A District Approach to Replace Gas: Complexity Challenges and Collaborative Stimulation

A Comparative analysis of Sluispolder and Palenstein

Palenstein Zoetermeer*

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*The photo on the title page is taken in Palenstein, Zoetermeer during a visit to the district. This photo shows the current status of the transition. In the horizontal block of houses are the energy neutral houses, delivered to the residents in the past month. However, on the forefront, you see privately owned houses and in the back high-rise buildings fill the picture. Technically we are able to produce energy neutral housing today. However, realizing a gas-free district remains challenging. This research hopes to shed light on the complexities challenging and the processes enhancing the transition.

Summary

- This research studies the development of a district approach in local governments to realize the replacement of gas in the energy transition.
- This research conducts a comparative case study between the district Sluispolder, Maassluis and Palenstein, Zoetermeer. This comparison is interesting and relevant as the cases are currently in a different stage of the transition process. The district approach of Palenstein is more developed than Maassluis.
- The main research question of this research is: *To what extent are complexities inherent to a sociotechnical energy system challenging the scale-up of a transition approach to discard natural gas and to what extent do collaborative governance processes benefit the scale-up of this transition approach?*.
- This research defines the energy system as a *multilevel sociotechnical complex system* in which the interactions of niche, regime and landscape level explain the dynamics of a transition. This study focuses on the dynamics and development at the niche level.
- The development of a district approach at the niche level is indicated by its current *scale-up capacity*. scale-up capacity is necessary in order to scale-up the district approach to other districts and consequently contribute to the energy transition. scale-up capacity is achieved by d*eepening and broadening* a district approach. Both the district approach in Palenstein and Sluispolder lack scale-up capacity concludes this research.
- Five complexities are introduced in the theoretical framework: *social, technical, financial, legal and time complexity*. In the empirical analysis, only the first three (social, technical and financial) complexity is considered. These three complexities were mentioned most and an important interaction and synergistic relation between these three complexities found. The three complexities are interrelated and increase each other's complexity.
- *Collaborative governance* is measured as a process (CGP) in which the stakeholders have to engage in principled engagement and have shared motivation and capacity for joint action. The presence and the impact of this process are measured at three levels: in the municipality organisation, in the district and in the region. Regionally a CGP is absent as it is too early in the transition for different municipalities to collaborate. Regional collaboration could be beneficial when districts achieved more scale-up capacity. At this point, districts are focused inwards. Zoetermeer shows a fully developed local CGP is vital for the development of a district approach. Internally, a program approach and sufficient administrative and executive support is necessary however a formal CGP is not found. In Maassluis neither a local or internal CGP is found. The most important CGP is the local CGP in which the key stakeholders are: the municipality, the housing corporation(s) and the network operator.
- Residents, especially private, are identified as the biggest challenge in the development and realization of a district approach in both cases. They increase social, technical and financial complexity, however, are also unfitted to join a CGP. Intense and the appropriate communication is necessary with the residents to inform, interest and involve them. In addition, financial constructions need to be developed in order to make a transition within their capabilities and within their interests.

Acknowledgment

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The Erasmus University: introduced an interesting and relevant subject to research and a dedicated and helpful supervisor during the research process. Jurian Edelenbos provided the necessary input, proposals and reflection to this research without which this research would not have been the same.

The respondents: in both Zoetermeer and Maassluis people were eager to contribute to the research. Both municipality and other local stakeholders responded to the interview invitation with enthusiasm and provided the necessary data during the interviews.

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1. Introduction

1.1 Problem Set

"In order to achieve the climate targets, almost all buildings in the Netherlands have to be taken care of. That means roughly 50,000 existing homes per year sustainable in 2021 and by 2030 we need a rhythm of 200,000 per year. In that case, we can jointly emit 3.4 Mton less CO2 in 2030 than in the reference scenario (RVO)*"*

On international, regional, national and local level ambitions are expressed and agreed on to limit global warming. To achieve these multilevel ambitions a transition is required towards a new, sustainable energy system in which renewable energy sources replace the current unsustainable energy sources (Verbong & Geels, 2007; Walker & Cass, 2007). The Brundtland commission defines sustainable development as *"development that meets the needs of the present without compromising the ability of future generations to meet their own need"* (Nikolic, 2009). Besides international treaties such as the COP 21 and European policy such as the 2020 Energy Strategy, the Dutch government has set the unilateral ambition to reduce 80-95% of the total of GHG (Greenhouse Gas) emissions by 2050 (RVO). One of the approaches to achieve these ambitious objectives is to no longer rely on natural gas as a source of energy. This is a vital aspect of the Dutch energy transition as currently the houses and buildings in our built environment use 30% of the Dutch energy (Tweede Kamer, Februari 2018). In the Climate agreement of 2018 the Dutch government has set 2050 as the year the Netherlands is no longer reliant on natural gas.

In this transition away from gas the eyes are often on local governments (Tweede Kamer, Februari 2018). Local governments are setting own ambitions in order to realize national and international objectives (MRDH, 2017). The municipalities of the Netherlands are responsible for the houses and buildings in their environment (Tweede Kamer, Februari 2018). This confronts local governments with the immense challenge to find a way to turn 200.000 houses sustainable per year, which includes replacing natural gas as a source of energy by sustainable energy sources. Some municipalities set the deadline to achieve independence from gas even decades earlier than the national objective (MRDH, 2017). These municipalities are increasing their ambitions and their efforts to achieve independence from gas. As no local government has yet completed the transition, leading municipalities are subject to this study. These leading municipalities are forced to experiment with novel approaches to generate innovation and transition in their local energy system. The problem set of this research will be the struggle to develop novel approaches to realize alternatives for natural gas in the municipalities currently leading in the Dutch energy transition.

1.2 Research Objective

The focus of this research will be the local transition towards a sustainable, gas free, local energy system. First and foremost the aim of this study is exploratory. At this point, local governments are facing a necessary but disruptive transition of the socio-technical (ST) energy system, which will require uncertain and still unknown steps. This study aims to generate insights on the effort to find an appropriate approach to discard natural gas in buildings and houses of municipalities leading in the dutch energy transition. The challenges perceived by local stakeholders will be studied. In addition,

strategies to overcome the challenges and to make substantial steps are explored. The aim is to generate outcomes which are of value to municipalities in which a transition effort is yet to set off.

First of all, this research conducts an analysis of the local ST energy system and its inherent complexities. This research builds on existing research on the integration of the social and technical parts of the energy system. Both social and technical aspects of the local energy system are taken into account to advance the understanding of the complexities produced by their integration and interaction. Second of all, this research aims to identify the influence of the complexities in a ST energy system on the development of an appropriate approach to discard gas. Third, collaborative governance is proposed as a strategy to deal with the complexities and to achieve a local energy transition. Collaboration can emerge on different levels between a variety of actors. Hence, this research explores the contribution of three possible collaborative processes to a successful transition approach. First of all, collaboration within the local government organisation is considered. Secondly, local collaboration between stakeholders in the local energy system is studied. Third, regional collaboration between different local governments with a similar objective to lead in the Dutch energy transition and develop an approach to discard natural gas. The aim is to identify whether and in what way these different collaborative governance processes result in an appropriate approach to eliminate the dependence on natural gas in the built environment.

1.3 Research Questions

The question guiding this research and enable the accomplishment of the research objective is:

How does the complexity of a sociotechnical energy system challenge and collaborative governance benefit the scale up of a transition approach to discard natural gas?

A rather general main question is employed as this research will have exploratory nature. This will allow a wide range of complexity challenges and collaborative governance processes to be considered. In other words, a wider scope of literature can be considered and used to approach and analyse the case studies. In the case studies this will mean multiple complexities and their mutual interactions can be studied. In addition, the existence and influence of collaborative governance processes at three different levels is examined.

An appropriate answer to the main research question is built by answering the following sub-questions:

1. *What are the components, structures and dynamics characterizing a local ST energy system?*
2. *What are the dynamics of a transition of a local ST energy system (as analyzed in Q1)?*
3. *What are the complexities challenging a transition of the local energy system and how do they challenge the development of a transition (as analyzed in Q2)?*
4. *How does collaborative governance benefit the development of a transition?*

1.3 Scientific Relevance

Sustainable transitions have increasingly become the focus of research in social sciences (Markandt et al., 2012). This research will contribute theoretical insights on a variety of theoretical concepts. First of all, the theory on transitions of ST systems is advanced. The foundation of this research is established theory, in particular, theory developed by Geels, on the dynamics of a transition in a ST system. This research will approach the transition of the local energy system with a multi-level,

socio-technical perspective. This research is of scientific relevance as it recognizes and establishes a clear and convincing division of different complexities perceived in a ST energy system. These complexities are added as a barrier in the existing transition model by Geels in which innovative niches influence the established ST regime. Hence, this research aims to identify the inherent challenges in a complex, socio-technical energy system to this development of a local district approach. Explicating, testing and demonstrating the complexities inherent to a ST energy system generate a better understanding of the dynamics and development of a ST energy system. In addition, the complexity theory used (Hertogh & Westerveld, 2010), initially developed in large infrastructure projects, is applied in a different context, the energy transition. This strengthens the theory and broadens its applicability.

In addition, a collaborative governance process is as a strategy to overcome and control the complexities. First of all, this contributes to the theoretical status quo on collaborative governance. This study builds on the collaborative governance theory by Emerson (2015). This is a novel theory that still requires empirical testing. Collaborative governance between different stakeholders at different levels can be compared as this study regards collaborative governance at three different levels (regional, local, internal). This approach tests and stretches the empirical applicability of the theory.

1.4 Practical Relevance

The practical relevance of this study is demonstrated by today's paradox in de the energy transition of high sustainability goals however still little practical solutions to realize them. An energy transition towards a sustainable society has become inevitable however it has proven to not be an easy path to walk. Our current way of living is embedded in the social and technical structures, institutions and practices of today's society which makes a transition a large exercise. At every policy level, the necessity has been recognized and expressed however there is still no government (local, national or international) which has realized its sustainability goals. To realize this transition, sustainable alternatives for natural gas in our society and the appropriate approach to realize them needs to be determined. In order to achieve this a better understanding of the successes, failures, and challenges of current attempts is required. This enables future attempts to not make the same mistakes twice, build on the lessons learned and eventually realize the transition. This research will study the transition endeavors of the municipality and local stakeholders. As the Dutch Climate Agreement pronounces local governments have a central role in the energy transition. This makes it relevant to study the transition efforts at the local level. This research will provide more insights into the possible challenges which might occur during the implementation of a transition of the energy system on the local level.

1.5 Reading Guide

This research consists of seven chapters and the annexes. The chapters are structured in order to optimize the understanding of the research and to provide grounding for the conclusions of the research. This chapter, the first chapter, provides an introduction to the research. The problemset and the motivation for this study are set out in 1.1. In addition, this chapter includes the research questions guiding this research and the scientific and practical relevance of the study. In chapter two the theoretical foundation of the study is defined. A unique theoretical framework is composed by building up theoretical concepts drawn from different theories. This theoretical framework enables a relevant empirical study and valid answers to the research questions. The third chapter explains the methodology underlying this research. The fourth chapter is a descriptive chapter in which the case

studies are introduced. The fourth chapter contains the empirical results collected in the interviews and the analysis of these results. This is a vital chapter as it builds up to the conclusions of the research. The conclusions and the discussion of this research is found in chapter six. The last chapter provides recommendations based on the analysis, findings, and conclusions of this research. The recommendation is directed to the different stakeholders in a district transition.

2. Theoretical Framework

This chapter provides a theoretical framework. As this is a deductive research this theoretical framework will be the theoretical groundings and the starting point of the research. Relevant concepts will be chosen and linked to be able to answer the research question. These theoretical concepts will guide the empirical data collection in the further progress of this research. Additionally, the theoretical framework will embed this research in the scientific discipline of public administration. This research will contribute new theoretical insights as the theoretical concepts will be applied and research in new combinations and new contexts.

Every concept discussed in this theoretical framework will contribute to the transition model guiding this research (own drawing based on Geels) (figure 1). This model will be built up throughout this chapter and is completed when all the discussed concepts are integrated into the model. First, complexity theory in combination with socio-technical (ST) literature is used to analyze and characterize the local energy system. Secondly, a transition of a ST system is discussed with a multilevel approach. This is the foundation for the multilevel build up in the figure in which an interaction between the niche and the regime level is visualized. The third section focuses on scaling up of local district approaches; enabling a sustainable transition of the system. This is depicted as the blue lines going up from the niche level. Fourth, the challenges for a sustainability transition in a highly complex ST energy system are discussed. The red lines in the figure mark the complexity challenges. First of all, a line is drawn between the niche level to the regime level but also the interaction between the different niches at the niche level. Lastly, a collaborative governance process is proposed as a strategy to overcome the complexity challenges and scale-up the sustainable alternatives. The golden circle between the levels show the dynamics of the collaborative governance process. It is positioned here to break through the complexity and stimulate the scale-up process. In addition, the golden triangles show the input to and from the collaborative process. It is also breaking through the complexity lines around the niches. These concepts will result in the formation of figure 1. Next to figure 1 a legend is drawn in order to facilitate the understanding of the figure.

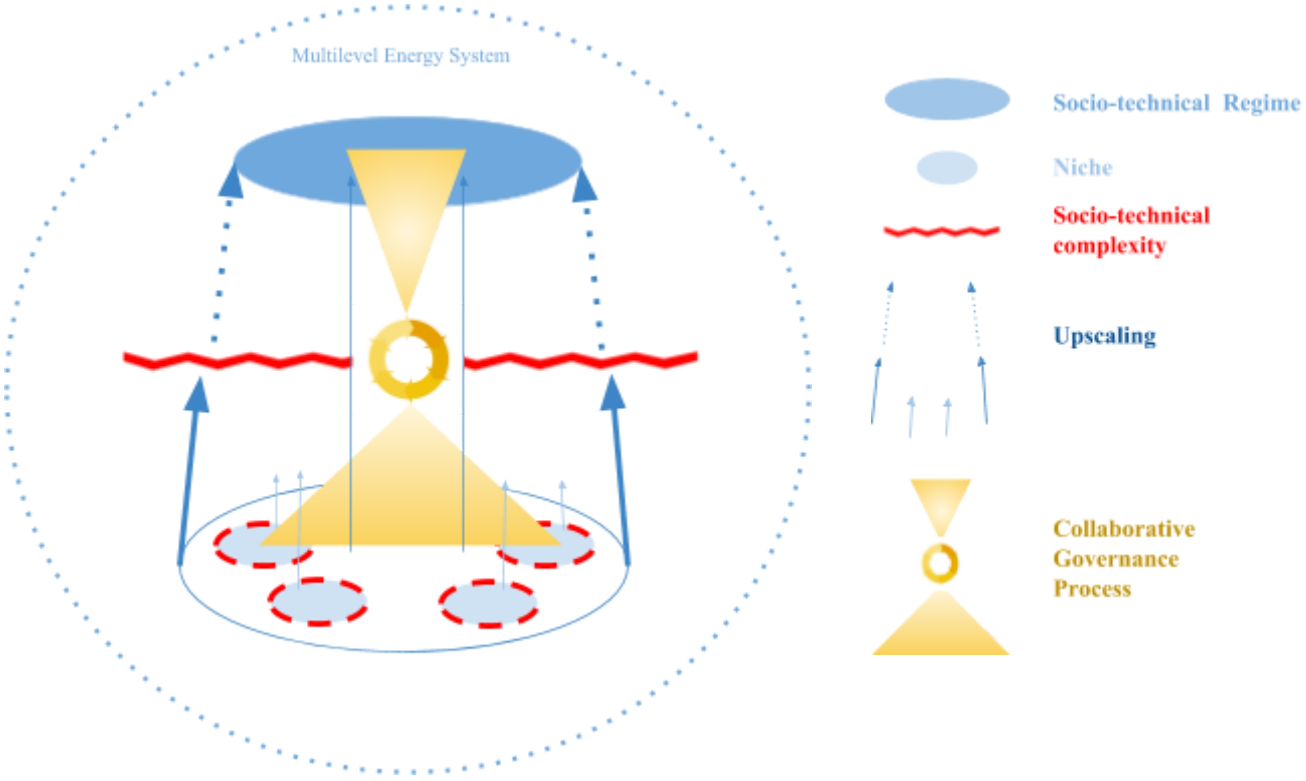


Figure 1: Conceptual research model (own drawing).

2.1 The local energy system

The local energy system will be understood as a socio-technical (ST) system, which is considered a specific type of complex system containing interacting, dynamic, adaptive elements (Nikolic, 2009) (Smith & Stirling, 2010). Since the 1990's scientific publications on complexity theory in public administration have accelerated (Gerrits & Marks, 2015). Today, the concept "complex adaptive systems" has become pivotal in understanding and approaching the reality in which policy is made (Gerrits, 2012). Gerrits (2012) identifies three principal properties of complex adaptive systems. First of all, the emergence of a system happens without superimposed control or deliberate design but as a result of the interactions of the heterogeneous actors. Second of all, the structures, processes, and norms which are the result of these interactions are not fixed. They are adaptive to internal and external changes of the system. Lastly, complex adaptive systems are uncertain and unpredictable.

The understanding of the local energy system and its dynamics remain limited as a full understanding of a complex system and its dynamics is impossible (Lawhon & Murphy, 2011). A complete understanding and predictability of the evolution of a complex system are impossible as the relationships between the system and its components are non-linear. Every social actor acting in complexity defines the system based on its own judgment, interactions, and boundaries. Social actors might behave and decide contrary to each other while active in the same system (Gerrits, 2012). "The system is the aggregate of all individual adaptive moves at the individual level, as is its evolution" concludes Gerrits. However, ST theory offers a framework in which the elements and their complexities, interdependencies, and interactions the local energy system can be explicated and better understood (Lawhon & Murphy, 2011).

A socio-technical energy system

At the foundation of the ST approach is the *coevolution* of technical and social systems. The technical energy system is made up of interacting technical artifacts and agents (Geels, 2002). Technical artifacts refer to the materials, machines, territory, and processes which help to produce, transport and deliver energy. The agents form "networks of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse and utilize technology" (Geels, 2004). The social system broadens the social context of the energy system beyond the network of technical agents. The social system contains the social actors, policies, organisations and institutions which are influencing, influenced by or have interest in the energy produced by the technical system (Nikolic, 2009; Fox, 1995).

Coevolution is the result of the adaptive behavior of the components of the systems and their reciprocal, non-linear relationships (Gerrits, 2012; Rotmands & Loormans, 2009). Initially, complex social system models considered technology an exogenous element of the system (Smith & Stirling, 2010). Additionally, the classic engineering perspective isolates the physical system and the technological artifacts from their social context (Nikolic, 2009). A ST approach recognizes that the technical artifacts are embedded in the social network of the system (Nikolic, 2009). Approaching the social and technical system as one ST-system is deemed crucial as "social processes shape the development and use of technology, but technologies, in turn, open up possibilities for new social practices" (Smith & Stirling, 2010). An iterative feedback process between the systems is perceived. Social actors constantly pressure the physical system to adapt to their demands which causes the physical system to change, which in turn leads to feedback from the social system and so on (Gerrits, 2012; Norgaard, 1994). "The complexity of this pattern of reciprocal influence creates two or more fully intertwined systems" is the conclusion (Gerrits, 2012).

In the energy system social and technological elements interact and *co-evolve* which result in socio-material patterns in a ST system which are hard to break (Lawhon & Murphy, 2011). An appropriate and convenient example of an interrelated ST development is the widespread establishment of the energy system based on fossil fuels. Technological development of electricity based on fossil fuel influenced and was influenced by the institutions created to accommodate and stimulate this development, this in turn increased the creation and diffusion of electricity-using goods and services which caused an increase dependency on fossil fuels and so on (Smith & Stirling, 2010). In order to break through these ST patterns a transition of the local energy system is necessary.

What are the components, structures and dynamics characterizing a local energy system?

The local energy system is a complex, sociotechnical system. The uncertain and unpredictable structure and dynamics of the system is determined by the interaction of the interdependent social actors and technical artifacts.

2.2 A Transition of the Local Energy System

A Multilevel Socio-Technical Transition

The second sub-question aims to understand the dynamics of a transition of the local energy system as set out in the previous section. In order to understand the dynamics of a transition the multilevel system approach is applied. In this section, the dynamics of a multi-level energy system will be discussed. A transition of the ST energy system is the result of interactions between innovative niches at the micro level with the established ST regime at the meso-level, within a ST landscape as its

exogenous environment at the macro level. Eventually, the development of the transition is determined by the extent to which the innovations of the niche level become mainstreamed at the regime level. These levels should be considered as a heuristic instrument to examine the complex diversity of actors, relations, and dynamics of a local energy system (Lawhon & Murphy, 2011). Figure 2, based on the ST multilevel model by Geels (2002) and Van Den Bosch & Rotmans (2008), shows the different levels and their relations. At the lowest level innovation develops in the niches with the objective to scale-up (the blue arrows) to the socio-technical regime of the energy system.

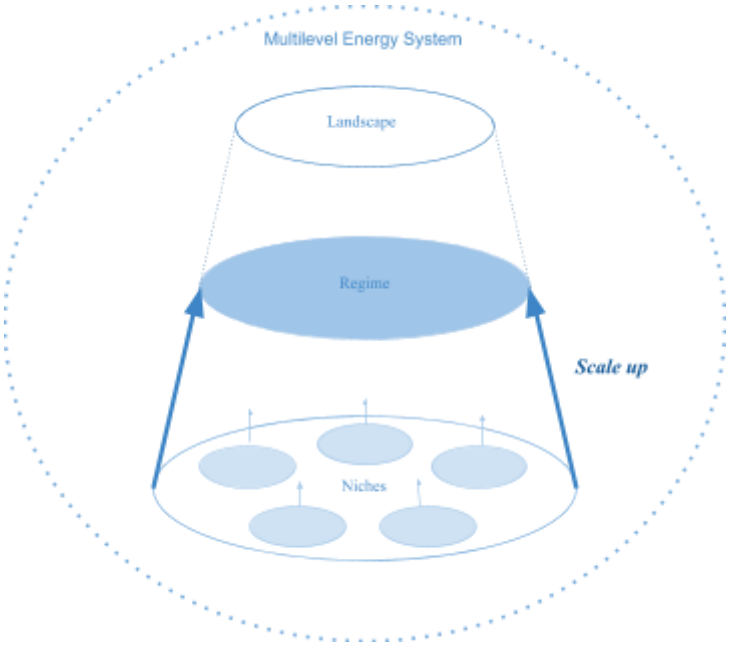


Figure 2: multilevel ST energy system (own drawing based on Geels, 2002 & Van Den Bosch & Rotmans, 2008)

In general, a ST system improves incrementally over a long time and is prone to stabilize (Brugge et al., 2005). A transition is a long-term process of structural change of the system, taking around a generation (25-30 year) to overcome the pressure in favor of the incumbent system and to break through the status quo (Rotmans & Loorbach, 2006; Jacobsson & Johnson, 2000). The ST landscape is the most rigid and the metaphor represents the hardness of its structure however the slowly changing processes such as climate change influence the speed and direction of transition in the system (Suurs & Roelofs, 2014).

The regime sets the status quo of the system and is, therefore, the subject of a transition (Geels, 2004). The ST regime is prone to seek stability due to path dependent and lock in as the three dimensions sustain each other (Geels, 2017; Suurs & Roelofs, 2014). The three dimensions of a ST regime are (Geels, 2005): "(a) network of actors and social groups; in the electricity regime important actors are utilities, the Ministry of Economic Affairs, large industrial users, and households; (b) formal, normative and cognitive rules that guide the activities of actors; examples of formal rules are regulations, standards, laws; examples of cognitive rules are belief systems, problem agenda's, guiding principles, search heuristics; examples of normative rules are role relationships, behavioral norms, (c) material and technical elements; in the case of electricity, these include resources, grid, generation plants, etc" (Verbong & Geels, 2007). Technical artifacts and infrastructures increase stability as their "hardness" creates path dependency of previous investments (Geels, 2004). Social

actors create stability through their interdependent networks. Rules and regimes stimulate stability as a result of their self-fulfilling character. They guide the perceptions and actions of the social actors and the development of technical artifacts which creates their path-dependency (Geels, 2004).

At the micro level, the novelties fueling a transition emerge. Niches are the locus of radical, transition innovations which emerge in spaces protected from the mainstream market (Geels, Suurs & Roelofs, 2014). Examples of protection applied at the niche level are laws and regulations or financial subsidies (Smith et al., 2010). This protection enables niche innovation to deviate from the incumbent regime and its rules, actors, and artifacts and develop innovation alternatives at the niche level (Rotmans 2005; Den Bosch & Rotmans, 2008). In a transition, when innovation at the niche level is it diffuses in the system and becomes mainstreamed at the regime level (Smith, 2007). In this research, the districts in which an approach is developed to replace gas is considered a niche. Local governments and other stakeholders often receive financial support, subsidies, from higher policy levels (regional or national) in order to develop sustainable alternatives to natural gas. This will eventually enable the realization of national objectives through the diffusion of sustainable sources and innovative approaches from the niches to the regime level through *scale-up*.

Green Innovation experiments

Innovation, however, is a tricky concept and is differently explained and conceptualized in different scientific disciplines. At the core of all interpretations is a radical, intentional change of established practices and thinking (Sørensen & Torfing, 2016). Nevertheless, the lion share of the literature on innovation is dedicated to technical product and process innovation in public or private organisations. These are inapplicable for a sustainable transition for three reasons. First, it has as led to isolated or accidental events of innovation without lasting changes or contributions in the system (Sørensen & Torfing, 2011). Second, in an innovative process, the focus is often on groundbreaking technical developments and discoveries. Where this is part of the innovation process, it is also crucial to take into account the social processes of innovation (Sørensen & Torfing, 2011; Seyfang & Smith, 2007). Third, it is important to realize the difference between incremental innovation and transition innovation (Negro et al, 2012; Van Den Bosch & Rotmans, 2008). Whereas incremental innovations is compatible with the incumbent energy system; transition innovation introduces sustainable alternatives which require system alterations.

An unsustainable energy system is too wicket for incidental and incremental technical solutions and requires a systemic approach and a wicket solution (Bommert, 2010). This research regards *green systemic innovation* as relevant to the transition of the local energy system. Specific to systemic innovation is the focus on processes on a societal level and the impact of their environment (Suurs & Roelofs, 20144). “Systemic innovation leads to fundamental changes in both social dimensions and technical dimensions and, most importantly, in the relations between them” define Suurs & Roelofs (Suurs & Roelofs, 2014). In their elaborate work on eco-innovation Kemp & Pearson have characterized the transition towards a sustainable, renewable-based energy system a *green system innovation*: “Alternate systems of productions and consumption that are more environmentally benign than existing systems” (Kemp & Pearson, 2007).

The definition of a *transition experiments* introduced by Den Bosch & Rotmans will be used to conceptualize the attempt to develop a district approach in order to replace natural gas by the stakeholders in municipalities leading in the transition. The concept of transition experiments is suitable as it implies system innovation. A transition experiment aims to contribute to a transition by

introducing system innovations in order to overcome a societal challenge (Van Den Bosch & Rotmans, 2008). A transition experiment is trying to fulfill societal needs in new and greenways. Local transition experiments are the fuel of a transition of the energy system as it aims at bringing sustainable societal change by fading out natural gas from our society (Van Den Bosch & Rotmans, 2008). These experiments could emerge as projects, products, services, and processes which contribute to the development of a sustainable energy system, initiated by a wide range of public and private stakeholders (Rotmans, 2005). Transitions emerge and develop as a result of the interaction of a wide range of public and private stakeholders on the different levels of the local energy system (Rotmans, 2005). This research will focus on the local stakeholders relevant to the replacement of natural gas in the local energy system. These stakeholders have either interest or influence in this transition.

The process of developing previously deviant sustainable practices in niches and embedding successful practices in the incumbent regime in the course of a transition is called *scaling up* (Van Den Bosch & Rotmans, 2008; Coenen et al., 2010; Sandick , 2010; Roy et al.,2013; Van Doren et al,2016**)**. This research will focus on the process of scaling up local alternatives to gas from niches to the regime. Transition experiments in the energy system are considered successful in contributing to the transition whenever they introduce and embed radical, changes in the incumbent local energy system by introducing sustainable *culture, practices and structures* (Van Den Bosch & Rotmans, 2008). In the words of Den bosch & Rotmans: "the mechanism 'scaling up' is defined as embedding a transition experiment in –new- dominant ways of thinking (culture), doing (practices) and organizing (structure), at the level of a societal system (Van Den Bosch & Rotmans, 2008).

The impact of niche practices is explained by the functioning of the incumbent system, the emerging solution in the niches and their interactions (Negro et al. 2012). For a local solution to have the opportunity to scale-up it requires a window of opportunity in the incumbent system. This window of opportunity appears under three conditions (Haans). First of all, when a *tension* in the functioning of the incumbent regime as a result of changes in the landscape develops (Van Den Bosch & Rotmans, 2008). The second condition is *stress* as a result of misalignment within the incumbent regime (Van Den Bosch & Rotmans, 2008). When the decisions and actions in a sub-regime push its development in a deviant direction the regimes become misaligned and a window of opportunity presents itself for a niche to scale-up its green innovative culture, practice, and structure (Geels, 2004). *Pressure* on the regime from the niche level is the third condition (Van Den Bosch & Rotmans, 2008). This pressure is building when the transition experiments in the niches produce green system innovation and provide an adequate alternative to the incumbent functioning of the regime.

This research will focus on the *pressure* built from the niche levels on the regime. However, the pressure is insufficient as an adequately developed *alternative* to the incumbent regime is lacking. At this point, there is still no alternative and approach to replace the use of natural gas. So the focus of this research is on the development of appropriate alternatives at the niche level and its capacity to scale-up. This research disregards the fulfillment of the first two conditions. An example of growing landscape *tension* is the perceived risks of climate change (the landscape). The negative externalities such as environmental denigration put pressure on the incumbent regime. Exploiting the created opportunity, however, could be challenging as incumbent technical and policy stakeholders tend to downplay of the impact of negative externalities as it threatens their position and interests (Geels, 2004). An example of growing *Stress* within the incumbent ST energy regime is a misalignment in the energy system. For example, the turn away from fossil fuels and a growing attention to renewable

energy sources in science and politics is not reflected in socio-cultural behavior and norms or established policies and legislature.

Van De Bosch & Rotmans propose two necessary steps on the niche level before the regime level can be reached (Van Den Bosch & Rotmans, 2008). First of all, *deepening* the alternative within the niche allows the stakeholders to engage in a learning process by continuing experimenting in the context of their own niche. The objective in this phase is to learn as much possible on the innovation introduced by the alternative and its consequences in a specific context. In the niche context actors can learn in what way the innovation changes the culture, practice and structure of the local system. In the deepening phase the process and substance of projects and programs change in order to create an optimal learning context. First of all, the objective becomes developing new ways of thinking and doing in order to fuel a transition. In order to do this it is essential to formulate explicit learning goals connected to the societal (transition) objective. In addition, a facilitative process is necessary. An open searching and learning process enables the development of new alternative ways of thinking and doing. Learning can be done individually and collectively. Collective learning can be initiated by applying the transition experiment in different contexts or by sharing lessons with other similar innovation attempts (Van Den Bosch & Rotmans, 2008).

The second step is b*roadening* the transition experiment at the niche level enforces the stability and robustness of the innovation introduced. Broadening requires the process to focus on linking the experiment with a broader context in which the experiment can be connected to other experiments. Eventually, the substance of the projects or program adapts to other contexts which facilitates the development of the experiment. The *broadening* process results in niche-regimes which increase the foundation and stability of transition experiments and consequently the capacity to challenge and influence the ST regime (Van Den Bosch & Rotmans, 2008). Niche-regimes are different transition experiments in different niches which link their efforts and increase their influence (Van Den Bosch & Rotmans, 2008).

The capacity to *scale-up* of is thus achieved in two steps: learning in a specific context, opening up to and linking efforts with other niches in niche-regimes and eventually achieve embeddedness of sustainable practices, culture, and structure in the sociotechnical energy regime. Therefore this research assumes that the capacity of a local transition experiment to scale-up and influence the ST regime can be measured by determining the level of deepening and broadening it has achieved.It is important to note that these dimensions are not necessarily sequential or chronological dependent in the development of a transition. Both learning and linking practices can be pursued in and between niches at the same time (Van Den Bosch & Rotmans, 2008).

The findings of the previous section are summarized in the theoretical answer on the second subquestion:

What are the dynamics of a transition of a local energy system (as analyzed in Q1)?

In a multilevel ST local energy system, a transition is initiated and driven by transition experiments at the niche level. By scaling up the practices, culture, and structure proposed in the experiment the ST regime a transition of the local energy system is established. The capacity to scale-up the solutions developed in the transition experiment to the regime level can be achieved by local stakeholders by deepening and broadening the transition experiment.

This research will continue to, on the one hand, analyze what complexities in the local energy system challenge the scale-up capacity of local transition experiment and on the other hand, explore the benefits of a collaborative governance process in the local energy system to the development of a scale-up capacity. The next part of this chapter will elaborate on the complexities inherent to the local energy system influencing the development of scale-up capacity with the transition experiments.

2.3 The challenges of socio-technical complexity

In this sections subquestion three is answered. In the previous subsection a complex system is characterized by uncertainty and limited understanding. This research will explore to what extent the complexities of a ST local energy system challenge the scale-up capacity of transition experiments. In this research, a district approach to replace gas in the district is the studied transition experiment. In figure 3 ST complexity is visualized as a red barrier interrupting the scale-up process on the niche level, between niches and from the niche to regime level. This research focuses on the complexities influencing the scale-up capacity of a district approach by challenging the *deepening* and *broadening* process. The landscape has been left out as the focus of this research is on the interactions within the niches and with the regime.

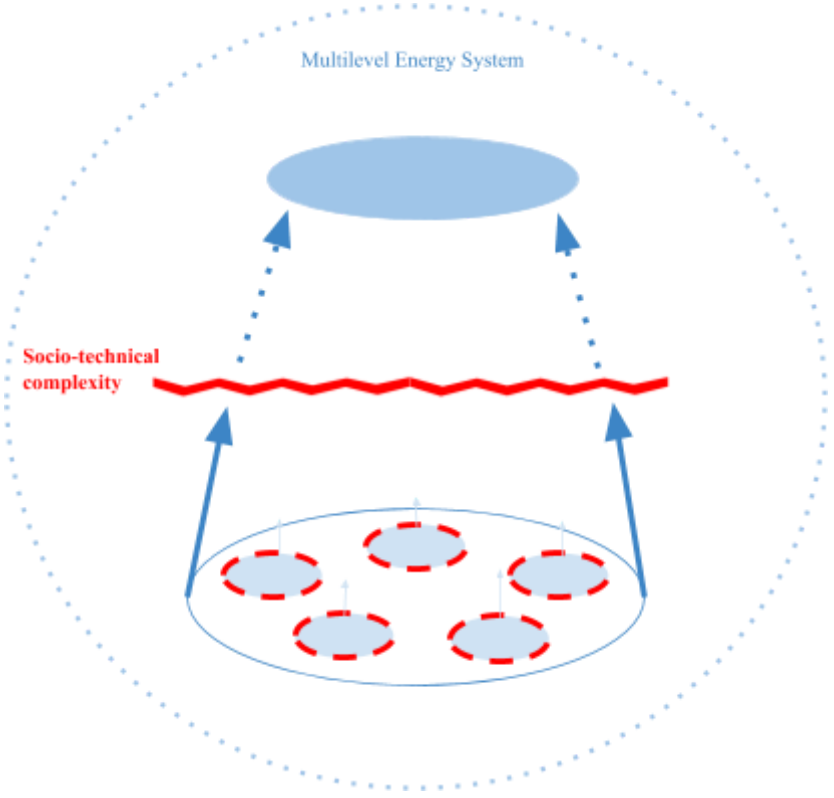


Figure 3: Conceptual Model with Complexities (own drawing)

As theoretical work on the specific complexities experienced in the energy sector has not been found insights will be drawn from complexity studies in a different sector. Hertogh & Westerveld (2010) have elaborately discussed and analyzed complexity and the challenges for the management and organisation of large infrastructure projects. Although they have applied and derived their research on the complexity in a different environment they offer a clear and adequate division of different types of complexities perceived in a ST system. Like the large infrastructure projects in the research by

Hertogh & Westerveld (2010), is the transition of the local energy system approached with a complex system approach in this research. The complexities are the result of a "practitioners view" research in which the perceptions of complexity in complex (large infrastructure) projects and programmes of the different stakeholders were collected. This was deemed essential in order to arrive at an inclusive understanding of the complex system as the involved stakeholders can perceive a problem or situation differently and even contradictory (Gerrits, 2012) (Hertogh & Westerveld, 2010). This fits the methodology of this research as also in this research the perspectives and perceptions of stakeholders of the local energy system are inquired. This research will build on the complexities perceived in large infrastructure projects by applying these insights to a new sector. New insights will be derived on the broader applicability of these complexities and on the complexities perceived in the local energy transition by stakeholders.

The focus of this research will be on the complexities and their interdependencies in a ST local energy system. Social, technical, financial, legal and time complexity are complexities inherent to a ST system. An overview can be found in table 2 on the next page. These domains should be approached as interrelated and coevolving. As discussed technical artifacts of the energy system are embedded in the social context. Technical developments result in consequences for the social context and the other way around. Technical and social complexity interact and fortify the complexity of the system (Lawhon and Murphy, 2011). By acknowledging these different complexities a comprehensive and integrated complexity approach is established. Moreover, all six recognized complexities provide a clear structure to discuss and analyze the challenges in a transition in a complex ST system. The different complexities will be discussed to establish a better understanding of the challenges of complexity of a local energy system.

Table 2 provides an overview of the complexities and their challenges as identified by Hertogh & Westerveld (2010).

Table 2: Complexities and their Challenges (Westerveld & Hertogh, 2010)

Complexities	*Challenges*
Technical Complexity	• Unproven technology • Technical uncertainty
Social complexity	• Conflict of interests • Different meanings and perceptions
Financial complexity	• Costs & Benefits calculation • Cost & Benefits equal division
Legal complexity	• Changing, non-existent and conflicting laws.
Time complexity	• Long time frame with continuous developments • No sequential process of implementation

2.3.1 Technical Complexity

First of all, the energy system is complex due to the large and determining role of technology for the development of the system. Unproven technology and technological uncertainty are suggested as the two main challenges in a technical complex system (Westerveld & Hertogh, 2010). Both will be projected on the local energy system.

Unproven Technologies

The first challenge perceived as a result of technical complexity is unproven technology (Westerveld & Hertogh, 2010). A transition of the local energy system requires the development of new, alternative technologies in innovative niches in order to change the current (socio-)technical regime and landscape (Geels et al, 2017; Van Den Bosch & Rotmans, 2008). Innovation is necessary but the introduction and application of innovative technologies also increase the risks as these technologies are often not yet proven (Westerveld & Hertogh, 2010). "*Technical innovation is unstable, uncertain, experimental and fragile propagating different design options, many of which will fail"* explain Geels (Geels et al, 2017; 465). In the niches introduce alternative technical solutions are introduced and applied such as renewable energy sources which are less developed than incumbent technologies of the energy system which have developed and strengthened over decades. Their appropriateness and applicability are yet to be proven for the wider regime.

The challenge of unproven technologies for a transition of the energy system is increased as a result of the connections with the other complexity dimensions. For example with the social dimension as unproven and, new technologies could embolden discussion among the different stakeholders involved. The technological innovation developing sustainable alternatives challenge established technical structures in the energy system (Geels et al, 2017; Van Den Bosch & Rotmans, 2008). In contrast to the established technical structure is the reliability of innovative technology not yet accepted by the system. Moreover financial and time complexities increases as a decision based upon an innovative technology could result in schedule or budget overrun since the developments, effects, and impact of the technology are not yet known (Westerveld & Hertogh, 2010). Lastly, innovative technologies could increase legal complexity when new technologies require new regulation and legislation.

Technical Uncertainty

Technical uncertainty is a result of the innovative technologies introduced in the niches. However, this uncertainty is inherent to (proven) renewable energy sources. Traditional energy sources and generation (e.g. coal thermal plants) created a controllable energy system. However, the accessibility of renewable energy sources (e.g. solar, wind, hydro) are highly conditional and unpredictable as it dependents on climatic conditions and could vary per day, hour or even minute (Koutsoyiannis, 2016; Bessa et al. 2013). These uncertainties and variability create new challenges for modeling the energy system and an extension for managing the energy system and its transition. These uncertainties could result in unanticipated drops or highs in the production of energy which could result in unbalance of the supply and demand of energy at a certain point. The fundamental uncertainty makes it problematic to make large-scale energy policy and therefore to determine the optimal strategy to achieve a sustainable transition of the energy sector (Cai & Sanstad, 2014). This could result in forecasts errors and consequently in large financial costs (Bessa et al., 2013).

2.3.2 Social Complexity

As discussed earlier, the complex energy system is the result of the entanglement social and technical systems. Besides technical complexity is social complexity therefore also inherent to a ST system. Hertogh & Westerveld put different meanings and perceptions guiding stakeholders and conflicts of interest between stakeholders at the core of social complexity (2010). The politics inherent to sustainability transitions are added as a factor increasing the complexity challenge for a ST transition.

Perceptions

As people interpret their environment subjectively different meanings and perceptions are inevitably (Hertogh & Westerveld, 2010). This is in line with complexity theory which explains how complexity in a system is generated due to the heterogeneity of actors with a different problem and solution definitions (Gerrits, 2012). Public administration scholar N. Luhmann explained how social actors dealt with the complexity of their surroundings. According to Luhmann people develop, maintain and adapt mental models as a strategy to reduce and grasp complexity in order to act (Brans & Rossbach, 1977). "*In the arena where many players meet, there is no longer one reality to which we can refer, but there are many realities and meanings of all involved that 'circulate' through social processes"* (Hertogh & Westerveld, 2010; 155). In combination with ambiguous (unproven and uncertain) innovative technology, the challenge becomes fortified as the objectivity and reliability of "knowledge" becomes disputed. This could challenge the decision-making and policy-making process in the energy system.

Interests

In a complex system, different actors interact based on their own interest. Thus, many interests are at stake in a heterogeneous social(-technical) system (Hertogh & Westerveld, 2010; 155). This becomes a challenge whenever the interests of influential stakeholders are incompatible.

Conflict of interest and difference in perceptions drive the inherently political character of a sustainable energy transition (Meadowcroft, 2011). Political processes, inside the local government but also between other stakeholders, determine what decisions are made by whom and when. However they are fluctuating and driven by individual interests, values and interpretations of the political stakeholders (Bolton & Foxon, 2015; Meadowcroft, 2011; Markard et al, 2012). A politicisation of the transition could challenge the long-term sustainability objective by pressing short-term political (individual) interests and objectives (Bolton & Foxon, 2015). Additionally, the incumbent regime and its stakeholders are threatened as a transition requires the installation of new ST practices, culture and structure evolved at the niche level (Meadowcroft, 2011). This challenges transition experiments in the creating and diffusing alternative culture, practice and structure and achieving scale-up capacity.

2.3.3 Financial Complexity

Financial complexity poses a challenge for decision making and a transition of the local energy system as a result of the ST complexity. First of all the cost and benefits of a policy are often hard to calculate (Hertogh & Westerveld, 2010). Here, financial complexity holds a tight connection to technical complexity. The ST systems develop as a result of the introduction and diffusion of innovative technologies. However, innovative technologies have uncertain future dynamics and therefore uncertain future returns. New sustainable energy production, storage, use or transport opportunities often demand large financial investment by public and private stakeholders without

guarantee on the decrease of costs or an increase of returns (Meadowcraft, 2011; Bolton & Foxon, 2015). With emerging technologies, it is challenging to determine the appropriate policy as better alternatives might emerge or current options disappoint (Ullash et al., 2009).

Moreover, an equal division of the costs and benefits between the involved stakeholders proves difficult. Since, stakeholders have different perceptions, interests, and influence they have different expectations of the assigning of cost and benefit (Hertogh & Westerveld, 2010). Consequently, social disputes could further push up the costs.

2.3.4 Legal complexity

Legal complexity is the result of established, changing or non-existing legislation or rules. Firstly, previously made legislation determines the possibilities in policy-making today. In the current globalized world, there are rules, processes and legislation installed on multiple-levels to which policy-makers in a local energy system have to adhere. In the multilevel ST perspective of the local energy system a transition requires the upscaling of niche innovation, however, the alternatives introduced by transition experiments could undercut and threaten the established, dominant regulatory and legislative regimes (Meadowcroft, 2011). In other words, innovative alternatives encounter contradictory legislation which was initially made in a different situation and during a different time frame. This could pose a challenge for development or transition of the system. Additionally, there might be a lack of legislation on new technologies or decision-making processes. An absence or deficiency of rules could result in major turmoil in stakeholder networks (Hertogh & Westerveld, 2010). This indicates the complexity of ST system in which innovative technologies complicate social processes and additional complexity is generated.

2.3.5 Time Complexity

Time complexity is a dimension which intersects and is part of all other four complexities discussed. A transition of the local energy system is a long-term process with a long-term impact. This has significant implications for policy making today. First of all, due to the long-term development of the ST regime also the ST landscape in which the regime is embedded changes (Geels, 2002). Both the social as the technical dimensions of the system and its environment change due to for example technical innovations, political change or changes of awareness, need views and interests in the society.

As a result of the long timeframe, the tensions between the technical and social dimension of a ST system becomes more apparent. The adaptive behavior of social actors of the system is the effect of cumulative feedback loops over time and are aimed at reaching alignment with their changing environment (Gerrits, 2012). The time dimension is a crucial aspect as the dynamic of every situation differs as time progresses (Gerrits, 2012).

Additionally, over time the implementation progresses. However, in a complex system, the implementation of a policy, process or transition happens often with a non-linear implementation process (Hertogh & Westerveld, 2010). This means the implementation is an iterative process which is shaped by feedback loops. This poses a challenge for stakeholders as uncertainty about the development and eventual results of decisions dominates. Additionally, public decision-making requires transparency and communication with the involved stakeholders. This is problematic when the exact progress and impact of a transition on the stakeholders is unknown (Hertogh & Westerveld, 2010).

After the first theoretical examination of the different complexities of a ST energy system, it is possible to answer subquestion three. In section 2.4 a potential strategy is proposed to overcome the challenges set out in this section.

What complexities inherent to an energy system could challenge the transition away from natural gas (as analyzed in Q2)?

A transition in a local energy system could be challenged by social, technical, legal, financial and time complexities inherent to the local energy system.

2.4 Collaborative Governance Process

After the identification of six types of complexities inherent to a complex local energy system, also the processes which benefit the development of the scale-up capacity of the district approach are discussed. Collaborative Governance has emerged over the past decades as a new strategy to bring together the different public and private stakeholders in an attempt to manage and steer a complex public sector (Ansell & Gash, 2008). A collaborative approach is introduced as it could help realize the necessary development and diffusion of innovation to achieve the transition of the energy system (Emerson, 2011; Bovaird & Loeffler, 2016; Bommert, 2010). Figure 4 demonstrates the position, relations, and influence of collaborative governance in the local energy system. Collaborative governance is incorporated as a strategy to overcome the previously drawn complexity barriers. Hence it is drawn as a path crossing the boundaries created by the complexity challenges. It, therefore, contributes to the development of the scale-up capacity of transition experiments and eventually stimulates the scale-up to the ST regime.

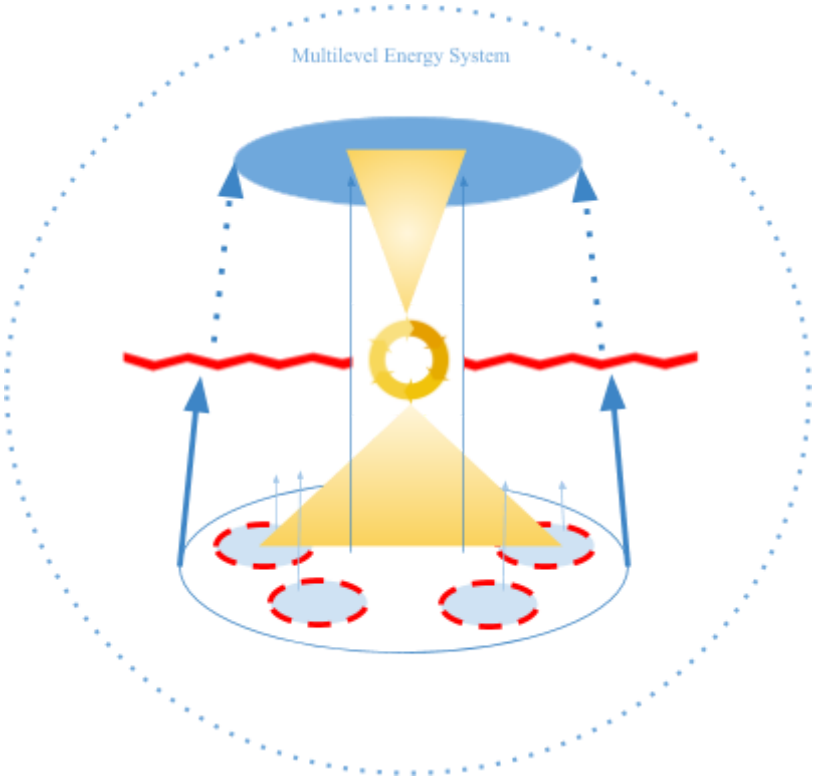


Figure 4: Conceptual Model with Collaborative Governance (own drawing)

2.4.1 Collaboration

Margerum (2011; 6) defines collaboration as "*an approach to solving complex problems in which a diverse group of autonomous stakeholders deliberates to build consensus and develop governance and collaborations*". Innovation is accelerated as the quality and quantity of innovations increased by collaboration as differences of stakeholders and their insights are celebrated and exploited instead of dismissed (Bommert, 2010). The perspectives, interests, and actions of different stakeholders unfold a broad and deep understanding of the system and accelerate the growth of innovative ideas (Sørensen, E., & Torfing, 2016; Bommert, 2010)

Collaborative innovation establishes an integrative innovation cycle which benefits the innovation process (2011, Bommert, 2010). First of all, innovation is accelerated by collaboration as the different stakeholders contribute different perspectives and ideas and engage in mutual learning which fuels the *generation of ideas* for better solutions for complex issues *(*Sørensen, E., & Torfing, *2011; Fung, 2006; Bommert 2010).* The second benefit of collaboration to the flourishing of innovation is the *selections of ideas* as the collaborative stakeholders engage in a joint assessment and decision-making process based on compromise and agreement reducing the risk on stalemates, group thinking, veto-players and conflict as the innovation process proceeds (Sørensen & Torfing, 2011; Bommert, 2010). Third, collaboration facilitates the *implementation of ideas* as conflict and resistance can be avoided through widespread ownership and responsibility, costs and benefits can equally be divided and implementation resources shared. Eventually, the collaborations can facilitate and benefit the dissemination of innovative practices throughout the system as a result of social and professional networks between the stakeholders (Sørensen & Torfing, 2011). The assumption in this research is that collaborative processes instigate, facilitate and sustain innovative output and therefore are necessary to develop and implement alternatives to natural gas which have a capacity to scale-up and contribute to the transition process of the Dutch energy system.

2.4.2 Governance

Local governments are confronted with the challenge to realize the (inter)national objective to replace gas with a sustainable alternative in a complex energy system. A failure of top-down government aimed at controlling a complex system and its components has been broadly recognized in the literature (Hertogh & Westerveld, 2010; Wagenaar, 2010). Strategies of control in a complex energy system are often insufficient or even counterproductive (Hertogh & Westerveld, 2010). Governmental control fits a system in which (sub) problems can be isolated, there is consensus on a fixed problem and preferred solution between the stakeholders and linear decision making between hierarchical stable layers is possible (Hertogh & Westerveld, 2010; Van Twist, 2003). Only top-down control by the local government is not appropriate in the transition of a complex ST energy system. In a complex system such as the local energy system *government* is exchanged for *governance* in which the government together with a wider network of stakeholders are influencing the outcomes of public policy (Bovaird & Loeffler, 2016). The concept *governance* knows numerous definitions. However at the core of these definitions is a horizontal process in which different stakeholders are interacting in collaborating processes in multilevel, cross-boundary partnerships (Wagenaar, 2007). Collaborative Governance has emerged over the past decades as a new strategy to bring together the different public and private stakeholders in an attempt to manage and steer a complex public sector (Ansell & Gash, 2008).

2.4.3 Collaborative governance

Collaborative governance as understood and applied in this research is drawn from the collaborative governance framework developed by Emerson et al (2011). Emerson et al (2011) define collaborative governance as "*the processes and structures of public policy decision making and management that engage people across the boundaries of public agencies, levels of government, and/or the public, private and civic spheres in order to carry out a public purpose that could not otherwise be accomplished*" (Emerson et al, 2011, p.3).

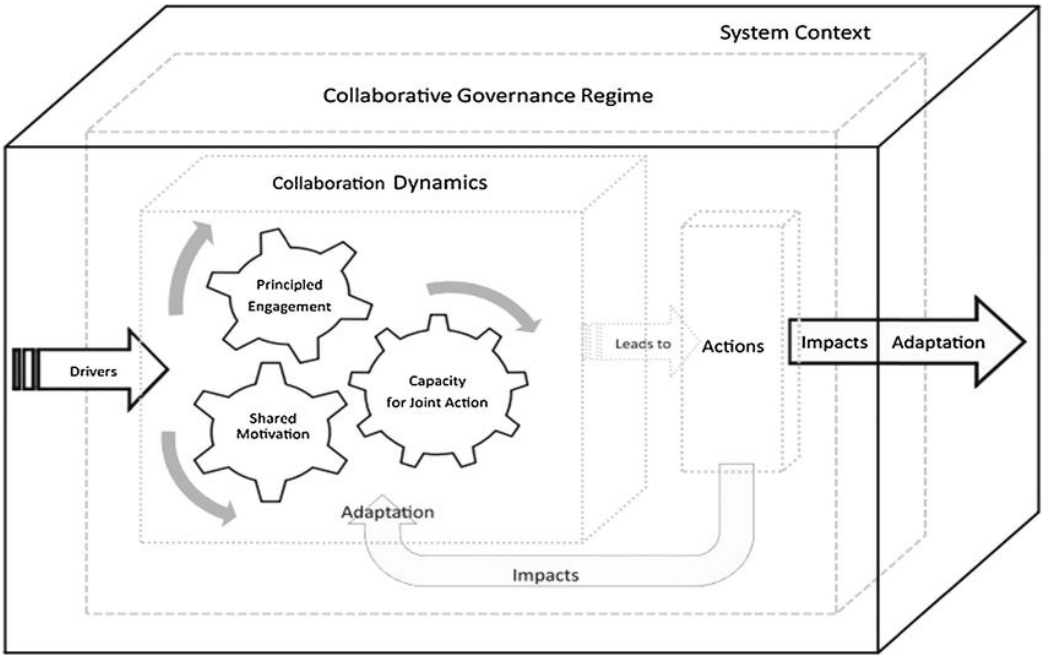


Figure 5: Collaborative Governance Framework (Emerson, 2011).

In the integrative collaborative governance framework of Emerson et al. collaboration emerges in a three-dimensional system (Figure 5). The system context hosts the political, socio-economic, environmental and other dynamics which constrain or stimulate collaboration in the collaborative governance regime (CGR). The CGR is the dimension in which collaborations take place as a result of *"a set of implicit and explicit principles, rules, norms and decision-making procedures around which actors expectations converge in a given area*" (Emerson et al, 2011; 6). In the CGR collaboration dynamics result in actions which impact the CGR itself and could eventually lead to adaptations in and of the system context. Nevertheless, the focus in this research will be on the collaboration dynamics between the stakeholders of the ST energy system and its influence on the transition of this system.

The framework of Emerson, and in specific its collaboration dynamics, are chosen because of the integrative nature and system perspective. First of all, the framework is based on a meta-analysis of older established collaborative literature and models from which earlier important insights are combined. Second of all, this framework acknowledges collaborative governance between boundary crossing public and private stakeholders, as is laid down in the definition (Emerson et al. 2011). This framework, therefore, fits the scope of this research as this research looks at the endeavors of public and private local stakeholders of the local energy system. At the same time, is the framework detailed enough to elaborate on the challenges of governance in complex systems and propose appropriate strategies to manage these complexities. Additionally, the framework allows researchers to study individual elements and interactions separately.

Unfortunately, this research is too limited to include all dimensions of the framework and therefore the collaboration dynamics will be studied in isolation from the other dimensions and their elements. The collaboration dynamics proposed in this framework are relevant to this research as collaboration can be studied as an iterative process in which the presence or absence of the variables essential to achieve collaboration can be analyzed.

2.4.3 Collaboration Dynamics

The collaborative dynamics are composed of three iteratively interacting components: principled engagement, shared motivation and capacity for joint action. These dynamics are set in motion by influences from the system context.

Table 3: Collaborative dynamics

Principled Engagement	*Shared Motivation*	*Capacity for Joint Action*
Discovery	Mutual Trust	Procedural/institutional Arrangements
Definition	Mutual Understanding	Leadership
Deliberation	Internal Legitimacy	Knowledge
Determination	Shared Commitment	Resources

Principled Engagement: complex issues such as the local energy transition have made a wide variety of stakeholders with different and sometimes contrasting interests, perceptions and objectives interdependent in a problem-solving process. Principled engagement requires these boundary-crossing interactions between a diversity of stakeholders to be civil open and inclusive, in which all stakeholders and their diversity of interests, perspectives and knowledge are equally considered. These engagements are not necessarily face-to-face but could also take place at a distance according to Emerson et al. Principled engagement enables thoughtful, effective and creative decisions in which different interests and perspective are considered and combined.

The four basic process elements driving principled engagement are *discovery, definition, deliberation,* and *determination;* together they make up "a dynamic social learning process" towards a shared purpose. The interactive process between these four elements generate principled engagement and together reinforce shared motivations and the capacity for joint action. *Discovery* is the first step in which the stakeholders explore each other's interests and objectives and their similarities and differences in a first basic dialogue. The *Definition* process refers to the effort of the stakeholders to achieve shared meaning in common interests and objectives. This process aims to collectively describe the problem, mutual expectations, and process criteria. *Deliberation* is considered a core ingredient for successful collaboration as deliberation allows stakeholders with contrasting interests or perspectives to engage in reasoned communication on the exploration of the common good by listening to each other. Deliberation is essential in order to generate mutual trust, understanding, and commitment in the collaboration process. The *determination* process is the conclusion of joint decisions on the further procedure ("setting agendas, tabling a discussion, assigning a workgroup

etc.") and substance ("reaching agreements on action items or final recommendations") of the collaborative process and the implementation of the determined collective strategy.

Shared Motivation: when principled engagement occurs, shared motivation can be achieved. However, eventually the processes will mutually enforce and influence each other as "*repeated, quality interactions through principled engagement will help foster trust, mutual understanding, internal legitimacy, and shared commitment, thereby generating and sustaining shared motivation*" (Emerson et all, 2011; 14). Shared motivation consists of four interacting elements: *mutual trust, understanding, internal legitimacy and commitment. Mutual trust* between the collaborating actors is the result of successful principled engagement and crucial in collaboration as it results in mutual understanding and mutual commitment in the process (Emerson, 2011; Ansell & Gash, 2008). This also indicates the iterative character of the collaboration process. Trust building is a continuous process throughout the collaboration process and can be time-consuming and challenging (Ansell & Gash, 2008). *Mutual understanding* refers to a state of respect and understanding for each other's interests and perceptions without necessarily sharing the same set of values or goals. *Internal legitimacy* explicates the sense of interpersonal validations achieved in mutual understanding. Internal legitimacy is achieved whenever stakeholders mutually confirm each other as trustworthy and credible after having accepted their similarities and differences. Lastly, *commitment* can be achieved whenever trust and internal legitimacy have enabled stakeholders to cross their organisational, sectoral and/or jurisdictional boundaries and commit to a shared *process* (Emerson et al, 2011l; Ansell & Gash, 2008). The stakeholders in the collaborative process need to adopt the belief that it is their shared responsibility to negotiate in good faith in a collectively owned decision-making process with the aim to find an outcome with mutual gains for those involved. This requires a mutual recognition of the process and a willingness to give up own interest in order to uphold the collaboration. (Ansell & Gash, 2008).

Capacity for Joint Action: the interactive, iterative cycle of collaborative dynamics is complete with the capacity for joint action. Whereas it is an intermediate outcome of principled engagement and shared motivation it also creates a new impetus for the cycle and the strengthening and improvement of the other two elements. Capacity for joint action is necessary in order to achieve outcomes which could not have been reached by individually acting stakeholders. The capacity of joint action is the result of the presence and interaction of four elements: *procedural and institutional arrangements, leadership, knowledge, and resources.*

First of all, in order to sustain and manage repeated collaborative interactions *procedural and institutional arrangements* are crucial. These could range from informal norms to formal rules of interactions and differ in detail from general protocols to regulating the deeper character and development of the collaboration process. These arrangements both need to define what collaboration entails on the intra organisational level for the individual stakeholders and for the interaction between the stakeholders in the CGR at the inter-organisational level. Secondly, *leadership* is necessary in order to achieve the capacity for joint action. Leadership is an ambiguous concept and could as a sponsor, translator, technologist, facilitator, manager etc. and could be practiced by different stakeholders within the collaborative network. Moreover, leadership could be "an external driver, and essential ingredient of collaborative governance itself and a significant outgrowth of collaboration" (Emerson et al. 2011; 15). Third, *knowledge* is in ways the start, driver, and objective of collaboration (Thomson & Perry, 2006; Emerson et al. 2011). Incomplete knowledge drives collaboration in order to achieve improved and additional knowledge. Collaborative dynamics require the sharing,

aggregation, and generation of knowledge. Knowledge in collaborative governance is information and data weighted, processed and infused with the understanding, judgment and values of the collaborative stakeholders. Lastly, a collaborative process is desired as it allows the sharing of *resources*. Resources disparities may impose an initial barrier to interaction between the stakeholders of the system however, collaborative dynamics allows the sharing and redistribution of resources which facilitates the shared and common goals in the system. Examples of useful resources are *"funding, time, technical and logistical support; administrative and organisational assistance; requisite skills for analysis or implementation; and needed expertise"*. Sharing resources determines the legitimacy, efficiency, and success of collaborative dynamics.

Collaborative governance has been proposed and elaborately discussed as a strategy to overcome the system complexities challenging a transition of a local energy system and to increase the scale-up capacity of transition experiments.

4. How are the socio-technical challenges overcome and the scale-up process accelerated?

A collaborative governance could help to accelerate the scale-up capacity of local transition experiments to replace natural gas by bringing together the relevant stakeholders in a collaborative governance process. This process requires principled engagement, shared motivation and capacity for joint action and stimulates innovation in a transition of a complex energy system.

2.5 Conceptual Model

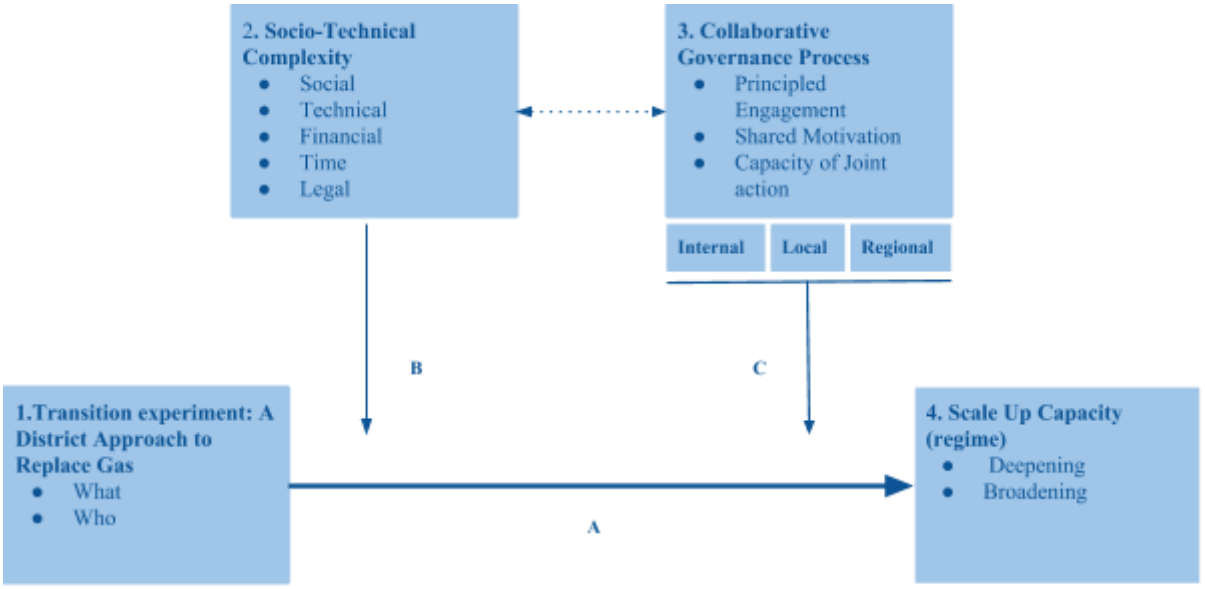


Figure 6: Conceptual Model

A. The process central in this research is the development of the scale-up capacity of a district approach, the transition experiment. In the conceptual model, this is indicated with *Arrow A* between a district approach as the independent variable (1) and the scale-up capacity as the dependent variable (4). It is crucial to indicate the transition experiment within its niche (1); what stakeholders are (in)directly involved in the development of the transition experiment and in what way? Additionally,

the content and aim of the alternative initiated in the transition experiment is discussed. In other words, aims the approach to challenge the regime and introduces the approach an adequate alternative to the status quo. These questions have established the two indicators of variable 1. Thereafter, the scale-up capacity of the experiment can be determined. The literature research has led to the assumption that a window of opportunity is created at the landscape and regime level. In order to achieve scale-up capacity the experiment oughts to deepen and broaden its innovative alternative to natural gas. The remaining concepts and indicators are aimed at discovering and explaining the capacity to scale-up and propose a process to increase the capacity. When this has been accomplished the innovation introduced by the transition experiment can be scaled up to the regime. In other words, the experiment contributed to the transition of the energy system.

B. The scale-up capacity of a transition experiment is influenced and challenged by the context of a local energy system. *Arrow B* is the influence of the complexities of an energy system (the antecedent variable) on the development of the scale-up capacity of the transition experiment(relations A between variables 1 and 2). As discussed in the theoretical framework there are five types of complexities explicated: technical, social, financial, time and legal complexity. These five complexities are the indicators of variable 2. The complexity level measured could help to explain the scale-up capacity of transition experiments. In addition, it identifies the complexities transition experiments deal with in the *deepening* and/or *broadening* phase of the scale-up capacity.

C. A collaborative governance process (variable 3) is proposed as a process which could benefit and stimulate the development of scale-up capacity. A collaborative governance process facilitates deliberative interaction and communication between the actor's which could stimulate deepening and broadening. In addition, collaboration increases the innovations in quality and quantity. This influence is indicated by *arrow C.* This research will determine what collaborative processes are present in the two cases and how it influences the development of the scale-up capacity of the transition experiment. A collaborative governance process is analyzed at three levels: the regionally in the NGUA program, locally in the district and internally within the municipality organisation. First of all, on each level, it is analyzed to what extent a CGP is present. Secondly, the influence of the presence or absence of a CGP on the development of the scale-up capacity of a district approach is analyzed

3. Methodology

3.1 Research Strategy

This research conducts qualitative empirical research. Qualitative research focuses on understanding the subjects of the research deep, elaborate and holistic (Yin, 1989; Paes, 2008). The researcher aims to know what happens, how it happens and for what reasons in that specific case. Qualitative research is often explained as dichotomic to quantitative research in which the latter uses hard data in the form of numbers and the former soft data, meaning words, images and symbols (Neuman, 2014; Mayring, 2014). In this research, a qualitative research strategy is applied as this fits the problemset and research question. This study aims to understand the process of the transition towards a sustainable local energy system by studying the interactive processes from a holistic (systemic) perspective. The aim is to obtain a better understanding and knowledge of specific causal mechanisms. This type of insights can be achieved by qualitative research (Neuman, 2014). With this objective, it becomes essential to analyze the variables and their relations situated in their specific context as this attaches meaning and value to the variables (Neuman, 2014). The boundary between the object of study and its context becomes vague. Therefore, qualitative research often has a nonlinear research design in which meaning is discovered and attached to the concept throughout the research process instead of testing preset hypotheses of concepts by systemic, numeric measurement (Neuman, 2014).

Within qualitative research, multiple research strategies can be applied. In this research theoretical knowledge from academic sources is combined with empirical knowledge obtained through empirical research in two case studies. The theoretical framework and its theoretical concepts are used to approach reality in order to derive the right information and insights in order to answer the research question. This research collects its empirical knowledge in case studies, which is a prominent and long-standing research strategy in a qualitative research (Verschuren, 2003). Already in 1989 Yin stated the still relevant definition "*A case study is an empirical inquiry that: investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used." (Yin, 1989; 23).* As is set out in the theoretical framework, this research applies a complex systemic perspective in which the complexity of the system is acknowledged. A case study is an essential strategy to honor this complexity perspective in the empirical data collection. It offers the opportunity to study a phenomenon or process and its dynamics elaborately in its specific context (Paes, 2008). Hutjes provides an overview of the characteristics of a classic case study. According to Hutjes a case study focuses on the perspectives and interpretations of participants, on interactive processes and on the situated context. Moreover, this is executed with a holistic, idiographic and explorative approach (Hutjes, 2000). The development of a local sustainable district approach in order to replace gas is a complex problem set which requires this strategy in order to come to relevant insights and conclusions.

This study conducts a comparative study of two cases. Two cases will increase the understanding of the subject studied. As Yin explains this makes it possible to study the concepts in and across different contexts (Yin, 2003). In these two cases, the researcher can reflect on the similarities and the differences in the cases (Baxter & Jack, 2008; Stake 1995). Both can increase insight in the occurrence and the development of the studied concepts. It provides more insight in which findings

are valuable which increase the validity of the conclusions. The fact that more cases increase the validity of the results is a grounded assumption (Eisenhardt, 1991). In addition, a better theoretical reflection and evolution is possible (Eisenhardt & Greabner, 2007). Multiple case studies increase the quality of the empirical results in theory testing and developing. The cases of this research are the two municipalities Maassluis and Zoetermeer and their pilot districts Sluispolder (Maassluis) and Palenstein (Zoetermeer). These two local governments are not random selections. The sample used in this research is intentional and goal oriented (Thiel, 2015).

These two municipalities are participating in the Next Generation Urban Areas project. This research studies the CPG within the NGUA. The title of the formal project plan is "*collaborating on sustainability"* (MRDH, June 2017). Moreover, the objective of NGW is to achieve scale-up to the districts of all MRDH municipalities which fits the subject of this study (MRDH, November 2017). This makes the NGUA a relevant sample criterion for this study. However, in the NGUA program, 10 districts in 10 municipalities are participating. This study focuses on Sluispolder, Maassluis, and Palenstein, Zoetermeer. Palenstein, Zoetermeer has been selected as case study as it has been identified as leading in the NGW program (MRDH, June 2017). A far developed case study could provide insight in the processes that accelerate the development of a district approach. In addition, the complexities that were encountered and moreover how these complexities are dealt with. Palenstein, Maassluis is chosen as case study as this municipality is at the start of the transition. In this case the focus is put on the complexities that arise at this point. As many local governments in the Netherlands have not yet started it is valuable to discuss the challenges and requirements at the beginning of a transition in a district.

Palenstein and Sluispolder are comparable districts in size and population. However, they are on a different point in the transition process. Zoetermeer and Maassluis provide different contexts to study the development of a district approach in different stages of the transition process. This provides a comprehensive insight in the transition process. This improves conclusions on the complexities challenging the transition process. In addition, the impact of an absent or present CGP can be explained. Maybe Zoetermeer already overcame complexities which Maassluis is still facing and perhaps the district approach in Zoetermeer is further developed as a result of a local or internal CGP which Maassluis still lacks.

3.2 Research Method

A research method determines how data is collected and analyzed. This research applies two qualitative research methods. First of all, semi-structured interviews are conducted with stakeholders in the local energy systems of Maassluis and Zoetermeer. The second method is a content analysis (Mayring, 2014). A textual analysis of documents related to the district approaches and the local energy transition in the cases studies is conducted.

The former, semi-structured interviews, is chosen as it fits the problem-set of this research. Semi-structured interviews enable the collection of new information on a chosen topic. This method fits a systemic complexity approach as this focuses on the dynamics of the system and its elements. Stakeholders with their own perceptions, interpretations, and actions are elements which are shaping the system. Interviews allow insights in these stakeholders and their behavior in order to achieve a better understanding of the dynamics and development of the system and consequently of the development of a district approach within this system. Summarized, semi-structured interviews offers the possibility to confirm what is already known but also provides the opportunity to discover new

insights and information (Paes, 2008). This way, new perceptions and understanding of the subject of research can be learned. Additionally, a (semi-)structure in the interviews will provide reliable, comparable qualitative data as the interviews will derive information on the same topics and concepts.

The second method is the content analysis of documents. This method is used to achieve a deep understanding of the previous, current and planned developments in the cases is required in order to understand the context system and its complexity. Moreover, policy documents provide insights into the behavior, plans and ambitions of the stakeholders in the cases. Content analysis is necessary in order to have a full understanding of the relevant stakeholders, their activity and their context.

3.3 Operationalisation

In order to apply the conceptual model to the case studies, the variables and indicators need to be operationalised. The theoretical concepts set out in chapter 2 need to be made observable. Table 4 provides the operationalisation of the theoretical framework. The first column indicates what concept is operationalized. Subsequently, the concepts are explained and operationalised with multiple indicators. These indicators make it possible to observe the concepts in practice. All concepts are operationalized with nominal indicators (Thiel, 2015). There is no order or rating of value. Every indicator holds its individual content and meaning. In other words, this research operates with qualitative variables (Thiel, 2015). A question matching the definition is composed in order to collect information on the indicator in interviews. These questions can be found in Annex I.

Table 4: Operationalization

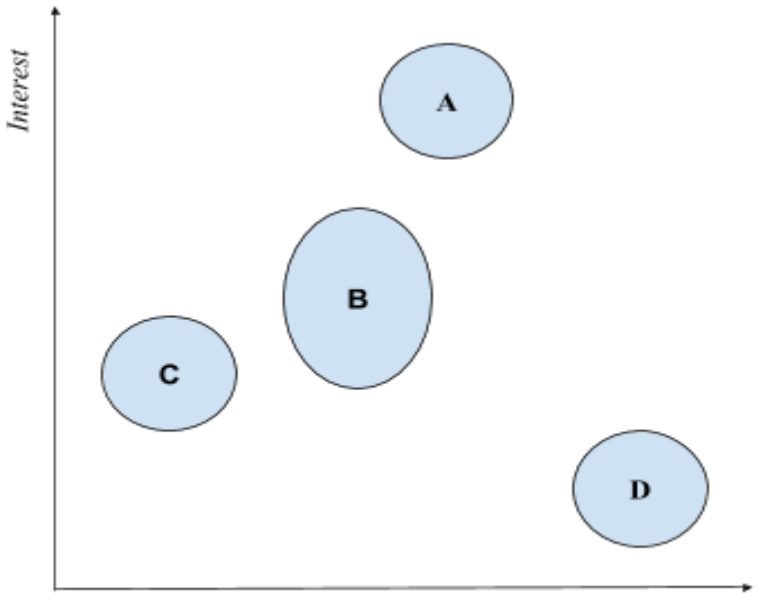
	Concept	Indicators	Definition
1.	Transition Experiment	Who	Actor(s) involved in the transition experiment.
3		What	Green system innovation of the transition experiment/ contribution to a sustainable local energy system.
4	scale-up capacity	Deepened	The transition experiment has engaged in a learning process with regard to experimental innovations (Bosch & Rotmans, 2009).
5		Broadened	The local transition experiment is deliberately connected to innovations in other niches, both within and outside the same domain or function.

7	Deepening	Individual learning	Focus on learning about the innovations (as a product and process).
8		Collective learning	Tuning and sharing learning experiences between different actors.
9	Broadening	Connect	The targeted connection of transition experiments to comparable Transition Experiments (Bosch & Rotmans, 2009).
10		Apply	Apply transition experiments in a different context (physical environment).
11.	Social-technical complexity	Technical complexity	Technical uncertainty
12			Unproven Technology
13		Social Complexity	Conflict of interests involved actors
14			Different perspectives involved actors
15		Financial complexity	Difficult cost & benefit calculation
16			Difficult cost & benefit division
17		Legal complexity	Established conflicting laws
18			Lacking laws
19		Time complexity	Long time frame with continuous and unpredictable developments

20	Collaborative governance	Principled engagement	Stakeholders are deliberately communicating on shared interests, definitions, and the common good.
21			Decisions on the further procedure and substance of the collaborative process
22		Shared Motivation	Stakeholders have achieved internal legitimacy by establishing mutual trust and mutual understanding.
23			Commitment to the collaborative process and its objectives by all stakeholders
24		Capacity for Joint action	Procedural and institutional arrangements to manage repeated interaction between the stakeholders.
25			Sharing, balancing and generating of knowledge and resources between the stakeholders.
26			Leadership expressed by one or more actors in the process.

3.4 Research sample

Besides operationalizing *what* is being researched and *how* it is researched, it is of relevance to indicate *who* is being researched. In order to come to valid conclusions at the end of this research, a useful sample of the population relevant to this study has to be interviewed. The interviews for the data collection in this research are held with stakeholders in the municipalities Maassluis and Zoetermeer. The respondents are chosen based on their relevance in the transition of these districts. This relevance is determined based on their degree of influence and interest in the transition. A stakeholder could be relevant as a result of a lot of influence in the development of the transition, however, has little interest in it. This is visualized in graph 1. For example, a municipality could be stakeholder A. The municipality has a lot of interest in realizing the transition, however, their influence at this point is not so strong with the currently little enforcement resources.



Graph 1: stakeholders analysis

In Maassluis the municipality has set high ambitions to become CO2 neutral in 2040. In the latest Coalition Agreement (2018-2020) the municipality acknowledges that reaching these ambition is something "the municipality cannot do alone, but can only be reached in cooperation with others". By applying this research to the municipality of Maassluis more insights will be drawn on the development of ambitions. In addition, the municipality has chosen the district Sluispolder as a pilot to create a district approach to replace gas. 10 interviews were held in Maassluis. The interviews in Maassluis have been conducted in two rounds. The first round at the beginning of 2018 and the second round halfway 2018. The first round of interviews, every respondent with a *, was conducted as data collection for both this research and the TNO project in Sluispolder. The two rounds of interviews, therefore, have been conducted with a slightly different interview guide. The first round consists of more general interview questions on the development of the transition in Sluispolder. In these interviews, the respondents were asked to elaborate on the perceived the challenges, the opportunities, and the necessities in the transition of Sluispolder. The interview guide is found in Annex x. The second round of interviews was comparable however the questions on the challenges were in specific on the different complexities identified in the theoretical framework. In addition, questions on collaborative governance were added. The interview guide is found in Annex x. In table 5 the respondents, their function and their relevance to this study are indicated. The respondents with an * in their code are respondents from the first round.

The second local government is Zoetermeer. In Palenstein, the pilot district of the municipality of Zoetermeer, the housing corporation De Goede Woning has put a transition process in motion by starting a (re)construction project in Palenstein realizing 120 gasless houses. Consequently, on March 29, 2017 five stakeholders signed the Green Deal: the municipality, Stedin, De Goede Woning, Vestia, and Vidomes. The latter three are housing corporations with property in the district Palenstein. Palenstein is the most developed district in the NGUA program (O1). In the Palenstein, Zoetermeer case seven interviews are conducted. Table 5 provides an overview of the respondents in the Palenstein, Zoetermeer case.

Besides stakeholders, in the two cases, an interview has been conducted with the initiator of the NGUA at the MRDH. This interview was deemed relevant and necessary as it would provide insights

into the objectives, challenges, and development of the collaboration process in the NGUA project. In addition, an interview has been conducted with the founder of Factory Zero but also government program Energiesprong and Stroomversnelling. In the latter, the aim is to renovate 111.000 homes to energy neutral in 5 years by introducing radical innovations. His knowledge is broad combining the technical and social aspects. He is often hired by governments as energy transition consultant. However, with Factory Zero they aim to introduce easy applicable sustainable house makeover constructions and techniques to the construction market. As they argue "bad quality, high prices and long periods of nuisance prevent people to make their houses healthy, comfortable and energy efficient" (factory zero). This interview is deemed relevant as in this interview a different side of the coin is looked at. Factory zero is a firm aiming to influence the supply side whereas the other respondents are stakeholders on the demand side of technique and construction. Factory Zero supplies the energy modules used in the reconstruction by De Goede Woning in Palenstein.

Tabel 4: The Respondents

#	Code	Organisation	Relevance	Function	Responsibility	Interview Date
1	**M1**	Municipality Maassluis	**High interest & medium influence**: high sustainable ambitious and responsible for realizing a transition in the municipality.	Policy Officer Sustainability	Responsible for drafting, developing and realizing policy on sustainability in Maassluis. Representing the municipality of Maassluis during NGUA meetings and in the NGUA workgroup.	5-07-2018
2	**M2.a***	Maasdelta (2)	**High interest & high influence**: Property holder of 50% of Sluispolder. Realize sustainable housing in Sluispolder.	1) Head of Location Maassluis 2) Project Leader Real Estate Development	2) developing new real estate projects and redeveloping existing real estate. Since this year with the emphasis on sustainability and energy. In Maassluis, this means realizing sustainable new construction and making existing homes more sustainable over the coming years.	05-02-2018
3						
4	**M2.b**	Maasdelta	*Additional interview for more insights.*	Project Leader Real Estate		16-08-2018

			Property holder of 50% of Sluispolder. Realize sustainable housing in Sluispolder.	Development		
5	**M3**	Municipality Maassluis	See M1	Strategic Policy Officer	Consults on the themes strategy, staff, urban development & public housing within the municipality. Involved and interested in the transition of Sluispolder; in specific to assure the interests of the house owners in the Sluispolder are considered in the transition process.	17-08-2018
6	**M4**	Municipality Maassluis/ Encom consultancy	See M1 Encom: an independent consultancy advising in making strategic transition choices, implementing the sustainability policy and achieving your sustainability ambitions. + energy coordinator.	Manager Energy Maassluis / Energy consultant at Encom	With the help of a professionally developed application, the energy consumption is analyzed and connection management, energy monitoring, and energy cost management are provided.	28-06-2018
7	**M5***	Municipality Maassluis	See M1	District Coordinator Sluispolder	Intermediary position in connecting internal municipality affairs and external district affairs in the municipality. Including the residents of Sluispolder and other external stakeholders in the transition process towards sustainable districts.	20-02-2018
8	**M6***	Municipality Maassluis	See M1	Director Spatial planning: traffic and environment	Responsible within the municipality of Maassluis for policy on the spatial planning of Maassluis with a focus on traffic and the environment. Setting sustainable objectives, make the necessary policy and	08-02-2018

					move and connect the relevant stakeholders to realize a sustainable Maassluis.	
9	**M7***	Stedin	**High interest & medium influence:** Realize the right infrastructure to enable the phase-out of gas and the electrification of the area.	Area director Energy transition Zuid-Holland.	Support municipalities in the area Zuid-Holland (inc. Maassluis) with knowledge and capacity in the sustainability transition.	08-02-2018
10	**M8***	VBBM (residents' interest representation organisation)	**Medium interest & low influence:** advise Maasdelta and the municipality on the interests and needs of the residents, with a focus on living quality (not sustainability).	Policy officer	communicate the interests of residents to the municipality or Maasdelta closer	9-2-2018
11	**M9***	Educational centre "het Spectrum"	**Medium interest & medium influence:** realize a sustainable school building with e.g. 250 solar panels, a rooftop garden with sustainable irrigation system and a green/blue schoolyard by mid-2018. Increasing sustainable awareness amongst students, employees and the environment.	Principal	Responsible for own building and the education of the children in the district.	12-03-2018
12	**M10***	Residents Sluispolder	**Low interest & high influence**: owners of the houses in the district decide on the transition of their property.	(ex) resident sluispolder and Former Chair residents committee	Represent and lobby the interests and experiences of the residents of Sluispolder towards policy-makers in the municipality and Maasdelta.	22-02-2018
13	**Z1**	Municipality Zoetermeer	**High interest & medium influence**:	Manager of the programme	Public official at the municipality of Zoetermeer for	10-08-2018

			Responsible for directing and facilitating the transition.	Sustainable and Green Zoetermeer at the city of Zoetermeer	16 years. Currently responsible for the management of the sustainability and green program of Zoetermeer. The initiator of the participation in the NGUA program. Part of Workgroup Gas-free Palenstein	
14	**Z2**	Municipality Zoetermeer	See Z1	Program manager Palenstein	Responsible for the integral coordination of both the physical and social sectors in the municipal policy in Palentein. With a focus on the reconstruction plans in the district. Part of Workgroup Gas-free Palenstein	23-08-2018
15	**Z3**	Vestia	**Medium interest & high influence:** Vestia is property holder of ⅓ of the rental houses in Palenstein and responsible for the transition of their property. Partner of the Green Deal Palenstein	Senior Policy Advisor Sustainability	Responsible for the development of the sustainability policy of Vestia. Represents Vestia in initial interactions in a district approach. When the ambitions for a district approach are concluded a project manager takes on the responsibility (Z4). Part of Workgroup Gas-free Palenstein	20/08/2018
16	**Z4**	Vestia	See Z3	Project manager Palenstein	Responsible for the execution of the sustainability policy of Vestia in Palenstein. Part of Workgroup Gas-free Palenstein	27-08-2018

17	**Z5**	Goede Woning (2)	**Medium interest & high influence:** Property holder of ⅓ of the rental houses in Palenstein. + Initiating and realizing sustainable housing in Palenstein. Partner of the Green Deal Palenstein	1)Team Leader Energy and Maintenance	Responsible for the project in Palenstein which realizes 120 Energy Neutral houses.	13-09-2018
18				2)Manager Real Estate		13-09-2018
19	**Z6**	Stedin	**High interest & medium influence:** Realize the right infrastructure to enable the phase-out of gas and the electrification of the area. Partner of the Green Deal Palenstein	Area director Energy transition Zuid-Holland.	Realize the right infrastructure to enable the phase-out of gas and the electrification of the area. Support municipalities in the area Zuid-Holland (inc. Maassluis) with knowledge and capacity in the sustainability transition.+ Partner of the Green Deal Palenstein. Part of Workgroup Gas-free Palenstein	17-08-2018
20	**Z7**	Municipality Zoetermeer	See Z1	Alderman Sustainability & Real Estate	Part of Steering Committee Gas-free Palenstein	13-09-2018
21	**O1**	MRDH	**Medium interest & medium influence**: initiator and director of the NGUA.	Strategic adviser Economic business climate/ Project leader of the NGUA program within the MRDH	Responsible directing the NGUA program within the MRD.	16-07-2018
22	**O2**	Factory Zero	**High interests & low influence:** Factory Zero supplies the energy modules used	Co-Founder	Many years experience in the energy transition. He is regularly asked as an advisor to companies, ministries, and	23-08-2018

by construction firm Dura Vermeer in the re(construction) by de Goede Woning.

members of parliament (at home and abroad) because of his unique view on this issue.

3.4 analysis techniques

In order to analyze the collected data the conducted interviews are recorded and subsequently transcribed. The result, a full transcript of every interview, forms the raw data of the research. In order to infer conclusions from the collected data qualitative analysis of the raw data has been conducted. By coding the transcripts and documents relevant to the research the data was categorized and arranged according to the theoretical foundation of this research. The coding of the documents was conducted in decoding program Atlas T.I which enables in-depth, elaborate and organized coding. The data were categorized according to the concepts making up the conceptual framework and as set out in the operationalization of this research. A axial coding technique was applied that allows identifying connections between codes. Questions and hypotheses about causes, consequences or links between concepts in the research can be confirmed or undermined. In addition, new relations can be discovered which were not yet considered.

3.5 Research Quality

The chosen operationalization, research method and research design have the aim to optimize the quality of this research. The quality of the research is determined by the reliability and validity of the research (Thiel, 2015).

Reliability of a research is determined by the accuracy and consistency of the measurement of the operationalized concepts. The collections of the data, the analysis, and the derived conclusions ought to be achieved through deliberate, systematic research instead of coincidence (Thiel, 2015). The first risk in this research is the intersubjectivity of data. In a qualitative research conducted in two case studies the procedures, data, and results are verbally communicated. "Other things being equal, numbers and symbols, in principle, are more precise than words" indicates Verschuren (2003). In addition, the outcome of the qualitative research method of (semi) structured interviews is inevitably dependent on the researchers and its personal analysis (verschuren, 2003). In order to avoid these pitfalls this research, first of all, conducts interviews with a semi-structuralized interview list which systematically researches the central concepts in this study. Secondly, of every interview, an elaborate report or transcript is written which is shared with to the interviewee for feedback and approval. Third, the steps taken in this research process are made transparent and shared with the reader.

Another pitfall inherent to a case study research is the lack of external validity, or in other words *generalization* of the study. The *external validity* of a study indicates whether a study and the results are limited to the specific context or are applicable to a broader scope. A case study has little external validity as the number of research units is small (Verschuren, 2003) and the conclusions tied to the context (Paes, 2008). Therefore, it must be noted that the outcome of this study is not offering generalizable results. However, in order to create greater validity, two case studies have been conducted. The results and analysis of these cases are compared in an extra analysis. A comparative

case study gives conclusion a greater external validity. In addition, these results offer a point of perspective, a case for learning and inspiration and a point of departure for further research. Insights can be drawn on the theoretical concepts and their applications, the methodology used and eventually on the content of the results.

4. Case Description

In this research two cases are compared in order to determine what complexities are challenging the development and realization of a district approach to replace gas with sustainable alternatives. Considering multiple cases allows the analysis of a collaborative process between these governments and their local initiatives. The cases subject to the analysis of this research are local governments participating in the regional collaboration program *Next Generation Urban Areas (NGUA)*. The governments participating in this program are developing district approaches in a pilot district in their municipality. First of all, the NGUA program will be described. Subsequently, the two local governments Maassluis and Zoetermeer, will be introduced.

4.1 Next Generation Urban Areas

Next Generation Urban Areas is a development project in the Regional Investment Program, initiated by the Metropolitan Region Rotterdam Den Haag (MRDH). The MRDH is an urban agglomeration in the province South Holland in the Netherlands. 23 local governments are collaborating in the MRDH with the objective to improve the development of the region (REF). The NGUA was initiated in 2017 in order to realize high-quality living environments in the urban areas of the region by 2030 (O1). The NGUA adopts an integrative approach in which the sustainability challenge is understood in relation to employment and education in the district. Therefore the project comprises different lines of development among which smart mobility, sustainable housing, water management, local production, waste management etc. (MRDH, November 2017). Thus, realizing a sustainable energy system is part of the overall broader objective of the NGUA program to establish sustainable urban areas. This research will focus on the realization of the ambition "to achieve urban areas with a flexible, diverse, well maintained and **CO2 free** housing stock"(MRDH, November 2017; 7).

Seven local governments with a leading position in the regional energy transition were invited to participate in and contribute to the NGUA project. One or more districts in every local government function as pilot districts in which a district approach is developed, evaluated and applied (table 5). The participating local governments received funding from the MRDH to dedicate to their district approaches. The NGUA is financed by the national government (Ministry of Home Affairs) which supports the regional approach with €60.000. In addition, the MRDH has contributed €130.000 to the preparation and organisation of the NGUA and €300.000 to concrete projects within the NGUA (MRDH, November 2017). During regular meetings, the participating governments share successes, challenges, and lessons learned in their district. Eventually, as the MRDH states, the goal is to scale-up successful practices to other districts in other MRDH municipalities (agendapunt 5 MRDH). The MRDH offers assistance and facilitation to the collaborating local governments in the NGUA (MRDH, November 2017; June 23). The MRDH helps governments to define the substance, organisation and finance of their local initiatives. Moreover, by creating the platform NGUA they stimulate governments to share knowledge and collaborate on specific topics. The project provides the

MRDH with the role of regional authority; filling the gap between local and national governments (O1).

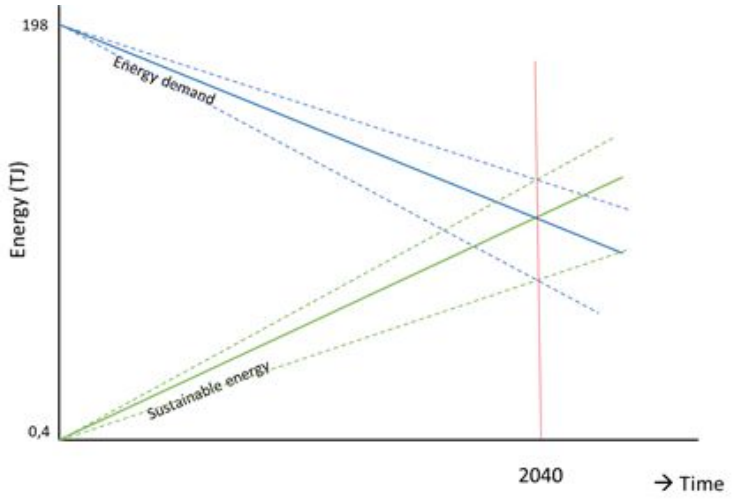
Table 5: Next Generation Urban Areas	
Municipality	**District**
Den Haag	*Mariahoeve & Moerwijk*
Maassluis	*Sluispolder*
Nissewaard	Sterrenkwartier
Rotterdam	Bospolder-Tussendijken, Prinsenland/Lage Land, Reyersdijk & Charlois
Vlaardingen	Holy
Zoetermeer	*Palenstein*
Westvoorne	Westvoorne

4.2 Maassluis

Maassluis is a municipality in the province Zuid-Holland. Maassluis has 32.470 inhabitants (2017: CBS) and covers 10.12 km2. The municipality is part of the Metropool Region Rotterdam Den Haag. Maassluis was considered a municipality with high GHG emissions relative to its surrounding area. In 2015, Maassluis emitted 104.371 tCO2. In the sustainability program of Maassluis published in 2017, an indication is made to what extent the ambitions for 2020 are realized. With 128.000 tCO2 in 2017, the ambition of a total of 99.000 tCO2 in 2020 still requires work. The lion share, 106.00 tCO2, of the current Co2 emission of Maassluis can be assigned to the built environment. Mobility is responsible for the remaining 22.000 tCO2 (Maassluis, 2017).

Ambition

In 2008 the 15 municipalities in the region of Rotterdam, among which was Maassluis, adopted a shared sustainability ambition to reduce the Co2 emission with 40% by 2025 (relative to 1990). Maassluis has set even higher sustainability ambitions for the transition of their municipality. In their ambitions, they aim to lead the transition by 10 to 15 years. In the "Duurzaamheidsvisie gemeente Maassluis 2012 – 2015" the council formalized the ambition to realize a CO2 neutral maassluis by 2040 (Maassluis, september 2012). To enforce this ambition it has also been included in the coalition agreement and the council program. In September 2017, the ambitions are made concrete in the "Duurzaamheidsprogramma Gemeente maassluis" published. The ambitions expressed in this vision are confirmed and continued in the Coalition Agreement of 2018-2020 (Maassluis, 2018). As laid down in the vision "*there are two switches we can turn in order to realize our ambition; the energy consumption and the application of sustainable energy sources*" (Maassluis, 2018). This implies that in 30 years the energy use is decreased and when energy is used this is covered by sustainable energy sources. This is illustrated in Graph 1.



Graph 1 (TPSR Maassluis Report, TNO)

Sluispolder

Although the ambitions of the municipality cover the entire city of Maassluis this research will focus on one district: Sluispolder. Sluispolder has been designated as a pilot district by Maassluis in which a district approach is developed to achieve sustainability. In total the district Sluispolder has 6245 inhabitants in an area of 81 ha. Sluispolder is mainly a residential area with 3278 houses of which 48% is owned by the housing corporation Maasdelta and 42% is owner-occupied. Sluispolder in specific is appropriate as a pilot as the district is subject to large restructuring plans which are currently being implemented. In 2014, the zoning-plan "Sluispolder-West, phase 1" has kicked-off the restructuring of the district. This has created momentum for a transition. The buildings (1016) in Sluispolder West were built in the fifties and sixties of the 20th century. The Heath Transition Atlas produced by Over Morgen shows the lion share of the houses in Sluispolder currently have energy label E or lower (map 1). In total 610 homes will be deconstructed and replaced by only 393. Many stacked multiple-family homes will be replaced by single-family homes surrounded by large gardens. The larger district Sluispolder-Oost (1.600 houses) is not yet subject to the restructure plans however it will be after Sluispolder-West has been realized.

Map 1: Energy Labels Sluispolder, Maassluis

SSD

In 2018 Sluispolder, Maassluis became subject to a research project by research and innovation organisation TNO. Maassluis became a pilot municipality in the Smart Sustainable Districts (SSD) project initiated by Climate-KIC. SSD is a European wide program to assist districts in their transition to sustainable and climate-resilient communities (TNO report Maassluis). This program includes pilots in nine districts: **Rotterdam**'s Stadshaven Harbour, **Utrecht** The New Centre, **London**'s Queen Elizabeth Park, **Paris**' Les Dock de Saint-Ouen, **Gothenburg**'s Johanneberg, **Malmö** southeast, **Berlin** Moabit West, **Helsinki**'s Kalasatama and **Copenhagen** Energy Block. Maassluis is the first small municipality joining the program. Small municipalities need different approaches as they face other challenges in their sustainability transition as they have less resource, experience and network connections according to SSD.

In order to realize the ambitions set by the municipality of Maassluis, TNO, in collaboration with the local stakeholders, created a variety of possible scenarios of a CO2 neural Sluispolder in 2040. TNO organized four meetings in total. Two meetings, the first and the last, were within the municipality organisation. The other two were attended by a wide range of stakeholders in Sluispolder. In the first municipality meeting the representatives of different departments of the municipality collaborated in a stakeholder mapping exercise to identify the relevant stakeholders in the transition of Sluispolder. These stakeholders have been approached to cooperate in the research by being interviewed and participate in workshops. During the first meeting, the results from the interviews and the system analysis were validated by presenting and discussing them with the stakeholders. The second meeting, an even wider range of stakeholders participated. During this meeting the stakeholders collaboratively drafted transition paths to realize the scenarios of a sustainable Sluispolder in 2040. TNO concluded the project in July 2018 with an elaborate report on the scenario's, transition paths and the lessons learned (reports TNO). Eventually, the insights drawn from this project should help to create scenarios and transition paths for other districts in Maassluis. In addition, the lessons learned are communicated on a European level with the intent to eventually achieve one appropriate approach to the transition of districts.

4.3 Zoetermeer

Zoetermeer is the second case in this research. Zoetermeer is a city in the province of South Holland and with 124.710 (January 2018) and has the third largest population after Rotterdam and The Hague (Zoetermeer.nl). Zoetermeer is part of the MRDh and is a participant of the NGUA program. Zoetermeer has a total energy use of 5.789 TJ. Only 2.5 percent of this energy, 263 tj, is renewable energy. In addition, Zoetermeer emitted 470.769 tCO2 in 2017.

Palenstein

The district assigned as a pilot district in Zoetermeer is Palenstein. Palenstein is the first district in Zoetermeer in which the municipality is taking the sustainable initiative to realize a gas-free district (Project Plan). Palenstein is a suitable district as the large restructure and maintenance projects create momentum for a transition. In 2017 a population of 5740 was registered in Palenstein. 2855 households are occupying 3079 homes. Palenstein is built from the 60's onwards. In the 60's there was a high demand for affordable housing which resulted in most high rise buildings. Today, the housing vision has changed. Since 2012 large restructuring projects are replacing high rise buildings with a more varied housing stock. Map 2 shows the current energy labels in the district Palenstein.

Map 2: Energy Labels Palenstein, Zoetermeer

70% of the housing stock of Palenstein is equally divided over three housing corporations: de Goede Woning, Vestia, and Vidomes. De Goede Woning has taken the initiative to start constructing energy neutral housing. Houses which use as much energy as they produce, sustainably. Currently, both de Goede Woning and Vidomes are pursuing this policy. Vestia has not yet made policy on the transition of their property.

Green Deal

In 2017 the most important stakeholders in the transition of Palenstein, the municipality, the three housing corporations, and the net operator, have signed a *Green Deal* in which they have committed to a common objective: realizing a gas-free Palenstein by 2040 (Zoetermeer.nl). Between the municipality and the housing corporations, a collaborative structure was already in place during the restructuring process. The net operator was included in the collaboration as the net operator is owner of the underground gas infrastructure. In Palenstein the underground infrastructure dates back to the birth of Palenstein. 50 years is the age at which gas and electric infrastructure are economically due. This creates momentum for a transition. However, as the technical lifespan of the infrastructure is expected to be twice as long there is no necessity or urge to replace this in Palenstein for the net operator (Z7). The Green Deal commits the signing partners to shared objectives, individual and collective roles and responsibilities (Zoetermeer, May 2018). With this collaborative structure, the stakeholders hope to create a context in which a gas-free Palenstein can be realized (Zoetermeer, May 2018).

Project Plan

At this point, the partners in the green deal have composed a *project plan* for the transition of Palenstein. First of all, the partners have collectively studied the alternative possibilities to gas in

Palenstein. They found five possible alternatives (Zoetermeer, May 2018). As Palenstein has a wide variety of houses the district has been divided in clusters. Map 3 indicates the cluster of palenstein.

Map 3: Clusters Project Plan Palenstein, Zoetermeer

The clusters are divided based on the type of buildings in this part of Palenstein as for every type of house a different solution has to be found. Currently, projects have been started in Cluster 1. Cluster 1 covers around 50% of the houses in Sluispolder, from which half is owned by the housing corporations. The houses in Cluster 1 are mainly high rise buildings with 11 to 20 floors (Zoetermeer, May 2018). In Cluster 1 the partners have decided on a low-temperature heatnet with a ground-coupled heat exchanger as a sustainable heat source. However, at this point, this option is only able to reduce the use of gas by 60%. 100% is not yet possible in the current business case. This project is therefore still in development. The other clusters are still subject to exploration, research or preparation.

4. Analysis

This research initially started with five complexities: social, technical, financial, legal and time. Although the different complexities have been brought up in the interviews the analysis has only included the first three complexities. Although judicial and time complexities were not denied in their entirety in the interviews it became clear the three most perceived and discussed complexities were social, technical and financial complexity. In addition, in order to keep the analysis focused and relevant the analysis will discuss social, technical and financial complexities and the interactions and connections between these complexities.

4.1 Maassluis

In the Maassluis case data is collected on the current status quo of the gas replacement task. The scale-up capacity of a district approach to replace gas in Sluispolder is analyzed. In addition, the complexities challenging the development of a district approach are analyzed. Third, at three levels a CGP and its influence on the development of a district approach is analyzed. Every section concludes with a short concluding analysis.

4.1.1 Status Quo (scale-up capacity)

As written in the case description, Maassluis has set the ambition to become Co2 neutral in 2040. In order to realize the reduction of CO2 production Maassluis has to find a way to replace natural gas with a sustainable alternative, as respondent M1 explains (M1). The district Sluispolder is designated as the pilot district in which Maassluis is developing a district approach to realize the conversion from gas to an alternative. Sluispolder is the niche in the transition of Maassluis in which a transition experiment is taking shape. In order to identify the development progress of the transition in Maassluis the scale-up capacity of the district approach developed in Sluispolder will be analyzed. scale-up capacity is achieved whenever the district approach is deepened and broadened.

Searching for alternative ways

In the *deepening* dimension of achieving scale-up capacity, the stakeholders in Sluispolder are learning whilst searching for alternative ways to think and act in order to realize the conversion from gas to a sustainable alternative. In Sluispolder the stakeholders enabled the deepening of the process and substance of a potential district approach. A *searching* process appears in Sluispolder. No longer the stakeholders are continuing to incrementally improve the status quo. A searching process is perceived in Sluispolder. In Sluispolder there are multiple projects in development which contribute to the conversion of Sluispolder. There is a swimming pool in transition, a sustainable school building in construction, an ambitious and vigorous housing corporation realizing sustainable housing and the research organisation TNO has been accelerating the *search* process with a six-month project.

First of all, the swimming pool in Sluispolder is becoming sustainable (M3). However, according to M3, one of the challenges at this point is finding an appropriate alternative to gas as the pool has a high heat demand. The swimming pool is realized with the support of the municipality (M3, KIKOFF). A second sustainable initiative is the construction of a new sustainable school building for the elementary school in Sluispolder (M9, KICKOFF). In the new school building, the focus will be on sustainable energy production and usage and energy saving. This is in collaboration with the

municipality. With a subsidy provided by the municipality 250 instead of 50 solar panels are now realized, exemplifies the school director (M9).

Third, the housing corporation Maasdelta, owner of 50 percent of the property in Sluispolder, is pursuing and realizing a sustainable reconstruction policy in Sluispolder. Since 2016 Maasdelta has had the policy to realize housing without gas when the opportunity presents itself (M2b). In other words, whenever reconstruction is planned. In Sluispolder, Maasdelta has planned to replace 600 houses with 400 energy neutral houses. The first cluster, two streets, has already been realized (M2b). The new houses are no longer gas depended and are set up with a heat pump. As Maassluis is not (yet) connected to a regional heatnet, individual heating with a heat pump is the current possible alternative explains Maasdelta (M2a). However, this only applies to new constructions. "*It is more difficult to realize this in existing buildings. There is still no policy for phasing out gas in existing homes"* explains Maasdelta. Reconstruction is not profitable for the houses in Sluispolder according to Maasdelta (M2a).

Fourth, as of the beginning of 2018, TNO (a research organisation) and Over Morgen (a consultancy firm) were asked to assist in the development of the transition in Maassluis. The two tracks evolved separately. This research will focus on the TNO project as TNO specifically contributes to the development of the district approach in Sluispolder. In the TNO project, the focus was on developing scenarios of a sustainable Sluispolder and plan transition paths for the short and long-term to realize these scenarios (TNO, September 05, 2018). In the TNO project, the searching phase was increased and intensified. In the potential scenarios, TNO proposes a variety of energy and climate adaptation measures to achieve a sustainable Sluispolder in 2040. For the purposes of this research, the climate adaption options will not be taken into account. The report proposes three options for an alternative way of heat supply to replace gas and two options to meet the electricity demand in Sluispolder with sustainable energy (report TNO). After TNO finished their project in July 2018 the municipality was left with the responsibility to decide on the substantial part of the district approach; which alternative should replace gas in Sluispolder?

The searching phase has not yet delivered an appropriate district approach to replace gas in Sluispolder. The interviewees, with the municipality and other stakeholders, demonstrate the district approach of Sluispolder is still in an early stadium of the searching phase. At this point, the municipality of Maassluis has not decided on how they are replacing natural gas in the Sluispolder. This is confirmed in the interview with the project director in Sluispolder, she describes the current state in Sluispolder as the early *"research phase" (M1).* This was confirmed during an interview with another employee of Maassluis (M3) who indicates an early searching phase as he explains that *"we really find ourselves at the early start [of the transition in Sluispolder], I do not know when what will happe*n" (M3). Also, the network operator is yet unable to answer any questions on the developments in Sluispolder *"the involvement of Stedin in Sluispolder has not really taken off yet*" (M7*) This, however, is increased in the TNO project. After the TNO project, five months later, he indicates increased involvement however still with little results (Z7). To conclude the project in Maassluis the results, the scenario's and transition paths were presented to 15 employees of the municipality by TNO. During the meeting, the attendees of the municipality showed a searching attitude. At the meeting (4), a variety of question was raised by the attendees on how to determine what scenario and which options are most appropriate for the districts (report 4).

Learning

As indicated in the theory, a transition experiment reaches scale-up capacity by learning individually and collectively. For Maassluis most relevant learning process is collectively on the regional level. M1 illustrates a collective learning process with other municipalities such as Rotterdam, Den Haag, Schiedam and Zoetermeer within the NGUA program. "*We share lessons with municipalities within the NGUA. Lessons are currently shared between municipalities and not so much within Maassluis*" declares M1 in the interview (M1). The municipalities in the NGUA also assigned districts in which they strive for the removal of gas. As Maassluis joint the NGUA later than other municipalities they could instantly build on the lessons learned in the other municipalities in the program. The first, and fundamental, lesson learned was to start with a district instead of municipality-wide. An additional lesson is to conclude a statement of intent with the stakeholders within the district to guarantee commitment and the fulfillment of promises made. Another interview with the municipality of Maassluis illustrated a lesson learned on how to involve house owners in the transition process (M3). In neighboring municipalities Schiedam en Vlaardingen a Service Point has been realized at which house owners can collect information and receive individual advice on how to make their own houses more sustainable (M3). Besides collective lessons drawn from other municipalities, TNO published a report with the key lessons learned during the six-month project in Sluispolder (TNO, September 17, 2018). The key lessons are contributing to the objective of the Climate KIC program to develop a blueprint transition process for districts in small municipalities (Report LL).

The lessons learned in the collective learning process are all related to the process of a district approach (M1, M4). Finding concrete alternatives for the buildings in your own district requires a district-specific analysis. *"The moment you are working on a district approach, the district municipality or another municipality has nothing to do with it. However, you can learn from the approach that other municipalities have applied to a similar district. (...) Which does not mean you make a copy and it is arranged, eventually it requires customization to your own district"* explains M4. However, according to M4 collective learning still occurs insufficiently as every municipality still tries to invent the wheel by themselves again. This is a waste, according to the respondent, as municipalities miss out on synergetic benefits (M4).

A learning process amongst the stakeholders in Sluispolder appears not yet fully present at this point, as M1 also indicated. The first indication of this a lack of interaction with each other on the subject. In the TNO project, TNO facilitated the stakeholders the first collective encounter on the development of a district approach in Sluispolder. During the TNO project, 4 stakeholder meetings were organized. These meetings demonstrate a learning process amongst the stakeholders in Sluispolder. On the evaluation forms which were shared after each meeting, the participants were asked whether they had collected new insights or knowledge during the meetings. First of all, two internal meetings with a large number of municipality employees from different departments. 6 of 8 answers on the first internal municipality meeting were positive and indicated new knowledge or insights were acquired. Unfortunately, there was no evaluation of the second and last municipality meeting. Second, two meetings have been organized which brought together a wider scope of stakeholders in Sluispolder (Annex IV: Report 2 & 3). Both stakeholder meetings produced only one negative answer. A large majority of the attendees indicated they had collected new knowledge or insights during these two meetings (Annex v).

Conclusion
As analyzed in the previous section the municipality of Maassluis expressed the ambition to realize a sustainable Maassluis by 2040. The focus in the transition of Maassluis is currently on the district of Sluispolder. This decision is based on the lesson learned by municipalities with more progress in the transition to start with a district approach. This indicates a collective learning process between different local governments in transition, facilitated by the NGUA programme. The district of Sluispolder embodies the niche in the transition of Maassluis, as the district approach developed in Sluispolder could eventually be used in other parts of Maassluis (M1). In addition, Sluispolder is a niche in the Dutch energy transition as eventually every district has to replace gas.

Although there are developments which contribute to a gas-free Sluispolder they are insufficient to meet the ambitions of the municipality or to realize a district without gas. The status quo is an accumulation of ad hoc initiatives which are indeed sustainable, however, coordination or connection lacks hence the opportunity on synergy. "At this moment sporadic, independent activities are being organized. However they do not work towards something, there lacks a vision" evaluates M9 the current developments in Sluispolder. The first steps towards a more integral learning and searching process are made when TNO joint the transition process of Sluispolder. However. As TNO has concluded their project in July 2018 they are no longer involved in facilitating and shaping the process. As TNO left the process it depends on the stakeholders to continue the deepening process. Moreover, in order to achieve scale-up capacity, a broadening process is required, which currently has not been perceived.

4.1.2 Complexities

In the previous section, the current scale-up capacity of the district approach in Sluispolder has been analyzed. The district approach in development in Sluispolder has not yet achieved scale-up capacity. Sluispolder is at the beginning of the deepening phase and a broadening process lacks. This section analyzes the complexities challenging the development of a district approach to replace gas. This means, the complexities found are complexities perceived in the deepening phase of the scale-up process. In the interviews, the respondents were asked to elaborate on five complexities. However, the three complexities with the most impact will be analyzed: social, technical and financial.

Social Complexity

Social complexity is challenging the development of a district approach. This complexity has been identified by all stakeholders which have been interviewed in this research, however in different intensity and with different explanations. Social complexity is measured as the result of two types of conflicts: a conflict of interests and a conflict of perspective between the different social actor (Hertogh & Westerveld, 2010). Both conflicts have been identified and will be discussed below.

The transition of Sluispolder is an environment in which many stakeholders are involved. A stakeholder is defined by either or both its level of influence and interest in the process. The key stakeholders which have been identified as relevant in this phase of the transition are the municipality, the housing corporation, the system operator, local organisation or firms and the residents of the district. The development of the transition of Sluispolder is therefore also dependent on a wide variety of stakeholders. With a wide variety of stakeholders, there is an equal variety of perceptions on the status quo in Sluispolder and the sustainability ambitions for Sluispolder as "*people give different interpretations of objectives*" (Hertogh & Westerveld, 2010). All stakeholders which are interviewed

for this research have recognized and confirmed the objective to develop a district-focused approach to achieve a sustainable Sluispolder without gas (M1, M2, M3, M4, M5*, M6*, M7*, M8*, M9*). There is no conflict in the objective of a sustainable Sluispolder. However, not all stakeholders share the same approach, timeline or interpretation of the objective. The most important conflict of interests and perspective is found between on the one hand the residents and on the other hand the municipality and the housing corporation.

First and foremost, a conflict in a sense of urgency to start with the energy transition has been identified. The residents of Sluispolder seem to lack or have a low sense of urgency. This is identified as a social complexity influencing the progress of the transition process by nine respondents in Sluispolder (M1, M2, M3, M4, M5*, M6*, M7*, M9*, M10*). For residents, this lack of urgency is explained in the interviews as a combination of other priorities and the large investment necessary in order to turn houses gas free. This lack of urgency is identified with both renters of the property of Maasdelta and private homeowners.

In the interviews, it is argued that homeowners have no opportunity or interest to invest in their homes as a result of a lack of money, information, and priorities. Sluispolder is a district in which many residents deal with socio-economic problems such as unemployment, debt, and segregation (M6, M1). "*For many, this [sustainability] is a problem far in the future and has nothing to do with everyday life because they already have enough problems to deal with*" explains M1. In addition, residents might make investment decisions based on other priorities such as a new kitchen (M3, M4). "*For an old house an investment of 30 to 40 thousand euros is required, for some residents this more than their yearly salary (...) and if people spend their money they invest in a car, a kitchen or new bathroom"* M4 elaborates on the lack of urgency with the homeowners in Sluispolder.

This is mutually enforced by a lack of information and understanding by the homeowners of the current sustainability developments, possibilities en plans (M1, M3). A lack of information is confirmed in an interview with an ex-resident of Sluispolder "*neither the municipality nor the corporation has in any way accommodated the residents with a plan or idea for a new residential destination during the (re)constructions" (M10*)*. This quote alludes to the reconstructions plans in Sluispolder which asked residents to move (temporarily). Communication with the residents is crucial in order to get them informed, interested and involved in a transition process (all interviews). "*It is crucial to be transparent and to include the residents in the process in order to create the right expectations"* indicates one respondent (M7*). And even when homeowners are aware of the sustainability objective they often miss knowledge and capacity to act on it "*if you really want to get people involved you have to further unburden them. People will not start by themselves, they need appropriate and reliable advice"* clarifies M3. The municipality organized information meetings however these did not have the desired result. The turn-out at the first meeting was very low amongst the residents of Sluispolder in addition there was no follow up after the first meeting and (M6*, M8*) M8*, the residents representative, emphasizes "*the municipality should learn from such an experience and handle the communication differently next time"*.

In addition, although renters are not responsible for the investment costs of their homes they might be confronted with higher rents. The national EPV policy allows housing corporations in the Netherlands to ask for a reimbursement from the renter when they increase the energy efficiency of the house (M2). The housing corporation in Sluispolder was confronted with opposition by its renters when they

announced a higher rent of the newly constructed, sustainable houses in Sluispolder. *"People are not yet willing to pay more rent for a more energy-efficient home,"* concludes Maasdelta (M2.b). This moved Maasdelta to guarantee equal rent for the newly constructed sustainable homes in Sluispolder. Maasdelta explains the opposition with a lack of perspective and commitment to sustainability (M2.a*, M2.b). *"Residents just want a comfortable home to live in. They have no perspective on sustainability.*" (M2.b).

Conclusion
In the interviews, a conflict in perspective and interest with the residents of Sluispolder was unanimously illustrated. This is therefore proposed as currently the main social complexity. The main reason of this conflict is the lack of urgency with the residents of Sluispolder to act, both homeowners and renters. As laid out, this has an array of proposed reasons which, this research argues, are mutually linked. A lack of urgency is the result of a lack of priority which is the result of a lack of understanding which in turn results of a lack of communication and information.

The impact of this complexity on the development of an effective district approach in Sluispolder is explained by the role of residents in the transition. As explained earlier, a stakeholder is identified by either or both its interest or influence in the district approach in Sluispolder. The large impact of the conflict in perspectives with the residents of Sluispolder can be explained using this definition. On the one hand, the residents of Sluispolder perceive no interest in the sustainability of their house as long as their homes are comfortable and financial investments are still necessary in order to achieve sustainability. In addition, their interest in sustainability gets undercut by their day to day socio-economic problems or different priorities to invest in. However, on the other hand, the influence of residents of Sluispolder on the progress of the energy transition, and the realization of the removal of gas is powerful. As the organisation of the Interest of the Resident emphasizes in the interview "without the consent of the resident nothing will happen in Sluispolder" (M9). Especially the homeowners are in a powerful position as, at this moment, they still decide when and what happens with their property.*

Technical Complexity
In order to realize a transition of the current energy system, new technologies are developed and applied. These innovative technologies are often unknown to the stakeholders which result in uncertainty. In Maassluis four respondents (Round 2: M1-M4) have been asked about technical complexity directly. The six respondents from the first round of interviews (M5-M10) have not answered this question, however, also not raised technical complexity in their top three challenges. Technical complexity which influences the process has been recognized by all respondents in the second round. The perceived intensity of the complexity and its influence differs. In addition, a variety of reasons and the explanations for technical complexity is provided. These are discussed below.

According to the municipality, the housing corporation and Stedin (M1, M2.a*, M2.b, M3, M4, M7.b) a lack or excess of technical options as an alternative to gas is not what causes technical complexity. "*There is a limited number of things you can do, the choice is not that big"* according to M3. This is confirmed in another interview with the municipality of Maassluis *"there are not that many options, no endless variety*" indicates M4. However, a decision on what alternative to gas should be applied proves challenging. The explanation provided by the interviewed stakeholders is not the lack or excess

of technological options but it is the complexity in the application of the technology. *"I think already a lot is possible, however, the application makes it complex"* concludes M1. Questions such as "*what option fits my house?*" (M3), "*how are you going to deal with the current infrastructure?"* and *"how and by whom is the technique installed in the buildings and houses?" (*M1) are questions which indicate the complexity in the application of the technique.

First of all, the unfamiliarity with the innovative technologies necessary for a transition complicates the decision-making process for the municipality, housing corporations and residents (M1, M2, M3, M4). "*Partly it is unfamiliarity, a lot of parties deal with unfamiliarity [with the current technological developments]. We do too. And that poses a challenge" (M2.b).* Complexity is created by fundamental unfamiliarity, as stakeholders are not aware of the rapidly innovating technologies, illustrates respondents (M2.b, M3). In addition, complexity is increased as stakeholders are still unfamiliar with the consequences of the new technologies (M1, M4). M4 worries "*For example, a heatnet turns out to, technically, be the ideal alternative. I doubt if people are aware of all the consequences*". Many necessary technologies are new, unproven technologies from which the consequences, especially on the long-term or on a greater scale, have not yet been established. Thus, unproven technology might have the necessary potential; it also creates more risk and uncertainty (Hertogh & Westerveld).

Second of all, it is complex to match new, innovative technologies to existing and sometimes old houses which are in a bad condition (M1, M2, M3, M4). Since July national law requires new constructions to be built without gas. However, "*the buildings which are already built are the real challenge*" confirms M1. Also, the housing corporation declares there is not yet policy on the reconstruction of the current houses in Sluispolder. "*The town center often consists of old buildings and the residential districts around the are an accumulation of buildings from the 60's, 70's, 80's and 90's. All these different constructions require a different approach"* elaborates M4 in his answer. This is indicated as a crucial challenge to both the municipality and the housing corporation.

Third, for stakeholders, it is a challenge to decide when to make a decision on the technique. As pointed out before, the speed of the innovation of technology is extremely high today (M2). The complexity is to determine the right moment to make a decision without being certain whether this is the best option possible. This discussion also occurred during the final presentation meeting of TNO at the municipality of Maassluis. The questions "*How do we determine how much we have to hurry? Do we invest or do we wait for the developments which are still to come which might make options more efficient?"* were raised by a participant from the municipality (Report 4). Fourth, stakeholders are hesitant to make decisions at this point as it results in technical path dependency (M4). Every option requires an adaptation of the buildings and infrastructure after which other options are locked out. As M4 explains "*if we decide to make houses more sustainable by means of a heat pump it results in fewer properties which are available for a collective heatnet. However, a heat net requires everyone to join"*.

Conclusion:
In Sluispolder technical complexity is perceived as challenging by the stakeholders to the development of a district approach in Sluispolder. Uncertainty is created as new technologies have not yet been applied on a larger scale and the (long-term) consequences are not yet known. Stakeholders are therefore challenged in choosing the right option for the right building. In addition, finding the right moment to decide is a challenge as a result of fast innovation and path dependency of the techniques.

The analysis of technical complexity shows it is related to and even reinforces social complexity. Technical complexity increases uncertainty in the process which in turn amplifies social complexity as it could increase conflicts of perspectives. Uncertainty decreases an undisputed objective reality to which stakeholders can hold on to and base their interactions on. In addition, without having a clear vision it is hard to involve the resident. Social complexity shows it is crucial to set up clear communication with the residents in order to inform, interest and involve them in the transition. "Eventually, you have to draw a concrete plan as residents need a clear answer" explains M1. However, technological complexity puts of residents even more. M2 experienced that "when it becomes more complex, residents tend to lose their attention". This is confirmed by a resident of Sluispolder. During the third TNO meeting, a resident explained the "the technical language often used is putting off residents. Someone who is not involved in this subject quickly loses their interests. (Report meeting 3). *So currently, technical complexity reinforces the social complexity and increases the challenge.*

Financial Complexity

Financial complexity in a transition is challenging the development of a district approach by all stakeholders interviewed in Sluispolder. The investments necessary in a district approach are very large, difficult to define and above all difficult to pay.

First of all, as mentioned earlier the investments necessary for the transition are very large, on that the stakeholders agree (M1, M2, M3, M4, M6*, M7*, M8*, M10*). However how large exactly is hard to determine at this point (M1, rapport 4). As it remains challenging to determine to what extent technologies can be installed, in what houses, and with what consequences financial calculations remain uncertain (M4, M3, M1). In addition, the current financial calculations might not be up to date tomorrow as a result of rapid innovation or scale-up (M4, report 4). As explained during TNO meeting 4 "w*hen sustainable alternatives are becoming more popular, they will be applied more and eventually become cheaper*".

Second, it is complex to decide how to pay for the large investment necessary in a district approach (M1, M2, M3, M4, M10*). The housing corporation proposes everyone (the municipality, the residents, Maasdelta and Stedin) pays their own share of the required investment. However, the stakeholders agree that eventually most of the costs will to be for the residents of Sluispolder (M1, M2, M3, M4, M6*, M7*, M10*). However, these same stakeholders also recognize that at this point the residents are not willing or are unable to make the required investments (M1, M2, M3, M4, M6, M7*, M10*). "W*e have to determine how we finance this. A resident will not be able to just invest 15 000 euros to replace the gas in their homes"* explains M1 the complexity currently challenging the transition. This issue is also recognized by the residents of Sluispolder. *"Let's face it, eventually the residents have to pay the majority of the costs of this transition. However, there is a limit to what residents are able to afford*" emphasizes an ex-resident of Sluispolder (M10*). *New finance constructions need to be develope*d" argues M1.

Third, complexity is increased by the risk in an increase in energy poverty as the socio-economic consequence of the transition (M1, M4). At this moment, participation in the transition appears only possible for the middle and high-class households. Households with a higher income, higher education and higher awareness of their behavior appear more prone to invest in sustainability (ECN).

Paradoxical, an energy efficient house might result in lower monthly costs which is of higher urgency to lower class households. In addition, a risk is that "*maybe even when you do not participate in the transition, your house will decrease in value*" warns M1. A result is a group which will be socio-economically disadvantaged by the energy transition.

Lastly, the municipality is not able to provide clarity on their financial role in the transition. *"The question is how much money the municipality is going to make available for supporting and stimulating change"* explains M6 the financial uncertainty. This is confirmed by another municipality employee "*the question is whether the money is made available*" (M3). This is further explained by the many different interests and priorities which influence the allocation of the money available within a municipality organisation (M3). M4 argue in the same directions "*it is a matter of using the money for the right things"* (M4). In the last TNO meeting within the municipality organisation it is argued: "*The bench of M&A decides where their money flows and if that is sustainability"* (Report 4).

Conclusion
Financial complexity is a current challenge to the development of an adequate district approach in Sluispolder. The investments necessary to replace gas are large and it proves hard to find ways to realize them. Every stakeholder has to take their own responsibility however, this also means the largest share of the investments will be on the account of the residents. At this point, residents are not able to make these investments. This is aggravated as the municipality is not sure if and how they can support and facilitate these investments.

Financial complexity overlaps with technical and social complexity. As the appropriate technical solutions are not yet known and their long term, large scale consequences are uncertain it is hard to determine the costs. This uncertainty increases the risk of a disinvestment which in turn challenges the stakeholders to make the investment at this point. "We have the risk that options become cheaper or cheaper and more efficient options are established" expresses a municipality employee at the fourth TNO meeting (rapport 4). Social complexity reinforces financial complexity as residents are not willing to make the investments at this point (M1, M3, M7*). *This challenges realizing the necessary investments. Only when social complexity is marginalized and residents increase a sense of urgency and their investment priorities they might invest in sustainable adaptations to their houses. In order to overcome the financial challenge* "*it is important to involve homeowners in the district and provide them with the right perspective" argues M7.*

4.1.3 Collaborative Governance

This research studies the collaborative governance process (CGP) at three different levels. In addition, the influence of a CGP or the absence of a collaborative governance process on the development of a district approach is analyzed.

Internal

The first level on which a CGP is studied is within the municipality organisation of Maassluis. Collaboration between the different departments of the municipality on the transition is viewed as crucial by multiple respondents (M1, M3, M4, M5*). *"Without internal communication, the residents will be flooded with fragmented initiatives from different departments of the municipality which will only result in an overstressed resident"* explains M5*. It is crucial to creating internal cohesion in order to generate a collective plan which is jointly communicated and implemented outside the organisation. "*Do it right at once, with everyone together"* stresses M5*. M4 points out the risk that

different departments carry out their individual tasks without central coordination or in correspondence with the planning of an energy transition. As an illustration, he adds *"people are replacing sewing systems, without being concerned with the energy transition as they feel this has nothing to do with them."* (M4).

The same respondents indicate the collaboration on the subject energy transition is not yet at the required level. "*The municipality of Maassluis is fragmented"* (M5*) and "*the municipality knows many islands within the organisation"* (M4) agree the two municipality employees in separate interviews. This image is confirmed in the evaluation forms of the first meeting of TNO within the organisation of Maassluis. On the evaluation forms, 5 attendees indicated it was the first time they collectively came together to discuss the topic (Annex V). The meeting was evaluated positively and the interaction between the different employees was evaluated as useful and interesting. M1 reinforces this images during the third TNO workshop in which *"improving the communication within the municipality*" is stressed as a required direct action within the municipality (Report 3). Lastly, a lack of collaboration and coordination within the municipality is seen in the current ad hoc initiatives in Sluispolder as discussed in 4.1.1. Several solutions are provided by the respondents. M5 proposes a collective manifest in which individual and collective objectives, tasks and responsibilities are formulated and formalized. This should decompartimalize the organisation in order to increase communication and shared responsibility (M5). In addition, M4 pleas for the installation of project leaders focused on sustainability and the energy transition within the different departments of the municipality (M4). A project leader could guarantee the transition aspect is recognized and considered in the different departments.

M3 provides useful inside on the current internal organisation on the subject sustainability within the municipality. At this point, the subject sustainability is managed by a "task approach". With a "task approach" one employee is assigned to the portfolio sustainability. The implementation of policy on this subject is done through individual projects. The employee is responsible for the realization of these projects without the guidance of an organisational structure. An alternative approach, as M3 explains, is a program approach."*This means you really structuralize the approach and invest in the regular interaction of the relevant people in the organisation. You constantly review the progress on all the aspects of the subject jointly".* This approach requires an organisational structure is installed including boards, workgroups and regular moments of interactions (M3). This approach is time and resource consuming which could discourage it. At this point, a "core group" sustainability is active within the municipality in which a couple of motivated volunteers discuss and work on the subject. However, as an interview points out, moments of interaction were "*a few times in the past half year and always whenever TNO or Over Morgen had something to discuss" (*M3). This can not yet be considered a program approach or a CGP.

analysis

The argument of a lack of communication, coordination, and collaboration within the organisation might be explained by the current approach on sustainability and the energy transition within the municipality. A project approach means one employee approaches the subject pragmatic and involves and contacts the stakeholders necessary to realize a single initiative or project (M3). In addition, the current Core Group Sustainability cannot be considered a sufficient CGP as it is on a volunteering base and meetings and interactions are rare. The lack of a CGP within the organisation thus discourages the development of a coherent district approach. As is currently perceived, it results in

individual ad hoc projects. The district approach necessary to realize a transition in Sluispolder involves a wide range of adaptations in which the interaction and contribution of many departments are required. Internal CPG is therefore valuable and desirable for the development of a district approach.

Local

"*A district approach is the most effective and efficient approach, as long as you do it together*" M7* emphasis. A local collaboration approach is explicitly referred to as essential by 5 (M1, M2, M5*, M6*, M7*) stakeholders. "*Local stakeholders and residents need to play a role in the process in order to realize the energy transition*" stresses M5*. Unfortunately, at this point a local CGP is insufficiently developed in Sluispolder. However, in the interviews and during the TNO stakeholders meetings momentum is perceived for a local CGP. Stakeholders recognize the necessity and show interest in the transition and an incentive to collaborate. This will be discussed below.

First of all, based on the interviews and the meetings in the TNO project interest and commitment with the stakeholders in Sluispolder has been perceived. As described in 4.1.1, Sluispolder already houses multiple initiatives which contribute to the transition of Sluispolder. M6* indicates "*Pioneers within the district assure the transition starts playing a role in the district. For example, Maasdelta shows a lot of enthusiasm"* (M6*). In the interview, Stedin mentions multiple times that " *Stedin will act as a partner of the municipality and ensure that the right knowledge and capacity is introduced"*. In addition, in the third TNO meeting, in which a wide variety of stakeholders participated, a widespread commitment to contribute and participate in a transition approach appeared. A collaboration activity during the workshop between representatives of the housing corporation, residents, the municipality, the local school and the regional waterboard produced a short-term action list including realizing a covenant between the local stakeholders in which *"stakeholders need to make agreements on what has to be done by whom, collectively or individually. Local stakeholders can express their ambitions in this covenant" (Report 3)*. Moreover, a covenant is essential in a successful collaboration process to assure commitment of the involved stakeholders (M5*, M7*). M7* recognizes the housing corporation, the municipality, Stedin and the Associations of House Owners are the essential partners in a collaborative governance process (M7*).

The responsibility to use this momentum and bring parties together has been assigned to the municipality of Maassluis. The role of the municipality is to direct and facilitate the transition in the district according to the majority of the stakeholders (M1, M3, M4, M5*, M6*). This role includes activation, stimulation and providing information according to M3. Municipality respondent M6* specifies their role: *"for the municipality, this involves actively bringing stakeholders together and also participating itself*" (M6*). Also, Stedin adds in the interview its role as a collaborative partner depends on the initiative taken by the municipality as "*Stedin will only become more active if this request is expressed by the municipality" (*M7*). However, M6* indicates that the first thing on the list for the municipality is to "*think about the role of the municipality within the transition of Sluispolder*" (Report 3). This indicates the municipality is still searching for the appropriate role within the district.

Conclusion

At the local level, a full CGP has not been perceived. Still, the necessity in order to realize a coherent district approach to realize a transition in Sluispolder has been recognized by the relevant

stakeholders. This means momentum is building. A local CGP brings the different puzzle parts of stakeholders together which enables an effective and efficient approach and in addition it formalizes the commitment of stakeholders to their responsibilities in a collaborative district approach. The municipality is regarded as a facilitator and stimulator of the CGP by a majority of the stakeholders. In other words, for the leadership role in a CGP the municipality has been proposed. Moreover, stakeholders are supporting the idea of a covenant in which stakeholders can formalizes their role and responsibility in a CGP. Thus, whereas a CGP has not yet been realized the potential is present in the district.

Regional

Although a necessity to collaborate on a regional level in the energy transition is recognized and emphasized (M1, M3, M4) a CPG has not fully developed yet. The regional CGP studied in this research is the collaboration within the NGUA program in which Maassluis and 10 other municipalities collaborate (MRDH project plan). A central objective in the program is to realize collaboration in order to facilitate the transition. The project plan writes in the assignment description: "*where regional joining forces apply, this is organized. Opportunities are used by upscaling, speed and connection. Only then will a rapid be created" (*MRDH, June 2017*).* However, at this point, the NGUA has not (yet) generated a CGP according to Maassluis (M1, M4, O1). The program did result in useful knowledge sharing.

The MRDH argues the NGUA program has stimulated the transition process in the municipalities (01). Maassluis is used as an example "*although Maassluis joined the program pretty late, they managed to take a leading position*". This is the result of knowledge sharing between the municipalities as a central objective is sharing lessons, experiences and knowledge (MRDH, June 2017). Today the program has mostly facilitated and stimulated the circulation of knowledge between the governments (M1, M3, M4, O1). However, this is not a CGP. "*I would say collaboration is more than this. However, you could say knowledge sharing is the most basic form of collaboration"* concludes the MRDH representative. In an evaluation of the NGUA program so far, the MRDH concludes the municipalities are mostly occupied with their own development at this point. As the representative of the MRDH explains *"municipalities are not yet decided on the collective alternative way to supply energy. As long as this is not figured out, no-one will move" (*O1). Concrete steps, and thus concrete challenges and therefore concrete collaboration opportunities have not yet presented themselves. This is confirmed by M1 in Maassluis:*"at the moment the collaboration is not yet happening as at this point it does not fit in our project. Although it is an official objective of the program it is still a struggle to figure out how we incorporate it" (M1)*.

Lastly, as previously perceived, Maassluis has not realized a CGP on the internal level. This lack might result in a minimal effect of a regional CGP in the district. As M4 illustrates, although there might be motivated people representing their local government in regional collaboration and interaction, the influence is minimal as the momentum set in motion at the regional level dies within a fragmented municipality organisation (M4). Thus, before collaborating on the regional level, "*you have to make sure the entire organisation is top-down impregnated with the subject" (*M4).

analysis

A regional CGP is not perceived. The municipalities participating in the NGUA program have so far merely shared knowledge, experiences, and insights. As the MRDH describes, all the municipalities

are still in the exploring phase in which they are still too much occupied with their own project. As the MRDH explains "in practice, municipalities are really more concerned with their own approach. And that is complicated enough. It is only one of the tasks on the plates of the local governments". At this point, the regional collaboration will only increase the complexity of the transition. The individual municipalities need more internal clarity and development of their approach before scale-up on a regional level will be beneficial. In addition, the regional collaboration will have little influence on the local process and development as long as local governments do not have their internal organisation in order on the subject. The momentum builds by one motivated municipality representative at the regional level will not be translated to development within the district as "the deeper you enter the organisation the more the impetus dies" (M4). Nevertheless, it is not like the NGUA has prevented municipalities to develop. So far the NGUA program has stimulated municipalities, such as Maassluis, to start and develop a district approach. This is the result of knowledge sharing. However, knowledge sharing is merely a part of the joint action capacity within a CGP.

4.2 Zoetermeer

In the Zoetermeer case data is collected on the current status quo of the replacement of gas. The scale-up capacity of a district approach in Palenstein is analyzed. In addition, the complexities challenging the development of a district approach are analyzed. Third, at three levels a CGP and its influence on the development of a district approach is analyzed. Every section concludes with a short concluding analysis.

4.2.1 scale-up Capacity

As written in the case description, Zoetermeer has set the ambition to replace gas in the district Palenstein by 2040. The district Palenstein is designated as the pilot district in which Zoetermeer is developing a district approach to realize the conversion from gas to an alternative. The buildings blocks of such an approach are the process, the substance and the finance necessary to phase out gas in a district explains the municipality of Zoetermeer. The process includes finding a supportive coalition, a governance form which allows the transition to developing and the necessary amount of participation. The substance concerns determining the right energy source and techniques to replace gas. Lastly, the transition pursued in the district approach needs to be financed. Therefore the business case of the approach needs to be in order (Zoetermeer, June 27, 2018). Palenstein is the niche in the transition of Zoetermeer. In order to identify the development progress of the scale-up capacity of the district approach developed in Palenstein will be analyzed. scale-up capacity is achieved whenever the district approach is deepened and broadened.

Deepening

In the *deepening* dimension of achieving scale-up capacity, the stakeholders in Palenstein are learning whilst searching for alternative ways to think and act in order to realize the conversion from gas to a sustainable alternative. In Palenstein the stakeholders enabled the deepening of the process and substance of a potential district approach.

Searching for an alternative

In Palenstein the stakeholders are actively and collectively searching for alternatives to replace gas. The first step was to set the objective to find an alternative to gas. In the transition plan the stakeholders have indicated they have to find "*a scalable approach to realize gas-free districts"* (Zoetermeer, June 27, 2018; 3). This is confirmed in the green deal covenant. The first objective of the

Green Deal is collectively realizing a district approach containing appropriate and affordable energy alternatives to gas (Green Deal).

After the stakeholders in palenstein formulated and formalized their shared objectives and collaboration process, the next step was to collectively research the possible options to replace gas, the substance of the process (Green Deal, Z2, Z3, Z7). "*In order to achieve the objective [a gas-free Palenstein in 2040] solutions and best practices must be sought together"* is one of the starting points of the Green Deal. Respondent Z7 emphasizes the importance of a collective searching process as *"in this phase of the district approach to energy transition no one offers an example of a completed process" (*Z7). In the interviews held in Palenstein the existence of this collective search process was recognized and explicitly mentioned (Z2, Z3, Z7). *"The first collective decision was: ok, we are going to do collective research, we are going to investigate the possibilities"* indicates respondent Z2, representing the municipality. This is also mentioned in an interview with a different partner of the Green Deal "*the first phase was research, considering the possibilities"* (Z3).

Based on 3 collectively determined factors the options are analyzed: available sustainable energy, applicability on the houses in the district and financability of the option (Zoetermeer, June 27, 2018). For one cluster in the district, an appropriate solution has been found. For the mainly stacked houses in cluster one the low-temperature heat with a ground-coupled heat exchanger is proposed and partly executed. However, the option is not optimal as financial resources lacking to fully implement it. In addition, there are six other clusters with a variety of buildings for which an appropriate alternative has not yet been determined (Zoetermeer, may 2018). De Goede Woning indicates *"one part houses we might have in control, however, the stacked houses of 5 floors and above are a completely different situation. The best option for that is still to be proven"*. The stakeholders are thus still searching for the substance of their district approach.

Learning

As indicated in the theory, a transition experiment reaches scale-up capacity by learning individually and collectively. The stakeholders should set explicit learning goals and create a learning context (De Bosch & Rotmans, 2008). In multiple documents drafted by the municipality of Zoetermeer learning is explicitly formulated as a central objective in the process to develop a district approach (Zoetermeer, May 2018; Zoetermeer, June 2018). Learning in the current searching and development process in Palenstein will enable scaling up the result to other parts of Zoetermeer. (Zoetermeer, may 2018; 3). Z7 expresses the goal to *"to find an approach to make the district gas-free and to learn as much as possible for other districts in the future" (Z7).* "*How do you organize it, how does that work. What setbacks do you encounter, what are the impossibilities and what are things you should do?"* summarizes Z7. In the request report for an additional subsidy, the municipality of Zoetermeer elaborates on the objective to learn "*what we learn in Palenstein will be translated to multiple scalable knowledge and model*s" (Zoetermeer, June 2018, 6).

Within the district, the stakeholders are learning individually and collectively. The three building blocks of a district approach show the concrete lessons learned. First of all on the process. The process in Palenstein produced a successful collaboration model with an adequate governance model, a supporting coalition and an independent process director (Zoetermeer, May 2018). Secondly, a blueprint of the substance of the preparation and the implementation of the district approach is realized, including a calculation model, an assessment framework for the different possibilities and a

model for the execution (Zoetermeer June 2018). Third, new skills and knowledge are obtained for the professionals realizing the district approach (Zoetermeer June 2018). The last building block, a sufficient financial plan in order to execute the district approach is still lacking in Palenstein.

One of the objectives formulated was a collective learning process between the three housing corporations (Zoetermeer, may 2018). The action plan states "*the three housing corporations have highly similar property in Palenstein. If one housing corporation executes a project, the other three will learn from it"* (Zoetermeer, may 2018). However, the reality at this point seems to differ from the intention. A difference in planning and policy prevents collective learning. De Goede Woning, the only housing corporations which is already realizing energy neutral houses in the district, expresses the importance of drawing lessons in their project in order to improve in other projects (individual learning) and in order to help others to prevent making the same mistake (Z5). Their biggest lesson at this point is to set up an adequate communication process with the residents. The other housing corporations seem interested in what they do, but they remain in a wait-and-see position explains Z5.1. This is confirmed by Vestia. *"You watch and you read along and you contribute your own projects in the district. However, it continues to be very much from your own approach and with your own challenges."* elaborates Z3. The project manager in Palenstein from the same corporation confirms this image. *"They [Goede Woning) have a different sustainability policy. They are pursuing energy neutral housing. That requires a completely different approach to for example the communication with the residents on housing costs etc."*.

Regionally, there is potential to set up collective learning processes. First of all, the participation in the NGUA program on the regional level was initially set up to create a collective learning process with other municipalities in the MRDH region (Z1, Zoetermeer June, 2018). However, this did not have the desired result. *"Yes, that [collective learning] was the intention with NGUA. But, in my opinion, that did not bring us much"* admits Z1. In a different interview with the municipality, this is repeated and explained: *"it might sound a little perky, but I have the feeling we are at the vanguard in this"* (Z2). The municipality Zoetermeer mostly delivered, giving other municipalities the change to learn, instead of taking new information home indicates the municipality (Z1, Z2, Z6, Z7)

Secondly, Stedin, the net operator, offers a context for regional collective learning. This is a stakeholder involved in more municipalities pursuing district transition. Therefore, Stedin has had the opportunity to take away lessons from different cases (Z1, Z7, Zoetermeer June 2018). They have created a calculation model, the Infrastructure Footprint (IF) which is used to formulate district specific scenarios with alternative options by using data and input provided by the local stakeholders. *"Together with Stedin we have used their model to search for the most efficient possible options, Stedin is also active in other municipalities, obviously you consider those experiences"* explains Z1. A third potential regional learning context for Zoetermeer is created by the housing corporation Vestia. Vestia is a housing corporation active in 4 municipalities (Rotterdam, Den Haag, Delft and Zoetermeer). In every city the Senior Policy Advisor Sustainability interviewed in Palenstein is involved in a local district approach process. "T*he good part of this is that what you take away in one municipality you can use in another*" he explains (Z3). The biggest lessons he has learned is to start focused in a narrow district with a limited amount of houses (Z3). For example, *"ten districts have been appointed in The Hague, one of which is Den Haag Zuid West. Well, that's already 30,000 homes. That is too big, you can not get through that. So that is something which is really the good in*

Palenstein". This could offer possibilities to collaborate with districts in municipalities in which the housing corporations also have property.

Broadening

As only a little concrete projects are realized in the current district approach at this point a broadening process is not yet an issue. Potential broadening process on the regional level is discussed. However only whenever there are more municipalities at the same speed and the same position in the process this could evolve (Z1, Z2, Z6)."*At this point it [linking projects] does not offer any opportunities yet*" explains Z1.

However, locally a potential broadening process is foreseen in the different projects pursued by different property holders. As indicated, there are three housing corporations which have comparable property in the district (Z5.1). In the government documents, a collective learning and searching process was foreseen, this could also mean they connect or link their initiatives in a broadening phase. However, as the housing corporations indicate, this is not the reality as everyone is focused on their own projects, challenges, and objectives. For now, the housing corporations are pursuing different policies and the Goede Woning is so far the only corporation realizing anything concrete (Z3, Z4, Z5.1, Z5.2). This prevents a broadening process as the housing corporations are not yet able and willing to link their initiatives.

Conclusion

The stakeholders in palenstein are currently engaged in a searching and learning process to develop a scalable district approach to replace gas in Palenstein with a sustainable alternative. This has been indicated in the official documents published by the government and in the interviews held with a wide variety of stakeholders. Explicit learning objectives are formulated for the stakeholders in the development of a district approach. In addition, already valuable lessons have been drawn from the process in Palenstein. As there is not yet a district approach formulated anywhere at this point, the searching and learning process in Palenstein is vital for both the development in Palenstein and for other governments with the objective to realize sustainable districts in their municipality. As Palenstein is the frontrunner in the region, a regional learning process has not yielded any benefits for them. However, the other way around, the lessons learned in Palenstein create a foundation for further development of the transition in other places. The lessons include an appropriate process, substance and finance construction.

Whereas a searching a learning process has developed in Palenstein, it has not yet produced a district approach to realize the transition of an entire district. There are ideas on the required process and organisation. The substance of an approach is analyzed and proposed. However, so far it has only realized the start of a transition in one of the six clusters in the district. The development of a full district approach is elaborate as every building type demands its own searching and learning process on a possible alternative way. Especially the stacked housing complexes are still a challenge. Moreover, an adequate financial construction in order to realize the options is not yet realized. The learning phase has not yet been completed. Broadening at the regional level has little potential at this point. As previously indicated, Palenstein is a pioneer in the energy transition which makes linking and connecting with other district approaches and their projects not possible. In addition, local broadening potential has not yet been realized as parties have different plannings and policies at this point.

4.2.2 Complexities

In the previous section, the current scale-up capacity of the district approach in Palenstein has been analyzed. The district approach in development in Palenstein has not yet achieved full scale-up capacity. Palenstein is the deepening phase and a broadening process lacks. This section analyzes the complexities challenging the development of a district approach to replace gas. This means the complexities found are complexities perceived in the deepening phase of the scale-up process. In the interviews, the respondents were asked to elaborate on five complexities. However, the three complexities with the most impact will be analyzed: social, technical and financial.

Social Complexity

Initially, the interviewed stakeholders deny a challenging social complexity in Palenstein (Z1, Z3). In two interviews this is explicitly expressed. "*The social aspect played a minor role here"* indicates Z1. The absence of social complexity was explained by a variety of reasons. *"No conflicts of interests"* were perceived between the stakeholders, Z3 explains the current absence of social complexity in Palenstein. Z1 argued social complexity was prevented because agreements between the stakeholders assured a shared point of departure and a shared objective (Z1). Nevertheless, further analysis shows social complexity as a result of both conflicts in perspective and interests. First of all, conflict in planning between the property holders in Palenstein indicates complexity as a sense of urgency to act varies per stakeholder (Z1, Z2, Z3, Z4, Z6, Z7). *"Tuning the different plannings is a challenge. Whereas one has already started others do admit they have to act one day, however, this could also be in 10 years. That is the challenge"* explains Z7. The houses in Sluispolder are divided over four types of parties: (three) housing corporations, homeowners, the municipality and commercial parties (Zoetermeer, May 2018).

The first conflict is amongst the corporations active in Palenstein en in the Green Deal (Z1, Z2, Z3, Z4, Z5, Z6, Z7). The Groene Woning initiated the replacement of gas and is close to completing their first project of 120 energy-neutral houses in Palenstein. However, the other corporations still lack a concrete policy on the transition of their property. Vestia explains replacing gas has no priority in their policy. "*We had no intention to start any restructuring projects in Palenstein. The rentability was good. The sustainability, oke, maybe the houses are not top notch but they are not bad either. There were no problems with the quality of life. No, there was no urgency"* illustrates Z3. The process to replace gas in the district of Palenstein is preceding the initial planning of Vestia, explains Z2. "*We are forced to expedite projects. However, a natural timing is preferred. For example whenever major maintenance is planned for a building"* Adds Z2. This hesitance and conflict in planning were also noticed by the other stakeholders. "D*uring the process we noticed the corporations are not too keen to participate at first*" perceived Z2, representing the municipality of Zoetermeer. Nevertheless, although it was not on the planning of the housing corporation, the necessity to address the issue is recognized (Z3, Z4). *"The next step is to really figure out what we can do there"* adds Z3. In the energy vision of De Goede Woning they set the ambition to become CO2 neutral by 2050. The reconstruction plans in Palenstein provided them with the opportunity to start realizing the ambition (Z5).

The second conflict is in the perception of urgency between the residents of Palenstein and the objective to replace gas in the district. The private homeowners are the most challenging as they both lack perspective and interest in the transition (Z1, Z2, Z3, Z5.1, Z6, Z7). For the private homeowners a transition is not within their interest as the preconditions to make it attractive and available without

risks lack, explains the alderman of Zoetermeer. "*Residents often think, I live comfortably, my rent is low. That is more important for them than living sustainable and energy efficient,"* explains Z4. Also, the housing corporations perceived a conflict of interest and perspectives with the renters of their property (Z3, Z4, Z5). To be able to execute reconstruction the corporations requires 70% of the renters to agree with the plans and their consequences (Z1, Z2, Z3, Z4). At this point, the perspective on comfortable living with the renters of Vestia conflicts with the transition objectives. A lack of urgency with their renters is expressed by Z3 *"renters are not eager to replace gas. As soon as it requires more money, it is going to be difficult. (..) so yes, that's a challenge you have to face"*. In addition, the reconstructions necessary to realize sustainable housing brings unrest and hinder which increases conflict in interest as they have to move (Z5).

At the Goede Woning this complexity seems less of a challenge. 90% of their residents accepted the reconstruction of their houses and the consequences (Z5). First of all, in order to minimize the nuisance de Goede Woning realized their reconstructions while the renters continued living in the houses throughout the process (Z5). In addition, the corporation went through an intense communication process in which individual conversations were held with every renter (Z1, Z2, Z3, Z5). However, also the Goede Woning indicates that the social aspect is the biggest challenge "*20% is technical and 80% is social*" declares Z5.2. The biggest lessons in their first Palenstein project is the importance of communication before, during and after the reconstructions. *"It is one thing to get your support beforehand, but you also still want to be welcome for a cup of coffee afterward*" explains Z5.1. Vestia however, lacks financial resources and time to perform such policies (Z3, Z4).

Conclusion
At first social complexity was denied in the interviews. However, social complexity in Palenstein is perceived as a result of a conflict of perspective and interest. The housing corporations in Palenstein have a different sense of urgency to replace gas. This is the result of conflicting (long-term) schedules and their dependence on the perspectives of residents. As is indicated, the perception of comfortable living of renters do not include sustainability at this point in time and in addition, they do not have the inherent interest to replace gas. One housing corporation shows this complexity can be overcome by adequate communication with the residents. However, an intense communication program requires time and money, which not every corporation has.

Technical Complexity
In the first place, technical complexity is minimal according to every stakeholder in Palenstein (Z1, Z3, Z4, Z7). Vestia denies technical complexity is challenging the development of a district approach as "*the technical solutions are manageable (..), you can find enough reliable technical concepts"* (Z3). This is confirmed by the municipality. Z1 confirms *"the technical part yes, we have the picture on how it should work" (Z1).* Also, the net operator is not challenged by technical complexity "*technology is not complex in that sense. We work with existing techniques. The technology in itself is not the challenge" (Z7).* Z4 indicates that in the transition plan composed by the Green Deal partners the different technological options are already laid down (Z4). However, technical complexity challenging the development of a district approach is not entirely absent in Palenstein.

First of all, although the stakeholders claim the right technology is already available it does not mean it is already applicable. Firstly, the technology to replace gas with an appropriate alternative is available for a single house. However, a district approach requires technology which covers all houses

in the district. As Z1 argues, *"there is still a lot of innovation to take place in construction and the installation sector to make it feasible and affordable"*. The technology necessary to, technically, realize gas-free housing has already developed, however, it is not yet applicable on a large enough scale. This requires large investments to further scale-up of the technology. Hence, as Z1 indicates, this might be more of a financial and organisational complexity as it is technical (Z1). Second of all, the applicability of the technology is also challenged by the complexity to find the right technology for the right building recognizes respondents from the municipality and the housing corporations. "*What we run into now is that you obviously need completely different solutions for one type of building compared to the other"* explains Z3. Palenstein is a district with a wide variety of houses including high rise buildings, multi- and single-family homes. De Goede Woning has found a solution for their single-family homes, however, Vestia's property is 80% stacked "*so if we want to do something that has a real effect. Yes, then it should be a solution in the stacked form"* explains Vestia (Z4). However, to determine and execute the right technical solutions for all the different houses large investments are required. However, as for Vestia, those investments are not within their capacity at the moment (Z3, Z4).

Second of all, it is challenging to decide on the right moment to make a decision on the technology (Z1, Z5, Z6). Technological innovation or parallel developments on other levels challenge decisions on the district level (Z1, Z2). As respondent Z1 indicates, at this point there are no regional options to replace gas. However, a regional heatnet is in development (Z1, Z2, Z5). The uncertainty of possible new options challenge the decisions today. "*A risk is the promise of tomorrow that there are much better solutions and that we do not have to do anything today"* explains Z6 the risk of future innovation. However, when you decide to wait you might miss the momentum of the transition (Z1, Z5, Z6). "*Look, we have to make a decision now. So if you are going to wait for those heat networks, and in the meantime, major maintenance takes place everywhere, you will miss natural moments"* explains Z1. On the other hand, if you make a decision this requires the adaptation of housing and infrastructure which locks out other possibilities and creates path dependency (Z1, Z5). De Goede Woning and Stedin emphasis it is important to not act on the uncertainties but use the certainties and the possibilities of the technology today (Z5, Z7). *"Whenever new opportunities present themselves in the future we will consider them when the time is there"* explains Z5.1.

Third, the decision on the appropriate technology to apply in a district approach is challenged by the uncertainty in the capacity of current and future sources as an alternative to gas (Z1, Z2, Z7). First of all, although the technology to generate and allocate heat or energy, adapt houses and renew infrastructure is available, the source might cause uncertainty. The net operator provides an example of the geothermal source realized in The Hague. *"That source has not provided any heat yet. That is a reason for concern, will it ever?"* (Z7). Second, innovative sources which look promising are also uncertain and cause complexity. As the net operator puts forward "*So if you look at hydrogen gas, it seems perfect. You can use the current infrastructure. But, it must be generated sustainably. And is there enough hydrogen gas? And what does it cost? At what price can you buy it?" (Z7).*

analysis
At first sight, the respondents denied the challenge of technical complexity. However, a further analysis showed multiple technical complexities challenging the development of an adequate district approach. Whereas currently, the options are sufficient to realize a gas-free house, it is a second to realize a gas-free district. Finding the right moment to make a decision seems challenging. Decisions

are challenged as by making a decision you create path dependency. However, by waiting on developments on other levels or in technology you might miss the natural momentum for a transition. Also, the uncertainty of current alternative sources challenges an adequate district approach. It is unsure if the alternative sources generate enough to replace gas.

Currently, the stakeholders do not have the capacity to replace gas in the entire district. According to multiple respondents, this is the result of the complexity of the investments necessary to achieve scale-up. Although technically a lot is possible, the technological solutions do not have the chance to develop without large investments. However, not all stakeholders, such as homeowners, renters, and housing corporations, are willing or able to make. This challenge connects technical and financial complexity as "*the complexity increases when you consider whether you are able to pay for it. The option you choose, its affordability and what that means for your residents, your homeowners, and your housing corporations. That is a very important aspect." summarizes the net operator* (Z7).

Financial Complexity

Financing the execution of a district approach challenges the stakeholders (Z1, Z2, Z3, Z4, Z7). In order to further develop and implement the alternatives to gas large investments are required. In the transition plan, the stakeholders have attempted to indicate the expected costs for every option per house. These estimations are enough to show the investments are substantial and currently not yet possible (Zoetermeer, May 2018). In cluster one, the business case is met by only 70%.

De Goede Woning shows that with enough investment capacity gas-free housing can be realized (Z1). Nevertheless, not all stakeholders have the capacity to make the required investment (Z1, Z2, Z3, Z4, Z7). First of all, both respondents indicate the housing corporation is not yet able to afford projects comparable to de Goede Woning due to the high investments necessary (Z3, Z4). In addition, housing corporations are limited by the wishes and capacity of their renters. *"Renters just do not want to pay more. And in that sense, we think for our renters. We believe it should not costs more"* explains *Z3.* Not being able to finance the required investment is not only explained by a lack financial resources of a stakeholder but a stakeholder might have different priorities and a different planning to spend their financial resources on (Z1, Z3, Z4, Z7). "*The biggest challenge is money. The financial capacity of housing corporations. Partly, this will be covered whenever they have restructured plans anyways. But what if they don't? Or whenever they have not recognized it [replacing gas] as their priority?"* emphasis municipality respondent Z1. This is confirmed in the interviews with the housing corporation (Z3, Z4). Z4 explains*"we have money on our account. But that money was originally intended for repaying the loans we have. Due to the interest rate, we decided to invest the money on our own property, however, we are restricted by strict investment frameworks.* "

Residents are the second group of stakeholders which might be guided by different investment priorities. Homeowners do not save for large investments. At this point, there are no appropriate financial constructions enabling homeowners to invest in their houses. *"The moment you sell a private home. And there will still be a loan to make it more sustainable, that has to pay off at that moment" (Z1).* New financial constructions are necessary in order to make it affordable and appealing for homeowners to invest in their houses (Z1, Z2, Z3, Z6).

analysis

A district approach, according to the transition plan, consists of a process, a substance, and finance. A process which produced possible technical alternatives to replace gas is achieved. However, the next step is to find a way to finance the execution of it. Without proper financial possibilities, a district approach remains a mere transition plan. However, this is challenged by the current will or capacity to invest by the stakeholders in Palenstein. This is a challenge, however, this in itself is not financial complexity. Complexity is produced by the reasons why stakeholders are unable to make the investment. To understand the complexity challenging making the necessary investments a link back to technical and social complexity is required.

At this point, investments are challenged by a conflict in planning between the different stakeholders in the Palenstein. A conflict in planning in perspective results in stakeholders with different purposes and interests. This guide their behavior, in specific, their investment decisions. This is both the case for residents and for housing corporations. Vestia indicated they have no priority or interest in the transition of their property whenever there is no large maintenance planned in the first place. The result is, there are no resources allocated for this purpose. In addition, this is fortified whenever a housing corporation is less solvent which requires them to be careful with their spending. On the other hand, de Goede Woning only required little extra investments as they already planned the renovation of their property. This is also the case with homeowners and residents. As their perspective of comfortable housing might not include sustainability they have no priority or interest in investing in their houses. For homeowners, the investment for a transition is not within their interest as there is not yet an appropriate construction to make this possible for them. Due to the financial and social complexities described above, technical complexity is increased. The technical challenge is to apply the technical alternatives which are new and not yet applicable on a larger scale. To achieve scale-up and more understanding of what alternative fits which building, large investments are required.

4.2.3 Collaborative Governance

Internal

In Zoetermeer the ambition to replace gas is initially approached as a real estate policy (Z1, Z2, Z6). This provides a focus, momentum and a foundation for the transition (Z1, Z6). The existing reconstruction plans in Palenstein created momentum for a transition (Z2, Z6). In addition, as plans were already made, these could be used as subject to sustainable adaptations (Z6). "*You have to start somewhere. Real Estate provides that trigger. And to analyze how you can make that sustainable. Because often you need a natural moment for that"* summarizes the alderman (Z6). Real estate also provides the necessary focus to start the transition according to Z1, later in the process, other aspects can be connected and attuned. However, Z2 indicates the biggest lesson learned in the process is to work with an integrated approach and to attune the different aspects of the reconstruction and the transition more (Z2). "*It could be that there are plans to renew the sidewalk or the public lights or the green has just been redone. Imagine that they come in with large machines and demolish everything. Or the street has to be broken open for the infrastructure. You have to know and tune these things on time"* Z2 explains the risk of a fragmented municipality approach (Z2).

A real estate approach also provides the opportunity to base the organisational structure on the structure of the real estate policy process. The restructuring project of Zoetermeer already established

an internal and collaborative structure together with the housing corporations active in the district with a steering committee in which the administrators and directors make the decision and workgroups in which the public officials prepare, draft and implement the plans (Z1, Z6). This initial structure is split up in one part focused on the initial restructure plans and one focused on replacing natural gas in the district explains respondent Z2. This closely connects the transition task to the real estate responsibility of the municipality. In the steering committee Gas-Free Palenstein the alderman with multiple portfolios including Energy Transition, Living, Real estate and the district Palenstein represents the municipality (Z2, Z6). In addition, there are three working groups which collaborate to realize the transition and in which the municipality participates from different angles. The scope of the initial reconstruction workgroup is wider than sustainability as it considers all aspects of the reconstruction. This group is managed by the program manager Sustainable and Green Zoetermeer (Z1, Z2, Z6, Zoetermeer, may 2018). The program manager of Palenstein is responsible for facilitating the process. "*All sorts of decisions that have to be made. My role is to coordinate and plan the process a bit, and for example also the finance, etc."* Z2 elaborates on his role. The reconstruction group is complemented with a "*how and when*" workgroup and a communication workgroup. The "*how and when*" workgroup is responsible for the technical research and decisions on what the alternative to gas should be and when this should be realized (Z1).

An administrative steering group is crucial according to the municipality (Z1, Z6). A steering group in which administrators and directors make decisions guarantees the crucial support for the policy. *"And the policy also need backing on a managerial level. So administrators, the council and the politicians must find it important. If they do not consider it important, then it becomes difficult as an official*" expresses the alderman. This is affirmed by the public official Z1, as he explains that without this backing and internal support in the organisation a policy will not stand a chance within the organisation (Z1).

Local

In de district Palenstein a CGP is developed between the local stakeholders. The collaboration is positively viewed by the stakeholders (Z2, Z3, Z7). First of all, the importance of a collaborative governance process and the role of a Green Deal is discussed. Second of all, the theoretical aspects of a CGP are analyzed. And third, the impact of the process is analyzed.

Importance Collaboration

A local collaborative process is deemed important by all respondents. The municipality emphasizes the risk of the absence of a collaborative process. Without a structure in which the relevant parties are joined would cause a major challenge to the realization of an adequate district approach (Z2): "*In that case, everyone would start doing their own thing. And if for example, a solution covers multiple buildings it is vital that every party is willing to join"* explains Z2. The importance of collaboration is also discussed in the interview with Stedin. The net operator argues *"no stakeholder can make a district natural gas free on its own. You need each other. Only together the puzzle is complete" (Z7).* Every stakeholder holds a part of the puzzle as every stakeholder has their own mandate in the district which individually not enough to influence the entire district (Z7). Moreover, this dependency is intensified by the innovative nature of the transition explains Z7: "*the process does not exist yet so it can only come into existence with some sort of co-creation. Together we have to figure out what path will lead us to the result".* Additionally, a collaborative governance process is valuable as it facilitates collective learning. *"It makes you look beyond your own work. You learn from each other.*

Therefore it is necessary, knowledge-wise, to use the knowledge of multiple parties" explains Z4. Compared to hiring consultants, a collaborative governance process in which everyone invests an equal timeshare is a more effective and efficient way to generate knowledge argues Z4, the housing corporation.

Importance Green Deal

In palenstein the collaborative governance process is formalized with the Green Deal Gas-Free Palenstein, signed by the municipality, the three housing corporations and the net operator Steding (Green Deal). The green deal has been important in strengthening the CGP in Palenstein (Z1, Z3, Z4, Z6, Z7). "*We really got more involved in Palenstein as the Green Deal was set up there. We really got started on a transition plan on how to remove gas in Palenstein"* indicates Stedin. Vestia, a housing corporation with property in four cities (Rotterdam, Den Haag, Delft, and Zoetermeer), regards Zoetermeer as the municipality with the most developed district approach according to Z3. "*And that is also due to the green deal that brought people together and has them express ambitions together. You are collaborating"* Z3 explains the leading position of Zoetermeer (Z3). A second benefit of the Green Deal according to Z3 is the influence on the organisations involved as "*the Green Deal also increases support within an organisation. It helps to put the subject on the map internally"* (Z3). As the alderman explains the strength of a Green Deal might not be it its legal power, however, it does bring the parties together and put them around a table (Z6).

As previously explained, the transition to replace gas in Palenstein was added to the already existing plans to restructure the district. Hence, already a collaborative governance structure was in place between the municipality and the housing corporation (Z1, Z2, Z3, Z4, Z6). This meant not only internally the municipality had an established process to build on, but also locally in the district a collaborative governance process was already in place between the municipality and the housing corporations. Already several years ago the municipality and corporations concluded collaboration agreements on the restructuring of Palenstein (Z2, Z6). *"It is important to have something to build on"* emphasizes Z6. Stedin joined the collaboration as the owner of the gas and electric infrastructure in the district. Z3 praises the decision by the municipality to start the transition in Palenstein as the existing collaborative structure enabled to continue and build on the status quo with the additional objective to replace natural gas (Z3). "*People already know each other and are already working together*" Z2 evaluates the benefits of building on an existing collaborative structure (Z2).

Local Collaborative Governance Dynamics

It has already been indicated that collaboration between the Palenstein is present. The stakeholders recognize the importance and a Green Deal has been signed which formalized a collaborative structure, based on the structure already in place. The remainder of this part discusses the absence or presence of the different dynamics of a CGP and their influence on the collaboration and the development of a district approach.

Principled Engagement

The collaborative dynamic principled engagement is necessary to guarantee open and deliberative interactions between the collaborating stakeholders. Principled engagement in Palenstein is an ongoing process leading up to the Green Deal, generating the Green Deal and principled engagement is now further accelerated by the Green Deal. In Palenstein the stakeholders interact regularly which

sets and keeps the principled engagement dynamic in motion. The stakeholders meet monthly in the working group and a couple of times a year in the steering committee.

During these meetings, the discovery phase is developed as the main concerns, interests and values of the stakeholders are identified and explained (Emerson et al. 2011). According to Z2 it was vital to find each other and guarantee a shared interest and take that as your starting point. Z2 adds the risk of not having these deliberate engagements: "*when you do not have those meetings, and you don't have a collective interest and every stakeholder just goes their own way you will miss vital opportunities"* (Z2). In Palenstein the stakeholders have found their shared interests (Z2, Z5, Z6). This is confirmed by the housing corporation. Z4 argues "*we all have the same problem. So everyone also has a shared interest. Eventually, we want sustainable buildings in the district. In that way, despite conflicting interests, you can have a collective objective* (Z4). In addition, in the *definition phase,* the stakeholders collectively define and describe the problem, mutual expectations and process criteria (Emerson et al. 2011). The collective definitions are formalized in the Green Deal document in which the parties declare their agreement on the definitions of central concepts used. In addition, the goal of the collaboration is written down.

In Palenstein Stakeholders are *deliberately* interacting on the development of a district approach to replace gas in Palenstein. "*The collaboration, as a deliberation structure is going well"* evaluates Z3.*"Together with other housing corporations, the net operator and the municipalities, we think strategically on a district level. You deliberate on the long-term policy. It's vital you find each other to discuss this"* (Z3). In this process, as Z3 argues, it is vital to call to right people to the table, strategic people with a long-term vision and the authority to decide on sustainability in their organisation (Z3). In Palenstein this has been successful. "*As housing corporation and the municipality, we have found each other [in a long-term vision]. And also Stedin is a crucial party, with strategic people"* argues the housing corporation.

The *deliberation* in the collaborative interactions eventually leads to joint decisions on the substance and further procedure of the implementation of the determined collaborative strategy, in the *determination* step (Emerson et al. 2011). With signing the Green Deal the parties agreed to the clause *"parties consider it desirable to lay down agreements and follow-up steps in this agreement for their cooperation".* The Green Deal acts as a contract between the different stakeholders in which they formalized their agreements on the objective, the principles underlying the deal, the organisation and the process of the implementation and the individual roles and responsibilities (Green Deal). "*The method of collaboration and further working arrangements are laid down in the work plan Palenstein Aardgavrij"* as the document argues *(*GD, p5).

Shared Motivation

The principled engagement between the stakeholders as described in the previous section can result in *mutual trust and understanding, internal legitimacy* and eventually joint *commitment* and vice versa. When shared motivation is achieved this could stimulate principled engagement (Emerson et al. 2011). In Palenstein shared motivation is perceived as there is mutual trust, understanding, legitimacy and commitment between the stakeholders.

In Palenstein *trust* is indicated as a central concept in the collaboration process. This is implicitly indicated as parties speak positively of other parties in the collaboration. For example, Z3 the housing corporation speaks of Stedin as "*a save party"* in the collaboration process. But also explicitly called

out. The municipality emphasizes trust as crucial. Z2 states "*It is a matter of trust. Collective trust. What we have seen in the process is that a corporation is not really that eager to participate. And gradually you see that by sharing knowledge, by showing and being transparent about how you approach things, they become enthusiast".* This is confirmed by Z4 when he said: "*It [collaboration] is based on trus*t". In the Green Deal the parties agreed to "*the willingness to open up the process to deal parties so that they can actively take part in the process, and actively think about solutions in legislation, finance, technology and process" (Green Deal p3).* As Z2 argues this transparency could lead to increased trust and understanding amongst the parties (Z2). Z3 notes trust is sometimes challenged by the privacy of internal data and processes within the organisation. This prevents organisations to be 100 percent transparent to each other.

Mutual understanding in between the collaborating stakeholders Palenstein is achieved as the parties are in a state of respect and understanding for each other's interests and perceptions without necessarily sharing the same set of values or goals. When asked what made the collaboration in Palenstein so successful Stedin stated "*I believe it is important to leave room for each others interests, progress and possibilities. I think this is a very important aspect" (Z7).* To the same question respondent, Z4 answered: "*despite conflicting interest we can have a shared objective".*

The last aspect to assure shared motivation between the collaborating stakeholders is commitment. The Green Deal holds the clause: "*The parties have committed themselves to making an effort to achieve the goals of this Green Deal" (GD, p2).* Commitment of the stakeholders is thus agreed on by the stakeholder in the Green Deal. The importance of commitment is recognized by the stakeholders in the interviews (Z1, Z2, Z6, Z7).*"If you might want to do things together, or if a joint solution is needed. Then you need the commitment of all parties"* argues respondent Z2. Also, Z7 recognizes the significance of commitment "*you could of course promise that you will collaborate. But at the same time, you need the commitment to investigate things. That is one of the conditions for success, the commitment".* The respondents confirm commitment with the stakeholders in Palenstein (Z1, Z2, Z5, Z6, Z7). Z1, Z5, Z6, and Z7 argue the Green Deal was crucial as commitment is expressed and formalized in the collaboration agreement.

Capacity for Joint Action

Deliberate interaction is deemed vital to a collaborative governance process. In order to sustain and manage repeated collaborative interactions *procedural and institutional arrangements* are crucial (Emerson et al. 2011). The moments of interactions are secured in the agreements on the organisation and process in the Green Deal. The Green Deal states that the core group Palenstein meets every second month to discuss the progress and the management of the collaboration. In the collaborative structure in Palenstein the stakeholders meet in two other formats. The steering committee meets a couple of times a year (Z2). The work groups, however, meet approximately every three weeks according to the interviewed stakeholders (Z2, Z3, Z7).

Leadership, practiced by one or more stakeholders in one or more ways is considered crucial to a collaborative governance process. In Palenstein the presence of a single leader is denied by the stakeholders. "*No, that is all equivalent, you are just 25% of it"* argues respondent Z4. Everyone needs each other so everyone has an equal say in the collaboration. However, in collaborative Palenstein multiple potential leaders can be deduced. First of all, the steering committee, in which indeed all the four parties have a representative, has a leadership role in the sense that the steering

committee is responsible for the decisions. The Green Deal argues *"the steering committee Palenstein will guarantee the progress of this collaboratio*n". Z2 confirms that "*in that steering committee are the directors of the corporations and the network operator. And ultimately they decide together with the municipal alderman how things will go in the future."*.

The second stakeholder with a leadership role is the municipality of Zoetermeer. The respondents of the municipality, the housing corporation and the network operator all assign the role of director of the transition to the municipality (Z1, Z3, Z7). This includes bringing parties together in the first place (Z7). Investing resources and energy in the facilitation of the collaboration process (Z2, Z3, Z4). And eventually taking the final decision on the alternative to replace gas in the district (Z1). In addition, the role of director is also been assigned to the municipalities in the national climate agreements. This is emphasized by Z7 "*it is important to realize that within that climate agreement it is explicitly the role of director that the municipality gets assigned"*.

The last party with a leadership role is the hired process manager, an external party. The process manager is responsible for managing the collaboration process. The presence of a process manager is indicated as a vital to guarantee an appropriate collaborative process *(Z2, Z3, Z7).* According to Z3 a process manager is a valuable part of the process as he brings the parties more together. *"He brings information together. And that is necessary as we continue to argue from our own perspectives and our own challenges*". Later respondent Z3 adds the process manager is also vital as he makes sure they stay committed to the collaboration process. The belief in the importance of a process manager is shared by respondent Z7. He explains that on moments that the manager was absent, immediately the progress of the collaboration stagnated. The process manager guarantees a ritm in the interactions between the stakeholders which is vital according to Z7, "*especially in this phase, when no one knows what he is going to do and there is no-one to tell you how it is done" (Z7).*

The potential to take joint action is achieved when *knowledge and resources are shared* between the collaborating stakeholders. First of all, knowledge sharing is at the foundation of the transition path drafted by the green deal stakeholders (Zoetermeer, may 2018). "*Important part of everyone's responsibility is sharing the required data in order to collaborate"* states the document. Z4 emphasized that knowledge sharing is an important aspect of collaboration as the knowledge of multiple stakeholders can be combined and used (Z4). Examples of useful resources to share are *"funding, time, technical and logistical support; administrative and organisational assistance; requisite skills for analysis or implementation; and needed expertise" (*Emerson, 2011). The Green Deal guarantees to share of non-financial resources of the parties as the parties have agreed to collaboratively research and determine a solution. Parties share their skills, organisation, support and expertise. The green deal states the different field of expertise of the stakeholders. For example *"municipalities have the best estimation of the local context and the timing and direction of the transition"* in addition the network operator "*can deliver information on the conditions of the net. And, together with other parties, execute the adaptations to the different infrastructures" (Green Deal)*. However, financial resources are not shared in the CGP in Palenstein. It is also agreed that every stakeholder is responsible for its own investments (Z1, Z3). The Green Deal holds a clause on the cost distribution in which this is affirmed. In addition, the municipality as the director of the transition is responsible for delivering the process management and therefore also pays the corresponding costs (Green Deal, 9).

Regional

For the transition of Palenstein the Next Generation Urban Area program has been of little benefit is argued in all the interviews (Z1, Z2, Z3, Z4, Z6, Z7). Z1 believes the program did not really deliver any results in Zoetermeer. He argues that at this point "r*egionally there are not many opportunities for us*" (Z1). Z3, the housing corporations noticed little of the regional collaboration attempt, "*I have heard about it a couple of times but I have not really come across it again. It appears a little quiet"*. Stedin seems slightly disappointed with the results of the NGUA. "*I don't think it came out very strong. For example, it did not result in a blueprint for a process*" (Z7).

However, the stakeholders do not deny the relevance of regional collaboration in a program such as NGUA. "*The plans of connecting things seems good"* argues the housing corporation *(Z3)*. He later explains this as he believes it is a necessity to start collaborating at the regional level. The municipality to sees the potential of regional collaboration: *"I do still believe in it, in that it could work" (Z1)*. There are two reasons recognized why regional collaboration is desirable. First of all, regional collaboration enables scale-up. "*Eventually, we have to scale-up. It does not make sense, if we keep going at this rate, we are not going to make it*" indicates the alderman (Z6). Regional scale-up is necessary in this sense as it allows sharing lessons (Z6, Z7) and achieving a blueprint process for a district approach (Z7). Second of all, the municipality and the housing corporation argue the relevance of a regional collaborative process is the scale-up benefits enabled by collaboration (Z2, Z3). "*The idea is that we can create scale benefits. And challenge the market to develop better supply.(...)When you pick a common type of building this could really bring you benefit"* (Z1). The municipalities should determine the overlap in the type of buildings in their districts and collectively approach commercial parties who could execute the developed solution.

The stakeholders also have their suggestions on why the regional collaboration currently lacks in results and impact in Zoetermeer. First of all, a regional collaboration is not yet beneficial as the progress of the transition process in the municipalities is uneven. Some municipalities have already developed more than others explains Z1 (Z1). "*The possibilities are just not there yet. For example, Maassluis also joined the process further in the process, and they are just not as far" (Z1)*. As Zoetermeer is at the vanguard of the transition in the MRDH it is not helpful for Zoetermeer to collaborate and share with other municipalities (Z1, Z2). Z7 makes a comparable argument *"it is hard to estimate what to do and where all the stakeholders are in the process. Some places just developed faster than other districts*". These stakeholders emphasize the complexity of different municipalities having their own developments and their own process which might not be easy to match. The municipality of Zoetermeer emphasizes the focus in Zoetermeer is local *(Z1). "We really focused on the local level. The local level is directive"*. The local level is the focus at this point in time as also technical *"at this point you can only go for local solutions, on the regional level there are no possibilities"* (Z1). The housing corporations explain that currently, the analysis is at a house and complex level as it is dependent on the type of building (Z3, Z5).

Conclusion

In Zoetermeer, the influence of CGP on three levels and its influence on the development of a district approach has been analyzed. On the local level, a fully developed CGP is perceived. Internally, there is no CGP in accordance to the theory however the subject is supported and taken into account in the organisation. There are multiple departments working on the transition and there is an organisational within the organisation to realize the transition of Palenstein. The stakeholders in

Palenstein agree that a regional CGP within the NGUA has not lived up to the potential yet. A regional collaboration is recognized as important for the development of the transition. However, CGP is not in the interest of Zoetermeer at this point as Palenstein is at the vanguard of the regional transition. In addition, at this point in time, the district approaches in the different municipalities have not yet progressed enough to make regional collaboration possible and beneficial in general. First municipalities have to develop their own district approach in which they analyze their district, its characteristics and the possible alternatives. Hereafter they can look for overlap with other municipalities. Collaboration is deemed beneficial whenever municipalities can join forces in challenging the market.

The reason for the leading position of Zoetermeer in the energy transition argue the stakeholders, is the formalized and intense local collaboration. In Palenstein the stakeholders collaborate in far developed local CGP. The dynamics principled engagement, share motivation and collective action capacity have all been identified to some extent in Palenstein. According to the stakeholders, the advanced collaboration in Palenstein is effective as a result of the Green Deal, a collaboration agreement signed by the relevant stakeholders. The Green Deal formalized the structure and the organisation of the CGP. Therefore, it has guaranteed many aspects of the interacting dynamics of a CGP. In Palenstein the Green Deal was built on an existing collaborative structure between the municipality and the housing corporations on the restructure task in the district. By using this structure as the foundation of the Green Deal, parties exploited good connections and proven governance structures to advance the progress of a district approach.

4.3 Comparative analysis

In the previous two sections, the two cases are analyzed individually. This is the first layer of analysis in which separate results are generated and analyzed. A second, deeper layer of analysis is possible in a comparative case study. The analyzes of the two cases are compared by discussing the differences and similarities in the results. This allows deeper reflection on the theoretical concepts and the current situation in the districts and the progress of the transition.

4.3 Results

Tabel 6 contains the results of the analyzes on both Sluispolder and Palenstein. The results are positioned side by side in order to provide a quick overview and enable an easy comparison of the results. However, the comparison deserves more attention and consideration. This section will, therefore, elaborate on the differences and the similarities between the results form the cases.

Tabel 6: Results

VARIABLE	SLUISPOLDER	PALENSTEIN
scale-up capacity	**Limited**	**Limited: deepened**
Deepening	● Expressed ambition to search for an alternative. ● No learning objectives or process.	● Searching, developing and realizing alternatives in a district. ● Conscious learning objectives and process.

	● Building on process lessons from other municipalities.	
Broadening	Not present.	Not present.
Complexities	**All complexities.**	**All complexities.**
Social	Residents lack urgency. ● *Interest:* is with other socio-economic priorities. ● *Perspective:* on comfortable living does not include sustainability.	Housing corporations have a lack of urgency ● *Interest:* of their renters are guiding. ● *Perspective:* on comfortable living with their renters does not include sustainability.
Technical	● *Uncertainty:* fast technical innovation ● *Unproven*: consequences on the long-term and large scale.	● *Uncertainty:* yield alternative source, technical innovation and development on other levels. ● *Unproven:* applicability on large scale.
Financial	● C*alculation*: unknown and uncertain technology complicates calculation. ● *Distribution*: uncertain financial responsibility municipality.	● A challenging however not a complexity.
CGP	**None.**	**Locally.**
Internal	*None:* project approach.	*None:* program approach (real estate)
Local	*Potential:* stakeholders show motivation and commitment.	● *Principled engagement* ● *Shared motivation* ● *Capacity for joint action*
Regional	*Limited but valuable.* ● Shared objective ● Knowledge sharing	*Limited and without benefit.* ● Shared objective ● Knowledge sharing

4.3.1 scale-up capacity

In both cases, the local government assigned a pilot district in their municipality to develop a district approach. Along the lines of the transition dynamics in both municipalities, this district can be regarded as a niche in the energy transition. A niche in the transition of the municipality itself, as in both cases the goal is to eventually apply the district approach to other districts in the municipality.

But also a niche in the national transition as the national goal is to replace all gas in the Netherlands with a sustainable alternative. The different districts together could form a niche regime in order to eventually adapt the status quo in the socio-technical regime to one in which gas is no longer the default option. However, at this point the right conditions lack to form a niche regime.

Both cases indicate a niche in which a district approach is being developed. However, the district approach in both cases has not achieved scale-up capacity yet. scale-up capacity requires deepening and broadening. At this point in the transition, the niches are deepening but not yet broadening their transition experiment. "*The municipality is in the exploratory phase. The results are not concrete enough to set the next step*" explains the MRDH project manager of the NGUA (O1). He perceived that within the NGUA the municipalities were not able to broaden their approaches as these were not yet developed far enough to link or apply concrete results. His observations match the situation in both Maassluis and Zoetermeer. The stakeholders are engaged with the local context of their niches and focus on their own approach.

The comparative analysis shows the deepening and broadening dimension are viewed as sequential. Niches are first focused on properly searching and learning within the context of the district. Only when this has achieved concrete results a regional broadening process appears possible according to the respondents. In both districts, the stakeholders are currently searching for an approach to replace gas with a sustainable alternative. In Palenstein concrete alternatives are already found for part of the buildings in the district. In Sluispolder a detailed analysis of the district Sluispolder has begun. Maassluis and Zoetermeer show the importance of a learning environment and conscious learning objectives at this point as the transition is just at its beginning. On the one hand, individual learning is necessary in order to learn from the development within your own district. In the development of the district approach Palenstein there are concrete learning objectives. The stakeholders are drawing lessons on for example "*what the challenges, the impossibilities or the opportunities are" (Z7).* At this point, Maassluis lacks a conscious local learning process. Individual learning also fuels collective learning as lessons from one district could also help other districts to develop faster, better and further. This point is amplified as Maassluis exploited the collective learning process enabled by the NGUA. As Maassluis joined the program later it could build on experiences and lessons of municipalities, such as Zoetermeer, which have already developed and learned more. Zoetermeer did not experience this collective learning opportunity. The lessons learned are on the process and organisation of a district approach. Eventually, this could result in a blueprint of a roadmap on how to create a district approach. A blueprint of the substance of a district approach might be inefficient. Every district has it own construction characteristics and therefore needs customized solutions.

4.3.2 Complexity

The analysis of the status quo of the local transition shows that currently, individual district approaches are in development. In other words, the transition experiments are deepening within the context of the niche. This means the complexities analyzed are complexities challenging the deepening process. Complexities challenging the development of an adequate district approach to replace gas. This research initially started with five complexities: social, technical, financial, legal and time. Although the different complexities have been questioned in the interviews the analysis has only included the first three complexities. Although judicial and time complexities were not denied in their entirety in the interviews it became clear the three most perceived and discussed complexities in both cases are social, technical and financial complexity. In addition, these three complexities show an

interesting dynamic and interaction. Already in both the individual case analysis the overlap and interaction between the complexities is indicated. The dynamics of the interaction between these three complexities clearly demonstrates the development and the structure of the complexity of a socio-technical energy system challenging the energy transition.

Figure 7 has been drawn to visualize the construction and interaction of the three complexities. You can read and use the model in two ways. On the one hand by starting from the center outwards. You can use the drawing as a dissection of the complexity of an energy transition. With every step outwards the complexity of the transition of the local energy system becomes more dissected and tangible. This makes the complexities understandable and applicable to the reality in practice. Or on the other hand inwards to the center. The latter shows that every complexity, drawn from practice perceptions, interacts with the other two. At the center of the drawing, the three complexities come together.

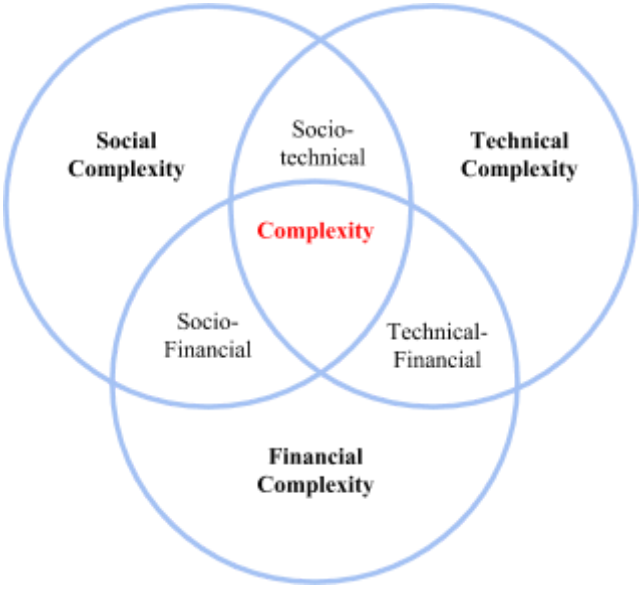


Figure 7: Complexities in an Energy Transition.

Complexities

The model is explained with the cases analyzed in this study. The main social complexity found in both cases is a conflict in perspective and interest between the stakeholders, especially between on the one hand the housing corporation and the municipality and on the other hand the residents. A lack of urgency to contribute to the transition is challenging the development and implementation of a district approach. However, this lack of urgency can be connected to the two other complexities. Technical complexity is increasing social complexity as it challenges residents to get involved in the transition process. Residents are put off by the complexity in the first place because of a lack of understanding but it also challenges other stakeholders to communicate with the residents to inform, interest and involve them in the matter. Social complexity increases technical complexity as it challenges the development of the technology. In order to get familiar with new technologies and their consequences on the long term and on a large scale the technologies need to be applied. Residents or other stakeholders with a lack of urgency prevent the application and therefore prolong the development process. However, and here the third complexity comes in, the reason behind a lack of urgency or

perspective often is a lack of interest and ability to get involved. In order to apply the technological options to the houses, large investments are required. However, the stakeholder who has is responsible for these investments, the resident, does not have the resources or interests to pay for it. At this point the government lacks in a solid financial construction to enable this. The main financial complexity is finding the right construction to finance the district approach. Financial complexity again is fueled by technical and social complexity. Without technical certainty, it is hard to calculate and distribute the costs. And without financial means, it is hard to develop the technique to decrease technical complexity. Social complexity challenges the calculation and distribution of the costs and benefits of the transition. Every stakeholder holds their own objectives, means, and requirements which have to be taken into account. The interactions and dependencies of the three complexities show the overall high complexity level of developing and realizing an adequate district approach.

4.3.3 Collaborative Governance Process

At three levels a CGP has been analyzed. Within a government organisation (internal), within the district (local) and within the MRDH (regional). Studying these processes completely separate would ignore the dependencies and influences between the levels. Therefore both the dynamics on the levels and between the levels are analyzed.

A comparison of the analysis in Maassluis en Zoetermeer shows that the CGP has so far developed most on the local level. In addition, in both cases, a local CGP is proven most essential CGP for the development of a district approach. In Palenstein the local CGP was argued to be the largest factor enabling the development of the district approach. Formalizing a CGP in Sluispolder is regarded as the next necessary step by the stakeholders to advance the transition in Palenstein. A collaboration between the key stakeholders is required as every stakeholder holds a piece of the puzzle. Every stakeholder has its own regime of property and responsibility within the districts which means no one can realize the transition alone. In addition, collaboration prevents ad hoc initiatives in the district and allows synergy between the stakeholders. In Sluispolder this is still the case as different stakeholders pursue individual projects without coordination or shared objective. Together the stakeholders can exploit each others knowledge, expertise and the scale benefits. An example of the effectiveness and efficiency of collaboration is the cluster division of Palenstein. Together the stakeholders have divided the district up in seven clusters based on the type of houses. This enables them to, collectively, find a solution for every type of cluster. Instead of only focusing on your own property.

In order to achieve a proper CGP a collaboration agreement is required. This is shown in the development of the collaboration in Palenstein. In Palenstein the Green Deal was established in 2017 in order to assure a shared objective and commitment to the process and the objective by all the stakeholders. In Sluispolder this has not yet been established. So far, in Sluispolder the stakeholders have come together twice in two voluntary meetings organized by TNO. However, at the last meeting, the stakeholders expressed their motivation to sign a covenant in the district. Stedin, which is involved in both cases, perceived the influence of a Green Deal *"I am involved in both trajectories, in Zoetermeer more intense than in Maassluis as in Zoetermeer we have signed the Green Deal. With those parties we really started working and produced a transition plan on how to take on the district Palenstein" (Z7).* Also, the MRDH, which made an inventory of the developments in the different NGUA districts, argues the Green Deal has been an important factor in getting Palenstein at the vanguard *"Palenstein is a successful example. All parties are involved and have collectively committed to the process. These Green Deal have signed a Green Deal"* (O1). Palenstein shows the

Green Deal is crucial as it has produced principled engagement, shared motivation and capacity for joint action. The Green Deal provides a way to make agreements on a shared process with shared objectives and above all shared commitment.

Key stakeholders

The two cases identify the same key stakeholders and their role in an effective local CGP. The first stakeholder is the local government. In both cases, the local government is assigned the role of director and facilitator of the transition. Although the government might not have the resources or power to realize the transition itself it has the crucial role to enable the transition. First of all, it has the responsibility to pick a district and facilitate the necessary collaboration by bringing the parties together and facilitate their interactions. A concrete example is the process leader hired by the municipality in Zoetermeer. Second of all, this role includes making the final call on the alternative to replace gas. Lastly, the municipality has the responsibility to set up communication with the residents of the district to inform them of the process and the decisions. The second important stakeholder is the housing corporations in a district. Both in Zoetermeer and in Maassluis a solvent housing corporation with high sustainability ambitions owns property in the district. Z2 explains *"as the houses in Palenstein are subject to the transition it is very effective to already have the most important parties [the housing corporations] at the table as Palenstein consists of more than 70% of social housing. This makes it easy to start in this Neighborhood"* (Z2). In both cases, these corporations have started to replace gas with sustainable alternatives in their properties. Zoetermeer has shown this could be the starter of a local CGP. The corporations already have a long collaboration history with the municipality throughout the development of the district. This partnership could be used as foundation for an extended and renewed CGP on the transition of the district. In order to achieve a local CGP this partnership is extended with the net operator in the district. The net operator is the owner of the gas and electric infrastructure in the district and therefore responsible for making the adaptations necessary for the transition. The net operator is active in multiple municipalities and could, therefore, bring knowledge and lessons. In addition, the net operator could help to structure the collective planning as they indicate when, where the infrastructure requires maintenance. This creates momentum for a more integrative reconstruction to replace gas for the buildings connected to the infrastructure.

The last key stakeholders are the residents of the district however, this groups should not be included in the collaboration agreements. The residents require their own trajectory in which they are informed, interested and involved in the developments of the neighborhood. Both the renters and the homeowners have a lot of influence on the development of the transition. As indicated before, this conflicts with the interests they currently have. Both cases indicate residents should only be involved whenever concrete plans have been made which can be presented and discussed (Z5, M1). The municipality in Maassluis argues "*But you can not do that [involve residents] too soon. You first need to have more clarity and then offer solutions within those frameworks. You can not just tell them "just think, how do we get rid of the gas". That is possible but can also cause uncertainty and unrest. You have to find a balance"*. De Goede Woning in Palenstein showed that an adequate communication process yields support. They also still indicate communication is crucial. The importance of communication is also shown in Maassluis *"although Maasdelta introduced a compensation scheme for the renter, this was not clear to all residents."* (M8*). The representative of the renters explains this prevented renters to support the reconstruction plans.

Relation with Internal CGP

The municipality holds an important decision within the local CGP. It is supposed to be the initiator, the facilitator and the director of the collaboration according to all stakeholders. First of all, the municipality has to pick a district to begin with. Within the district, it should bring the parties together, provide the conditions for collaboration and a transition to flourish and eventually take important decisions on the appropriate alternative of gas in the district. This requires a strong municipality with a clear message. However, when the subject lacks support and structure within the organisation it is hard to take on this position. As seen in Maassluis, a lack of coordination and foundation results in ad hoc initiatives in the district. In Zoetermeer, the municipality acts as a united party striving for one objective. Both in Maassluis (M3) and in Zoetermeer (Z1) the importance of administrative support in is emphasized. Whenever administrative support is missing a topic gets easily overthrown by one of the many other priorities a municipality has (M3, Z1). In Zoetermeer there is a widespread support which allows the transition of palenstein to be a priority. In Maassluis a new administration has recently formed which makes support an uncertain but necessary factor at this point (M1, M3). With support time and money can be invested in getting the right people to do the right things within the organisation. It also helps to connect the transition to an existing policy and structure. In addition, in Zoetermeer the policy to replace gas has been approached as a real estate policy and therefore is connected to the implementation of the bigger reconstruction challenge in Palenstein. Also in Sluispolder there is a reconstruction policy which presents this opportunity.

Relation with Regional CGP

In both cases, stakeholders have expressed their disappointment in the current regional collaboration. Regional collaboration is deemed beneficial in order to collectively develop a process blueprint for a district approach and to eventually achieve collaborative scale-up. However, the municipalities in the regional CGP are still too much focused on their own local developments. Currently, the development processes differ in every municipality. The difference between Maassluis and Zoetermeer is a perfect example. Palenstein is far ahead on the development of a district approach in comparison to Sluispolder. This prevents a collective development process. However, at this point knowledge sharing and collective learning on the regional level is valuable for the municipalities still at the beginning of the transition. Maassluis indicates they build on lessons drawn from the processes in other municipalities, such as Zoetermeer. This, however, has no value for Zoetermeer as a pioneer in the region. Regional collaboration, therefore, becomes interesting whenever districts have achieved internal support and organisation, local collaboration and analyzed their local situation. Then they can collectively challenge the market to achieve scale-up capacity. As the MRDH summarizes "*collaborating is really accomplishes things together and currently, it is mainly sharing knowledge which you can take with you or not in your own assignment. Making joint baskets is really more cooperation. Together 5000 houses in the market, challenge the construction industry to come up with a good concept is collaboration*" (O1).

4.3.4 Revised Models

Based on the individual and the comparative analysis the initial conceptual model will be revisited and the relations which were indicated will be discussed again in this section. Figure 7 is a revised version of the initial conceptual model (figure 5) based on the empirical research and analysis. In addition, the theoretical drawing (figure 1) is revised to fit the focus of the analysis.

Revised Conceptual Model

Figure 8 visualizes the relations confirmed, changed and added as a result of the empirical research in Maassluis and Zoetermeer. The different relations will be discussed one by one.

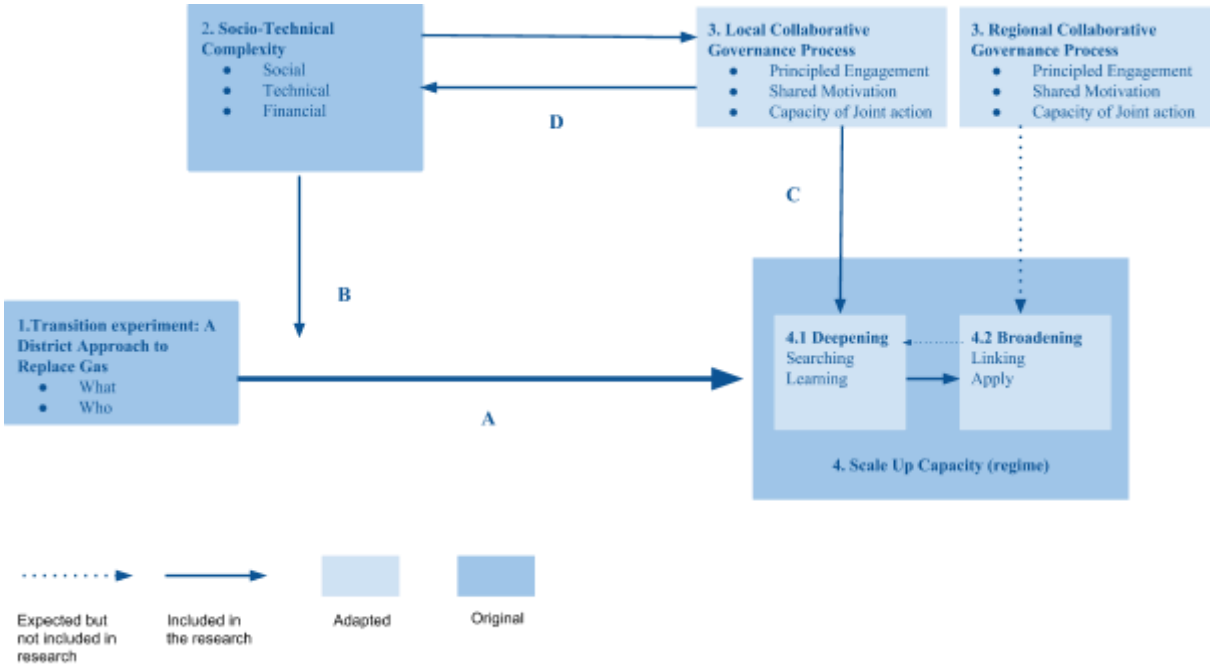


Figure 8: Revised Conceptual Model

A: Both theoretical and the empirical research indicate the objective to achieve scale-up of a district approach. The theory states that a transition experiment requires to develop in order to pose an adequate alternative to pressure and change the current socio-technical regime. Both locally in Zoetermeer and Maassluis and regionally by the MRDH the objective is expressed to develop an approach which can be applied to other districts and eventually fully replace gas as the default option in our built environment. In addition, the national government has put the responsibility to innovate and start the transition on the local governments. This research found that scale-up is deemed necessary for two reasons. First of all, in order to create a blueprint for an effective district approach which will allow a faster transition of other districts. This could be achieved by collective learning and broadening process amongst multiple districts. Second, eventually, scale-up creates scale benefit. When multiple districts have constructed their approach they can link their efforts in order to find collective solutions, challenge the market and lower the costs.

In the initial model deepening and broadening were assumed to be two equal aspects of scale-up capacity. The empirical analysis in this research shows deepening is required before broadening can be pursued by the districts. Before the transition experiments (district approach) can be linked or applied to other districts they have to be deepened in their own context. The stakeholders have to search for an adequate alternative and consciously learn in that process in order to apply this to other contexts. To indicate this relation the two aspects are separated within scale-up capacity. Nevertheless, this research is not able to say anything on the process at the moment district approaches start broadening. Therefore the dotted line indicates the possibility that broadening and deepening co-develop as the internal deepening probably continues.

B. The list of complexities has been shorted to the three complexities analyzed in this research: social, technical and financial. These complexities are challenging the development of an adequate district approach during the deepening process. It, therefore, challenges the scale-up capacity of a district approach. However, this research is unable to determine whether the same complexities challenge the broadening phase as the cases in this research are only deepening at this point. It is vital to realize the complexities cannot be studied separate but really jointly create the complexity challenging progress in the deepening phase.

C. Multiple aspects of relation C have been adapted in the revision. First of all, internal CGP is dismissed as a concept in this model. The research determined that a full internal CGP in the municipality organisation is not necessary to stimulate the development of a district approach. Zoetermeer showed that internal support and internal organisation in a program approach is enough to start the deepening phase. Local and regional CGP are separated in two processes which develop separately. Palenstein indicates the powerful stimulation of the deepening phase by a local CGP. In Palenstein the vital local stakeholders have committed to a collaboration agreement which guarantees all the indicators necessary for a full CGP as proposed by Emerson. In Palenstein this local CGP is the main stimulation of an effective, collective searching and learning process in the development of a district approach to replace gas. The responsibility to develop a district is divided over different stakeholders. These stakeholders hold different power, knowledge and resources. In order to find a district approach to realize a transition of the entire district, the key stakeholders have to be committed and motivated to contribute their share. A local CGP motivates and commits stakeholders to collectively work towards a shared goal (replacing gas) and share the necessary knowledge and resources.

A regional CGP has not been found at this moment. This CGP is thus not vital for the deepening a district approach within the context of a district. However, the research indicates a potential for regional collaboration whenever districts are broadening their approach. In addition, scale-up can be facilitated by a regional CGP. Different districts can join forces and create approaches which cover a larger scale. However, it also emphasizes this is not the case yet and offers a potential for when approaches have developed more locally.

D. A local CGP appears to decrease the complexity challenge. In Zoetermeer it has been determined that a formal CGP moves stakeholders to take into account each other's perspectives and interests. In addition, they create and commit to the shared interest to replace gas in the district. In addition, the interactions and collaboration increase a shared perspective on sustainability in the district. However, it does not completely dismiss complexity. Complexity also still challenges a CGP the stakeholders have different requirements, plannings and resources. This makes it difficult for stakeholders to commit to a shared objective. To indicate this mutual influence two arrows both ways have been drawn between the two concepts.

Revised Theoretical Drawing

At this point, the district approaches have not yet achieved scale-up capacity. Therefore, the focus in this research is on the niche level. The model constructed in the theoretical framework (figure 1) has been adjusted to fit the focus of this analysis. Figure 9 shows the new model (own drawing). The niches are representing the different districts in which a district approach is developed. In this case, Zoetermeer and Maassluis would each be depicted as one of the niches. The model shows the

dynamics of the deepening and broadening dimensions with the blue arrows. The striped arrows linking the niches are broadening dynamics and the vertical dotted arrows the deepening dynamics. It has been concluded a deepening process requires to be developed sufficiently before the development of the approach can be linked in a broadening process. As a result of the broadening dynamics, the districts could eventually form a regional niche regime. The red interrupted lines indicate the complexity challenging the local development of a district approach and the formation of a niche regime. The golden circle within the niches indicates a local CGP and the golden circle between the niches regional CGP which could benefit the development within and between the niches.

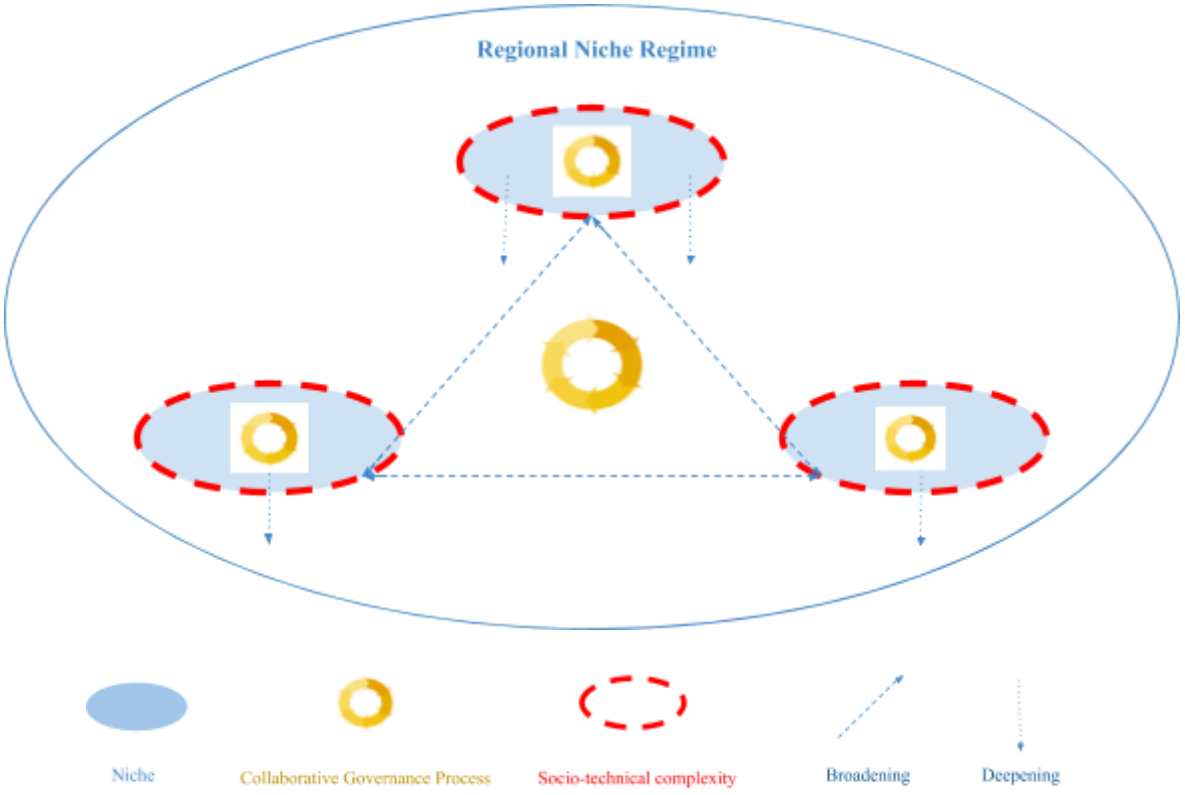


Figure 9: Niche level scale-up Dynamics

5. Conclusion & Discussion

5.1 Conclusions

The goal of this research is to answer the research question "*To what extent are complexities inherent to a sociotechnical energy system challenging the scale-up of a transition approach to discard natural gas and to what extent do collaborative governance processes benefit the scale-up of this transition approach?"*. The extensive theoretical and empirical research conducted has led to three main conclusions on the different aspects of this question with each an extensive foundation of findings.

5.1.1 Status quo: deepening district approaches in individual niches

The first conclusions is that the transition experiments to replace gas have not yet achieved scale-up capacity in order to transcend the niche level. The transition experiment studied in this research is the district approach in which a process and solution are developed to replace gas in a local district. Eventually, the individual district approaches have to develop, link and scale-up in order to replace all the Dutch gas. In order to start scaling up, a district approach requires sufficient scale-up capacity. As the theory indicates this is achieved by deepening and broadening a district approach. A deepening process consists of the search for an innovative alternative to gas during which the stakeholders learn as much as possible from this process. Broadening is necessary in order to strengthen a approach by learning and improving it in other contexts and in connections to other approaches.

Currently, the districts do not have sufficient scale-up capacity as there is only a limited deepening process and broadening has not yet been possible at all. Both districts started deepening their approaches as stakeholders are searching for appropriate alternatives to gas in their district. The progress of this phase, however, differs in the two municipalities. In Zoetermeer the stakeholders collectively research the possibilities and already published a project plan which presents multiple alternatives for gas in Palenstein. However, it is not yet sufficient to replace all gas in the district. In Maassluis no concrete alternatives are established. Whilst searching the municipalities are learning individually and collectively. In Zoetermeer conscious learning objectives are expressed between the local stakeholders. In Maassluis there is not yet a local learning process. However, Maassluis is building on lessons from municipalities which already developed more, such as Zoetermeer. This is not yet considered broadening as this requires formal linking of approaches of the conscious application of one approach in another district. In both municipalities, it is determined that broadening is not yet possible. This is explained by insufficient concrete results in the districts and the disparities between the progress in the districts. This conclusion shows that sufficient deepening is vital before broadening can be achieved. However, it is not said that the deepening process is replaced by a broadening process when a broadening process has started, they might co-develop.

5.1.2 Challenged by complex social aspects, technique and money

The second conclusion confirms the negative impact of complexities on the development of scale-up capacity. The development of the scale-up capacity of a district approach is challenged by an interaction of social, technical and financial complexities. The interaction is visualized in Figure 6.

Social complexity is the result of a conflict of perspective and interest between the stakeholders in the district. Especially, the residents of the district have a divergent perspective and interest in the transition. They are driven by comfortable living and by their financial capacities and benefits. At this

point, neither of these aspects makes sustainability and replacing gas a priority to residents. In extension of this, housing corporations act in the interest of their renters which prevents them to adapt their policy and planning whenever renters oppose. Some housing corporations have enough individual resources to cut the costs, however not all corporation which makes these corporations reliant on the renter's position. Technical complexity is the result of uncertain and unproven alternatives to gas. Some alternatives are promising, however, do not provide the assurance of the capability pose an adequate alternative to gas. Complexity is created as it remains uncertain whether it will produce enough heat or electricity and whether it will be affordable and applicable. This is in connection with the complexity of new unproven technologies which are required to achieve a transition away from gas. Technically, it is possible to adapt or build a house to replace gas. However, it is another thing to realize this on a long scale and on the long-term. The consequences of the technologies are at this point not yet known on the large scale and long term. As a district often holds many different houses with different constructions it is even more complicated to apply and prove the technique on a large scale as for every type of house needs other requirements and considerations. Financial complexity appeared to be the biggest challenge, however, the smallest complexity. At this point, the fact is that the investments necessary to realize a transition are high and the stakeholders which have the responsibility to make the investments lack the financial resources.

The complexities mutually reinforce each other. Technical complexity is increasing social complexity as it challenges residents to get involved in the transition process. Financial complexity is created as a result of the technical complexity and the unproven and uncertain technology. Without knowing the consequences on a large scale and on the long-term it is impossible to calculate the costs of an alternative. In addition, social complexity and financial complexity are increasing technical complexity. In order to get familiar with new technologies and their consequences on the long term and on a large scale the technologies need to be applied. Residents or other stakeholders with a lack of urgency and a lack of financial resources prevent the application and prevent the development of the technologies to overcome the complexities. Social complexity challenges the calculation and distribution of the costs and benefits of the transition. Every stakeholder holds their own objectives, means, and requirements which have to be taken into account.

5.1.3 Collaboration as stimulation

The third conclusion is the confirmation of the positive relationship between collaboration and the development of a district approach. The research analyzed a CGP on three levels: the internal, the local and the regional level. Internally within the organisation of the municipality, locally between the key stakeholders in the pilot district and regionally between different municipalities with an ambition to replace gas with a district approach within the MRDH region. At this point, a local CGP between the stakeholders of the district is most important for the development of a district approach in the deepening phase, in which the districts currently are. It is vital to have the key stakeholders together to have shared objective, motivation and commitment to realize the transition. In addition, a CGP decreases social complexity. As the shared objective, motivation and commitment decrease conflict in perspective and interests. The comparative case study showed that a collaboration agreement positively contributes an adequate CGP. In Sluispolder the stakeholders have the motivation to commit and contribute to a transition, however, nothing has really happened without the direction of external parties such as TNO. In Palenstein the key stakeholders signed the Green Deal in which they have committed to a shared goal, individual roles and responsibilities, and shared rules, procedures and agreements. In addition, a local CGP and the agreements are stronger whenever they are based on

positive, existing relations and structures within municipalities, between the municipality and housing corporations, and between housing corporation and their renters.

In the district, the municipality has the director role in the collaboration and the transition. It is an objective party and should use this position to push and pull where necessary. Without a strong municipality with the appropriate organisation and support of the subject, a CGP will not develop (Zoetermeer did, Maassluis not yet). This indicates that a full and formal CGP within a municipality organisation is not necessary. However, a municipality does require enough administrative and executive support by the right people within the municipality to have access to the necessary resources and possibilities to make and implement transition policy, shows Zoetermeer. A fragmented organisation prevents the coordination of the development of a district approach. A program approach, as seen in Zoetermeer, is a way to make sure enough time and resources are spent on the subject and the subject is supported widely within the organisation. In Maassluis the district approach is currently approached by a project approach which is the result and increases a fragmented organisation. Besides internal CGP also regional collaboration is not yet developed. Regional CGP will be beneficial and desirable whenever districts developed their individual approaches more. At this point, municipalities and other stakeholders are focused inwards on the local development of a district approach. Regional CGP could eventually stimulate and enable broadening and scaling up the different district approaches predict the respondents in this research.

5.2 Discussion

Mainly drawn from the theory handed by Geels and Rotmans this research created a theoretical framework around the scale-up mechanisms. It is important to repeat and emphasize the theoretical transition mechanisms between the different levels of a socio-technical system are used in this research as an approach. The objective was not and has not been to further enhance this theory. The mechanisms are used rather shallow in order to fit the theory to the cases at hand. The research could have been more specific in applying the definitions of a niche, a regime and the mechanisms deepening and broadening. However, this was not within the time and capacities of this study. Most important within this research was the recognition and application of the mechanisms between the niche and the regime level to the cases at hand. The abstract concept regime has been concretized as the local government and everything above. The district in transition was defined as the niche. The research continued to analyze the complexities that challenge the adequate performance of the mechanism of deepening and broadening at the beginning of a transition in order to enable scaling up the innovative alternatives to the regime.

In order to research the socio-technical complexities challenging a transition the theoretical concepts developed by Hertogh & Westerveld are used. Their theoretical concepts are derived from the complexity in the development of large infrastructure projects. Based on the perceptions of stakeholders relevant to this development they recognized six different complexities: social, technical, financial, judicial, time and organizational. This research started of with the first five. However, throughout the research, it was decided to refocus on the first three: s*ocial, technical and financial complexities.* This decision was made in order to limit the scope in order to go into more detail on these three complexities and their relations. Taking into account six different complexity types would decrease the value of the conclusions of this research. Social, technical and financial complexities were chosen as they were perceived most present, related and troubling. These theoretical concepts drawn from large infrastructure projects were applied to the complexity of the transition replacing gas in districts. This research, therefore, formed a new subject to apply this theory. This research shows

that it is possible and valuable to transfer the theory to different cases and subjects. The theory offers a framework that can be applied to different complex situations.

Whereas Hertogh & Westerveld elaborately set out the six different aspects of complexity they only dedicate a small part of their analysis to the linkages and interaction between the different complexities. First of all, this research confirms what H&W already found, social and technical complexities have the strongest link and reinforce each other. However, this research offers a deepening in the relationship between the social, technical and financial complexities. The analysis of this thesis elaborates on the intangibility of the three complexities in the case of a district transition. In addition, both studies concluded social complexity as the most challenging. Social is an intangible and continuously changing aspect. Whereas financial challenges might be the most challenging they are not the most complex challenges. Financial challenges can be solved by assigning more money in the case of the transition.

In addition, this research offers a different way to deal with the challenging complexities. Hertogh & Westerveld elaborately formed and propose different strategies to deal with the complexity. The complexities which are studied in this research are best managed by interactive management propose Hertogh & Westerveld. This study explores the benefits of collaborative governance to a complex transition process. Part of interactive management by Hertogh en Westerveld is joint initiative, co-production and co-finance. Collaboration might be a deeper dive into the process of co-dealing with the complexities. Hertogh & Westerveld claim still one manager needs to oversee the interactive process. This is also found in this research. Collaboration is efficient however leadership by one or more parties is required. In the cases of the transition of the district, the municipality has the managing role as the director and facilitator of the transition.

Another theory drafted to deal with a complex transition is *Transition Management (Rotmans et al.).* Transition Management theory has not been considered in this research. Looking back this could have helped the research. This would have helped to better understand the mechanism between the niches and the regime. A link between Transition Management and Collaborative governance could help to make the conclusions of this research even more applicable and valuable. *"The very idea behind transition management is to create a societal movement through new coalitions, partnerships and networks around arenas that allow for building up continuous pressure on the political and market arena to safeguard the long-term orientation and goals of the transition process."* write D. Loorbach, J. Rotmans. (2010). This quote shows the importance of collaborative relations in order to strengthen the transition approach. A central question within the transition management theory is *"how do we influence, coordinate and bring together actors and their activities so that they reinforce each other to such an extent that they can compete with dominant actors and practices?" (Loorbach, Rotmans, 2010)* It might, therefore, be valuable to integrate the benefits of collaboration with the scale-up process in transition management strategies. The collaborative governance theory could hand concrete elements for an adequate collaborative network in transition management, in order to achieve scale-up capacity. Collaborative governance theory fits the scale-up mechanisms and the transition management approach. In collaboration the focus is on connection and sharing. Currently, collaboration is strengthening the deepening mechanisms within the niches. In the broadening phase, this collaboration could make a difference in connecting the niches and by collaboratively sharing knowledge and lessons accelerate the transition.

For future research, it would be relevant to take the concept in this research to study the relation or impact in depth. This research confirms the absence, presents, and relevance of the concepts and their relations in the development of a district approach, however, it does not go into much depth on mechanisms within the concepts and their relations. In addition, this study does not analyze all the different complexities challenging a district approach. Additional research would be interesting on other complexities challenging the development. This could also be studied with a different research approach. With an inductive research without a preset theoretical framework, interviews with key stakeholders on the transition process, might bring new insights on other complexities. An example is organisational complexity. The respondents of this research indicated the challenge of the organisation of the transition. Within an individual organisation such as a municipality or housing corporations. But also between organisations. The different stakeholders indicated the complexity of aligning all the different organisational requirements and plannings of the stakeholders in the transition. It is however beyond the scope of this research to include these perceptions. Lastly, the value of collaborative governance to transition management theory can be explored.

6. Recommendations

First of all, a general recommendation on drafting a district approach is made. Thereafter, to every key stakeholder, a recommendation on their role and responsibility in the district will be provided.

A district approach

Every district in the Netherlands is facing the challenge to replace gas for a sustainable alternative. The analysis and the conclusion of this study enable recommendations on the development and substance of a district approach. First of all, although a district approach already is a focus it is crucial to make sure the first pilot district has a narrow focus and is manageable. A small district provides more space to experiment with innovative processes and technologies. Providing 120 houses with the wrong installation is a lot easier to repair than 30.000 houses. In addition, it makes the decision-making process easier. In a smaller district, the parties are closer to each other which makes a first interaction in the municipality on the topic easier.

Second of all, the substance of the district approach should be focused, to begin with. The alternative is to use an integrative approach in which the different aspects of a sustainable district are connected in an integrative district approach. An example is a district approach in which socio-economic, climate adaptation and energy are combined. This, however, will result in endless calculation and discussion and little action. By linking the district approach to the reconstruction policy of a district it instantly becomes tangible and enforceable. There is an area focus, the relevant parties are known and already collaborating and there often is a organisational structure. Along the way, the district approach could be developed towards a more integrative approach in which different development opportunities could be connected.

The third and last recommendation for a district approach is to just start! Do not let the uncertainties of future promises and innovative technologies hold back the transition. The only way to improve technology and overcome the complexities is to apply them, analyze the impact, learn and improve. In addition, already at this point, many districts have started to develop a district approach. Do not waste the opportunity of the lessons learned in these cases. Instead of trying to reinvent the wheel all over use their lessons to build a new local district approach on. There are aspects of the district approach which require local and district-specific analysis and research. However, there are many aspects such as the appropriate organisation, process and different technological possibilities which can be used as the foundation of a new improved district approach.

The Municipality

The municipality is the core party of the transition of the district. This research shows that a municipality is crucial in initiating and facilitating a local collaborative governance process. The municipality should take on the responsibility to bring the different relevant parties together and facilitate interactions and collaboration. In addition, the municipality has its own role in the collaboration. It is the party which should facilitate the conditions necessary for other parties to act. The municipality has the role to create the right organisational, legal and financial conditions to realize the transition. However, in order to fulfill this role the municipality needs to act strong and united. And this is only possible when internally the organisation of the municipality on the subject is

adequate. This means enough of both administrative and executive support within the organisation is required. The administration needs to recognize the relevance of the topic and assign capacity and resources to a program on the development of the transition. In addition, the relevant departments need to include the transition in the drafting and execution of their policy. This could mean the real estate department enables gas-free housing and other departments are aware of large transition (re)constructions in order to adjust and accommodate the transition in their policy. This is necessary to realize a coordinated and effective policy as a united municipality instead of supporting ad hoc initiative without a clear objective.

The Housing Corporation

A housing corporation with property in the district is a vital part in the transition. In order to realize the transition of the houses in a district, the housing corporation(s) need to be on board. A housing corporation is able to make long term policy and investment plans which allows them to start, monitor and maintain a transition. The first recommendation is, therefore, to review policy plans and visions and make an attempt to integrate the objective to realize housing without gas. It is vital to make sure enough time and money is assigned to the realization of the transition objectives. In order to achieve this, it is important the organisation is top-down submerged with the transition objective. A second step is to figure out how housing without gas is developed. Fortunately, no housing corporation at this point is the first housing corporation to start this process. Therefore, it is efficient and effective to look for housing corporations which have already started a transition project and build on their lessons, insights and mistakes. This includes the technological aspects; how sustainable houses are constructed. However, more important is the social challenge of the transition. As housing corporation, the success of your policy is dependent on the support of your residents. Therefore, it is crucial to set up an elaborate, long-term communication traject with the residents. Overall, residents are not inherently supportive to the transition as they currently lack the understanding and the perspective. However, with an intense communication process before, during and after the reconstructions residents can be informed, interested and involved in the process. This might require adding a communication manager to the team. Lastly, just start! Find a district with momentum for a transition and, even though it is on a small scale, start replacing gas.

The Resident

A resident is a party with the most influence in the process. This is the first insight a resident has to embrace. The success of the transition is based on your willingness and capacity to joint. Part of this is out of the reach for a resident. At this point, the right financial and legal conditions are just not there yet. This is dependent on the developments in government policy and in the technique. However, changing your understanding and perspective on the transition is within the power of every resident. Therefore, at this point as a resident, you have to start informing yourself. Start by developing your own understanding of the transition and the necessity to replace gas. The next step is to analyze your own house, the possibilities for your house and the current developments in your district. Lastly, lobby! Make sure the authorities in the districts are pressured into creating the necessary conditions. This could be even more powerful whenever residents join forces within the district.

Stedin

As an house owner of the infrastructure Stedin has two faces in the transition. First of all, it is to replace the gas infrastructure with one that fits the new sustainable alternative. However, as this alternative is not yet known everywhere the current role is to facilitate the transition and collaborate

with other parties. Stedin is active in large parts of the region and is therefore involved in multiple district approaches. Stedin has the responsibility to use insights, experience, and lessons learned in one district to improve another. In addition, Stedin could use its own planning of infrastructure maintenance and replacement to create momentum in an area. This could help a municipality to pick a place to start a transition. Last, Stedin has a lot of technical knowledge which should be shared to help the development of a district approach.

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Tweede Kamer der Staten-Generaal 2 Vergaderjaar 2017–2018 32 813 Kabinetsaanpak Klimaatbeleid Nr. 163 BRIEF VAN DE MINISTER VAN ECONOMISCHE ZAKEN EN KLIMAAT Aan de Voorzitter van de Tweede Kamer der Staten-Generaal Den Haag, 23 februari 2018

8. Annex

Annex I: operationalization with general questions

	Concept	**Variable**	**Indicator (definition)**	**Question**	**Vraag**
1.	Local initiative	What	Green system innovation of the initiative/contribution to a sustainable local energy system.	In what way is your initiative contributing to a reduction of energy use or an increase of the share of sustainable energy?	Op welke manier draagt uw initiatief bij aan het verminderen van energieverbruik of vergroten van het deel duurzame energie?
2		Who	Actor(s) involved in developing and implementing the initiative.	Which stakeholders are involved in developing or implementing this initiative? What are the roles of the different stakeholders?	Welke stakeholders zijn er betrokken bij de ontwikkeling en de uitvoering van het initiatief? Welke rollen nemen deze stakeholders aan tov uw initiatief?
3	scale-up capacity	Deepened	The initiatives has engaged in a learning process with regard to experimental innovations (Bosch & Rotmans, 2009).	see question 5 & 6	-
4		Broadened	The local initiative is deliberately connected to innovations in other niches, both within and outside the same domain or function.	see questions 7&8	-
5	Deepening	Individual learning	Focus on learning about the innovations (as a product and	To what extent have you engaged in an internal learning process in order to	In hoeverre verbetert u uw process en project in een intern

			process).	improve your process or product?	leerproces?
6		Collective learning	Tuning and sharing learning experiences between different actors.	To what extent are different initiatives sharing learning experiences among each other?	In hoeverre delen initiatieven onderling leer momenten en ervaringen? In hoeverre stemmen verschillende initiatieven hun leerervaringen op elkaar af?
7	Broadening	Connect	The targeted connection of initiatives to comparable initiatives (Bosch & Rotmans, 2009).	To what extent have you strived and achieved a connections with other sustainable initiatives within the local system?	In hoeverre heeft u een connectie met andere duurzame lokale initiatieven in de omgeving nagestreefd en bereikt?
8		Apply	Apply initiatives in a different context (physical environment).	To what extent have you applied your initiative in different locations?	In hoeverre heeft u (de inhoud van) uw initiatief toegepast/uitgevoerd op verschillende locaties?
9	Socio-Technical Complexity	Social Complexity	Different perspectives involved actors	What is your interest in the local energy transition? On a scale of 1-5, to what extent are conflicting interests of stakeholders in the local energy system challenging the development of your initiative? Can you exemplify your answer?	Wat is uw belang in de lokale duurzaamheidstransitie? Op een schaal van 1-5, in hoeverre belemmeren tegenstrijdige belangen van de stakeholders in het lokale energie domein de ontwikkeling van uw initiatief? Kunt u uw keuze toelichten?
11			Conflict of interests involved actors	What is your interest in the local energy transition? On a scale of 1-5, to what extent are conflicting interests	Wat is uw belang in de lokale duurzaamheidstransitie? Op een schaal van 1-5, in hoeverre belemmeren

				of stakeholders in the local energy system challenging the development of your initiative? Can you exemplify your answer?	tegenstrijdige belangen van de stakeholders in het lokale energie domein de ontwikkeling van uw initiatief? Kunt u uw keuze toelichten?
12		Technical complexity	Unproven Technology	What technological challenges are you confronted with? On a scale from 1-5, to what extent is the unproven character of sustainable innovative technology challenging the development of your initiative? Can you exemplify your answer?	Met welke technologische uitdagingen en onzekerheden heeft u te maken? Op een schaal van 1-5, in hoeverre zijn de onzekerheden van innovatieve technologieën een barrière voor het ontwikkelen van uw initiatief? Kunt u uw keuze toelichten?
13			Technical uncertainty	On a scale from 1-5, to what extent are uncertainties of renewable energy sources challenging the development of your initiative? Can you exemplify your answer?	Op een schaal van 1-5, in hoeverre ondervindt u hinder aan de inherente onzekerheden van duurzame energiebronnen in het ontwikkelen van uw initiatief? Kunt u uw keuze toelichten?
14		Financial complexity	Difficult cost & benefit calculation	On a scale from 1-5, to what extent is the complexity of calculating the financial costs and benefits challenging the development of your local initiative? Can you exemplify your answer?	Op een schaal van 1-5, in hoeverre belemmert de complexiteit van het berekenen van de financiële kosten en baten de ontwikkeling van uw lokale initiatief?

15			Difficult cost & benefit division	On a scale from 1-5, to what extent are the complexities of the division of costs & benefits in the transition challenging the development of your local initiative? Can you exemplify your answer?	Op een schaal van 1-5, in hoeverre belemmert de complexiteit van de verdeling van de kosten en baten in de energietransitie de ontwikkeling van uw initiatief?
16		Legal complexity	Established conflicting laws	On a scale from 1-5, to what extent are there established regulations or laws which hinder the development of your initiative? Can you exemplify your answer?	Op een schaal van 1-5, in hoeverre is er bestaande wet en regelgeving die de ontwikkeling van uw initiatief belemmert?
17			Lacking laws	On a scale from 1-5, to what extent are there new or adapted regulation/legislation necessary in order to develop your initiative? Can you exemplify your answer?	Op een schaal van 1-5, in hoeverre is er nieuwe of aangepaste wet- en regelgeving nodig om uw initiatief verder te ontwikkelen?
18		Time complexity	Long time frame with continuous and unpredictable developments	Op een schaal van 1-5, to what extent are insecurities as a result of the long term character of the process challenging the development of your initiative?	Op een schaal van 1-5, in hoeverre hindert de onvoorspelbaarheid van de lange termijn van een transitie de ontwikkeling van uw initiatief?
19	Collaborative governance	Principled engagement	Stakeholders are deliberately communicating on shared interests, definitions and the common good.	To what extent are the stakeholders deliberately interacting on shared values, objectives and the common good?	In hoeverre vindt er op een regelmatige basis weloverwogen interactie plaats over gedeelde belangen tussen de stakeholders?

20			Decisions on the further procedure and substance of the collaborative process	Have stakeholders made decisions on further interaction? Are there decisions on the core values in collaboration or on the procedure of communication?	Zijn er afspraken gemaakt over de manier en inhoud van interactie en samenwerking tussen verschillende partijen?
22		Shared Motivation	Stakeholders have achieved internal legitimacy by establishing mutual trust and mutual understanding.	To what extent is trust and mutual understanding of each other's interests and values by all stakeholders?	In hoeverre bestaat er onderling vertrouwen en begrip voor elkaars belangen en waarden tussen de stakeholders van de lokale energietransitie?
23			Commitment to the collaborative process and its objectives by all stakeholders	To what extent are all stakeholders equally committed to the transition process?	In hoeverre hebben alle stakeholders een gelijke lange termijn commitment in de transitie?
24		Capacity for Joint action	Procedural and institutional arrangements to manage repeated interaction between the stakeholders	rt procedural or institutional arrangements are guiding the interactions between the stakeholders?	Zijn en er, en zo ja welke, procedure of institutionele regelingen leiden de herhaaldelijke interacties tussen de stakeholders?
25			Sharing, balancing and generating of knowledge and resources between the stakeholders.	To what extent are stakeholders sharing knowledge and resources?	In hoeverre delen stakeholders onderling kennis en middelen in het besluitvormings/ samenwerkingsproc ess?
				Als het antwoord op de vragen 14-19 positief is dan wordt er doorgevraagd met: Op een schaal van 1-5, in hoeverre helpt dit in de ontwikkeling van uw initiatief? Kunt u uw antwoord toelichten? In hoeverre heeft een samenwerkingsprocess x gestimuleerd? Hoe groot acht u het belang van	

				samenwerking om dit tot stand te brengen?

Annex II: Vragenlijsten

Interview Protocol I (Executed for and in collaboration with TNO)

aanleiding project, aanleiding.
Duurzaam Maassluis/Sluispolder: CO2 neutraal in 2040 gericht op energieneutraal+ klimaat adaptief

Introductie:
- voorstellen : achtergrond, functie, organisatie, interesse, rol, etc.

Persoonlijke informatie
Naam:
Functie, organisatie:
Rol:

Inleidende vragen

1. Wat betekent duurzaamheid voor u?
2. Wat is uw rol in de duurzaamheidstransitie?
3. Hoe draagt u bij aan een duurzaam Sluispolder/Maassluis?
    a. Doorvragen over zijn/haar initiatieven/acties/etc. Waarom wel/niet?

Vragen huidige situatie

4. Wat is uw visie op de duurzaamheidsambitie van de gemeente?
5. Hoe duurzaam is Sluispolder/Maassluis volgens u?
    a. Energieneutraal
    b. Klimaat adaptief
    c. Leefbaarheid
6. Wat zijn de *3* belangrijkste ontwikkelingen en uitdagingen op dit moment in Sluispolder (bijv vergrijzing, herstructurering, etc)?

Vragen toekomst

7. Wat zijn de barrières en bedreigingen in het realiseren van een duurzaam Sluispolder?
8. Wat zijn drijfveren en kansen in het realiseren van een duurzaam Sluispolder? (voorbeeld: drivers=vergrijzing, economische crisis)
9. Wat is er voor nodig om de duurzaamheidsambitie te realiseren?
    a. Wat is er nodig om de barrières en bedreigingen weg te nemen?
    b. Wie is hiervoor nodig?
10. Welke rol ziet u voor uzelf en andere (lokale) stakeholders?

Interview Protocol II

Goededag,

Ten eerste hartelijk dank voor uw tijd en de mogelijkheid u te spreken. Zoals ik kort heb uitgelegd in de mail ben ik op dit moment bezig met het afronden van mijn Master Governance en management van Complexe systemen aan de Erasmus universiteit Rotterdam. Mijn onderzoek is gericht op het analyzeren van de ontwikkeling en opschaling van lokale duurzame energie initiatieven in de lokale energietransitie. De energietransitie is een complexe uitdaging die maar moeilijk op gang blijkt te komen. Dit heeft mij gemotiveerd om te onderzoeken welke soorten complexiteit de ontwikkeling van een wijkaanpak uitdagen. Daarnaast ben ik benieuwd naar mogelijk bestaande samenwerkings processen tussen betrokken actoren in dit vraagstuk en de invloed hiervan op de ontwikkeling van verschillende initiatieven. Deze processen bekijk ik op lokaal niveau, regionaal niveau en intern binnen de organisatie van de gemeente. Ik heb u uitgenodigd voor een interview omdat graag meer zou willen weten over uw rol en ervaring in de transitie van Sluispolder/Palenstein. Het interview zal worden opgedeeld in drie blokken; de voortgang van de transitie en uw rol, de uitdagingen en mogelijke samenwerking. Het interview zal waarschijnlijk max een uur duren. Gaat u ermee akkoord als ik het interview opneem om het thuis uit te werken? Heeft u verder nog vragen?

Initiatief

De eerste vragen zijn introducerend om de inhoud van uw initiatief te bespreken.

1. Op welke manier bent u betrokken bij de transitie van x?

2. Hoe ver gevorderd is de huidige transitie in x?

Nu we de inhoud van uw initiatief hebben besproken ben ik benieuwd naar de ontwikkeling ervan en de uitdagingen die u hierbij heeft moeten overwinnen of op dit moment nog voorziet.

Deepening

3. In hoeverre zijn er lessen getrekken in de ontwikkeling van de wijkaanpak(zowel procesmatig als inhoudelijk)? Wat waren hierbij de grootste uitdagingen?

4. In hoeverre delen partijen onderling leer momenten en ervaringen? In hoeverre stemmen verschillende initiatieven hun leerervaringen op elkaar af? Wat waren hierbij de grootste uitdagingen.

Broadening

5. In hoeverre heeft u een connectie met partijen in andere gemeente met een wijkaanpak in de regio nagestreefd en bereikt? Wat waren hierbij de grootste uitdagingen?

6. In hoeverre heeft u (de inhoud van) de wijkaanpak/ uw bijdrage aan de wijkaanpak toegepast/uitgevoerd op verschillende locaties? In hoeverre heeft u dingen toegepast die in een andere wijk aanpak zijn ontwikkeld? Wat waren hierbij de grootste uitdagingen?

Uitdagingen

We hebben net al gesproken over uitdagingen in de ontwikkeling van uw initiatief. Ik zou graag nog specifiek de verschillende complexiteiten van het energiesysteem bespreken en de ervaren uitdaging bij u.
Het gaat hierbij om complexiteiten in het energiesysteem. Dit kunnen technische, sociale, financiële, juridische en tijds complexiteiten zijn.

*6. Sociaal***:** n hoeverre belemmeren tegenstrijdige belangen en perspectieven van de stakeholders in het lokale energie domein de ontwikkeling van uw initiatief? Kunt u uw keuze toelichten?

*7. Technisch***:** Met welke technologische uitdagingen en onzekerheden heeft u te maken?
In hoeverre zijn de onzekerheden van innovatieve technologieën een barrière voor het ontwikkelen van uw initiatief? Kunt u uw keuze toelichten?

*8. Financieel***:** In hoeverre belemmert de complexiteit van het berekenen en verdelen van de financiële kosten en baten de ontwikkeling van uw lokale initiatief? Kunt u uw keuze toelichten?

*9. Juridisch***:** In hoeverre is er bestaande of ontbrekende wet en regelgeving die de ontwikkeling van uw initiatief belemmert? Kunt u uw keuze toelichten?

*10. Time***:** In hoeverre hindert de onvoorspelbaarheid van de lange termijn van een transitie de ontwikkeling van uw initiatief?

Samenwerkingsproces
Nadat de uitdagingen zijn besproken zou ik ook graag met u bespreken in hoeverre er een samenwerkings process plaats vind in het lokale energie van Maassluis en in hoeverre u dit van belang acht voor het opschalen van uw initiatief.
(deze vragen herhalen voor intern (bij interview met gemeente), lokaal en regionaal)

11. Hoe belangrijk acht u een samenwerkingsproces voor de ontwikkeling en opschaling van uw initiatief?

Principled engagement:
12. In hoeverre vindt er op een regelmatige basis interactie plaats tussen de verschillende partijen in de transitie van Sluispolder met als doel het vaststellen van gedeelde belangen en doelen?

13. Zijn er afspraken gemaakt tussen de partijen over de inhoud en process van de samenwerking?

14. In hoeverre heeft deze interactie geholpen in het ontwikkelen van uw initiatief?

Shared motivation:
15. In hoeverre bestaat er onderling vertrouwen en begrip voor de belangen en waarden van de verschillende partijen? In hoeverre heeft dit u geholpen in het ontwikkelen van uw initiatief?

16. In hoeverre bestaat er gelijkwaardige lange termijn toewijding van alle partijen die bijdrage aan de transitie van Sluispolder? In hoeverre heeft dit u geholpen in het ontwikkelen van uw initiatief?

Capacity for joint action:
17. In hoeverre delen stakeholders onderling kennis en middelen? In hoeverre heeft dit u geholpen in het ontwikkelen van uw initiatief?

18. In hoeverre is een samenwerkingsproces geinstitutionaliseerd? In hoeverre heeft dit u geholpen in het ontwikkelen van uw initiatief?

ANNEX III: Evaluation Forms for meetings

VRAGEN OVER DE BIJEENKOMST VAN VANDAAG

1. Hoe beoordeelt u de bijeenkomst van vandaag op een schaal van 1 (helemaal niet interessant) tot 10 (zeer interessant)? Kunt u uw antwoord kort toelichten?
1 2 3 4 5 6 7 8 9 10

2. Was het doel van de bijeenkomst van vandaag duidelijk voor u? Kunt u toelichten waarom wel/niet?

3. Heeft u nieuwe kennis en inzichten opgedaan tijdens de bijeenkomst van vandaag? Zo ja, hoe zou u deze omschrijven?

4. Terugdenkend, in welke mate bent u het eens of oneens met de volgende uitspraken over de bijeenkomst van vandaag? (Tabel)

		Zeer mee oneens	Oneens	Eens	Zeer mee eens	Weet het niet
a	Tijdens de bijeenkomst hebben we een evenwichtige en brede mix van belangen en perspectieven uitgewisseld					
b	Ik ben tevreden over de locatie					
c	Ik ben tevreden over het programma van de bijeenkomst					
d	Er was genoeg tijd voor discussie					
e	Ik voelde mij op mijn gemak tijdens de bijeenkomst					
f	De andere deelnemers waren bereid om naar mijn inbreng te luisteren					
g	De bijeenkomst hielp mij om de andere deelnemers beter te leren kennen					
h	De bijeenkomst hielp mij om te leren over het onderzoeksproject					
i	De bijeenkomst hielp mij om mijn perspectieven en meningen met de anderen te delen					
j	De bijeenkomst hielp mij om mijn eigen gedachten te structureren					