing where nothing can be done about: *“Yes, banking rules, financial rules, that just does not work.”* (Ma).

5.3.2 Finding new opportunities and organizational considerations

As with the barriers, there were also mentions of opportunities during the interview that have not been recognized during the literature research. Table 17 shows which opportunities were mentioned during the interviews. Which I shall discuss very briefly. Important to note is that some of these opportunities are linked to the success of local energy initiatives, however special elements towards their success are examined more closely in the next section. These opportunities and organizational considerations are about local energy initiatives and insights gained from the interviewees.

	Cases	Municipalities	Provinces	Supportive	Total
Local trust	3	3	0	0	6
Network	9	7	17	10	43
Right scale	1	3	4	4	12
Risk taking	3	3	4	2	12
Social pressure	6	1	3	1	11
Stimulate organisation of locals	0	2	2	0	4
Threat end date gas	2	2	1	0	5
Threat of missing out	1	1	1	0	3
Unburden	2	2	4	0	8
Understanding	10	4	3	7	24
Ways of financing	7	9	9	4	29
Will to act	6	3	2	0	11

Table 17: Newly found opportunities

Firstly, local trust is mentioned almost as a prerequisite for sustainable renovation projects to happen. This can be helpful for both bottom up and top down initiatives, for instance when local initiative takers have a certain trust among the people, the chances of success are larger as well as when such initiatives are initiated from the top. However mostly people mention local trust as something that must be present towards a specific person who is in charge of a project or element of a project. For instance, Mc states that: *“a block of houses has a head of that block who arranges things for the block, if that person has good contact with the neighbourhood then that makes quite a difference.”*

The next opportunity mentioned is a network, this is an organizational structure or large pool of contacts for a local initiative or an organization. This is mentioned by far the most by provinces, who lately have started with setting up such a network structure to organize parties in their province and to combine their knowledge into one group. The supportive parties mostly have such a networking role such as Sa states: *“we are going to connect 10 experts to us, multidisciplinary, architectural, architect, installer, lighting expert, etc.”*. Also, they provide a network when giving advice to the cases and the cases seem to be happy with such a network for knowledge or help with getting subsidy or regulations changes. As Cb puts it: *“...the will to find each other I think that is most important. If that succeeds, everything can work...”*. Hence lessons drawn from these two elements can be that there should be something of a local trust and also a network behind that trustworthy party.

Moreover, a project should be initiated on a right scale, by this the interviewees meant that the project should be large enough to create potential for market parties to earn the investment of an innovation back and the investment capital is large enough to enable this. Also, the project should be small enough to be appealing to the local people. The opportunity of social pressure comes in to play here, because when the right scale is chosen neighbours are expected to have some kind of social pressure on each other. For instance, if more than half of the people agree to join the project, the other might be wary not to join because their neighbours could disapprove of that. Or they could be afraid that they will be too late when they want to join maybe later. This could be described as fear of missing out, this can be stimulated by really focusing on missing the boat when speaking about the project, you then create the threat of missing out.

This fear of missing out, together with the threat of a strict end date of gas in that neighbourhood is seen as a good way to create urgency within people and to create push factors away from the gas. Pb states for instance that *“In the end you have to work towards something that it has to be so lucrative for a homeowner that they say, yes if I don’t join no, then I will miss out on this”*. A thing that is being done to create such pressure is to stimulate local people to organize themselves so there can be more of a ‘we’ feeling among them which could increase the pressure on surrounding neighbours. In the found opportunities this come closely to the free riding opportunity where people feel stimulated by a local energy initiative and hence also start acting.

Hourglass party/person	
Cases	1
Municipalities	5
Provinces	8
Supportive	3

Table 18: Views on hourglass party

A lesson that could be drawn is that it is important to start up initiatives on the right scale to enable local pressure to occur, but also to really create incentive or urgency. An element that could be used to organize things on the supply, information and governance side could be the creation of an hourglass party or person. This would be a person who takes on the responsibility of organizing multiple parties within the neighbourhood who is starting a project. The idea is that such a party or person funnels all the knowledge, experience, and further networks within involved parties to the local people so that there is an overview for the people in that neighbourhood. This would benefit energy projects where local people are at the base of the project since it will be clearer where they need to go with questions and this could save them from the hassle of dealing with multiple parties and also mitigates unclear relationships to other parties. Interestingly however, the cases mentioned the advantages of such a person by far the fewest, while the provinces mention this the most. The reason for this could be the fact that the provinces in the interviews indicated that they were already aware such opportunities and hence already started with creating such a party. Also, the indication that the existence of multiple parties connected to sustainable neighbourhood initiatives, which would be unclear or difficult was mentioned in 5.2.2. by far the least by the cases; hence they would find the least amount of benefit from such a party or person. Furthermore, there seemed to be the notion that direct linkages with the responsible parties were the most important. Or as Cc puts it: *“I do not believe that a person from the outside could do that. It is better to go straight to the table with those parties... In what way can such a person have a powerful position within those parties”*. A lesson that could be drawn is that there might be not created such a party from the supply side, but more someone from the demand side. This could be organized by creating incentive to organize as a group, so the hassle can be funnelled through a few persons, however with existing local trust.

Furthermore, an important element for a successful project is according to most interview categories to unburden the local people. This basically combats the hassle which we have found before, because people do not want to go through this hassle, you have to give them reason to join the project by taking this hassle away. Another important element is to create understanding within people, this could aid in creating insights of people in the urgency of a project and hence they are more likely to join a sustainable renovation project. Important to note however is that all interviewees seemed to agree that it is better to create a neighbourhood that can facilitate a future where is made use of another energy bearer. Therefore, all interviewees did not think that at this moment a net real fossil emission free neighbourhood renovation was the best idea. They stated that it is better to create circumstances and knowledge within neighbourhoods so that they were able to quickly change to the future when new energy sources become more widely available.

Lastly the ways of financing are mentioned much as an opportunity, which is about finding new and innovative ways of coupling the investment to the house instead of the home owner or about new ways of enabling collective loans so that individuals do not have to be under such great risk as is the case now. Hence these are no financial benefits or considerations but are more of a shift in the way the system of money, loans, and debt work at the moment. Lastly the will to act is mentioned as an

opportunity, this counteracts the will to act not present in the barrier category. Important is that the will to act is mentioned more, probably this is due to the fact that I have interviewed projects and other parties who are actively involved with sustainable neighbourhood renovation and hence have a will to act present within them, otherwise they would not have started the project in the first place.

5.3.3 Success factors for local energy initiatives

Since the cases where mostly local energy initiatives, or initiatives that were started by local people who had incentive to become active in the field of sustainable energy renovation. And because in the interviews an image appeared where the governmental parties seemed positive about the potential of such local energy initiatives since it partly relieves individuals from the hassle, it creates scale and it most likely also has local support. Therefore, it is interesting to gain insight in what their success and fail factors might be. In the table below different elements of the local energy initiatives are shown. The ones shown in red were given a negative feedback during the interviews, this could be policies that are bad or specific problems that were said to have negative effect. The green ones give a positive effect and the black ones are more neutral comments stated during interviews. I have calculated them to see whether there is a relation between success and present factors. Below table 19 I shall briefly discuss the outcomes and I will also mention some of the other important insights. It is important to mention that I can only give general comment on the outcomes since it is a qualitative research and hence there is no real numerical value, it is only used to gain insight.

	Pa	Ma	Sa	Pb	Ca	Cb	Sb	Cc	Pc	Mb	Mc	Total
Centralistic help for LEI	3	0	0	2	0	0	0	0	2	1	2	10
LEI active stimulation	0	1	0	3	0	0	0	1	0	1	1	7
LEI lucrative	0	0	0	0	0	1	0	1	0	3	0	5
LEI start on its own	0	1	0	2	0	1	0	1	1	2	1	9
Luck LEI	0	0	1	0	0	0	0	1	1	0	0	3
Mandate LEI	0	0	0	1	0	2	0	2	0	0	0	5
Ownership of LEI	0	1	2	2	0	4	0	2	0	0	0	11
Persistence	1	0	1	0	0	1	0	1	1	1	0	6
Personal problems	0	0	1	0	0	2	0	1	1	1	0	6
Personal qualities	0	0	1	2	0	1	0	3	1	1	0	9
Professionalization	0	3	3	5	0	0	0	5	1	3	0	20
Specific help for LEI	1	0	1	1	0	0	0	4	1	1	1	10
Specific help for LEI real link	0	0	0	0	0	0	0	1	4	0	0	5
Voluntary vulnerable	0	0	0	0	0	0	0	1	1	2	0	4
Total	5	6	10	18	5	12	0	24	14	16	5	115
Minuses and plusses	-1	4	8	8	0	4	0	15	5	4	-1	44

Table 19: Success and fail factors of local energy initiatives

When looking at the cases, Ca has a score of zero, this could be due to the fact that it was an interview with a housing corporation and no real Local Energy Initiative (LEI). However instead of mentioning the importance of having mandate as a LEI, they stated that the housing corporation had mandate to implement certain programs and hence can 'push' certain ideas. The most successful case Cc has a score of 15 while the less successful LEI had a score of only 5. The starkest difference between the two is the fact that the successful LEI receives specific help and is professionalized. Although this number

might be overdone due to the fact that they sometimes mention that such a professionalization or specific help could be better in order to improve.

The most interesting other elements in the table is that many provinces and municipalities mention a general or central help for the LEI, more than two times more than they mention a specific help. However as stated by Cc: *“What we cannot use is an energy coordinator at the municipality, because in no time he will be having a meeting with the province or with the other municipalities. With everyone and they are all sitting within their own cocoon. And if you need them, they do not have time because then they have to do everything, we do not really get benefit from that.”*. Therefore, a lesson that could be drawn is that the governmental organizations should try to create specific help for local energy initiatives as was also seen as beneficial by Pc before.

Another interesting element is that although some municipalities and provinces start to actively stimulate local energy initiatives, these mostly still start on their own, this could be due to an intrinsic motivation which was present. Another thing mentioned by Cc was the availability of time: *“We are both retired, so we also had some time and we had the idea we have to do something different.”*. The notion of time is also mentioned by other parties. This comes down to the fact that many of the initiatives are run by volunteers. As shown above this voluntarily can be a vulnerability because there is no other incentive to keep going other than your own intentions. Professionalization is very often mentioned as an opportunity to battle this vulnerability. Interesting however is that governmental agencies often think very different about this than cases. For instance, Mb states that it should be eventually *“Just really paid work”*. While the case Cc would just have the voluntarist, element professionalized for instance through: *“What we need is someone who supports us administratively, who keeps track of our address database. Who does the administrative work and ensure that our archive stays in order...”*. A lesson drawn could be that it is very important to gain understanding of what local energy initiatives need a what could really help them.

Furthermore, an interesting element is that of the mandate of local energy initiatives. As stated by the two local energy initiatives they only founded the cooperation because they needed to since they were required to do so if they wanted to do the project. This could be a barrier since it could scare people because it is also an element of hassle, hence it might be an idea to loosen regulations in such a way that it is easier to start a local energy initiative. This could make the threshold less high. Lastly there are elements in the table which come down to circumstances, for instance a bit of luck helps a lot in the success of local energy initiatives. For instance, if the first application for subsidy gets denied there is quite a chance that the initiative gets a moral blow, while when such application gets granted then morale gets a boost. Furthermore, personal qualities such as knowledge or experience in the sustainability field of the persons starting an initiative are also important. Also, personal problems among people or within the neighbourhood can be a problem for such initiatives, since it makes consensus creation harder. Also, the personal persistence is mentioned as critical for the success of such initiatives, however this is not something which can be steered, it just is present or not. Hence there is a bit of luck needed for local energy initiatives to thrive.

Lastly an element that is not shown in the table above is the importance of a high ambition or an ambitious goal regarding time limits. The cases state that one is better off with a target for the project to be achieved in 2020 or 2024 rather than 2050. This is the case since it creates a sense of urgency both in the project itself and people involved, therefore it makes sure that there is activity within the project. The same is mentioned by Mc which states that there should be pressure from the top or the government and also from the local initiatives in such a way that circumstances are created for ambitious steps to be taken.

5.4 Lesson drawing: shifting roles and seizing opportunities

As we have seen in the previous section there are a number of barriers and opportunities found that could either hinder or aid sustainable redevelopment. From the previous sections there can be distilled some recommendations that could guide and steer different actors within the energy transition to a path where more barriers are mitigated and where more opportunities are seized. One of the first central elements and lesson is that the role of governmental agencies should be more active. As can be seen in 5.1.1 there is a general consensus that this should be the case, also as shown in multiple examples an active stimulating government has indeed a positive influence on sustainable renovation projects, interestingly the same notion was made by Rotmans et al. (2001)

The complex decision barrier is mostly mentioned by the interviewees as the complex problem of creating a collective approach or organization to organize sustainable renovation on a larger scale in an area with all individual home owners. Hence the problem lies in the fact that each of the individual actors has their own opinion or incentive and therefore are difficult to organize. Although the creation of an hourglass party or person is suggested by both provinces and municipalities, the cases do not seem to think that such a supply side party is suitable. However, an hour-glass party is seen as something that is hard to organize and potentially has no real power or meaning, but some form of organization could create opportunities for larger scale projects. Hence a lesson that could be drawn is that there should be set up a program that creates incentive for local actors to organize themselves or to use existing organization structures as a starting point. The stimuli could be sought in financial incentives for instance by granting a percentage of discount on the maintenance of their housing when they do it together or by granting discounts on specific technologies that could be used in sustainable renovation projects. Another possibility could be a tax incentive to stimulate home owners to start a housing block association, this creates opportunities of the start-up of the organization of a neighbourhood. According to Rotmans et al., (2001) such activities could well be undertaken by governmental organizations. This way the scale advantages still hold their potential, building companies have an opportunity to create innovative concepts that they can earn back and there is local trust and social pressure or cohesion. Furthermore, this can be the start of a situation where buildings with different thermal qualities can be connected within a district heating distribution system as Conci & Schneider state (2017). The creation of an organization can mitigate various barriers found in the complex decision system category in the literature, firstly it decreases the number of actors who all have to individually pick the 'positive' option (Van Bueren & Priemus, 2002). It could streamline the different opinions among home-owners (Meijer et al., 2009) as well as the contrasting priorities (Berardi, 2013). Lastly it enhances changes of more communication and coordination among actors (Tuominen et al., 2012) since setting up an organisational structure within the neighbourhood can only begin with communication among actors.

An hour-glass party or person was discussed during various interviews. This can be seen as a party or person who sits in-between stakeholders. Such a party or person could facilitate or stimulate organisation among stakeholders and hence could aid in consensus creation.

Closely related to this lesson is a recommendation that is more specific for projects where multiple larger scale parties within the are involved. Specifically, it is about a notion that these parties should be more committing to each other from the start of the project, in this way there is more clarity about the potential amount of investment and the amount of return. Hence creating clarity, continuity and commitment is a recommendation that can be stipulated. This way you create opportunities for the creation of innovative ideas. The idea is that a market party could create innovative concepts or ideas when they have incentive to do so. If the project is only for one house, or if they are only guaranteed of a few houses in an area or the start-up phase of a project. Then there is no real incentive to invest much money in innovation or concept creation since their opportunity to gain money on that

innovation is very limited. Another element closely connected with the previous recommendation is that governments should try and take more risk in trusting the market party and to create a safe environment to make mistakes which enables them to try-out different innovative strategies. Without the option to make mistakes nothing will be tried; hence no steps will be made. Since nothing can be done. Especially in such transitions the learning of practice cases is very important (Rotmans et al., 2001; Loorbach, 2010).

Another important is that prior to a project there must be made clear agreements about what role every actor should take and how to act. Only in this way the mutual actors can keep trust in each other and feel confident that the project is heading in the right direction. Hence creating an environment that enables innovative processes or concepts. Furthermore, the collaborating parties should be working together on the project or plan from the start, this is necessary to ensure that the understanding of the parties is mutual agreed upon and that there are no surprises halfway the renovation project. Also, there should be a clear idea or picture where one wants to go as a municipality, but also for all parties involved to create synergy in the ambitions and the end goal. This can be seen as closely related to the notion made by Rotmans (2001) who states that there should be made a long-term thinking framework to shape short-term policy. Hence, clarity on the desired direction is indeed seen as an important prerequisite for innovation and success. The creation of a solid regulatory base is also mentioned by Painuly (2001). Moreover, the creation of understanding and involvement of different actors also closely links to what de Roo (2003) states about complex projects. Namely the more complex a project or problem is, the more stakeholder involvement is necessary.

Another recommendation is about a generic/specific approach or solution which is helpful in both collective and individual energy initiatives in order to gain a better understanding of the area and hence create an opportunity for collective approaches. A very interesting element is the so-called cafeteria model mentioned by one of the provinces in which there are multiple steps of interventions offered. Where step one only guarantees a certain amount of energy use reduction the subsequent steps continue to increase the energy reduction. In this way the scale advantages remain while people can still choose their own specific steps they take. Also, it is always beneficial to generalize the need in neighbourhoods to an extent that large steps can be made so that building companies can also gain experience on how to make such large steps. Again, learning by actively doing appears to be important (Rotmans et al., 2001; Loorbach). Closely related to this is the notion that there is always an individual element involved in collective approaches, this is necessary to create consensus among the individual people or home owners. This is a good way to create a form of organization among individual home owners and to mitigate the complex decision system, so stakeholder involvement as de Roo (2003) mentions is indeed important in complex problems. A complex decision system can be described as an element of such a problem and hence a communicative approach (de Roo, 2003) seems fitting. Furthermore, sustainability should be approached from different ways to appeal to different people due to different ideas behind the proposal of sustainable renovation projects. This helps to mitigate the lack of urgency since the urgency is created within another element. By creating understanding the potential for more generic approaches can be opened up.

An additional recommendation is that we should use the certainty we have and adapt to future changes. Or so to state, certainty should be created when possible and when not possible there should be acted knowingly of the existing uncertainties. This enables innovation, learning and start-up of projects. Hence a flexible or adaptive policy strategy could be followed. By this it is meant that one should not wait until it is certain that an investment is the right one for eternity, since this will be never the case with any investment in technology ever made. Therefore, we can only know certain what we know now, and we can only act accordingly. Hence investments that are proper decisions now must be taken in order to learn and to make steps to be able to facilitate new energy bearers. The perceived risks hence should potentially be undertaken. When looking to the transition management literature

it becomes apparent that the creation of certainty closely resembles the strategic and tactical activities that governments should undertake according to Loorbach (2010).

Moreover, there was a slight indication that there could be a mismatch in the current financial options to stimulate local energy initiatives and the understanding of the local energy initiatives about such financial benefits. However, this comes down to the hassle to find out these things when starting a local energy initiative. This could be funnelled by one of the organizational options shown above. Important for such a local party or person is that there should be something of a local trust and also a network behind that trustworthy party. This is necessary to not only gain the necessary knowledge from other parties but also to make sure that such an organizational structure has mandate.

Furthermore, it is important to start up initiatives on the right scale to enable local pressure to occur, but also to really create incentive or urgency. The main issue is that there must be a good balance between scale advantages and a certain social pressure or control to enable peer pressure and social advantages to occur. Another important element is that you have to give people reason to join the project by taking the hassle that they could link to such a project away. This could be done by giving the organizational structure as described above a bit more mandate to enable him to make decisions for the neighbourhood and to funnel the hassle.

Lastly it is important to gain understanding of what local energy initiatives need and what could really help them. Therefore, a recommendation is that the governmental organizations should try to create specific understanding and thereby help for local energy initiatives instead of generic guidance or aid that appears not to be helpful for local energy initiatives to thrive. Furthermore, it might be an idea to loosen regulations in such a way that it is easier to start a local energy initiative. This could make one of the thresholds to sustainable neighbourhood redevelopment initiatives less high. Namely one of the reasons for local energy cooperation's to start is simply because that is the only way they can make sustainable renovation happen.

6. Conclusion

This research identified ways or approaches that could stimulate sustainable neighbourhood renovation. Also, different theoretical insights that are important for sustainable renovation have been discussed. Firstly, we have identified that the precise meaning of sustainability and sustainable development and redevelopment is quite diffuse. After gaining understanding of the different concepts that exist in the field of sustainability we concluded that these many concepts all could have different and important consequences when they would be applied strictly. After more deliberation, we have concluded that none of the existing definitions around sustainable development or redevelopment was precise or ambitious enough to truly achieve the energy goals set by the Dutch government for 2050. Therefore, we argued that there should be a clearer definition which was more clear and therefore less ambiguous which could lead to better applicability. Hence, this research proposed the term net real fossil emission free neighbourhoods.

Then we have looked at redevelopment and specifically sustainable redevelopment. Which can be described as an alteration to a building that improves the quality of said building, in the case of sustainable redevelopment it also lowers the amount of energy consumption. We gained insights in potential advantages of energy renovation at the neighbourhood level such as smart energy networks. Potential routes have also been described, a district level as optimal scale is often mentioned.

We then looked at existing technologies that exist for energy consumption reduction or energy production. After that we gained insight in transition theory and gained understanding on how to apply such technology. Moreover, we investigated the different barriers and opportunities that existed within the transition management theory for sustainable neighbourhood redevelopment. We found five categories of barriers that could hinder sustainable renovation at the neighbourhood level, the following categories have been described in the literature: a complex decision system, financial considerations, the lack of knowledge or information, the lack of experience, and barriers that were present due to regulatory measures or the existing system. However, after conducting the interviews more barriers such as existence of uncertainty and the unclarity of different roles have been found. The presence of uncertainty does not come as a surprise since we established that the problem is quite complex and multiple stakeholders are involved, hence uncertainty must be taken for granted (De Roo & Porter, 2007).

We have also identified five categories of opportunities or incentives that could be seized in order to stimulate sustainable energy renovation. These categories consisted of: presenting information or examples, financial benefits, regulatory benefits, consensus creation, and the approach to sustainable redevelopment. Moreover, there were also newly found opportunities discovered in the interviews. The most important opportunities were gaining understanding of the specific problem to create incentive for local actors to act. Secondly it is important that the people in charge of the local initiative have a certain network behind them in order for them to be successful.

In chapter five we have analysed the role, importance and viewpoints of various actors such as governments, advisory parties but also owner-occupants, building parties and housing corporations who are active in sustainable renovation projects. Interestingly, there are sometimes differing ideas among the actors about who should have which specific role. Most parties agree that the government should be more active, however when looking at the degree of activeness we can see that both the municipalities and provinces apply more a facilitating approach while the cases would prefer or experience a stimulating approach from the involved governmental organizations. Hence the cases that have success benefit from a government that acts stimulating, the governmental organizations could learn from this and indeed act more active and actively start stimulating local initiatives. In order to help the local energy initiatives.

On the other hand, the opportunities that have been emerged from the literature are indeed being recognized and used to stimulate sustainable renovation on a neighbourhood level. The opportunities of creating consensus and adding financial benefits are mentioned the most. Also the importance of a network was recognized and applied a lot. The creation of understanding which is in a way an element of consensus creation was carried out a lot by the governmental organizations. This could be due to the fact that it is connected to giving information which was also mentioned. However, the common denominator among these opportunities lies in the approach of working together in order to achieve success. A network can be a way of working together while understanding and consensus creation creates the basis for working together among the different actors. This comes back in figure 2 where de Roo (2003) mentions a participative approach as fitting for such complex problems. This research argues therefore that the transition of sustainable neighbourhood renovation is especially a problem or question that should be solved by changing the approaches of different parties involved in the field.

From the analysis of the interviews we have gained multiple recommendations that could be used in order to stimulate sustainable neighbourhood renovation, these recommendations or lessons are described and discussed in the following section.

6.1 Lessons drawn

Firstly, a program that creates incentive for local people to organize themselves or to use existing organization structures could be set up as a starting point. This could decrease the number of different stakeholders who have to pick the 'positive' option (Van Bueren & Priemus, 2002). Such a program could help mitigate problems regarding misalignment of goals of actors living within a neighbourhood. Furthermore, it requires communication to set-up such an organization in the first place and hence reduces the chance of bad communication among actors. Furthermore, the fragmentation and temporality of stakeholders in construction processes can be mitigated since the organized party or group can act as stable actor that will not change often even if people leave or make an entrance in the neighbourhood. Via this way local people become more active and community engagement could increase in a way as Palumbo et al. (2017) describe. Furthermore, by creating an organization within neighbourhoods, larger scale district solutions as Conci & Schneider (2017) describe become possible. This could make the application more efficient and therefore enhance the success of the project. By combining multiple opportunities within an area also more individual barriers could be overcome. This could even lead to more people able to join the project which could create a flywheel effect.

Secondly, it could be beneficial if multiple parties are more committing to each other from the start of the project. In this way there is more clarity about the potential amount of investment and the amount of return. This can be achieved by stimulating actors to work together on projects from the start of a project. In this way you create opportunities for the creation of innovative ideas. An element of creating commitment towards each other lies in an approach where prior to a project there must be made clear agreements about what role every actor should take and how to act. Also, there should be a clear idea what direction is desired as municipality, but also for all parties involved to create synergy in the ambitions and the end goal. Hence clarity among actors, goals and expectations is necessary. This clarity is necessary to create a basis where the potential risks regarded to developing new innovations are perceived as not that high, this would help to create opportunities for market parties to invest in innovative technologies. Namely, when it is clear what the governmental organization and other stakeholders expect, a party has more clarity on the specific product that he needs to create. Creating such clarity closely relates to what Loorbach (2010) mentions as strategic activities that can be taken on by governmental organizations. Loorbach (2010) for instance mentions long-term goal formulation which closely relates to the creation of clarity of a desired direction of the municipality. Closely related to this is the notion that the little certainty that exist has to be used to base plans on.

As one interviewee stated before, there will never be a guarantee on the best solution, we can only see what would seem a good solution now and we have to work with that. Since if this uncertainty is not taken for granted, then no activities will be undertaken, and nothing can be learned. According to Loorbach (2010) and Rotmans et al. (2001) the learning process of a transition is very important, hence there should be created opportunities to have an active approach and learn while doing. This approach of learning by doing is an important part of transition management according to Rotmans et al. (2001) and Loorbach (2010). Hence a flexible or adaptive strategy should be followed to enable activity and learning. By this I mean that we should adapt to whatever current certainty exist and work with that but be flexible in our approaches to enable change when new innovations are discovered.

The third lesson drawn could be that a solution that combines both generic approaches with specific insights is helpful in both collective and individual energy initiatives in order to gain a better understanding of the area and thereby create an opportunity for collective approaches to emerge. To give an example, it could be beneficial to gain insight in the different houses in the neighbourhood in order to develop generic solutions to the specific needs for a certain set of houses, hence saving costs for constantly developing the same solution for the same kind of house. This creates insights and opportunities for more large-scale solutions. Furthermore, this opens chances for an approach along multiple scales which is important (Rotmans et al., 2001). Instead of limiting the solution to one house, the solution can be transferred along the whole neighbourhood or even across municipalities or cities. This could create the scale advantages as discussed in lesson one. Hence it is important to not solely focus on specific solutions but try to come up with generic ones that can be applied within different contexts. Important in this however, is that there is always an individual element involved in collective approaches, this is necessary to create consensus among the individual people or home owners. Hence the opportunity to create consensus comes from the individual element that stems from the complex decision system. Namely, the individuals that are the owner-occupants always have a say on projects in the neighbourhood, they are the parts of figure 1 by de Roo (2003) constitute the object or in this case project. Practically this could mean that one starts by stimulating and starting pilots which could then be used to learn lessons from that could be applied on a generic scale. When these generic lessons are transferred among other small pilots the quality of the project will be better due to the applied lessons and eventually this could lead to fewer costs and more experience. The adding of knowledge could be eventually important to start such a flywheel effect.

A fourth recommendation which could also help creating consensus is that sustainability and sustainable neighbourhood renovation should be approached from different ways so that people are addressed and reached on a more personal level. This could lead them to be more involved and more willing to join projects. Different ideas from these actors that can be stated as reason behind the proposal of sustainable renovation projects should be embraced and used in order to reach different actors with different opinions. This can be a beneficial approach when there is a lack of urgency in a neighbourhood. If one actor would join a neighbourhood renovation project based on comfort enhancement instead of an improvement of sustainability than this factor should be emphasized to address that specific stakeholder. There does not necessarily needs to be a sense of urgency within the actors on sustainability since they are reached via different underlying reasons. Via these various reasons they can be approached and helping neighbourhood redevelopment even without a specific interest for sustainable neighbourhood redevelopment. Furthermore, it can be a response to the contrasting priorities among stakeholders (Berardi, 2013), namely they might want to have financial benefits or comfort improvement via which they can persuaded instead of sustainability, hence the barrier is translated into an opportunity. And could be used to surpass the problem of a lack of urgency among local actors.

The fifth lesson drawn is that there might be a mismatch in the current financial options to stimulate local energy initiatives and the understanding of the local energy initiatives about such financial benefits. However, as stated in chapter 5, a more active role of governments in helping local energy

initiatives could help them retrieving such financial opportunities. Important for such an active approach to be successful however, it is important to gain understanding of what local energy initiatives need and what could really help them. Therefore, governmental organizations should try to create specific help for local energy initiatives instead of generic guidance or aid that appears not to be helpful for local energy initiatives to thrive. Also, such an active helping approach of a government towards that local energy initiatives helps local energy initiatives creating a network which not only improves their knowledge about financial options but helps them with gaining knowledge in general. Moreover these local energy initiatives can also show lessons to the network, which could lead to an increase in knowledge in the entire network. Furthermore, it is important that such a local initiative has some form of local trust in the local context; hence initializing such a project as a government could lack on this element, the connectedness of the local initiatives with their surrounding is very important. Therefore a stimulating measure instead of a top down approach seems more suited to achieve successful local energy initiatives. Moreover, it is important that the local initiatives are set up on the right scale to enable local pressure to occur, which can aid to really create incentive or urgency but also leaves opportunity for large scale innovations. By this I mean that when an initiative is too large then the local surrounding people who haven't joined, don't have a big connection with the other people in the project; hence feeling less inclined to act because there are more people who have joined the project. When the people in such a project live more close, chances are that they know the people that haven't joined yet, hence putting more pressure on those people to join because they feel social pressure to do so. Lastly it might be an idea to loosen regulations in such a way that it is easier to start a local energy initiative. What is mentioned now a lot is that the cooperation is only started since they have to do in order to get started, loosening regulations to start cooperation's could make the threshold to initiate such a project less high. When such a threshold is less high, more people might be inclined to set up a local energy initiative.

When looking at the main goal of this research or, the main question, it said: How can net real fossil emission free neighbourhood redevelopment in the Netherlands get stimulated within 33 years by activities from multiple actors, policy changes and changes in behaviour from involved actors? We can clearly see that there have been mentioned multiple ways that could aid sustainable neighbourhood redevelopment in the Netherlands. Firstly, a program to stimulate local organisation could be beneficial for stimulating local energy initiatives to occur since it mitigates the complex decision system which acts as barrier. Secondly, it is important to create clarity as governmental organisation in long term vision goals which also came back in the transition management literature, this creates a solid base for actors to act on. Important however, is that the uncertainty that will always exist within complex problems must be taken for granted and the different actors have to work with it in order to enable learning. Also, it is useful to combine generic approaches with specific insights to create effectiveness and consensus. Important for this is that both the generic context as well as the individual elements situated within a project area are considered. Additionally, it is important to approach sustainable neighbourhood renovation in different ways in order to appeal to the most possible people and create the most consensus among stakeholders. Namely multiple individuals can have different priorities among each other, hence when focussing on those different priorities such as more comfort or financial benefits more actors can be stimulated in order to create consensus and mitigate the complex decision system. Also, it will be good if governmental organisations stimulate and supported local energy initiatives in a specific way so that they receive the help they want and the help they need, this is beneficial for the success of local energy initiatives. Lastly it is important to set up local energy initiatives on the right scale in order to create social pressure.

Important to note is that these recommendations are not a real clear answer to the main question. However they can be helpful to gain insight in the different possible approaches to achieve sustainable neighbourhood redevelopment in various ways. These different recommendations should be seen as an intertwining set of approaches and recommendations that can help mitigate the flaws of one recommendation by adding elements of others. Hence it can be seen as a total package that could be

applied within different situations and different contexts. They are more of a guideline for recognizing potential ways to solve the different problems one could face when stimulating or implementing sustainable neighbourhood redevelopment.

6.2 Discussion

The outcomes of the research are no outcomes that should be seen on their own. The basis for them is laid by different scientific authors while the recommendations are meant to help planning professionals in stimulating sustainable neighbourhood redevelopment. Hence it is interesting to see what importance this research can add to the scientific literature and planning practice.

Firstly, the research began with a thorough discussion of different concepts used in the sustainability debate. Hence the thesis adds to the insight in the consequences of using such concepts and might change the way those concepts are used in science or policy. At least I hope that the usage of such concepts is chosen more deliberately with the differing consequences in mind. This would be helpful to clarify the exact meaning and could also improve the clarity of the usage of the concepts in science. Furthermore, the thesis discusses theoretical debates about complexity as mentioned by de Roo (2003) and transition management (Rotmans et al., 2003; Loorbach, 2010), due to the outcomes being relatable to those debates the thesis could help gaining insight in the practical applicability of those theories. To be more precise, the importance of stakeholder involvement is confirmed by the research. Also, the importance of long-term goal setting was found to be important as well as enabling actors to learn from practice. Moreover, the importance of context found in both literature and interviews might add insight to the perceived importance of complexity in practices. Furthermore, the wide array of barriers and opportunities discussed in scientific literature has been enlarged by the barriers and opportunities recognized during the interviews. Also, the understanding of those barriers and opportunities in practice has been enhanced as well as the importance of each of those barrier per stakeholder type.

When looking at planning practice, this research adds many insights for planning professionals. The outcomes that are closely linked to the transition theory can underline the importance of working with such concepts in mind. The fact that these concepts are also mentioned by the most successful province underlines the statement of the importance of transition management for planning practice. Furthermore, the different insights gained about roles taken and the success of the chosen roles could add to the understanding of different parties on the best role to take in sustainable neighbourhood redevelopment. Moreover, the lessons that have been drawn and the recommendations made could give guidance to planning professional who seek the best route to enable or stimulate sustainable neighbourhood redevelopment. The recommendations do not give a strict path or route, instead it adds insight that different planning professionals could interpret and implement on their own. I think that this is very fitting for the uncertain and unclear nature of the energy transition as a whole.

This research gave recommendations that can aid the stimulation of sustainable neighbourhood redevelopment in the Netherlands. Although the interviews were conducted in the Northern and Eastern part of the Netherlands, the results are also applicable in the rest of the Netherlands. There is namely no reason to argue that the findings found in this research cannot be applied in the rest of the Netherlands. The cases and governmental organizations that were interviewed namely shall not differ from similar organizations in the rest of the Netherlands. For instance one case was in a city that is no different for other cities in the Netherlands and also the village case is representative for the other parts of the Netherlands. Moreover, one of the supportive parties that has been interviewed is present throughout the Netherlands and also the governmental organization structures are also present throughout the Netherlands.

The application of context throughout this research is also important for the applicability of the recommendations throughout the Netherlands. Namely, the context in the other neighbourhoods in different parts of the Netherlands may differ considerably, but this imposes no problems since the context between different neighbourhood within the Northern and Eastern parts of the Netherlands might also differ considerably. However, since the research sees context as an important element to always take into account and therefore uses it to base recommendations around. Hence the different existing contexts in other parts of the Netherlands do not create problems for the outcomes. To be even more precise, the adoption of the contextual approach creates opportunity to apply the recommendations throughout the Netherlands due to the possibility to create a tailor made approach by having context as a base for that approach. Therefore I think that the recommendations that have been mentioned could be well implemented throughout the Netherlands.

6.3 Recommendations for future research

The research gave recommendation to many facets connected to sustainable neighbourhood redevelopment. However, there were elements that remained mostly untouched during this research or that were not touched upon enough. Due to time constraints I have been able to only interview various important actors involved within sustainable neighbourhood redevelopment, however there are more actors involved. To gain a more complete picture it could be helpful to interview more actors in order to gain understanding of their roles. Moreover, the importance of the intrinsic will of people to start up local energy initiatives, join such an initiative or get active themselves is touched upon to limited. To be precise, the importance of the individual attitude is not really investigated during this research. However, in the different interviews quite some emphasis was put on the role of the individual, the difficulty to steer them and therefore seeing individuals as a crucial element of success for sustainable neighbourhood redevelopment. This is also the main weakness of the research; hence this is an element that could be improved upon. Hence one of the gaps in this research is the precise importance of the individual within a neighbourhood in order to achieve success. So a recommendation for future research is gaining insight in the role of individual attitude on successful neighbourhood redevelopment. Also the ability to guide or steer individuals as government is an interesting element since it could enable a more top down approach. Furthermore, since the cases in this research clearly have quite a strong social cohesion or bond due to their location or specific circumstances while at the same time they have a clear opinion that the importance of this should not be overrated it will be interesting to gain insight in this topic and to weigh the importance of social cohesion for the successful implementation of sustainable neighbourhood renovation.

There are valid reasons and arguments not to take the individual and social cohesion into account. The most important reason for this is the fact that this was not the main focus of the research. Also looking to the importance of the individual and social cohesion could distract from the main research focus. Also time constraints played an important part since I have to make a choice on what to take into account in the limited amount of time.

6.4 Reflection

This section will briefly discuss the process of the thesis, it will reflect on activities that have been conducted during the thesis, and it will also shortly discuss the effectiveness of the method and the outcomes.

When looking back at the process and outcomes of this research I could say it was sometimes a struggle where I met difficulties along the way. Difficulties in totally comprehending the subject was quite a difficult task, the theoretical framework in the beginning did not give me enough guidance to truly steer the research in the right direction. However, after considerable amounts of time I managed to

get to grips with the literature. The literature on sustainability and the different other concepts used formed initially also a barrier for this research since comprehending all the minor differences was quite hard. The analysis of the consequences of the usage of such concepts was very helpful in this regard, although it was quite time consuming. Furthermore, the literature on the application in theory was less helpful due to the fact that the theoretical approaches were hard to find in practice. Therefore, theoretical insights were not used as much as I could have been doing. The section about transition management proved to be very useful, many of the outcomes could be linked directly to elements mentioned by authors in that field. Additionally, the barriers and opportunities to sustainable neighbourhood redevelopment which are also mentioned in transition management theory proved useful and a good base for conducting the interviews.

One of the drawbacks of this time-consuming process as described above was that the scheduling of the interviews started later than I had expected. Furthermore, since the response of many interviewees was quite late, the total interview process took quite long. Also, the transcription took longer than assumed, hence leaving quite a small amount of time for the real analysis. When looking to the general process of the thesis I would say that my expectations on the length of certain activities was not correct, therefore time management would be something that I can improve upon. When looking at the method on its own, I would state that the use of interviews for conducting the research was an appropriate method. Many barriers and other factors previously unknown or not found in the literature were discovered during the interviews that would not have been discovered with questionnaires.

When looking at the results from the data and the research I think that they are interesting, however due to the fact that I have conducted interviews and not questionnaires there can be no statement about objective significance. This makes the results less clear and more nuanced. Such a result asks for a more explanatory analysis, when looking back, I would have liked a more clear result since this makes the analysis more easy and could lead to a stronger or more straight forward conclusion. However, due to the fact that the problem this research revolves around is a qualitative research, questionnaires were no good option. The results on the other hand are interesting and I think that I have come to some interesting lessons or recommendations. The main flaw I see in the results is the fact that they do not always incorporate the insights gained during the literature research. What I have learned hence is that the theories could be applied in a more active way in order to gain deeper insights since a deep connection between theory and practice would be even more insightful than the research conducted now. So in the next time I will think about connection theories with the interviews in a more active way and before the interviews have started to achieve the most insightful results.

When looking at the process, I think I have managed the different tasks in an appropriate manner without too much guidance of my supervisors. I feel that in the end I have been rewarded for the time investment and appropriate work approach by selection for a key note speech, which I consider an honour. Furthermore, I think I have been doing the things roughly according to plan, keeping my word with the agreements made with my supervisor. The main flaw during the process, was the fact that theoretical insights gained during my bachelor and master from de Roo were stuck in my head like second nature; hence missing the opportunity to include it actively up front. However, after feedback from my supervisor I have recognized the problem and included. The addition of complexity proved to be very important for gaining understanding of the processes. Moreover, it helped linking outcomes to that theory. However when I would have applied this earlier, it could have led to a better thesis.

I look back with satisfaction on the process of creating this thesis. Satisfaction because the general process was alright, satisfaction because the results were interesting, but mostly satisfaction because I have finished it.

7 Literature

Aerschot, M. F., van (2013). *Energie in de wijk: Het verduurzamen van de bestaande woningvoorraad als kans voor nieuwe werkgelegenheid en energie opwekken met de inwoners van Kreekhuisen als katalysator voor sociale duurzaamheid* (Afstudeer onderzoek). Accessed on 15-11-2017 via <https://repository.tudelft.nl/islandora/object/uuid:65f917d9-2738-430b-9303-4867255d4aa3/datastream/OBJ> .

Alberini, A., Bigano, A. & Boeri, M. (2014). Looking for free riding: energy efficiency incentives and Italian homeowners. *Energy Efficiency*, 7(4), 571-590.

Aleklett, K. & Campbell, C. J. (2003). The peak and decline of world oil and gas production. *Minerals and Energy-Raw Materials Report*, 18(1), 5-20.

Aleklett, K., Höök, M., Jakobsson, K., Lardelli, M., Snowden, S. & Söderbergh, B. (2010). The peak of the oil age—analyzing the world oil production reference scenario in world energy outlook 2008. *Energy Policy*, 38(3), 1398-1414.

Al-Hagla, K. (2008). Towards a sustainable neighborhood: The role of open spaces. *Architectural Research*, 2(2), 162-177.

Ástmarsson, B., Jensen, P. A. & Maslesa, E. (2013). Sustainable renovation of residential buildings and the landlord/tenant dilemma. *Energy Policy*, 63, 355-362.

Baek, C. & Park, S. (2012). Policy measures to overcome barriers to energy renovation of existing buildings. *Renewable and Sustainable Energy Reviews*, 16(6), 3939-3947.

Baxter, P. & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, 13(4), 544-559.

Belmans, R., Büscher, J., Jonghe, C. de, Pauw, P. de, Raedemaeker, P. de, Davelder, C., Grosjean, S., Hendrix, E., Lemmers, J., Palmers, G., Strobbe, M., Vaerenbergh, I. van & Vingerhoets, P. (2016). *De eindgebruiker centraal in de energietransitie*. Brussel: Koninklijke Vlaamse Academie van België voor Wetenschappen en Kunsten, Standpunten nr. 44.

Belzen, T. van (2017a). Gemeente kan gasloos bouwen niet afdwingen. *Cobouw*, 31-08-2017.

Belzen, T. van (2017b). Zelfs met extra geld moet het van de bouwers komen. *Cobouw*, 21-09-2017.

Bentley, R. W. (2002). Global oil & gas depletion: an overview. *Energy policy*, 30(3), 189-205.

Berardi, U. (2013). Stakeholders' influence on the adoption of energy-saving technologies in Italian homes. *Energy Policy*, 60(2), 520-530.

Bueren, E. M. van & Priemus, H. (2002). Institutional barriers to sustainable construction. *Environment and Planning B: Planning and Design*, 29(1), 75-86.

Cambridge Dictionary (2017). *Self-sufficient*. Accessed on 09-10-2017 via <http://dictionary.cambridge.org/dictionary/english/self-sufficient>. Cambridge University Press

- Carrer, P., Wargocki, P., Fanetti, A., Bischof, W., Fernandes, E. D. O., Hartmann, T., Kephelopoulou, S., Palkonen, S. & Seppänen, O. (2015). What does the scientific literature tell us about the ventilation–health relationship in public and residential buildings?. *Building and Environment*, 94(1), 273-286.
- Cattano, C., Valdes-Vasquez, R., Plumblee, J. M. & Klotz, L. (2013). Potential Solutions to Common Barriers Experienced during the Delivery of Building Renovations for Improved Energy Performance: Literature Review and Case Study. *Journal of Architectural Engineering*, 19(3), 164-167.
- CBS (2016). *Hernieuwbare energie in Nederland 2015*. Den Haag: Centraal Bureau voor de Statistiek.
- CBS (2017a). *Voorraad woningen; gemiddeld oppervlak; woningtype, bouwjaarklasse, regio*. Accessed on 07-06-2017 via <http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=82550NED&D1=a&D2=0&D3=1-11&D4=0&D5=4-5&HDR=T,G1,G2&STB=G3,G4&VW=T>.
- CBS (2017b). *Dierlijke mest; productie en mineralenuitscheiding; bedrijfstype, regio*. Accessed on 29-09-2017 via <http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=82506NED&LA=NL>.
- CBS (2017c). *Energieverbruik particuliere woningen; woningtype en regio's*. Accessed on 29-09-2017 via <http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=81528NED>.
- Clifford, N., French, S. & Valentine, G. (2010). *Key Methods in Geography*. 2nd edition. London: Sage Publications
- Conci, M. & Schneider, J. (2017). A District Approach to Building Renovation for the Integral Energy Redevelopment of Existing Residential Areas. *Sustainability*, 9(5), 747.
- Connolly, D., Lund, H., Mathiesen, B. V., Werner, S., Möller, B., Persson, U., Boermans, T., Trier, D., Østergaard, P. A. & Nielsen, S. (2014). Heat Roadmap Europe: Combining district heating with heat savings to decarbonise the EU energy system. *Energy Policy*, 65(2), 475-489.
- Corvacho, H., Alves, F. B. & Rocha, C. (2016). A Reflection on Low Energy Renovation of Neighborhoods in Southern Europe. *Sustainability*, 8, 987-1005.
- Dahal, K. & Niemelä, J. (2016). Initiatives towards Carbon Neutrality in the Helsinki Metropolitan Area. *Climate*, 4(3), 36.
- Dincer, I. (2002). The role of exergy in energy policy making. *Energy policy*, 30(2), 137-149.
- Doodeman, M., Koenen, I. & Belzen, T. van (2017). Miljarden gezocht voor klimaat en woningen. *Cobouw*, 21-09-2017.
- Egan, J. (2004). *The Egan review: skills for sustainable communities*. London: Crown copyright.
- EnergieKansen (2015). *Wat beweegt ons?* Accessed on 14-11-2017 via <http://www.energiekansen.nu/over-ons/>.
- EnergieLabel.nl (n.d.). *EnergieLabel woningen*. Accessed on 10-10-2017 via <https://www.energielabel.nl/woningen>.

- Farreny, R., Oliver-Solà, J., Montlleó, M., Escribà, E., Gabarrell, X. & Rieradevall, J. (2011). Transition towards sustainable cities: opportunities, constraints, and strategies in planning. A neighbourhood ecodesign case study in Barcelona. *Environment and Planning A*, 43(5), 1118-1134.
- Gemeente Assen (2009). *Duurzaamheidsvisie Assen 2009-2015*. Assen: Gemeente Assen
- Gemeente Dalfsen (2017). *Beleidsplan duurzaamheid 2017-2035*. Dalfsen: Gemeente Dalfsen
- Gemeente Groningen (n.d.). *Groningen geeft energie: programma 2015 - 2018*. Groningen: Gemeente Groningen
- Gemeente Zwolle (2015). *Agenda Duurzaamheid Zwolle: Op weg naar een toekomstbestendig Zwolle*. Zwolle: Gemeente Zwolle
- Gerdes, J., Marbus, S & Boelhouwer, M. (2016). *Energietrends 2016*. ECN Beleidsstudies. ECN-O--16-031.
- Gill, P., Stewart, K., Treasure, E. & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British dental journal*, 204(6), 291-295.
- Greco, A., Konstantinou, T, Schipper, R. Binnekamp, R. Gerritsen, E. & Dobbelsesteen, A. van den (2017). Stakeholders View on Commercial Benefits for Energy Neutral Refurbishment of Let Properties. *World Sustainable Built Environment Conference 2017 Hong Kong*. Accessed on 20-11-2017 via <https://repository.tudelft.nl/islandora/object/uuid:259f57df-00ac-4328-af98-d5a98dcbc698?collection=research>.
- Hauge, Å. L., Thomsen, J. & Löfström, E. (2013). How to get residents/owners in housing cooperatives to agree on sustainable renovation. *Energy Efficiency*, 6(2), 315-328.
- Heiskanen, E. & Matschoss, K. (2017). Understanding the uneven diffusion of building-scale renewable energy systems: A review of household, local and country level factors in diverse European countries. *Renewable and Sustainable Energy Reviews*, 75(6), 580-591.
- Hellinga-Oving, A.B.G. (2017). *De gemeente Winsum gaat gasloos en duurzaam bouwen*. Grondzaken in de praktijk.
- Herrmann, A. (2013). Biogas production from maize: current state, challenges and prospects. 2. Agronomic and environmental aspects. *Bioenergy research*, 6(1), 372-387.
- Holden, E., Linnerud, K. & Banister, D. (2016). The imperatives of sustainable development. *Sustainable Development*, 25(3), 213-226.
- Hopwood, B., Mellor, M. & O'Brien, G. (2005). Sustainable development: mapping different approaches. *Sustainable development*, 13(1), 38-52.
- Hunt, D. V. & Rogers, C. D. (2005). Barriers to sustainable infrastructure in urban regeneration. *Proceedings of the Institution of Civil Engineers-Engineering Sustainability*, 158(2), 67-81.
- IPCC (2015). *Climate change 2014: Synthesis report*. Geneva, Switzerland: IPCC
- Jabareen, Y. R. (2006). Sustainable urban forms their typologies, models, and concepts. *Journal of planning education and research*, 26(1), 38-52.

- Jakob, M. (2007). The drivers of and barriers to energy efficiency in renovation decisions of single-family home-owners. *Centre for Energy Policy and Economics (CEPE). Zurich, Switzerland: CEPE*
- Janssens, A., Vaillant Rebollar, J., Himpe, E. & Delghust, M. (2016). Transforming social housing neighbourhoods into sustainable carbon-neutral districts. *11th Nordic Symposium on Building Physics, Trondheim Norway*
- Jensen, P. A. & Maslesa, E. (2015). Value based building renovation—A tool for decision-making and evaluation. *Building and Environment, 92(2), 1-9.*
- Jensen, S. R., Purup, P. B., Kirkegaard, P. H., Petersen, S. & Strange, A. (2017). Towards a Holistic approach to Low Energy-Building Design: Introducing Metrics for Evaluation of Spatial Quality. *PLEA 2017, Edinburgh.*
- Jepson Jr, E. J. & Edwards, M. M. (2010). How possible is sustainable urban development? An analysis of planners' perceptions about new urbanism, smart growth and the ecological city. *Planning Practice & Research, 25(4), 417-437.*
- Kann, F. M. G., van (2015). *Energie en ruimtelijke planning, een spannende combinatie.* Groningen: InPlanning
- Kenworthy, J. R. (2006). The eco-city: ten key transport and planning dimensions for sustainable city development. *Environment and urbanization, 18(1), 67-85.*
- Khan, J. (2005). The importance of local context in the planning of environmental projects: examples from two biogas cases. *Local Environment, 10(2), 125-140.*
- Larco, N. (2016). Sustainable urban design—a (draft) framework. *Journal of Urban Design, 21(1), 1-29.*
- Lewis, N. S. (2007). Powering the planet. *MRS bulletin, 32(10), 808-820.*
- Lieberman, E. S. (2005). Nested analysis as a mixed-method strategy for comparative research. *American Political Science Review, 99(03), 435-452.*
- Loorbach, D. (2010). Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance, 23(1), 161-183.*
- Luederitz, C., Lang, D. J. & Von Wehrden, H. (2013). A systematic review of guiding principles for sustainable urban neighborhood development. *Landscape and Urban Planning, 118(1), 40-52.*
- Marszal, A. J., Heiselberg, P., Bourrelle, J. S., Musall, E., Voss, K., Sartori, I. & Napolitano, A. (2011). Zero Energy Building—A review of definitions and calculation methodologies. *Energy and buildings, 43(4), 971-979.*
- Meijer, F., Itard, L. & Sunikka-Blank, M. (2009). Comparing European residential building stocks: performance, renovation and policy opportunities. *Building Research & Information, 37(5-6), 533-551.*
- Melchert, L. (2007). The Dutch sustainable building policy: A model for developing countries?. *Building and Environment, 42(2), 893-901.*

Menassa, C. C. & Baer, B. (2014). A framework to assess the role of stakeholders in sustainable building retrofit decisions. *Sustainable Cities and Society*, 10(4), 207-221.

Meyer, N. I., Mathiesen, B. V. & Hvelplund, F. (2014). Barriers and potential solutions for energy renovation of buildings in Denmark. *International Journal of Sustainable Energy Planning and Management*, 1, 59-66.

Milieu Centraal (n.d.). *Energieneutraal Verbouwen*. Accessed on 14-11-2017 via <https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/energieneutrale-woning/energieneutraal-verbouwen/>.

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (2013). *Het bouwbesluit 2012*. Accessed on 16-11-2-17 via <http://www.bouwbesluitinfo.nl/media/download/infoblad-verbouw-en-functiew-herz-apr2013.pdf>.

Morel, J. (2016). FrieslandCampina doopt veehouders om tot leveranciers groene energie. *Trouw*, 07-05-2017.

NOS (2016a). *Na vijftig jaar gaat Nederland afscheid nemen van aardgas*. Accessed on 08-09-2017 via <https://nos.nl/artikel/2139598-na-vijftig-jaar-gaat-nederland-afschied-nemen-van-aardgas.html>.

NOS (2016b). *Windmolens bij jou in de buurt: hier staan ze*. Accessed on 28-09-2017 via <https://nos.nl/artikel/2144876-windmolens-bij-jou-in-de-buurt-hier-staan-ze.html>.

NOS (2017a). *Advies bij formatie: maak klimaat prioriteit*. Accessed on 25-04-2017 via <http://nos.nl/artikel/2166387-advies-bij-formatie-maak-klimaat-prioriteit.html>.

NOS (2017b). *Klimaat was nog nooit zo belangrijk in formatie als nu*. Accessed on 27-04-2017 via <http://nos.nl/artikel/2170242-klimaat-was-nog-nooit-zo-belangrijk-in-formatie-als-nu.html>.

NOS (2017c). *Trump: VS trekt zich terug uit klimaatakkoord Parijs*. Accessed on 06-06-2017 via <http://nos.nl/artikel/2176207-trump-vs-trekt-zich-terug-uit-klimaatakkoord-parijs.html>.

NOS (2017d). *Vorig jaar wereldwijd 9 procent meer duurzame energie opgewekt*. Accessed on 07-06-2017 via <http://nos.nl/artikel/2177049-vorig-jaar-wereldwijd-9-procent-meer-duurzame-energie-opgewekt.html>.

NOS (2018). *Zwaarste aardbeving in Groningen sinds 2012*. Accessed on 16-01-2018 via <https://nos.nl/artikel/2211036-zwaarste-aardbeving-in-groningen-sinds-2012.html>.

Olsson, S., Malmqvist, T. & Glaumann, M. (2015). Managing sustainability aspects in renovation processes: Interview study and outline of a process model. *Sustainability*, 7(6), 6336-6352.

Østergaard, P. A., Mathiesen, B. V., Möller, B. & Lund, H. (2010). A renewable energy scenario for Aalborg Municipality based on low-temperature geothermal heat, wind power and biomass. *Energy*, 35(12), 4892-4901.

Painuly, J. P. (2001). Barriers to renewable energy penetration; a framework for analysis. *Renewable energy*, 24(1), 73-89.

Palumbo, M. L., Fimmanò, D., Mangiola, G., Rispoli, V. & Annunziato, M. (2017). Strategies for an urban renewal in Rome: Massimina Co_Goal. *Energy Procedia*, 122(1), 559-564.

PBL (2016). *Opties voor energie- en klimaatbeleid*. Rapport 2393. Den Haag: Planbureau voor de Leefomgeving (PBL).

Provincie Drenthe (2013). *Beleidsverkenning Energietransitie: Op weg naar een duurzame Drentse energiehuishouding*. Assen: Provincie Drenthe.

Provincie Drenthe (2017). *Magazine Expeditie Energieneutraal Wonen - 2017*. Assen: Provincie Drenthe.

Provincie Drenthe (n.d.). *Energieagenda 2016-2020: Op weg naar een energieneutraal Drenthe, van bewustzijn naar bewusten*. Assen: Provincie Drenthe.

Provincie Groningen (2016). *Vol ambitie op weg naar transitie: Programma Energietransitie 2016-2019*. Groningen: Provincie Groningen

Provincie Overijssel (2015). *Duurzaam Ontwikkelen Overijssel*. Zwolle: Provincie Overijssel.

Rabionet, S. E. (2011). How I learned to design and conduct semi-structured interviews: An ongoing and continuous journey. *The Qualitative Report*, 16(2), 563.

Ragin, C. C. (2013). *The comparative method: Moving beyond qualitative and quantitative strategies*. Oakland, California: University of California Press.

REN21 (2016). *Renewables 2016 Global Status Report*. Paris: Renewable Energy Policy Network for the 21st Century.

Risholt, B. & Berker, T. (2013). Success for energy efficient renovation of dwellings—Learning from private homeowners. *Energy Policy*, 61, 1022-1030.

Risholt, B., Time, B. & Hestnes, A. G. (2013). Sustainability assessment of nearly zero energy renovation of dwellings based on energy, economy and home quality indicators. *Energy and Buildings*, 60, 217-224.

Ritchie, A. & Thomas, R. (2009). *Sustainable urban design: an environmental approach*. New York: Taylor & Francis.

Roo, G. de (2003). *Environmental Planning in the Netherlands: Too good to be true*. United Kingdom: Ashgate

Roo, G. de & Porter, G. (2007). *Fuzzy Planning – The role of actors in a fuzzy Governance environment*, United Kingdom: Ashgate

Rosen, M. A. & Dincer, I. (2001). Exergy as the confluence of energy, environment and sustainable development. *Exergy, an International journal*, 1(1), 3-13.

Rotmans, J., Kemp, R. & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*, 3(1), 15-31.

RVO (2014a). *Technieken voor een energieneutrale woning*. Utrecht: Rijksdienst voor Ondernemend Nederland (RVO).

RVO (2014b). *Blok voor Blok: De bevindingen: Grootschalige energiebesparing in de bestaande woningbouw*. Den Haag: Rijksdienst voor Ondernemend Nederland (RVO).

RVO (2015). *Rapportage hernieuwbare energie: Deel2 Blik op innovatie*. Zwolle, Utrecht: Rijksdienst voor Ondernemend Nederland (RVO).

RVO (n.d. a). *Overijssel - Overijsselse Aanpak 2.0* Accessed on 06-11-2017 via <https://www.rvo.nl/initiatieven/energiebesparing-bestaande-bouw/overijssel-overijsselse-aanpak-20>.

RVO (n.d. b). *Database Energiezuinig Gebouwd*. Accessed on 21-12-2017 via https://www.rvo.nl/initiatieven/overzicht/27008?f%5B0%5D=field_initiative_facet_1%3ARenovatie%20woningbouw&page=1.

Sağlam, N. G., Yılmaz, A. Z., Becchio, C. & Corgnati, S. P. (2017). A comprehensive cost-optimal approach for energy retrofit of existing multi-family buildings: Application to apartment blocks in Turkey. *Energy and Buildings*, 150, 224-238.

Sanders, F.C. (2014). *Duurzame Ontwikkeling door Collectief Bewonersinitiatief: Leidraad voor professionals om bewonersgroepen aan duurzaamheidsopgave te verbinden*. *Dissertation, TU Delft*.

Shove, E. & Walker, G. (2007). CAUTION! Transitions ahead: politics, practice, and sustainable transition management. *Environment and Planning A*, 39(4), 763-770.

SEN (n.d. a) *Doelstelling*. Accessed on 21-12-2017 via <https://www.samenenergieneutraal.nl/doelstelling/>.

SEN (n.d. b) *Initiatiefnemers*. Accessed on 21-12-2017 via <https://www.samenenergieneutraal.nl/initiatiefnemers/>.

Soest, J.P. van, Wiltink, H., Soest, H. van, Luken, E., Londo, M., Mozaffarian, H., Himbergen, H. van, Dorp, R. van, Mechelen, X. van, Dumont, M & Wismeijer, R. (2014). *Routekaart hernieuwbaar gas*. ECN, Groen Gas Nederland, De Gemeeynt, RVO.

Thuvander, L., Femenías, P., Mjörnell, K. & Meiling, P. (2012). Unveiling the process of sustainable renovation. *Sustainability*, 4(6), 1188-1213.

Tigchelaar, C. & Leidelmeijer, K. (2013). *Energiebesparing: Een samenspel van woning en bewoner - Analyse van de module Energie WoON 2012*. Petten, Amsterdam: ECN & RIGO.

Torcellini, P., Pless, S., Deru, M. & Crawley, D. (2006). Zero Energy Buildings: A Critical Look at the Definition. *National Renewable Energy Laboratory and Department of Energy, United States*. Conference Paper: ACEEE Summer Study

Tuominen, P., Klobut, K., Tolman, A., Adjei, A. & de Best-Waldhober, M. (2012). Energy savings potential in buildings and overcoming market barriers in member states of the European Union. *Energy and Buildings*, 51, 48-55.

United Nations (2016). *Transforming our world: the 2030 Agenda for Sustainable Development*. Accessed on 22-09-2017 via <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication>.

Urgenda (n.d.). *Energieneutrale huizen*. Accessed on 25-09-2017 via <http://www.urgenda.nl/themas/bouw/energieneutraal/>.

Urgenda (2014). *De agenda; Nederland 100% Duurzame energie in 2030*. Accessed on 11-09-2017 via <http://www.urgenda.nl/documents/rapport-nederland-100procent-duurzaam2030.pdf>.

Wang, N., Phelan, P. E., Gonzalez, J., Harris, C., Henze, G. P., Hutchinson, R., Langevin, J., Lazarus, M.A., Nelson, B., Pyke, C., Roth, K., Rouse, D., Sawyer, K. & Selkowitz, S. (2017). Ten questions concerning future buildings beyond zero energy and carbon neutrality. *Building and Environment*, 119, 169-182.

WCED (1987). *Our Common Future*. Oxford: Oxford University Press. World Commission on Environment and Development (WCED).

Weiland, P. (2010). Biogas production: current state and perspectives. *Applied microbiology and biotechnology*, 85(4), 849-860.

Wheeler, S. M. (2013). *Planning for sustainability: creating livable, equitable and ecological communities*. London: Routledge.

Wijngaard, R. van den, Folkert, R. & Middelkoop, M. van (2014). *Op weg naar een klimaatneutrale woningvoorraad in 2050*. Rapport: Den Haag: Planbureau voor de Leefomgeving (PBL).

Williams, K. & Dair, C. (2007). What is stopping sustainable building in England? Barriers experienced by stakeholders in delivering sustainable developments. *Sustainable development*, 15(3), 135-147.

Wilson, C., Crane, L. & Chryssochoidis, G. (2015). Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy. *Energy Research & Social Science*, 7(50), 12-22.

Winston, N. (2010). Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas. *Sustainable Development*, 18(6), 319-330.

Wu, X. & Zmeureanu, R. (2011). Exergy analysis of residential heating systems: performance of whole system vs performance of major equipment. *12th Conference of International Building Performance Simulation Association, Sydney, Australia*.

Yigitcanlar, T. & Teriman, S. (2015). Rethinking sustainable urban development: towards an integrated planning and development process. *International Journal of Environmental Science and Technology*, 12(1), 341-352.