Mobilizing Citizens in the Dutch Heat Transition

A research showing conditions for successful citizen mobilization in the Dutch heat transition.

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I. Preface

In front of you is my research into the success conditions and the successful mobilisation of citizens in the heat transition. It was quite a process to master the method. But in the end I am satisfied with the result.

I would therefore like to thank Huub Ploegmakers for the intensive support during the research process. I would also like to thank Pieternel Blankenstein for giving me the opportunity to participate in the processes for making the municipality of Nijmegen natural gas free (which is why I would also like to thank the natural gas-free team in Nijmegen).

Fellow students and friends helped me to check my research for language. For this I would like to thank Marijn Gradussen, Linda Schravendeel, Martijn Stuiver and Pim Beckers for checking on language and structure. I would especially like to thank Tessa van Kesteren for the support during the process.

I learned a lot from this research and recently started working at a company. I hope to be able to apply my knowledge at this company in the field of spatial planning and sustainability.

II. Summary

The Netherlands face the complex challenge of making all houses free off natural gas by 2050. To complete this task, 7 million houses and 1 million buildings must be made natural gas-free. The Dutch government and local communities are implementing neighborhood approaches in order to influence citizens to implement sustainability measures. These neighborhood approaches must eventually ensure that this complex task is achieved. The 'Programma Aardgasvrije Wijken' in which neighborhood approaches are being experimented with, is criticized by various Dutch research organizations. The criticism is mainly based on the fact that set goals are not achieved and that only a few houses in the program have been made natural gas free. According to this study, the criticism is not entirely justified, because success in the aforementioned reports is mainly based on the number of houses that have been made natural gas free.

In this study, however, a different measure of success is applied. Measuring success is based on two important notions. First, the process in an experiment is important. Secondly, it is important to realize that the final step for making a house natural gas-free is still a choice made by citizens themselves. Therefore, the measurement of success in this study is based on citizens' perceptions of sustainability measures and the eventual implementation of sustainability measures.

This research not only looks at the success of experiments in sustainability transitions. It also focuses on the conditions (or combinations of conditions) that can contribute to the successful mobilization of citizens. These conditions are built on existing studies, that focus on experiments for sustainability transitions. The success conditions that emerge from these studies are, as indicated in the studies themselves, not proven conditions. Therefore, this research wants to empirically study the (combinations of) conditions that contribute to successful citizen mobilization. The six success conditions studied are experiments at neighborhood level, support for initiatives, competent participants, principled engagement, funding availability and the presence of an experienced leading actor.

The combination of studying the (combinations of) conditions and measuring successful citizen mobilization leads to an answer to the main question below:

"What conditions influence the successfulness of local experiments/initiatives in the Dutch heat transition?"

It was decided to study the degree of success and the related success conditions in the current Dutch heat transition in the built environment. The cases selected in this research are the neighborhood approaches that are currently active in the Dutch heat transition. These are the experiments that have been started as a result of the Green Deal Natural Gas-Free Neighbourhoods (2018). The

'Proeftuinen' from the 'Programma Aardgasvrij Wijken (2019). And the local heating collectives as mentioned in the 'Local Energy Monitor (2019)'.a

The collected empirical data was analyzed by means of a Qualitative Comparative Analysis (QCA). This analysis is aimed at studying underlying relationships between (combinations of) success conditions and successful citizen mobilization.

This research shows that there is already a reasonable number of experiments in which citizens have been mobilized to a reasonable extent. However, only a small number of the experiments prove that there is a high degree of successful citizen mobilization, in other words that citizens have really implemented sustainability measures. It is interesting to see that competent participants in an experiment are sufficient for success. Even if other conditions in an experiment are not or hardly present. However, in the cases studied, there are not many neighborhoods where these competent participants are present. The support for initiatives can be seen as a necessary condition for successful resident mobilization, but in this research, there are almost no cases where initiatives are not supported.

The aforementioned conclusions are only part of the conclusions that can be drawn from this study. However, they do show that there is often a more complex context underlying the conditions. The research analyzes this complexity and tries to make connections between the outcomes of cases. These outcomes can contribute to the knowledge about neighborhood approaches in the Dutch heat transition. It shows the importance of certain (combinations of) conditions in relation to the successful mobilization of citizens. Of course, this research has its limitations, which makes it necessary for future research to investigate other conditions that can contribute to the successful mobilization of citizens.

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1 Project Framework

1.1 Introduction

The Netherlands will have to contribute to the reduction of global emissions. In the Paris Climate Agreement, it is decided to limit the average temperature increase on earth to well below 2 degrees Celsius, with a target of 1.5 degrees Celsius. It is established that global emissions will have to be reduced by 80 to 95 percent by 2050 referred to 1990 (Ros et al., 2016). In order to mitigate these climate effects all countries must make up plans. For the Netherlands various policy reports and research agendas have suggested how this should be achieved (Regeerakkoord vertrouwen in de toekomst, 2017; De opgaven voor de nationale omgevingsvisie, 2017 & Energieakkoord voor duurzame groei, 2013). Recently these policy reports, and the Paris Climate Agreement have been reinforced by the Climate Act (Klimaatwet) enacted by the First Chamber on 28 May 2019 ("BijzonderStrafrecht ", 2019).

Within these policy reports there is a common focus on the energy transition. In a report by the RVO (2015) a schematic overview is given that shows a strategy for the energy transition, characterized as Trias Energetica. This overview, which was originally introduced in 1996 by Novem (E. Lysen) and further elaborated by TU Delft (Duijvestein) consists of three pillars. It represents the following three consecutive steps; 1. Reduce the demand for energy, consisting of urban planning actions and engineering actions 2. Make use of sustainable energy-solutions, which is split up into two aspects: heat-recycling and generating renewable energy and 3. Use fossil-fuels (only if needed) efficient, formed by creating efficient solutions and reducing waste. As is also argued in RVO (2015) the steps form a guidance, that succeed one another. All steps are closely related to changes in the built environment. The main focus in this research is on the heat transition within the built environment.

With regard to the goals set for reducing fossil fuels, a lot of steps are considered. Recently the Dutch Climate Agreement (Rijksoverheid, 2019) made up a report regarding assessments for the energy transition. Chapter C, in this report, focusses on the built environment. In order to reach a sustainable natural gas-free environment 7 million houses and 1 million buildings have to be transformed into isolated and gas-free dwellings. This target is necessary to reach the aimed reduction of 3.4 Mton of CO_2 before 2030. The three pillars in the Trias Energetica have in common that they intersect with the everyday life of citizens. In an essay of Platform31 this is also described as a *'matter of being behind the front door of citizens'* (Heeger & Buitelaar, 2018) Interference into the private spheres of citizens can be problematic and even lead to strong resistance. For a successful transition to occur citizens need to act upon the vision made by the Dutch government. Only when all citizens participate in the heat transition, the transition will succeed.

In order to complete the task of the heat transition, a large number of citizens still needs to be mobilized. The mobilization of citizens in the heat transition has been given the following definition in this study*: 'Taking sustainability measures in or at one' s own house or making the choice to switch to alternative heating solutions'*. Notice that the definition is split in two parts, where the first part is aimed at individual sustainability measures and the second at collective heating. The definition arises from the following notion made in the report of the Algemene Rekenkamer: 'It are the owners of houses and other buildings who actually make them natural gas-free. Homeowners can decide for themselves whether to disconnect their houses from natural gas and apply to alternative heating solutions'(BZK, 2020). Freedom of choice is an important factor in the definition, that is why it is important to not only look at the number of houses that are free of natural gas. Instead, it is important to look at the underlying consciousness and choices of citizens.

In recent years, various experiments and intiatives that aim to achieve a natural gas-free society, have been started in the built environment. In 2017, the central government introducted the Green Deal. The cases that are part of the Green Deal (2017) are mainly municipalities that have indicated that they wish to start making a neighborhood free of natural gas. This is limited to a commitment by the municipality to take steps towards a natural-gas free neighborhood. The 'Programma Aardgasvrije Wijken', that is elaborated below, assumed that there were municipalities that already had well advanced plans as a result of this Green Deal.

The 'Programma Aardgasvrije Wijken' tried to join already existing (established) projects. From this, 26 neighborhoods that will receive a funding for a neighborhood oriented approach in the heat transition were selected as a 'Proeftuinwijk' in this program. The extra resources are ought to create extra space, to achieve the aims that are mentioned in the program that is set out for the 'Proeftuinwijken' (BZK, 2020). The main aim in the 'Proeftuinwijken' is to makes households free of natural gas or ready for an alternative heating solution (heating network). Besides this, there is deliberate attention to learning processes regarding the neighborhood approaches.

In addition, many communities have started their own initiatives. These citizen-led initiatives are mainly formed in cooperation's of citizens and are focused on processes that incorporate inhabitants of the neighborhood into the process related to the heat transition. The main activities of these initiatives are focused on building awareness, looking after the interest of citizens and setting up neighborhood-oriented approaches in order to draw up heat related plans. It may also be the case that an initiative chooses to take heat under its own management. This is referred to as collective commissioning (Collectief Opdrachtgeverschap) and the eventual development, management, financing and ownership of a collective heat system.

Partly due to these initiatives and experiments, the Dutch government aims to reach different time-related goals. The first goal is to make thirty to fifty thousand homes free of natural gas by 2021 (BZK, 2020). An accountability study that is conducted by the 'Algemene Rekenkamer' criticizes the approach and the results of the 'Programma Aardgasvrije Wijken'. This study is an annual research into the accountability of ministers' reports on their expenditures, operations and policies. The program, is in more detail, criticized for being too broadly defined, having changing goals and for not making as many houses' natural gas-free as needed. Therefore, the program is regarded as a failure in the sense that it fails to meet its expectations.

In contrast to the outcome of the 'Algemene Rekenkamer', which measures success mainly based on results achieved set against the financial resources spent on the program. In this research a different perception of success is used, here success is expressed as the actual mobilization of citizens in the Dutch heat transition (see aforementioned definition). Measuring success in this way is more in line with current practice, where the actual steps to transfer to alternative heat solutions are taken by the citizens. Influencing these citizens is therefore important for an experiment to be successful; the conditions that are important in this respect are first of all substantiated theoretically and then tested empirically. By examining the conditions this research tries to get an understanding on how success can be achieved in experiments.

1.2 Research aim

As mentioned in the previous section, this research empirically tests which conditions are crucial for successful experiments, where citizens are successfully mobilized. In order to define these success conditions, this research will build on literature aimed at experiments in transitions. The conditions will be tested empirically with a survey that is addressed to the experiments described in the introduction. The aim is to build a framework in which the different conditions are shown as causal relation sets of on the successful mobilization of citizens. This can be linked to the different cases that are researched. This also shows the explorative nature of this research where the main aim is to discover paths (combinations) of conditions for successful citizen mobilization. With a Qualitative Comparative Analysis (QCA) this research aims to achieve the foregoing.

QCA is most applicable to achieve the aim as with this method the multiple conjunctural causation of (combinations of) conditions discovered. Berg-Schlosser, De Meur, Rihoux, and Ragin (2009) describe this as different causal 'paths' that can lead to the same outcome, multiple shows the number of paths while conjunctural is aimed at describing that each path consists of different conditions. The paths offer the preservation of in case complexity, this in turn best applies to the cases studied. Within the cases the following quote shows the importance that context has for the

experiments/initiatives: *"Context turns out to be important: every neighborhood is different due to culture, urban or rural, shrinkage or growth, region, availability of heat sources and building methods. This requires tailor-made solutions." (PAW, 2019).*

The foregoing notions can be narrowed down to a smaller understanding of the main aim of this research, which is the following:

"The aim of this research is to determine which conditions could contribute to the successful mobilization of citizens in the Dutch heat transition, placed in the built environment".

1.3 Research questioning

As is addressed in the research aim and the introduction, the mobilization of citizens is subject to various conditions, that could lead to a successful experiment/initiative. This means that the concept 'citizen mobilization' is a hard to define concept. The research should be aimed at showing the multiple conjunctural causation of (combinations of) conditions. Berg-Schlosser et al. (2009) describe this as different causal 'paths' that can lead to the same outcome, multiple shows the number of paths while conjunctural is aimed at describing that each path consists of different conditions. This notion will be further elaborated in the methodological chapter on QCA. In order to research these paths a number of analytical steps have to be taken. These steps are part of the questions, the questions can be linked to the research aim, as with the research aim the successfulness of conditions in the heat transition regarding citizen mobilization can be explained.

Main question:

What conditions influence the successfulness of local experiments/initiatives in the Dutch heat transition?

The main research question can be split up into smaller sub- questions. That are mainly empirical follow up questions

Sub-question 1:

To what extent have citizens actually been mobilized in the experiments/initiatives, in the Dutch heat transition?

Indicators that show when a neighborhood is successfully mobilized have to be set up in order to answer this sub-question. These indicators are based on literature with regard to socio-technical experimenting. Subject to this successful mobilization are different conditions or combinations of conditions, which according to literature have an effect on the mobilization of citizens in the heat

transition. Therefore, it is important to show how far the cases have progressed in terms of citizen mobilization.

Sub-question 2:

What conditions drive the mobilization of citizens in the experiments/initiatives, in the Dutch heat transition?

This sub-question is aimed at tracing the paths of the conditions in their real-life settings. This will be done via surveys with experts in the field of the heat transition in the different cases selected. This, to empirically test what conditions are present in the neighborhood. As is also described in Berg-Schlosser et al. (2009) using the method of QCA means that an iterative process is produced. This means that this sub-question can only be answered when there is a constant link between empirical data and theoretical backgrounds. In such a way conditions, paths and linkages can be analyzed, in order to form a 'modest generalization' of key conditions for the successfulness of citizen mobilization in the heat transition.

1.4 Societal Relevance

The societal relevance can be projected in several aspects that are not only case-specific for the municipality of Nijmegen but can be stretched further to national Dutch policy. The assessment to become a CO2-neutral and natural gas-free society in 2050 is determined by the Dutch government. Correspondingly, it is unavoidable for citizens to adapt their behavior and living environment to the new reality. This research contributes by showing which conditions (or combination of conditions) are related to the successfulness of citizen mobilization in the heat transition.

At first the term of 'no-regret measures' has to be explained in order to show why researching conditions for citizen mobilization matters in terms of societal relevance. "No-regret measures designate opportunities for the reduction of greenhouse gas emissions that are worth undertaking whether or not there are climate-related reasons for doing so" (IPCC, 1996, p.271 in Ostertag, 2012). This understanding is however very broad for example; no regret-measures applied to make energy-renovations on houses are defined as measures that are easily earned back by savings on energy costs. Policy-making should also be based on this aim of implementing no-regret measures. Thus, the aim, as is projected in chapter 1.2 is to set verified causal conditions that show how citizens can be mobilized. With regard to these conditions the municipality can invest on policy that makes no-regret measures achievable.

Contributing to the aspect of no-regret measures are the people willing to take these measures. An 'effectmeting informatie energielabels' shows that one-third of the Dutch home-owners wants to take energy saving measures. However, the heat transition is dependent on infrastructural changes as well as on changes to dwellings of inhabitants. Meaning a form of involvement of citizens, which will be further elaborated in chapter 2 on the theoretical background, is inevitable in the heat transition (Heeger & Buitelaar, 2018).

Furthermore, it is important to adress that every local government in the Netherlands has to make a Heat transition vision (Transitievisie warmte) (van der Molen, van den Wijngaart , van Polen, & van Bemmel, 2018). Similar to that with more focus on spatial planning the omgevingswet will be implemented after 2021 and municipalities have to make up an 'omgevingsvisie' that adresses how local governments aim to arrange citizen participation. In order to fill in this trajetory and description of how to involve stakeholders, giving in insight into conditions regarding citizen mobilization seems fruitful for setting up supported plans.

The foregoing understandings combined have their added value for local municipalities, as well as for the pilot projects concerning alternative heating solutions. This research can serve as a guide for learning processes on different combinations of conditions and their effect on citizen mobilization in the heat transition. As will be described in the following chapter on methodology, QCA builds on the assumption of falsification. This means that there are conditions of occurrence to the research phenomen (Outcome). This means that this research also shows insight in which conditions or combination of cases seem less effective for the mobilization of citizens, meaning initiatives in the heat transition can make no-regret decisions if these conditions are left out or lacking..

1.5 Scientific Relevance

The aim of this research is focused on specific Dutch pilot projects in the heat transition. These cases are researched in a holistic manner meaning that the cases are studied with respect to their contexts. Making it that the in-case complexity is not lost in the delineation of the research. The holistic approach adds to the scientific knowledge on mobilizing citizens in the heat transition, as it also shows linked to the complexity of cases why conditions providing the outcome are present.

Literature argues that one of the manners to mobilize citizens is formed by socio-technical experiments, that are aimed at sustainable change. Socio-technical experiments are argued in literature to be key factors in altering existing regimes and can act as seeds to kick off change (Kemp, Schot, & Hoogma, 1998; Kivimaa, Hildén, Huitema, Jordan, & Newig, 2017; Meadowcroft, 2009; Sengers, Wieczorek, & Raven, 2016). The aforementioned initiatives and experimental programs can thus be regarded as socio-technical experiments in this research.

As Sengers et al. (2016) argue a promising direction for scientific research on the topic of the energy transition could be aimed at zooming out and research a larger number of projects with multiple empirical methods. This way of researching should be aimed at finding patterns among the cases researched. Using a QCA method (as this research does) provides to research these patterns in different cases. By researching these patterns, Sengers et al. (2016) state that success- and failure factors could be identified. This research is aimed at researching the conditions that are linked to citizen mobilization, by adding the notion of policy conditions and governance. This research adds to the scientific relevance of transition pathways and transition experiments.

Furthermore, Sengers et al. (2016, p. 162) give another example of a topic that needs further exploration in terms of experimenting for the sustainable transition is expanding research on the geography of transitions. Because cities can be seen as 'sites of frantic interaction where multiple socio-technical systems connect, possibly providing opportunities for radical change'. Especially shifts in the system can mean actors of change see opportunities to radically change. However, cities are also subject to complex dynamics and path-dependent process, often formed by existing regimes.

The research topic that Sengers et al. (2016, p. 162) logically address goes out to: What role can city-officials and other change agents play in local experimental forms of transition management given these path-dependencies and complex settings? By researching the cases in their complexity, the conditions also regarding local officials can be filtered out, at the same time the combination of conditions that leads to successfulness of citizens mobilizing in the heat transition can be showed. It also shows which radical change should and can be sustained.

The conditions of success that are presented within literature on experimenting are not written in stone, and thus open for exploration and refinement (Van Buuren et al., 2016). The research by Kivimaa et al. (2017) shows that there is a need for more research on the outcomes of experiments. They argue that the empirical analysis on criteria of experiments is poorly defined and explored. Often there is a lack of enough information on the processes, input and configurations that entail climate change experiments. Kivimaa et al. (2017, p. 26) show that there is a need to study: 'the successes and shortcomings of climate governance experiments with reference to the articulations of policy, politics and polity.'

The study of conditions in the Dutch heat transition adds to the empirical relevance of this research. There are several authors that have researched literature on citizen mobilization, experimentation and participation. However, most of these frameworks are not empirically tested, which this research will do with the use of QCA. At last the field of Spatial Planning (geography) does not have a lot of

experience with the method used in this research (QCA). It is feasible to conduct more research regarding comparing cases and conditions with the use of QCA.

1.6 Readers guide

This research is divided into logical steps, that are suitable to answer the main question. The elaboration of the methodology is given first. QCA as is described in Berg-Schlosser et al. (2009) is built on the assumption that theory circulates three times through the research process. It is thus important to first elaborate on the methods used. After that the theoretical framework is given. The measurement of success and the conditions are operationalized, with regard to the theoretical framework and the methods. Thereafter, the results from the survey will be addressed and strengthened by qualitative data from explorative interviews and information from project websites. the collected data will simultaneously be prepared for the analysis. The prepared conditions are analyzed and the results from the Qualitative Comparative Analysis are then elaborated. The conclusions explain how the analyzed results relate to the context of experiments in the Dutch heat transition regarding successful citizen mobilization. Finally, the limitations of the study are discussed and finally recommendations are made.

2 Methodology

This chapter focusses on the decisions made regarding methodology and data collection. As stated in chapter 1, the specific techniques and combined operationalization of this research will be elaborated in chapter 3. In order to approach the main research question effectively, the methodological foundation will be discussed primary to the theoretical framework. This is a logical structure as this study is based on a qualitative comparative analysis of multiple cases regarding the Dutch heat transition. For a qualitative comparative analysis, it is important to let theoretical understandings circulate in the research process (Berg-Schlosser et al., 2009). Therefore, it is important to first address the research philosophy, in order to understand how this research is conducted and how the existing theoretical concepts are used in this regard.

Thus, after elaborating on the methods an overview of the general literature with regard to experimenting for sustainability transitions will be presented. Subsequently, explorative interviews will be used to gain a better understanding of the perception of success in the selected cases. Once a better understanding of the context of current heat transition experiments is attained, a survey is set out. This survey aims to gather insights in the successfulness of experiments and the conditions for success. Finally, as all required data is gathered, a Qualitative Comparative Analysis (QCA) is applied to answer the main research questions.

The decision to use the QCA method is based on the multi-actor and multi-level characteristic of the heat-transition. As Oteman, Kooij, and Wiering (2017) describe in their work, the discourse of the field of the energy transition has become more multi-level and multi-actor, showing the complexity in which the conditions are situated . Through the use of the QCA method, one can gather more in-depth insights on different cases, while capturing the causal complexity of the particular. Relevant reports that cover the Dutch heat transition show that context is of importance for experiments, every case is different due to variations in culture, and other factors of which urban or rural, shrinkage or growth, region, availability of heat sources and building methods are examples (Rijksoverheid, 2020). With the use of the QCA method, combinations of causally relevant, conditions and cases may be made (Rihoux & Lobe, 2009). The paths between the cases and the conditions offer the preservation of in-case complexity. This, in turn, best applies to the cases studied, where the context is important for successful citizen mobilization.

2.1 Research philosophy

'Qualitative Comparative Analysis' (QCA) is both an approach (comparative case-oriented research approach) and a technique (collection of different techniques based on the theory of sets and Boolean algebra) (Ragin, 2006). This method was first introduced by Charles Ragin (1987) in his work

on ‘The Comparative Method’. QCA can best be described by two main principles: (1) the assumption of complex causality in cases, and (2) the importance of making a combination of detailed case analyses and cross-case comparisons. The perspective of the QCA method on causality will be elaborated on below. With the QCA method, researchers aim to answer questions regarding the combination of conditions that produce a phenomenon or event.

2.2 Perspective on causality

It is important to understand that the QCA method addresses ‘causes of a given effect’ as set relations, where the causal complexity is best modelled by three aspects: (1) asymmetry, (2) equifinality, and (3) conjunctural patterns(Thomann, 2017, p. 2). Asymmetry refers to conditions which cause the occurrence of the outcome to be different from those leading to its non-occurrence. Equifinality is best described by Berg-Schlosser et al. (2009), who said that *‘different paths can lead to the same outcome’* . A researcher does not assume isolated effects when focused on conjunctural patterns. Rather, the effect of a single conditions may only unfold in combination with other conditions (Thomann, 2017, p. 2). Thus, the QCA method forms a conception of causality that leaves room for this causal complexity.

Schneider and Wagemann (2010) have argued that QCA differs from for example regression analysis, the QCA method does not build on additivity as is projected in regression analysis. To illustrate, if X increases and Y increases one can conclude that there is correlation between the two. Changes in the variable will also affect the dependent outcome. This correlation is also symmetric: if X is correlated with Y, then Y is correlated with X. In contrast, within the QCA method relations are seen as set relations (will be further explained in paragraph 2.3). Another important difference from mainstream statistical methods is that QCA considers cases as ‘wholes’. With QCA, the context is taken into account, where one condition is dependent on the other (combinations of) conditions in a given set. Lastly, QCA entails 'multiple conjunctural causation'. This means that there can be multiple combinations of conditions that could be equally necessary or sufficient for the outcome to occur.

As visualized in the previous paragraph, phenomena in social sciences are subject to this complex causality. The three aspects are thus important in this research, because experiments in the heat transition are subject to several intertwined conditions, where not one, but several relevant contextual aspects can influence the success of an experiment. The heat transition is a topic of research that can be incorporated in the social sciences. Therefore, this research is set to gain insight in set relations. Here, pathways to success can be indentified even if the paths to success are rare.

2.3 Epistemological foundations

To grasp the various applications and techniques used within the method of QCA, at first this research locates QCA in its historical epistemological context. With that, a comparison with other research methods will be presented.

The most important base is laid in the assumption of 'canons', which are, in particular, addressed by Mill (1884). Who shows the 'method of agreement' and the 'method of difference'. The first assumption according to Berg-Schlosser et al. (2009) refers to 'eliminating all similarities but one'. The latter shows the absence of a common cause or effect, even if all the other circumstances have not changed. These two methods both aim to extract a certain condition from comparing cases. However, one could argue that it is rather extreme, in for example social sciences, to isolate just one condition and control all the other conditions (Berg-Schlosser et al., 2009). A third method Mill (1884) in Berg-Schlosser et al., (2009, p.2) addresses is the indirect method of difference:

> *'If two or more instances in which the phenomenon occurs have only one circumstance in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance, the circumstance in which alone the two sets of instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon. (p. 396)'*

It is obvious that the methods referred to by Mill (1884) have a very positivist character. As stated earlier, within the field of social sciences, one cannot produce 'hard' factors, which is why it is nearly impossible to prove that certain causal relations are apparent. Still, it remains useful in eliminating irrelevant factors and making assumptions about causal conditions in the real world. The elimination of factors can also be seen as a way of 'falsification' which is a famous principle put forth by Popper (1959). With the elimination of false hypotheses, a researcher can get closer to the truth as false information is eliminated from knowledge. This could produce, an approximation of the *'conditions for the occurrence'* of a certain phenomenon, even when the method applied failed to eliminate all irrelevant factors. These conditions for occurrence are an important aspect of QCA.

2.4 Method

The QCA method thus builds on set theory, where "if ... then" hypotheses are modelled. These set relations can be interpreted as sufficient or necessary for the outcome. There are two types of QCA methods that are mainly used in social sciences (1) crisp set and (2) fuzzy set. Crisp set QCA builds on dichotomous scores, where a membership of 0 is out of the set and a membership of 1 is in the set. Fuzzy set QCA has varying membership scores between 0 (fully out), 0.5 (cross over point) and 1 (fully in) (Rohlfing, 2020). The cross over point is the where the membership in the set is more 'in'

than ‘out’ or vice versa (Ragin, 2009). In this research, fuzzy set QCA is used for the analysis, because with varying membership scores the information in cases is better preserved.

By using the QCA method a researcher can, with the help of Boolean algebra, provide insight into individual and sets of conditions (independent variables) that have a relation to a particular phenomenon (dependent variable or outcome). Basurto and Speer (2012) argue that the best way to analyze set relations is with set-theoretic methods. Within set theoretic methods there are three key elements for analyzing superset or subset relions,which are (1) sufficiency, (2) secessity and (3) INUS. These elements are aimed at unravelling complex causality (assymetry, equifinality and conjunctural causation) (Basurto & Speers, 2012; Legewie, 2013). The following section will elaborate on the distinction between these three concepts.

Sufficiency refers to the situation where if X is present, Y can occure (X ≤ Y). However, it does not mean that when Y occurs is X has to be present. It could be that other conditions that are sufficient also produce the outcome. Figure (1) visualizes the Venn diagram for X ≤ Y (Legewie, 2013) . Sufficiency can indicate if a subset relation exists.

Necessity refers to the situation where the degree of membership in Y (outcome) is less than or equal to the degree of membership in X (condition), thus Y ≤ X. This implies that set Y is a subset of set X, figure 1 visualizes this in a Venn Diagram (Legewie, 2013). From this, one can conclude that the outcome is also produced when the condition occurs in the set.

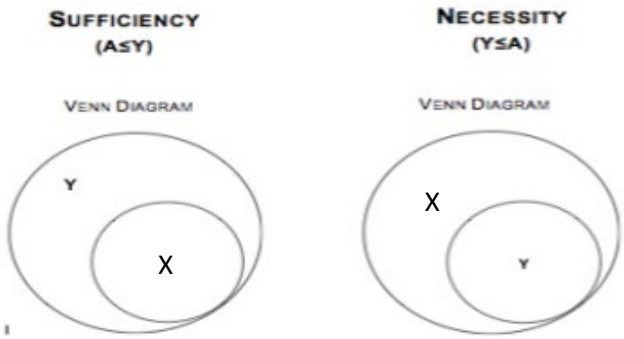

Figure 1: Sufficiency and Necessity. Reference: Legewie (2013)

INUS is important for adressing combinations of conditions (subsets with more conditions). Here, a condition can be insufficient for producing an outcome on its own, but a necessary part of a combination that is unnecessary but sufficient for producing the outcome. The Venn Diagram (figure 2) shows that set X is partially out (not necessary) set Y. However, in combination it is still a sufficient subset for producing the outcome Y (Mackie, 1965).

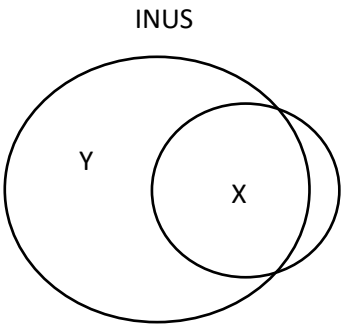

Figure 2: INUS. Reference: Mackie (1965).

Obviously, the key concepts showed above, about necessity and sufficiency are in line with the understanding of conjunctural causation. A 'path' that consists of certain combinations can indeed be sufficient for the outcome to occur. This however does not mean that this path is necessary for the outcome, as there may be different paths that produce the same outcome (multiple conjunctural causation.

With fuzzy set QCA one cannot simply adress membership as 'in' or 'out' the set. Rather, the membership scores are fuzzified, meaning that conditions can have all scores between 0 and 1. In order to analyze these scores, another method of calculation is used to determine the extent to which subsets are causally related to the outcome. To calculate the subset relation, the following measurements are used in this research. The first one is described as 'set-theoretic consistency' score and the second one is 'set-theoretic coverage'. The set theoretic consistency is best described by Ragin (2006 p.2), who explained that '*the degree to which the cases sharing a given condition or combination of conditions agree in displaying the outcome in question.'* In contrast, the theoretic set coverage is: *'the degree to which a cause or causal combination ''accounts for'' instances of an outcome' (Ragin, 2006).* Both measurements are key in addressing the set-relations of the conditions and combinations of conditions studied in this research. Further elaboration on consistency and coverage will be given in the analysis, as this is where it provides the most added value.

To generate the aforementioned measurements, this research uses STATA to perform the 'fuzzy' command.. This command provides the opportunity to conduct a detailed statistical analysis of the gathered data. In STATA, data collection, data processing and data analyses can be carried out. The advantage is that all information can be bundled together in the same statistical program.

2.5 Research Quality

This subchapter addresses the basic assumptions that are made regarding the methodology and what their effect is on reliability, internal and external validity and generalizability. In order to

conduct a valid and reliable research, it is deemed necessary to include measures of validity and reliability to ensure proper conduct of methods.

2.5.1 Reliability

At the basis of this study are consistency and coverage scores, that show how subsets are related to the successfulness of citizen mobilization. The scores should be elaborated to the extent that other researchers should get the same outcome with the same data. In addition to reliability is the fact that this study combines qualitative and quantitative research, hence it rejects the argument that qualitative studies lack reliability (Berg-Schlosser et al., 2009). In addition to the strength of the QCA-method is the fact that the decisions made are presented in detail and the steps taken to delineate information are given in the chapter on data collection and preparation. By giving sound explanation of the measurement of the outcome variable and the conditions, the results from the research should be the same when the study is repeated in exactly the same manner.

2.5.2 Internal Validity

As Basurto and Speer (2012) argue, the case of validity for the QCA method is debated. Researchers can choose different values for the crossover point in fuzzy sets. It is argued that by adjusting the cross over point a researcher can adapt it to achieve desired results. However, Basurto and Speer (2012) argue that this should, in fact, be seen as a strength of the method. Here, the researcher, through its in-depth knowledge of the selected cases, can determinate which values to give to certain conditions.

With that, the QCA-method uses membership scores that can have any value between 0 and 1. This improves the internal validity, because no information is lost in standardizing values to membership scores. This can for example be the case when there is a crisp set of QCA, where the values are dichotomized.

The conditions that are selected in this research are based on assumptions and theoretical understandings from literature on experimenting with sustainability transitions. The QCA method analyzes the quantitative data with added insights from qualitative data that is gathered. The combination of quantitative and qualitative insights strengthens the internal validity of this research.

2.5.3 Generalizability

The QCA method helps to systematically analyze a multitude of cases, providing a foundation for external validity. However, as is also argued by Berg-Schlosser et. al. (2012), research with a QCA-method is based on conditions that are specific for each case. The aim of this research is to examine patterns in cases with regard to conditions or combinations of conditions. With the help of QCA, to a

certain extent, generalizations can be made regarding causal relations. Still, the researcher has to be careful in its generalizations as the complexity of the cases is case-specific and is therefore only applicable for equivalent experiments.

For a large extent the causal relations that are analyzed should be seen as evolving insights. It still remains that cases and the outcomes are hypotheses. Reality is often more complex and one cannot cover all the conditions that are relevant in a certain neighborhood. With the help of future research, the empirical evidence for the conditions and combinations of conditions that produce successful citizen mobilization could be enhanced.

2.6 Data Collection Methods

In this paragraph the process and methods of data collection will be explained. Different methods and techniques are used to gather the data in this research. A literature study is used to identify successful citizen mobilization in experiments in the heat transition and address which conditions produce successful citizen mobilization. After that, the more qualitative collecting methods which are explorative interviews and desk research are elaborated on. At last, the questionnaire survey will be addressed.

2.6.1 Literature Study

Ragin (2000) argues that is useful to develop a list of measures for the conditions and the outcome. These measurements must be supported by theoretical knowledge gained through a sound study of the literature. The measurements should be operationalized based on scientific knowledge and/or based on the empirical knowledge of the context of the cases. Therefore, it is logical that a literature study forms the first step in order to conduct this research.

Berg-Schlosser et al. (2009) address that the use of theory and literature circulates in different stages of the research. To be more specific, in first instance, theory is used upstream in deciding on what cases and conditions are going to be researched. Second, the theory is used for several practical steps in the QCA analysis. Theory is then used to underpin how different combinations can produce the same outcome and how these combinations apply to the current practice in the Dutch heat transition.

2.6.2 Explorative Interviews

To strengthen the theoretical understandings and to get a better grip on the real-life context of successful citizen mobilization in the Dutch heat transition, several explorative interviews are conducted. It is important to grasp that the data collection, formed by a combination of literature review and explorative qualitative methods, are means to gain insight in the conditions that are

supposed to produce successful citizen mobilization. It is therefore interesting to conduct an open interview, to explore the conditions that are implemented in the cases. Interviews are constructed as open-ended, which leaves room for unexpected outcomes.

Table 1 shows the respondents who have been interviewed. The first column shows the name, the second column the specific organization or project where the respondent is active. The first three respondents listed in table 1 are the representatives of a project that is part of the 'Programma Aardgasvrije Wijken'. The last two rows in the table show the projects that are mentioned as heat initiatives in the 'Lokale Energiemonitor 2019'. The ThermoBello project was chosen because it concerns a successful heating project, which is relevant as it portrays how success is achieved. The other projects demonstrate best how current experiments are used by municipalities.

Table 1: Name an organization of respondents. Source: Author

Name	Organization
G. van den Brand	Municipality Nijmegen
R. Nikdel	Municipality Eindhoven
M. Lode	Municipality Hengelo
G. Verschuur	Project Themobello
U. van Wandelen	Municipality Arnhem

2.6.3 Questionnaire surveys

It is of importance for this research to test how the coordinators of a certain project view its success and the conditions that produce this success. With a survey, a larger case-selection can be achieved, which is useful for the comparison within the QCA-analyses. This means that the survey must be focused on specified characteristics that cannot be gathered using existing secondary data, which is aimed at other research topics. Therefore, it was chosen to set up a survey design that is specifically aimed at experiments in the heat transition.

The survey design should be tailor made to include the in-depth questioning needed to answer the measurements set in the operationalization. The use of qualitative open response questions is best suited to a study where a QCA method is applied (Basurto & Speer, 2012). The advantage of open-ended questions is that participants can express their viewpoints in their own words without a

limitation. In this way, the highest level of detail can be achieved. The questionnaire also has fixed-response questions.

Fixed-response questions are used to collect numerical data for statistical analysis. Obviously, these fixed-response questions have a higher level of abstraction than open questions. At the lowest level of detail, but important for this research, binary options are used. There are also fixed-response questions aimed at numeric values. For example, the number of houses in the project, or the estimated or actual costs for certain activities. For some questions, a Likert scale measurement was used as a fixed-response option. The Likert scale exists of five points, adding a neutral answer option and a choice in between two extreme anchor points (totally agree <-> totally disagree).

A survey via Internet (Qualtrics) was set out with a text of instructions via e-mail. The program used, Qualtrics, makes use of smart ways to project questions to the participants. Where, if certain questions are answered with 'no' or 'not applied' the follow-up question was not shown. In contrast, when extra (open response) information was needed when answered with 'yes' or 'applied', a follow-up question was presented to the participant. Qualtrics is also useful when exporting the data as it makes a file of all data gathered that can be used for analyzing.

2.6.4 Added data to supplement the findings from the survey

To strengthen the results in this research, measurements are taken to supplement the findings from the survey, in order to get a better understanding of the context of the cases studies and to verify and/or alter given answers. The use of data that is provided by others, is a way of quickly gathering a lot of information. On the downside the researcher is limited to the findings and information provided by others, the information in turn can be biased. The following data was used to supplement the findings from the survey:

- Policy documents: Rapportage Reflectieve Monitor 2019, Algemene Rekenkamer 2020, Lokale Energie Monitor 2019, Opweg naar aardgasvrij wonen SCP (2020) and multiple covenants in the Programma Aardgasvrije wijken (for example covenant of Purmerend (PAW, 2019)).
- Project websites: Mainly to find added data for cases that are covered in the Lokale Energie Monitor 2019 and for missing values in other cases.

2.7 Case Selection

As addressed in the project framework, this research takes into consideration88 cases in the Dutch heat transition, which are present in the built environment. The research population for this study is based on three different but related programs that represent the current projects in the Dutch heat

transition. The first one being the Green Deal. In total, 31 municipalities took part in the Green Deal 212 (2017) off which 24 are studied in this research. The number of studied cases is less than the total number of cases reflected, because of information asymmetry. The second program is the 'Programma Aardgasvrije Wijken' covering 26 cases. Last, the 'Lokale energie monitor 2019' covers 54 initiatives that are related to the Dutch heat transition in the built environment. A deliberate choice was made to investigate different types of projects, that originate from other programs and motives, in order to find out what differences and similarities there are between the cases studied.

In summary, the QCA-method used is ideal for exploring the success conditions within the Dutch heat transition, as it makes a combination between relevant literature, explorative interviews and gathered data through questionnaire surveys supplemented with added information. Within this methodological chapter the importance on the circulation of theoretical understandings in all phases of the research are addressed. Accordingly, the concepts and theoretical foundations regarding experiments for sustainable change will be elaborated in the following chapter.

3 Theoretical framework

3.1 Theoretical background of experimentation in sustainability transitions.

Experimenting for sustainability transitions has gained increased attention, making experimentation a central concept in the literature on sustainability transitions (Kivimaa, Hildén, Huitema, Jordan, & Newig, 2017; Naber, Raven, Kouw, & Dassen, 2017; Sengers, Wieczorek, & Raven, 2016). There are several concepts that describe experiments in literature. Most common used descriptions in sustainability transitions literature are: Living Labs, Pilots, Experiment Gardens, Initiatives and Transition Arenas. All these concepts base their approach on socio-technical experimentation, meaning in this research they will be conceptualized as Experiments. Within the concept experimentation an important division must be made in understanding that socio-technical experimenting is in contradiction with experimenting as meant in natural sciences, that takes place in a laboratory. Rather, experimenting as meant in this research views society itself as its laboratory, in which there is experimented with a variety of complex messy experimental processes with regard to alternative (heat) technologies and the accessory social and material realities (Sengers et al., 2016).

Experimentation, as indicated above, brings about change in a different way than is applied in the literature on social change and policy change (Kivimaa et al., 2017). Experimentation can challenge the reigning regime allowing for change in the socio-technological systems to occur (Meadowcroft, 2009). This makes it that experimentation can help overcome the more multidimensional and complex nature of climate change in contradiction to more traditional modes of governance (Kivimaa et al., 2017). To understand the traditional theoretical foundations of the success factors and conditions researched, insights in the historical and theoretical background on experimentation literature are important to take into account.

A part of the theoretical background can be found in one of the first publications that is researched by Kemp, Schot, and Hoogma (1998) on experimentation with respect to the sustainability transitions literature (Sengers et al., 2016). In their research Kemp et al. (1998) address that innovation literature is closely linked to literature on experimentation. Both showing that developing a new idea into a dominant practice is considered to face many obstacles due to lock-in processes. To overcome these obstacles and lock-in processes innovation literature shows two objectives that should be pursued simultaneously. System improvement and system innovation "*System improvement, incremental adjustments to existing practices to address perceived problems) and System innovation, experiments with fundamental adjustments to 'dominant designs''* (Meadowcroft, 2009, pp. 329-330).

Ideally system improvement should lead to incremental change because society can benefit from the incremental improvements when the adaptive potential of a socio-technical improvement is greater than forecasted. However, this only occurs when old technologies are not sufficiently delivering. For this research, that is placed in the heat transition, the latter named is not the case. Meaning that a two-sided strategy is more applicable. This includes, that system improvements should be regarded as a steppingstone to system innovation, eventually leading to a refraining from lock-in processes and thus the altering of 'dominant designs' (Meadowcroft, 2009). The literature on innovation recognizes the institutional, material and mental stubbornness of the system.

When experiments are successfully implemented and these dominant values are altered, literature speaks of system innovation. Experiments make it that a new socio-technical innovation can be established, with room for learning processes and societal embedding. Literature on sustainability transitions shows that the radical change that is needed over time to become more environmentally sustainable takes place in a technological, practice, and cultural oriented context. This gives important insights for the following definition of Berkhout et al. (2010, p. 262), which shows the definition of experiments as addressed in literature on sustainability transitions: *'planned initiatives that embody a highly novel socio-technical configuration likely to lead to substantial (environmental) sustainability gains" and "represent small initiatives in which the earliest stages of a process of socio-technical learning takes place.*

The definition addressed contains different important sub-factors for experiments in transitions literature. The first one is formed by the notion of 'initiatives' which can be small or planned, but do not always have to be small or planned, key is however that the 'initiative' has to embody a novel socio-technological configuration that can lead to a change with regard to sustainability gains. Second, the objectives of an experiment are formed by networks of actors and learning. Third, experiments should be regarded as seeds to kick-off change and can thus be regarded, when addressed successful, as key innovators of systems (Sengers et al., 2016). These 'seeds' can occur in a wide range of forms. Sengers et al. (2016) elaborates on five approaches experiments: 1. niche experiments 2. bounded socio-technical 3. transition experiments 4. grassroot experiments and 5. sustainability experiments.

3.2 Approaches to experiments in sustainability transitions.

The five notions that are elaborated by Sengers et al. (2016) show that socio-technical experiments can have different theoretical assumptions and focus points in their approach towards social and material change. At the same time, there are several commonalities between the different

approaches that are elaborated in the following paragraphs. These commonalities and differences give valuable insights for the conditions and success factors that are set up in this research.

The described conceptualizations of experiments are originating from the same theoretical background. The basis of the approaches on experimentation is addressed in the research of Kemp et al. (1998) and covers in particular the emergence of technological niches. However, as argued in Geels (2010) sustainability transitions with regard to constructivist thought lacks a shared vision, meaning that actors have different interpretations. These different views are also part of the different approaches to experimentation. Because of this mainly normative view towards change that the experiments aim to bring about, each of the experiments has different ideals and with that mechanisms.

As already stated, the theoretical foundations of experiments within sustainability literature can be related the approach on 'niche experiments.' Niche experiments as stated in Kemp et al. (1998) are approached in a more technological matter. With the niche being introduced in order to clear the abundance of a novel technology with societal benefits that are placed in R&D labs. However, due to selection pressures it is hard for these niches to alter existing markets in an already existing regime. Eventually, Strategic Niche Management (SNM) is aimed at creating protective policy measures that allow mechanisms of upscaling to contest the existing regime and thus create a new dominant regime. The approach on Bounded Socio-Technical Experiments (BSTE) was introduced to criticize the rather technological view of these niche experiments. BSTE's in contradiction to niche experiments, transition experiments and grassroot initiatives build on theories of social learning (Brown & Vergragt, 2008; Kemp et al., 1998). A form of higher order learning is needed within BSTE's, this is of particular use when there is experimented with innovations that require a high level of knowledge. Often BSTE's take place in a delineated geographical place and time and must be recognized by the participants.

Transition experiments are based on the same principle of upscaling as niche experiments, but in contradiction start from a different orientation. Transition experiments are designed in a fashion that they investigate new ways in which societal needs can be met These theories show that a structural change does not have to be achieved at all cost (Kivimaa et al., 2017). Rather, it builds on the complexity and dynamics in society and adjusts its goals constantly, because of that transition can better be steered towards societal goals. The steering towards societal goals, regarding transition management, can be conducted with 3 main processes: Deepening, Broadening and Upscaling. Deepening means providing for a space in which social learning can thrive. Broadening is referred to

as learning from other experiments and scaling up concerns more complex learnings about regime change (van den Bosch & Rotmans, 2008).

The approach of grassroot experiments can be linked to transition experiments in achieving a goal that is set by society. It combines both social and technological experimentation that is related to the niche experiments approach. However, grassroot experiments are initiatives that are set up from communal activities. This makes it that Grassroot Experiments are often valued intrinsically and are discussed in terms of their diffusion outcomes. As a result (often) they cannot be connected to mainstream socio-technological regimes (Seyfang & Smith, 2007). Still, as argued by Seyfang and Haxeltine (2012), one can also use the three processes that analyze the niche potential to move beyond the intrinsic values of Grassroot Experiments.

The combination of both approaches, transition experiments and niche experiments, are part of Sustainability Experiments. That Sengers et al. (2016) describe in terms of three key factors: 1. The experiments should be planned initiatives, meaning that there are grounded choices made in relation to the initiation of the experiment. 2. With highly novel socio-technical configurations. And 3. That the configuration needs to lead to a substantial sustainable gain for a community (Berkhout, Angel, & Wieczorek, 2009).

Obviously, all approaches mentioned on experiments are based on the niche experiments literature. However, as is also presented, intrinsically the types of experiments differ in their normative values. This is also found when studying the different approaches to experiments. In which there is a split made in the analysis of niches where reflexive learning, the formation of actor networks and the alignment of expectations are key elements. In contradiction, transition experiments focus on deepening, broadening and upscaling. This division can be characterized in two main lines of thought. In which niche experiments and sustainability experiments are geared towards technical and managerial change. And the line in which social/civic processes are at the base of change, herein BSTE's and grassroot initiatives are represented (Sengers et al., 2016).

Although, there are several differences between the approaches to experiments, far more significant are the commonalities between them. In all descriptions of transition experiments there is spoken of a socio-technical innovation. That could be the introduction of novel technologies or new social practices (Sengers et al., 2016). The implementation of these experiments takes place in an uncertain and ambiguous context, that is in real-life situations. The real-life situations make it that actions can have differing outcomes. This makes it important for experiments in the context of transitions to be focused on challenge led societal goals.

Summarized, this research argues that the approaches mentioned to experiments linked to sustainability transitions have the main aim of reaching structural change. This can be done in processes of wider diffusion and experiments that are a vehicle to initiate change on a small scale. The focus in this research is on the latter named form of change, as will be explained in the paragraph on success criteria. The differing outcomes of experiments make it hard to address one success criteria for an experiment. There is a key distinction in the approaches. That is, the split in a more technological oriented approach versus a more civil or social oriented approach.

Also, based on the approaches to experiments in sustainability transitions. It can be argued that there is consensus on the main aim, that is to reach societal transformation. Because of the diverse nature of real-life situations, processes of learning are important to avoid deviation from the main ambition. Learning proves that previously acquired knowledge can contribute to the achievement of the main goal (Sengers et al., 2016).

3.3 Success criteria

Experiments are thus key mechanisms for changing existing regimes. However, so far there has been little explanation on the 'outcomes' that experiments should ideally bring about and how these outcomes can result in a successful experiment. In the former paragraph the theoretical background as well as the approaches to experiments were given. These hold valuable insights for the measurement of success in this research. First, the loci of the following paragraph will be on the distinction between internal and external success that is made in literature on experimental projects. After that, there will be elaborated on the outcomes that experiments can bring about. Regarding these outcomes three main factors indicating success, as meant in this research, are given with respect to their backgrounds and mutual influence.

As already mentioned, the effectiveness and thus the successfulness of experiments is often measured and based on the goals of an experiment (Vreugdenhil, Slinger, Thissen, & Rault, 2010). The internal success of an experiment focusses on the main ambition of the experiment, which often exists of *'testing innovative approaches or concepts'*(technological) and developing *'new insights and knowledge'* (social civic). The new knowledge conducted can be used to improve decision making..

Conversely, incremental change through the mechanisms of external success in pilots, can create outcomes in the form of 'deepening', 'broadening' and 'upscaling'. These are further elaborated in Naber et al. (2017) where 'growing' can be linked to deepening that is described as learning as much as possible. from an experiment, resulting in an increase of the number of participants that support plans. After that mechanism of Replication and Accumulation can occur that refer to the broadening of experiments, meaning that experiments are repeated in another setting. At last, upscaling refers

to transformation of institutions and regimes, eventually external success is achieved when to a certain extent an experiment is upscaled.

The processes of upscaling are not studied in this research, as several researchers argue that only weak signs of upscaling are present in a real-life context. This makes it hard to achieve valuable results (Kivimaa et al., 2017; Sengers et al., 2016; Van Buuren, Vreugdenhil, Verkerk, & Ellen, 2016). With that most experiments researched are yet at the start of their process. However, the following citation shows the urge for critical evaluation of the internal success within experiments: *'Without it (critical evaluation) there is a risk that experiments become a political Potemkin village that hides the need to change policies for real transitions'* (Kivimaa et al., 2017, p. 25).

Thus, the focus of this research is on the internal success of experimental projects, as the processes regarding system innovation within the experiments give valuable insights for further uptake. It is however, as literature argues, not common practice that the success of an experiment results in a successful uptake of the experiment (Van Buuren et al., 2016). Kivimaa et al. (2017) elaborates on several different types of change that can occur in these experiments, that are applicable to this research. Change of discourse, new technologies, a change in infrastructure or built environment, institutional and policy change and new consumer and citizen practices. Most of the cases reviewed in Kivimaa et al. (2017) are linked to the built environment or the energy sector, showing the relevance of these types of change for this research.

Finally, the types of change reflect outcomes that are empirically studied in this research. Both insights from the success criteria and the approaches to experiments are combined to form the following key success factors in this research. An experiment according to theoretical understandings is successful when the new configuration meets its set expectations and thus, when the socio-technical innovation is functioning. Furthermore, the definite mobilization of the main practitioners in the experiment is viewed as an important success factor, this can be directly linked to energy-renovation investments (change in practices) or the perception about making such investments. Here, a more positive and nuanced vision on sustainability transitions can be seen as successful citizen mobilization. With regard to the foregoing statement on mobilization, it is important to understand that success also greatly depends on the phase of the project.

Therefore, phase can be used an alternative indicator for the successfulness of an experiment. Using phase as an indicator can be positive as it best describes how far the project has progressed, regarding the technological implementation of alternative heat solutions. With that it is not based on subjective information but builds on empirical data. The downfall of using phase as an indicator is that all the time related conditions give a false indication of the success of a project. For example, if

an experiment is at a relative late phase, more activities can take place in the process. Also, by taking the phase as an indicator one is assuming there is going to be an actual technical implementation. While this research is looking at the actual mobilization of citizens. Still, phase is, theoretically seen, considered as an alternative indicator for success.

3.4 Conditions for successful experiments

Normally experiments are placed outside or at the boundary of already present policy organisations and regime structures. Linked to the outcomes that are generated within experiments several conditions are mentioned that could, theoretically seen, influence the success of an experiment. Van Buuren et al. (2016); Vreugdenhil et al. (2010) address several characteristics and conditions within pilot projects. With the added value of the explorative interviews conducted a number of conditions are selected. scale, being a safe haven, competent participants, principled engagement and social learning, funding availability and an experienced Leading actor. These conditions will be further elaborated in the paragraphs below.

3.4.1 Scale

Scale can be directly linked to the literature on experiments for sustainability transitions, with scale being a dependent for variable for the success of such an experiment. Too large a scale can result in the process taking a longer time to be finished, leaving important learning processes behind. In addition, too small a scale may mean that the experiment is not a representative of the projects for which is being experimented. As argued in Vreugdenhil et al. (2010) scale can be split up into three main aspects: Temporality, space and problem scope. These determinants will be split up and elaborated below.

Space as mentioned in the literature on scale should reflect the quantity of houses in the experiment. As already stated, a large number of houses in the experiment means an increase in the risk addressed to the project and thus a lowered experimentation level. A small number of houses means that the experiment does not sufficiently represent other projects in the context of the heat transition. Thus, the number of houses within an experiment should not exceed certain proportions.

Time, that is strongly linked to space and the problem scope forms a key factor in scale. With regard to time literature often speaks of temporality or the phase of an project (Smith & Raven, 2012). Understandably, a shorter time period inherits smaller risks and less money invested in the project. A longer time scope could also mean the experiment has not yet reached its main ambitions and could be regarded as a failure in standard projects (Vreugdenhil et al., 2010). Time addressed as the phase is a main characteristic of an experiment meaning that other conditions can be dependent on it.

3.4.2 Being a Safe Haven

Current socio-technical dimensions create processes that over time create a lock-in, which allows for path dependent processes to occur. Path-breaking innovations aim to alter these existing structures. However, the socio-technical innovations that are often proposed find themselves in a structural disadvantage relative to the regime. For new socio-technical innovations to challenge the existing regime a 'safe haven' in other terms a 'temporary' protective space is required, according to Smith and Raven (2012). This should shield the innovation from existing selection pressures. The research of Smith and Raven focusses on the implementation of solar PV sells. But is also relevant to the heat transition, as the research focusses on the local aspects and experimentation, that are relevant to study in this research

The protective space, also mentioned as an innovation-specific proto-regime, is defined by Smith and Raven (2012, p.1027) as: '*deliberately created spaces through innovation-specific public or private interventions (active) or generic spaces pre-existing mobilization by advocates of specific innovations (passive).'* Active shielding is part of experimentation processes in which extra space is constructively given to a socio-technological innovation. Passive shielding is characterized as geographical locations that are naturally more suitable to alternative innovation options. However, it can also be formed by social/cultural values. For example, a group of inhabitants that want to trade of higher costs for ecological well-being. In sum passive shielding can be seen as exploiting the available opportunities and active shielding is seen as the strategic and deliberate creation of a safe space.

Active and passive spaces are not excluding each other, meaning that if one lacks it does not mean that there is no protective space. Still, in order to understand protective space both, have to be taken into account. Passive spaces are divided into two different indicators: First, geographical spaces that have certain socio-cultural or technological characteristics. (Oliver & Jackson, 1999). Second, spaces where a certain socio-cultural bias towards for example ecological well-being is present are referred to as protective spaces too. Both indicators are presented in the literature forming important aspects of a protected space, this makes it important to mention them under this condition.

Active shielding is a form of niche management that is subject to a number of aspects indicating a safe haven (Kemp et al., 1998). The extent to which failure is tolerated is mentioned as an important factor in defining a protective space. Furthermore, the distance to policy and the (increased) space towards legislation and regulation is mentioned as an indicator for protective space. Smith and Raven (2012) show that in order to overcome selection pressures there has to be experimented with regulation and policy as well. Creating space for initiatives and accepting them can be seen as an indicator for experimenting with new policy (Gaventa & McGee, 2010).

3.4.3 Competent Participants

Vreugdenhil et al. (2010) argue that participants in experiments can have multiple roles. Here, an initiator of an experiment can also, eventually, be the practitioner of the proposed heat solution. This makes competent participants an important condition for success in pilot projects. The notion of contextual dependency is also of importance within the condition of competent participants. Participants bring to the table important knowledge on local aspects. The local context, as already mentioned, is one of the main factors within a pilot. Literature thus argues that competent participants are a condition for success. However, literature does not fully address what features an ideal participant should bring to the table (Van Buuren et al., 2016; Vreugdenhil et al., 2010). This research distinguishes three main categories of participants (future users of a heat solution) in a pilot project. The entrepreneurial participant, the open for new knowledge participant and the closed sceptic participants.

The entrepreneurial participant is addressed in literature as a competent participant, which is able to span boundaries and produce coalitions of the willing. In terms entrepreneurial participants contribute to the success of a pilot (Van Buuren et al., 2016). Competent participants should be open for new knowledge as literature argues (Van Buuren et al., 2016). It can therefore be said, that if there is an above-average number of people in the pilot who are open for gaining new knowledge about the heat transition, there can also be spoken of competent participants. In contradiction, the participants that are more closed and sceptic to the pilot project, form a group that arguably do not form competent participants for a pilot project.

3.4.4 Principled engagement and social learning

As already elaborated in the chapter on the 'competent participants', participants have an important role in experiments. On the one hand citizens are participants of the project, on the other hand participants are also the final users of the socio-technological implementation. The foregoing stresses that a good process in involving participants is needed for an experiment to be successful (Van Buuren et al., 2016; Vreugdenhil et al., 2010). Vreugdenhil et al. (2010) argue that within pilot projects a model that is focused on involvement and communication for knowledge orientation has to be designed. This model includes stakeholder cooperation and learning from each other. To summarize this in order for social learning to occur, agreement and collective actions through communication and interaction in participatory settings have to occur (Muro & Jeffrey, 2008). The principled engagement should thus be formed in a setting of citizen participation. The elaboration on the different forms of participation will be given below.

The latter made assumption by Muro and Jeffrey (2008), is based on the notion that involving citizens at an early stage in the decision-making process and allowing them to exert effective influence. Increases the quality of the decision and reduces opposition to the decision making process. This is also applicable for cases where the experiment is started in as part of a bottom-up movement (grassroot experiments) (Foort & Kevelam, 2015). Citizen involvement can take place on many different levels. These levels indicate how much involvement citizens have in plan-making, this involvement relates to power over resources. Most commonly these levels are presented as 'stairs' on a ladder. Different researchers have elaborated on these levels of citizen participation. One of the earlier notions on citizen participation defines a ladder of citizen participation in 8 stairs (Arnstein, 1969).

However, the more recent model of Edelenbos and Monnikhof (1998) is more applicable for this research than the model of Arnstein (1969) as it addresses different methods for participation. In contradiction to the model of Arnstein (1969). Edelenbos and Monnikhof (1998) argue that the first and the last rung can be left out. As is argued in van Houwelingen, Boele, and Dekker (2014), this has to do with the fact that the first has nothing to do with participation and the last one does not have a role for policy makers. Meaning that 'Nonparticipation' applies to the level that inherits informing. 'Degrees of tokenism' refers to consultation and advising. And last 'degrees of citizen power' best applies to coproduction and delegated power. One must understand that a higher rung does not mean a better process. Each rung can be meaningful in decision making. This depends on the characteristics of the group and area that is under development. However, the rungs on the ladder do represent the level of empowerment, which as we have seen in the foregoing chapter does inherit the extent to which persons can mobilize.

Regarding the division of power, also addressed as the capacity to mobilize resources to achieve goals, this research makes a division between citizen participation in which social learning is achieved and citizen participation in which a lack of interaction results in limited social learning. There is an important notion to be made when studying learning as meant in the 'success of an experiment' and 'social learning' as a condition for success. In which the condition for success builds on the types of knowledge that are of a soft and contextual nature, regarding the interactions among actors and their interaction with the innovation. The division of stairs and their level of success represented in this research will be given in the operationalization.

3.4.5 Funding availability

Added resources that are provided by governmental organizations are ought to provide for a certain funding availability. A crucial condition for the successfulness of an experiment is thus formed by

added resources. Mainly if there are enough resources for experimentation, experiments can fund their main processes in a neighborhood approach. Van Buuren et al. (2016) focus on a number of different aspects that can be linked to the literature on experimentation Sufficient expertise and means to generate knowledge, monitoring and analysis, and enough manpower within the participating organizations. The room for experimentation that embraces the previous aspects can be formed by for example, financing, added time for exploring and the attraction of organizations/individuals with knowledge.

The funding availability can be provided by several organizations. These resources are used to encourage citizens to adopt energy conservation methods or as a form to tackle process costs (Hoppe, Bressers, & Lulofs, 2011). This still inherits that experiments are for a large part dependent on the willingness of the citizens in the neighborhood. Funding is therefore an overarching aspect of the various activities carried out regarding experiments. It is important to grasp the funding applied to several practices in experiments to filter out which funding exactly stimulates the successfulness of an experiment. The processes that are studied will be addressed in the operationalization.

3.4.6 Leading actor

The more open facilitative style that is formed within pilot projects finds its main groundings in the following notion made by Schot and Geels (2008, p. 538): '*SNM as a policy tool does not suggest that governments create niches in a top–down fashion, as is sometimes assumed by commentators, but focuses instead on endogenous steering, or steering from within. Such steering can be enacted by a range of actors, including users and societal groups*.' There are two aspects of importance in the description made. That is an experiment does not have to be created top-down and the steering can be done by several actors within the process. Within the condition on competent participants there is focused on actors that are placed within the pilot projects. This condition is focused on the competence of the leading actor or key figure within the process.

Literature does not fully cover what competences a 'good' leading actor should ideally bring to the table. Leading actors do ideally steer processes within experiments. Schot and Geels (2008) do elaborate on the steering of outcomes towards modulated goals. By adding a specific actor that strives towards certain goals, eventually (through the mechanisms of evolving dynamics) these goals are met, and the desired path is reached. Herein, learning processes are of importance, showing that the indicator for a 'good' leading actor should build on the leading actors experience and its time invested in the project and thus the direction it gives in the project.

3.5 Conceptual model

This subchapter elaborates on the conceptual framework that is based on the theoretical insights and the perspectives explained in the foregoing subchapters. The model in figure 3 forms a conceptual overview. That shows how the conditions connect to citizen mobilization. In the following part the methods used and the theoretical insights will be summarized in the conceptual model.

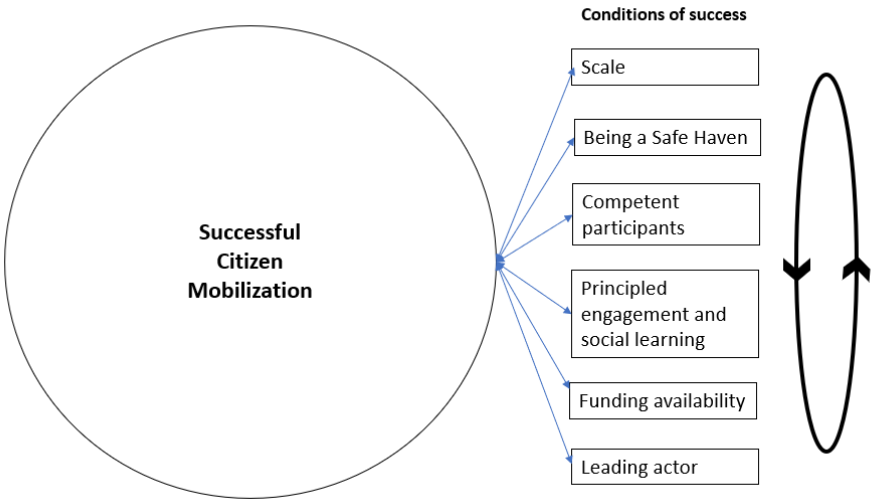

Figure 3: Conceptual Model. source: Author.

The model shows the experiments that are researched, the left circle focusses on the successfulness of the experiment. The conditions of success presented in figure 3 are based on the contextual factors and parameters that underly experiments. Regarding theories on experimentation for sustainability transitions the principle of complex causal conditions is mentioned. This is portrayed in the loop on the right of the model, showing that all conditions are mutually dependent variables for successful citizen mobilization. By using the QCA-method these complex causally related societal systems in which the conditions are placed can be narrowed down.

3.6 Operationalization

Within this research a fuzzy set analysis is made, meaning that memberships scores can have varying degrees between 0 and 1. It is therefore necessary to give values to the degree of in or exclusion of conditions in a set. It is needed to elaborate on a value that addresses when the condition is fully out (0), when the condition is fully in (1) and the cross-over point (determines when a set is more in than out) has to be addressed (Ragin, 2006). The theoretical backgrounds on the operationalized conditions are given in the theoretical framework. At first the outcome variable (dependent variable) will be operationalized. After that, the conditions that derive from the theoretical background will be operationalized.

3.6.1 Measurement of Success

Successful citizen mobilization (Outcome variable)

The mobilization of citizens is a choice of the citizens themselves. Therefore, the success measurement incorporates the thought process in making sustainability measures. It is therefore more meaningful to study the: 1. the consciousness about sustainability measures of citizens and 2. deliberate actions taken by citizens in the heat transition. The participants of the survey are asked four questions regarding this consciousness and the deliberate actions taken. In table 2 the four distinct questions are given, that test the successfulness off a project in this research. As is portrayed, the statements are layered from a low sense of mobilization, to a high sense of mobilization. A 5-points Likert scale is used to provide for choice options making the answers given more meaningful.

Table 2: Measurement of success. Reference: Author.

Indicators	**Answer options**				
Citizens are more aware of sustainability measures	O Totally agree	O Agree	O Neutral	O Disagree	O Totally disagree
Citizens are thinking about making their homes more sustainable**.**	O Totally agree	O Agree	O Neutral	O Disagree	O Totally disagree
Citizens make plans to make their households more sustainable	O Totally agree	O Agree	O Neutral	O Disagree	O Totally disagree
Citizens have made their homes more sustainable (have improved their energy label).	O Totally agree	O Agree	O Neutral	O Disagree	O Totally disagree

Phase (alternative descriptor of success)

The four phases described in chapter 3 are also represented in the survey as an alternative indicator for success. The four phases will be presented, and participants of the survey will be asked to fill in which phases are applied, this is done with a dichotomous measurement (Applied/Not applied). When a certain phase is applied, there will be asked if the phase is finished. The phases are related to a framework presented by 'EnergieSamen' an alliance that helps with neighborhood approaches in the Dutch heat transition. One, being the initiation of the project, second setting up a neighborhood energy plan that is supported by the participants, third making an implementation plan and last the definite implementation of the alternate heat solution.

3.6.2 Conditions

Scale

To measure the variable Scale the following indicators are set up: First, the number of housing equivalents within the project is questioned with an open response option. Temporality which is measured by the time already spent in the project (open response option) and the time horizon that is linked to the project (to be answered Yes/No, and if yes then when). Last, the type of project is researched, that is linked to 'openness and closedness' as well as to the problem scope of the project (Van Buuren & Loorbach, 2009; Vreugdenhil et al., 2010). The different types of experiments are given in table 3.

Table 3: Measurement of scale. Reference: Author.

Main Aim	Yes		No
This project experiments with specific technologies		If so, what kind of technologies:	
This project focuses mainly on closing a business case			
This project mainly tests new policies, with more influence for the participants.			
This project tests a specific neighborhood approach			

Being a safe haven

For this condition a 5-points Likert-scale measurement (see chapter on methods) is used to indicate the degree of acceptance to failure. In which 1 is no acceptance and 5 means that failure is fully accepted. In contradiction to logical reasoning, when failure is fully accepted experiments have, as argued in literature, a higher chance of succeeding (Van Buuren et al., 2016). Second, the degree to which participants can be free to speak out in the process is measured with a 5-points Likert-scale. With 1 being the process is not designed for people to speak out and 5 being the process is designed for participants to speak out. The reflective monitor on 'Proeftuinen' shows that the participation of citizens in the process is an important condition for success (Rijksoverheid, 2020) Third, the experimental law that is applicable for Dutch cases is referred to in this research with the question: Does the project make use of the extra room for experimentation provided by the 'Crisis en Herstelwet (2019)'. This room for experimentation can also be provided by other terms of arrangement, that is why the option 'other, types of arrangements' was given. The arrangements provide extra room for experimentation, by providing exceptions relating to legislation and regulations. Fourth the extent to which initiatives are offered space in becoming successful by the municipality is tested with a 5-point Likert scale.

Competent Participants

The measurement of the condition competent participants is, in this research, measured with four indicators. The first factor referring to the frontrunners/entrepreneurs can, as already stated, have separate outcomes. In which one is positive and one negative in determining if participants are competent. The first question is aimed at the quantity of frontrunners in the project. Frontrunners are defined as: citizens that aim to trade of higher resources (time, money) out of their own social and cultural values (Kivimaa et al., 2017). But can also be explained as the citizens that have already made essential sustainable measures to become natural gas free. These indicators are measured using a 5-points Likert-scale with the lowest being 0-10% and the highest being 40-50% of the citizens in the project. This question should ideally be followed up with: Do these frontrunners have a positive influence towards other participants in the project. To be answered with 1 being no influence and 5 being frontrunners influence others in their choices. The last question aimed at the openness towards learning and knowledge of participants is questioned as follows: Which percentage of participants is open for new knowledge and are willing to learn? This indicator is measured with a 5-points Likert scale ranging from 0-20% until 80-100%. The latter indicator can be directly linked to the argument made in the report the 'Rekenkamer' stating that an important aim of the experimental program is to learn for upscaling (BZK, 2020).

Principled engagement

This research chooses to use the ladder of citizen participation that was first elaborated by Arnstein (1969). Further elaboration on this model is made by Edelenbos and Monnikhof (1998) that show a model that is most applicable to the Dutch heat transition projects researched. Furthermore, it offers an overview of methods that are used in the process of involving citizens. These methods complement with insights from the explorative interviews and are used to test what is most applicable to the pilot projects researched. To address all possible manners of involvement it was chosen to set out a question on all levels of involvement. With information meetings being valued as the lowest level of participation, interactive sessions come second in the level of participation, working and project groups are third-level, neighborhood activities are valued after that in fourth place and individual meetings where participants take part in face-to-face conversations are valued as most participatory in this research.

For social learning within this condition the number of meetings, the average attendance and the representativeness of the participants are important indicators for principled engagement (Foort & Kevelam, 2015). The measurement that is described above to indicate principled engagement is described in table 4.

Table 4: Measurement of Principled engagement. Reference: Author.

Meetings	How many meetings? (open response)	How many citizens attended meetings? (open response)	Did the attendance represent the neighborhood? (to be answered yes/no)
Information meetings			
Interactive sessions			
Work/projectgroup meetings			
Neighborhood activities			
Individual meetings			

Funding availability

To measure which resources are used in respect to their activities table 5 was created. The total costs that are made and are covered in the column on the left. The estimated costs are given in the middle row, which are the costs made and/or the costs that are going to be made. The last column represents the question 'who finances the activity'. This question is important to answer if there is a grant or a financial incentive of a third party in the experiment(Van Buuren & Loorbach, 2009). Before the aforementioned information can be obtained the first row aiming at the appliance of the activities has to be filled in. The activities are mainly based on the approach that is elaborated by 'Buurtwarmte' an advisory party for the neighborhood approaches in the heat transition. Buurtwarmte sets out a 12-step approach for the implementation of alternative heat solutions. This 12-step approach can be brought back to 4 main phases of a neighborhood approach, these main phases are can be seen as an indicator of a successful project (Hieropgewekt, 2019). The activities within these phases are presented as activities in table 5.

Table 5: Measurement of funding availability. Reference: Author

Activities	Applied	Estimated Costs	Who finances the activity
Making up a process plan			
Process guidance with the neighborhood approach			
Organizing meetings			
Adding and organizing forms of communication			
Physical implementation of an alternative heat solution			
Drawing up a business case			
An application that monitors energy consumption at home level			

Experienced Leading actor

As stated in the theoretical framework, the role and competences of a leading actor is not proven to be a success condition within literature (Van Buuren et al., 2016). However, Schot and Geels (2008) argue that leading actors can give distinct steering towards an (feasible) outcome of the project. A leading actor is in this research is defined as the actor that leads the process and is responsible for the outcome. In this research the indicators for a competent leading actor are formed by: The function the leading actor has in its organization (open response option), the role the leading actor has within the project (open response option), the time a leading actor can spent within the project (open response option) and the experience of the leading actor with regard to foregoing heat-related projects (Likert-scale, 1 being no experience and 5 being a lot of experience). The last indicator forms a strong pillar in this condition as a leading actor alone would not make a large difference for an experiment. However, experience can be of added value to the experiment as learned processes can be added to a new case. Also, the time that the leading actor can spend in the processes could be an indication of success, where more time spend should lead to an more thorough neighborhood approach.

3.6.3 Added data

The foregoing success criteria and six conditions show the data that is collected with the survey. However, to make the data set complete for the analysis, data is added to be able to give answer to the research question. Within the survey participants are asked to give a brief description of the project. By adding this question as an open response option, a better understanding is gathered of the setting of the cases and in case specifics. The start of the project is also taken into account in this question, to understand how long a process within experiments takes place.

The cases that responded to the survey are divided into three distinct groups, that are also described in the project framework of this research. The division is made between ‘Proeftuinwijken’, heat initiatives as presented in the local energy monitor (2019) and Greendeal neighborhoods. Projects are also divided into collective aimed projects and individual aimed projects. Where collective aimed projects are targeted at larger groups of citizens with an alternative heat solution that is aimed at a relatively large number of citizens. Here, individual aimed projects are targeted at individual heat solution projects, all electric projects are a good example of these type of projects.

Distinct changes are made in order to organize the raw dataset into an analyzable set of variables. The dataset has a number of descriptive/textual questions that are transferred to numeric variable sets. At the same time values are altered for cases that, according to project websites, are differently valued on that particular variable. Those alterations will be elaborated and discussed in the results chapter of this research. The chapter on results shows both the relevant changes applied per given variable and the data added later to enhance the study.

4 Data Collection and preparation

This chapter elaborates on the data that is gathered with the questionnaire, supplemented with information that was gathered from project websites and explorative interviews. The variables that where formed in the chapter above are theoretically linked to the conditions. However, as results from the empirical data, not all variables have the same effect as is described in literature. This chapter addresses these variables and the steps taken to prepare them, to become valuable for the analysis. The conditions in this study have a certain membership in the outcome variable. It is therefore important to determine values that indicate when a condition (set) is more in than out of the outcome variable (cross over point). This cross over point is determined based on empirical data and acquired theoretical knowledge.

4.1 Preparation of the measurement for success

The measurement of the outcome condition was done by combining the four variables indicating the mobilization of citizens, measured with a five-points Likert scale. The variable 'successmeasure' that represents the outcome variable in this research (Y) was assembled out of the mean values of the four questions indicating the success of an experiment as explained in the operationalization. Obviously, for the variables to be combined it is important to calculate whether the average values used to compose the variable ‘successmeasure’ match each other. This has been done by applying a Cronbach’s Alpha test. The 4 mean values provide an outcome, an alpha of 0.8825, that indicates that the mean values can be combined to form the new variable indicating success.

The outcome variable that is now formed has numeric values ranging from 1 to 5 where 1 is totally unsuccessful and 5 is highly successful. For the reason that the outcome variable has a strong determining role in this research, at first a number of adjustments are made to the degree of success within cases. This was done by looking at project websites, the local neighborhood and energy monitor (2019) and the associated information about the ‘Proeftuinen’ that is given on the RVO platform. These success values are also compared with the textual information given in the survey and compared with the phase in which the project is in. The projects that have received a new value are elaborated below:

- *Heusden Hedikhuizen: given the value 3. The project has been given a neutral score as the project website shows that the project has just started, however the citizens involved in the project are active and have asked the municipality for support. This project has been given the value 3, because processes are in progress, but there is no strong indication of whether the citizens are actually mobilizing themselves. (Gemeente-Heusden, 2020).*

- *Hoornes Katwijk, given the value 3: According to the phase, the project has just started, but processes regarding alternative heat systems are already at place. The project website shows that there are a few houses (Gemeente-Katwijk, 2018).*
- *De Fryske Marren Balk given the value 3; project has just started and according to the presented phase the project is in the preparation phase. A feasibility study has been carried out, to show which alternative heat solution is most applicable to the neighborhood. The mobilization of citizens with regard to the consciousness of making sustainability is not made clear in the case.*
- *Purmerend Overwhere-Zuid has been given a high success score (5) as the reflective monitor states that with the presence of a heat network people are able to make a change (PAW, 2019)*
- *Apeldoorn, Kerschoten given the value 3: A project group is set up and plans are being made for a heat network fed by heated wastewater (70 degrees Celsius). This means that the project is not quite at the beginning, but citizens are already actively involved in the process.*
- *Tilburg, Amernet given the value 3; In the textual information given in the survey, it was argued that the heat network was already present. However, the project is aimed at making a lower temperature heat network. Therefore, a lot of work still needs to be done.*

The results from the survey are presented in table 6. The overview shows that most of the studied cases find themselves on or above the neutral score (3). However, only limited cases are proven to be highly successful, that is a score higher than four. It is also obvious that the outcomes, by combining the 4 indicators, have become more continuous. With regard to the values presented in table 7 a standardization was made with values between 0 and 1. This is done to present the membership scores for the quantitative comparative analysis.

For the standardization of the outcome variable the following anchors where set that represent the membership scores: the membership score representing fully out is set at 1 as this forms the lowest score possible in the outcome variable. The membership score representing fully in is set at 5 as this represents that all the variables that are inherent to the success measurement have a score of 5 (and not lower). The cross-over point that is most important in this elaboration is set on 3.25. This is done because of two reasons. First, the median level of the outcomes for this condition is 3.25 meaning that the cases above are more successful than the cases below the level of 3.25. With that, when plotting the outcomes on the success measurement, it becomes clear that a lot of cases are found in the neutral score (3). Therefore, it was chosen to take a score that is slightly above this neutral score. This to only include the cases where real mobilization occurs.

The status of the project divided over 4 phases can also be characterized as an alternative indicator for the success of an experiment. However, the above mentioned 'successmeasure' is more focused on the actual mobilization of citizens. The phase, on the other hand is mainly a pillar for the technological implementation of alternative heating facilities (implementation plan, implementation). At the same time, it shows how far the processes in the neighborhood have progressed because most projects, except for 3, are focused on a collective approach. The variable phase can be considered as an alternative descriptor of success. However, it is only meaningful to test the variables that are not time dependent. Because otherwise the outcome would just be the same as the total time spent in the project. Then the variables linked to time will have high membership in the outcome. The outcomes represented in the variable ‘phase’ are given in table 7. It is obvious that most cases researched are at current in the first stage of the process in becoming natural gas-free. On behalf of the arguments above and the results presented of the stage most cases are in. This research chooses to only include the ‘successmeasure’ to indicate success.

The outcome variable thus represents the extent to which citizens are mobilized. That is measured as steps in the consciousness about sustainability measures and eventually of implementing sustainability measures. Phase was left out the final analysis as it is lacking added value. This research also tests what conditions or combination of conditions have a meaningful membership in the outcome variable. The following paragraphs elaborate on those conditions and present the analyzed values for the conditions studied.

Table 7: Measuring Successful citizen mobilization. Reference: Author.

Successmeasure	Standardized scores (0 – 1)	Frequency
1	0	2
2	.0512821	2
2.5	.1153846	3
3	.2820513	10
3.25	.4871795	6
3.5	.6153846	4
3.75	.7051282	3
4	.7820513	3
4.25	.8333333	1
4.5	.9102564	5
5	1	2

Table 6: Phase of the project. Reference. Author.

Phase of the project	Frequency
1	17
2	8
3	8
4	8

4.2 Assessing and preparing the data for the success conditions

4.2.1 Scale

Within this study the values of scale expressed as expected duration and scale expressed as the number of houses in the project are measured. Logically, both variables could not be combined into a new combined variable indicating the scale of the project. Since both the variables expected duration of the project and the number of houses is measured in a different way. With that, both have a different kind of explanation in their measurement.

Therefore, this research chooses to measure scale as the number of houses in the experiment. This has multiple reasons. First, within the program of the 'Proeftuinwijken' there is argued that the scale of a project is directly linked to the number of houses in a project. A number of houses that is too large results in a cluttered case with missed nuances in learning objectives. A small number of houses in the project, often results in missed learning objectives and unclosed business cases due to high

costs with low numbers of participants. Therefore, the Dutch government set out a directive regarding the scale of a 'Proeftuin' that is 500 (Rijksoverheid, 2020). For the analysis of scale, a neighborhood level is taken with regard to the directive of the government and the calculation of the average neighborhood size in the Netherlands (CBS, 2020).

The delineation described above produces an average scale of 800 houses, that is used to dichotomize the interval variable number of houses. For this research the cases with a number of houses below 800 have been given the value 1 (fully in), as they find themselves within the neighborhood level. Cases with a number of houses that is higher than 800 where valued 0 (fully out) as they find themselves above the neighborhood level.

The expected duration of the project is not considered as an indicator for scale, as it predominantly reflects the phase of the project. It is therefore not a strong measurement for the scale. The duration, this is the time from start project until now (2020), can give valuable insights on how a project has progressed. From a first thought, one could assume that the longer a project runs, the more successful it will be. The consistency score for the duration of the project indicates that the variable has a moderate relation with the outcome. A logical reasoning would be that the longer a project takes, the more successful an experiment is. Considering the subset relation, this principle doesn't fully apply, a sufficiency score of at least above .70 would needs to be found in order to state that the former is the case. The longest duration of the cases researched is 6 years, where most cases' duration is shown to be around 2 -3 years. The duration of the project is thus merely used as a postestimation in this research. Where the standardized score for duration is set at 4 years (fully in), 1.99 (crossover point) and 0 (fully out).

The condition that addresses scale in this research has been given the letter 'H' in the qualitative comparative analysis. The condition that addresses the duration of a project has been given the letter 'T'.

4.3 Being a safe haven

As addressed in the operationalizations chapter, the condition being a safe haven was measured with the following variables: did participants in the project get enough room to speak out in the process (P), Did initiatives get enough support from the municipality (H) and are projects allowed to fail (F). All variables are measured with a five-point Likert scale. At first a Cronbach's Alpha test was conducted to see if the variables could be combined to form the condition of being a safe haven. This test resulted in a poor alpha of 0.3, showing that it is not meaningful to combine the means of the foregoing variables.

Empirical evidence and logical reasoning show that the variable most meaningful in explaining the success of an experiment, is the variable indicating whether there is enough support for initiatives in the neighborhood approach by the municipality). This variable is the most logical option for the analysis, as the room for participants in the process is also addressed in the condition 'principled engagement'. Where meetings in fact build on the same processes of letting participants participate in the process. Including this variable leads to a double measurement. The variable indicating if failure is allowed is in hindsight a bad one as it contradicts the outcome variable in this research. If failure is allowed and a project fails, this eventually means that citizens are not mobilized.

Table 8: Support for initiatives (cases). Reference: Author

Support for initiatives			
Answer options	**Frequency**	**Percentage**	**Cumulative**
Disagree	2,00	4,88	4,88
Neutral	8,00	19,51	24,39
Agree	20,00	48,78	73,17
Totally agree	11,00	26,83	100,00
Total	41,00	100,00	

Therefore, in this research, the indicator for being a safe haven is the support that is given by municipalities for initiatives. This is a logical remainder of the other indicators as it best indicates when an experiment can be regarded as a safe haven. That is when it is safe to create visions in an initiative that is supported by a local government (Smith & Raven, 2012). Table 8 presents that there are almost no cases that that do not support initiatives (N=2). Which forms a valuable insight for the analysis that is made in chapter 5. Being a safe haven has been given the letter 'Z' in the qualitative comparative analyses. Here the cross over point is set at 2.99, in this way the neutral scores are included.

4.4 Competent Participants

The choice has been made to combine all indicators that are linked to the condition competent participants. These are formed by the two frontrunner variables: Are there frontrunners (1) that want to trade of resources, time and money, to stimulate the process and influence other participants, and are there frontrunners (2) that have made substantial energy renovations to their households. Furthermore, it was tested if these frontrunners do influence the other inhabitants in a positive matter. And last the variable: 'are participants open for new knowledge'. The Cronbach's Alpha shows, with a value of 0.7629 that statistically seen it is meaningful to combine the variables. The condition competent participants is thus based on the combined indicators that are stated above and is given the letter 'B' in the qualitative comparative analyses. The condition competent

participants is standardized in the same way as the condition for being a safe haven. Where fully out is presented as 0 and fully in is set at 1, the crossover point is set at 2.99. Here again the neutral score is taken as more in than out of the set.

It is interesting to see how the competent participants are divided over the cases (Table 9). This makes it possible to see whether, in current practice, mainly neighborhoods where there are participants who already agree with sustainable beliefs are selected. Or that mainly experiments are selected, where there is a group of participants that are yet to be convinced of more sustainable beliefs. Table 9 shows that most cases are found to have not so competent participants. The cumulative percentage of cases below the value of 3 is circa 75 percent.

Table 9: Competent Participants score. Reference: Author

Score Competent Participants	Frequency	Percentage	Cumulative
0,00	2,00	4,88	4,88
0,25	1,00	2,44	7,32
0,50	1,00	2,44	9,76
0,75	3,00	7,32	17,07
1,00	2,00	4,88	21,95
1,25	1,00	2,44	24,39
2,00	3,00	7,32	31,71
2,25	8,00	19,51	51,22
2,50	3,00	7,32	58,54
2,75	7,00	17,07	75,61
3,00	4,00	9,76	85,37
3,25	2,00	4,88	90,24
3,50	1,00	2,44	92,68
3,75	2,00	4,88	97,56
4,25	1,00	2,44	100,00
Total	41	100	

4.5 Principled Engagement

A total of five different types of meetings have been included in the survey. In the five different types of meetings there is asked about the number of people in the meetings, the number of meetings and whether the attendance at the meetings is a representation of the people in the neighborhood. The five types of meetings can be divided into two different main variables: Collective meetings and individual meetings. The types of meetings connected to the main variables are given below.

This means that a number of the aforementioned variables are combined to form meaningful conditions for the final QCA analyses. Here, a separation is made between the meetings that focus on

individual interaction and those that focus on collective action. The former is measured by combining the following variables: face-to-face meetings (keukentafelgesprekken) and neighborhood/street actions. into a three-point scale, with the following values: 0 when there are no individual meetings, 1 when there was only one of both meetings and 2 when there was implementation of both meetings. It is also noteworthy that when many face-to-face meetings take place in the projects the project are more likely to succeed. Therefore, this variable will also be taken into account in the QCA as a single set. In addition, for the collective meetings a subdivision has been made that looks at the degree of participation in the process. In the reflective monitor an important success condition for citizen mobilization is the appliance of meetings where 'communication is crucial' (Rijksoverheid, 2020)

A division has been made of 5 points. Where 0 is no meetings, 1 is only information meetings, 2 interactive meetings, 3 project and working group meetings, 4 all collective meetings with a score below the median of the number of meetings, 5 all collective meetings with a score above the median of the number of meetings. The variable that then arises indicates the collective meetings as part of principled engagement. Within the final qualitative comparative analyses, the collective meetings condition has been given the letter 'M'. The condition individual meetings is indicated with the letter 'P'. Also, the variable indicating the room for participants to speak out in the process, that was measured as part of the condition being a safe haven, can be regarded as an indicator for principled engagement.

The foregoing indicators were all put to the test in the fuzzy set analysis, it can be argued that the variable collective meetings has the most meaningful results. This can be logically explained, as it is the most common approach of communication in the heat transition. The reflective monitor (2020) shows that the more citizens are involved and can contribute to the process, the more support there is for the heat transition. Within neighborhood approaches there is a variety of meetings that can be applied. For this research the different types of meetings are combined into one condition. Within this condition values are ranging from 0 when there are no meetings applied to 5 when all meetings are applied with thorough involvement of citizens. Therefore, the anchors set for this condition are 0 (fully out), 3.01 (cross-over point) and 5 (fully in). Three was valued to be more out than in, because the value three is linked to just one of the meetings addressed. From the value 4 up until 5 all meetings are applied, meaning that there is a thorough process of connecting with participants.

4.6 Funding availability

The variable created to indicate the condition extra resources is 'subsidy' and consists of the textual information resulting from the question 'who finances a certain part of the project'. The variable was

therefore created manually and supplemented with information from project websites, the local neighborhood and energy monitor (2019) and the reflective monitor of the 'Proeftuinwijken' (Rijksoverheid, 2020). The variable 'subsidy' is measured on a binary scale, i.e. is there (1) or is there no extra funding (0) to support the project. The cross table between the outcome variable and subsidy gives valuable insights regarding the characteristics of the funding availability (Table 10). Here, it is presented that most cases that are not successful are found to not have funding availability. In contradiction the cases that are found to be successful do make use of a certain funding. The condition 'funding availability is characterized as subsidy in the analysis and has been given the letter 'G' in the fuzzy set analysis.

Table 10: Success Measurement vs. Subsidy. Reference: Author.

	Subsidy		
Successmeasure	**0**	**1**	**Total**
1,00	2,00	0,00	2,00
2,00	2,00	0,00	2,00
2,50	3,00	0,00	3,00
3,00	6,00	4,00	10,00
3,25	4,00	2,00	6,00
3,50	1,00	3,00	4,00
3,75	0,00	3,00	3,00
4,00	1,00	2,00	3,00
4,25	0,00	1,00	1,00
4,50	1,00	4,00	5,00
5,00	0,00	2,00	2,00
Total	20,00	21,00	41,00

Also, data was gathered related to the costs made by the projects with regard to different steps in a neighborhood approach. However, these costs are related to the activities that took place in the experiment. This resulted in a low response on the variables indicating the costs. Low response leads to limited representativeness. Therefore, this research chooses to leave out a variable that indicates the total costs. The costs that are presented in the dataset show that the costs for the definite implementation are very high, but only very few cases have indicated these costs. Most cases are covered in the variable that indicates if there are costs made for communication (N=18). These costs are not very high but do show that most resources are put into the communicative action in the cases. In contradiction only limited resources are put into communication tools like applications that provide for information about sustainability measures (N=3).

4.6.1 Experienced leading actor

The condition 'experienced leading actor' was measured with several indicators that are given in the operationalization. When looking at the crosstab (table 10), where first the variables 'is there a leading actor' and 'the leading actor has experience' are combined into a dichotomous condition. With the value 0 represents a project that an inexperienced leading actor (or the leading actor is absent) and 1 represents that there is an experienced leading actor. It is obvious that most unsuccessful projects do not have an experienced leading actor and most projects that are successful do have an experienced leading actor. In total 22 cases have an experienced leading actor.

Obviously, fuzzy set analysis does not analyze mere relation scores, as indicated in crosstabs. Therefore, the variable 'experience of the leading actor' was standardized for the analysis. In this standardization the value zero stands for the absence of an experienced leading actor and the value 5 for a leading actor with a lot of experience. The anchors for the standardization of this condition are set at 1 (fully out), 2.99 (cross-over point) and 5 (fully out). The experienced leading actor condition has been given the letter 'A' in the qualitative analyses.

Table 11: Success measurement vs. Leading actor. Reference: Author

	Leading actor		
Successmeasure	**0**	**1**	**Total**
1,00	2,00	0,00	2,00
2,00	1,00	1,00	2,00
2,50	2,00	1,00	3,00
3,00	4,00	6,00	10,00
3,25	6,00	0,00	6,00
3,50	3,00	1,00	4,00
3,75	0,00	3,00	3,00
4,00	0,00	3,00	3,00
4,25	0,00	1,00	1,00
4,50	1,00	4,00	5,00
5,00	0,00	2,00	2,00
Total	20,00	21,00	41,00

4.6.2 Case specifics

Some variables included in this research are not strongly part of a certain condition. The first case specific that is addressed is the classification of cases into the program they are part of. Out of the 41 cases that are researched, 6 cases are classified as Greendeal projects, 14 cases are classified as 'Proeftuinwijken' and 21 cases are classified as Heat Initiatives. Another variable was set up indicating the main focus of the project. That can be divided in projects that are aimed at collective heat solutions and projects that target individual heat solutions. However, the dataset shows that

there are only four projects aimed at individual heat solutions. The technologies that are argued to be in this group of individual heat solutions are all electric solutions and projects mainly aimed at isolation. Most cases show that they aim to introduce a heat network, that can be fed with residual heat from waste burning installations, residual heat from water/wastewater, or collective heating systems with (seasonal) buffers (WKO). Rotmans (2019) shows in an essay about transition approaches for natural-gas free neighborhoods that there is not one technological solution applicable in a neighborhood approach.

Rotmans (2019)also shows that there are many different technical solutions that all contribute to the heat transition. At the basis of these techniques is actually always some sort of heat network. The challenge is to set up these networks in such a way that multiple sources can be connected to them, which can be replaced over time by more sustainable sources (hybrid heat networks). This means that there is no reason to argue that one of the techniques is the best, a combination of different techniques is in fact. The context is important for the right choice with regard to an alternative heat supply, where tailor-made solutions are a guarantee for success.

The duration, this is the time from start project until now (2020), is a variable that was intended to estimate if the time in the process also produces the outcome. From a first thought, one could assume that the longer a project runs, the more successful it will be. However, the fuzzy set sufficiency score indicates that there is only a moderate subset relation between the duration of a project and successful citizen mobilization (.680). This shows that the duration of the project, probably leads to vague results in the final analysis. Where a long process does not always mean that the project becomes more successful. The longest duration of the cases researched is 6 years, where most cases' duration is shown to be around 2 years. The duration of projects and results gained with regard to the 'Proeftuinen' is also criticized, where it is stated that the first neighborhoods were already experimenting in 2018. With the added resources a quantity of 2000 homes should have been made free of natural gas between 2018-2019, this was not accomplished in the time span given.

4.7 Overview and demarcation

The outcomes of the survey and descriptive statistics that were mentioned in this chapter, were given to describe the outcome variable and conditions. The conditions shown in table 12 are based on the theoretical background and the elaboration of the outcomes. These conditions are presented in the right column of table 12. The column in the middle of table 12 presents the conditions that together form the combination of conditions for the analysis. This results in the set Y = H Z B M G A notice that the variables are linked to a condition as described above.

Table 12: Description of analyzed sets. Reference: Author

Outcome variable	Combination of conditions	Conditions described
Y = successmeasure	Y = H Z B M G A	- Scale (H) - Support for initiatives (Z) - Competent participants (B) - Collective meetings (M) - Funding availability (G) - Experienced Leading actor (A)

5 Analysis

This chapter builds on the assumptions and information given in the previous chapters. Furthermore, it will elaborate how the combinations of conditions should and can be interpreted in order to answer the sub questions and main question. Ragin (2009) describes a number of sequential steps for the analysis with the QCA-method. First, the sufficiency and necessity scores have to be determined and elaborated. Second, a truth table has to be defined with all 'bestfit' combinations for the cases studied. Third, the Consistency of Fuzzy Subset Relations will be assessed. Last, the final reduction set with consistency and coverage scores will be addressed.

To begin with, it is important to understand that the number of conditions chosen in this research is based on methodological choices. With too many conditions selected and too few cases studied, the problem of 'limited diversity' can arise. Limited diversity occurs when a large amount of conditions is researched against a limited number of cases. The danger exists that a researcher can only give individual explanations instead of insights to the patterns of the complex causalities that are formed within the cases. Thus, the complex causality that can be explained by the cases studied is enhanced, when a limited number of conditions is selected. Berg-Schlosser et al. (2009) discuss that, the number of conditions should not outreach the amount of ten. Also, there must be no more conditions selected than the number of cases divided by three. Therefore, in order to create a research that gives better insights into the complex causal mechanisms regarding successful citizen mobilization in the heat transition, the choice has been made to limit the number of conditions to six. This applies to the six success conditions that are addressed in the theoretical framework. This makes for (2^6) 64 possible combinations where successful citizen mobilization could occur.

5.1 Addressing Sufficiency and Necessity scores for single sets

The subset relation forms the key set theoretic relation in the study of causal complexity. If there are cases sharing causally relevant conditions, that in turn uniformly exhibit the same outcome. Then these cases form a subset of instances of the outcome (Ragin, 2009). This can best be summarized by the following definition: 'fuzzy subset relation exists when the membership scores in one set are consistently less than or equal to their membership scores in another (Ragin, 2006, p. 6).

Such a subset relation of causally relevant conditions might signal that a condition is sufficient for the outcome. Ragin (2009) therefore argues that it is important to first address the sufficiency of a single set. The calculation of set theoretic sufficiency is as follows:

"Sufficiency ($Xi \leq Yi$) = $\sum(\min(Xi,Yi)/ \sum(Xi)$"

Here, the 'min' indicates that the lowest of the two values has to be selected. When all Xi values are less than or equal to their equivalent Yi values, the sufficiency score will be 1.00. Sufficiency thus shows Xi as a subset of Yi, in other words 'if X then Y. High sufficiency scores indicates that the subset may be interpreted as sufficient for the outcome (Ragin, 2009).

After addressing sufficiency scores one can determine if the condition is also necessary for the outcome. A condition is necessary when the membership in the outcome is consistently less than or equal to the membership in the subset ($Yi \leq Xi$). High necessity scores indicate that the outcome Y can only occur if the cause Xi (condition) is present. The following measure shows the subset relationship indicating of necessity:

"Necessity ($Yi \leq Xi$) = $\sum(\min(Xi,Yi)/ \sum(Yi)$"

Within this formula the 'min' indicates the lowest score of both measures. When all Yi values are less than or equal to the Xi values, a necessity score of 1.00 is found.

In table 13 the sufficiency and necessity scores are given. The first column shows the single sets analyzed. The second column shows the sufficiency scores of the corresponding sets. The first row in the table again shows the single sets. The second row shows necessity scores for the corresponding single sets. The abbreviations represent the conditions mentioned in the theoretical section.

Table 13: Sufficiency and Necessity Matrix. Reference: Made by author in Stata.

Sufficiency and necessity matrix							
	Y	H	Z	B	M	G	A
Y	1,00	0,59	0,95	0,53	0,67	0,64	0,68
H	0,58	1,00	0,79	0,37	0,41	0,52	0,56
Z	0,68	0,58	1,00	0,41	0,56	0,57	0,60
B	0,92	0,65	0,98	1,00	0,81	0,69	0,84
M	0,78	0,49	0,92	0,55	1,00	0,71	0,74
G	0,69	0,57	0,84	0,43	0,64	1,00	0,63
A	0,77	0,65	0,94	0,55	0,72	0,66	1,00

Notice, that all consistency scores indicating sufficiency are higher than .500, which means that all the membership scores in the single sets are consistently less than or equal to the membership in the outcome set. This shows that there are subset relationships between the single sets and the outcome variable. Table 13 also shows that all single sets have differing sufficiency and necessity scores.

The single set that has the highest sufficiency for successful citizen mobilization is the presence of competent participants (B) in the neighborhood (sufficiency score of 0.920). Meaning that this

condition is almost always sufficient for successful citizen mobilization. In contrast, the single set has the lowest necessity score (0.530). This indicates that the condition is not necessary for successful citizen mobilization.

Both the presence of thorough interaction with citizens (Principled Engagement, M) and the presence of an experienced leading actor (A) have relatively high sufficiency scores (0.781 and 0.772). This means that there is a subset relation between both (unique) conditions and successful citizen mobilization. Principled engagement of citizens in the process of an experiment is argued to be an important condition for successful citizen mobilization. However, the single set cannot be seen as a necessary condition for successful citizen mobilization. It is interesting to see that an experienced leading actor is sufficient for successful citizen mobilization as well. As the condition was introduced in an explorative fashion. Still, the condition is not necessary for successful citizen mobilization as the necessity score is too low (0.681).

The support for initiatives in an experiment (Z) has a sufficiency score of 0.682, indicating that the subset is sufficient for successful citizen mobilization. However, in this particular condition the necessity score is relatively high (0.947). This shows that support for initiatives in an experiment is almost always present when successful citizen mobilization occurs. However, as indicated in the results, there are only two cases in the total set that have a low membership score in the subset. This makes it difficult to make statements about the necessity of the support for initiatives, because there are too few cases that have a low membership in the set. This is also portrayed in table 8, where only two cases disagree in giving support to initiatives.

The condition funding availability (G) has a sufficiency score of 0.690, indicating that the single set is sufficient for successful citizen mobilization. The condition is not a necessary condition for successful citizen mobilization, this is indicated by the necessity score of 0.644.

The condition that shows if an experiment is at neighborhood level shows the lowest sufficiency score for successful citizen mobilization (0.579). This shows that there is low evidence in the cases that an experiment should be initiated at neighborhood level to let successful citizen mobilization occur. This may arise from the fact that heat networks often require a larger scale than a neighborhood or district to form a profitable project. In contradiction, experiments at neighborhood level, provide for more thorough learning processes. This is because in an experiment at neighborhood level citizens can be better involved and personal contact is possible.

This research focusses on the complexity that is inherent to the different cases. The output, that is formed by the reduction of conditions, is given in formula's that are processed with the fuzzy

command in Stata (Longest & Vaisey, 2008). However, as in the QCA-method projects, these formulas need further explanation and in-depth investigation. This is done with the use of qualitative data that is gathered during the process of researching. Therefore, at first an overview is given of the cases related to the combination, where a Bestfit value shows which cases have or do not have the conditions for successful citizen mobilization.

5.2 Truth Table Analysis: Bestfit Configurations

The advantage of using a fuzzy set QCA is the possibility of combining single sets into combinations of conditions. That in turn suggest different theoretical pathways to the successful mobilization of citizens in experiments placed in the Dutch heat transition. However, with fuzzy set QCA there is no straightforward way to sort cases according to the combinations of cases they display. As with fuzzy set QCA the membership scores in the outcome could be unique. Still it is useful to set up a truth-table. It is obviously not possible to isolate cases that share a specific combination of conditions, because of this uniqueness. Rather, cases can have partial membership in the displayed combinations of conditions (Ragin, 2009).

Table 14 shows the quantity of cases (last column) according to their 'Bestfit' configurations (penultimate column).The 'Bestfit' configuration represents the membership scores of the different conditions, These conditions are indicated, in the first column of table 14, with a given letter. A capital letter, for example 'A', indicates that the membership score of the condition A is higher than .50. In contrast, lowercase letters (a) indicate membership scores that are lower than 0.50. Capital letter thus indicate that a condition is more in than out the set and lowercase letters indicate that a condition is more out than in the set (Ragin, 2009).

Table 14: Bestfit configurations. Reference: Made by Author in Stata.

Municipality	Success	Y	H	Z	B	M	G	A	Bestfit	Quantity
Culemborg (CUL)	4,50	0,89	1,00	0,95	0,76	0,95	1,00	0,95	HZBMGA	4,00
Vlieland (VLI)	4,00	0,78	1,00	0,82	0,87	0,95	1,00	0,82	HZBMGA	4,00
Zutphen (ZUT)	4,50	0,89	1,00	0,82	0,60	0,82	1,00	0,82	HZBMGA	4,00
Amsterdam	3,75	0,70	1,00	0,82	0,76	0,82	1,00	0,82	HZBMGA	4,00
Tytsjerksteradiel	5,00	0,95	1,00	0,82	0,50	0,12	1,00	0,50	HZBmGA	2,00
Loppersum	4,50	0,89	1,00	0,95	0,68	0,27	1,00	0,82	HZBmGA	2,00
Leiden	1,00	0,05	1,00	0,82	0,50	0,05	0,00	0,27	HZBmga	1,00
Drimmelen	3,75	0,70	1,00	0,82	0,32	0,95	1,00	0,82	HZbMGA	3,00
Nieuwolda Wagenborgen	3,00	0,42	1,00	0,82	0,32	0,82	1,00	0,95	HZbMGA	3,00
Tilburg	4,25	0,85	1,00	0,95	0,25	0,82	1,00	0,50	HZbMGA	3,00
Oisterwijk	4,50	0,89	1,00	0,82	0,41	0,82	0,00	0,82	HZbMgA	1,00
Ameland	3,75	0,70	1,00	0,95	0,25	0,12	1,00	0,82	HZbmGA	1,00

Leidschendam-Voorburg	3,50	0,61	1,00	0,82	0,32	0,12	1,00	0,05	HZbmGa	2,00
Noordoostpolder	3,25	0,50	1,00	0,95	0,25	0,12	1,00	0,27	HZbmGa	2,00
Heusden	4,00	0,78	1,00	0,95	0,41	0,50	0,00	0,50	HZbmgA	5,00
Wierden-Enter	2,50	0,27	1,00	0,50	0,02	0,05	0,00	0,50	HZbmgA	5,00
De Fryske Marren	3,00	0,42	1,00	0,50	0,41	0,05	0,00	0,82	HZbmgA	5,00
Tilburg	2,00	0,16	1,00	0,50	0,18	0,12	0,00	0,50	HZbmgA	5,00
Het Hogeland	3,00	0,42	1,00	0,82	0,07	0,12	0,00	0,82	HZbmgA	5,00
Den Bosch	2,50	0,27	1,00	0,82	0,25	0,50	0,00	0,12	HZbmga	4,00
Rotterdam	3,25	0,50	1,00	0,95	0,25	0,27	0,00	0,27	HZbmga	4,00
Heusden	2,00	0,16	1,00	0,50	0,01	0,05	0,00	0,05	HZbmga	4,00
Midden-Drenthe	3,25	0,50	1,00	0,50	0,03	0,05	0,00	0,05	HZbmga	4,00
Hengelo	3,00	0,42	0,00	0,82	0,60	0,95	1,00	0,95	hZBMGA	1,00
Nijmegen	3,50	0,61	0,00	0,82	0,50	0,82	1,00	0,27	hZBMGa	1,00
Sudwest Fryslan	2,50	0,27	0,00	0,95	0,50	0,95	0,00	0,27	hZBMga	1,00
Sliedrecht	3,50	0,61	0,00	0,82	0,25	0,82	1,00	0,82	hZbMGA	3,00
Eindhoven	3,00	0,42	0,00	0,82	0,41	0,95	1,00	0,82	hZbMGA	3,00
Den Haag	4,00	0,78	0,00	0,50	0,05	0,82	1,00	0,82	hZbMGA	3,00
Nijmegen	3,25	0,50	0,00	0,82	0,25	0,82	1,00	0,27	hZbMGa	2,00
Haarlem	4,50	0,89	0,00	0,82	0,41	0,95	1,00	0,27	hZbMGa	2,00
Purmerend	5,00	0,95	0,00	0,95	0,25	0,27	1,00	0,50	hZbmGA	1,00
Deventer	3,00	0,42	0,00	0,82	0,41	0,27	1,00	0,27	hZbmGa	1,00
Apeldoorn	3,00	0,42	0,00	0,82	0,03	0,50	0,00	0,95	hZbmgA	1,00
Amsterdam	3,50	0,61	0,00	0,95	0,01	0,50	0,00	0,05	hZbmga	5,00
Delfzijl	3,25	0,50	0,00	0,50	0,18	0,05	0,00	0,05	hZbmga	5,00
Katwijk	3,00	0,42	0,00	0,95	0,18	0,12	0,00	0,05	hZbmga	5,00
Almere	1,00	0,05	0,00	0,50	0,05	0,05	0,00	0,27	hZbmga	5,00
Boxtel	3,00	0,42	0,00	0,82	0,03	0,05	0,00	0,05	hZbmga	5,00
Amsterdam	3,25	0,50	0,00	0,18	0,41	0,82	0,00	0,05	hzbMga	1,00
Peel en Maas	3,00	0,42	0,00	0,18	0,02	0,05	0,00	0,27	hzbmga	1,00

Table 14 is sorted according to the Bestfit configurations. The more conditions are present in the subset, the higher the configuration is displayed in table 14. The table also shows the standardized scores for the single set variables where values close to zero indicate that the condition is more out than in the set and the values close to one are more in than out the set. The non-standardized success measure is also included to show how the configurations are related to success. Successfulness is indicated with the letter Y in this research. Here again when successful citizen mobilization occurs the outcome is presented with a capital letter 'Y'. If successful citizen mobilization does not occur, the outcome variable is presented with a lowercase letter 'y'.

The configurations hZbmga and HZbmgA both have 5 best fitting cases. These are the cases in Amsterdam, Delfzijl, Katwijk, Almere and Boxtel for the configuration (HZbmga) and Heusden, Wierden-Enter, De Fryske Marren, Tilburg and Het Hogeland for the configuration (HZbmgA). For both the combinations the scores in the outcome variable (successful citizen mobilization) are rather low. Both configurations show that when there are many conditions with a membership lower than 0.5 the outcome does not occur. Both in the first and second combination the condition H is present, indicating that the cases are placed at neighborhood level. Notice that the support for initiatives (Z) is almost, except for one configuration, always present in the given configurations. This indicates that Z is present in all cases. However, it does not mean that Z always leads to successful citizen mobilization.

Another configuration that is highlighted is the one in which all conditions have a high membership score (HZBMGA). If all conditions have high membership, often successful citizen mobilization occurs. The table shows that (HZBMGA) does not have any cases where no successful citizen mobilization has taken place. The cases where all conditions are applied are: Culemborg, Vlieland, Zutphen and Amsterdam. This underpins the theoretical views expressed in Chapter 3. Thus, it can be argued that when all conditions are present an experiment should become successful. Within this combination it is not necessary to have thorough involvement of citizens in the process. The cases Tytsjerksteradiel and Loppersum are both successful experiments and best fit the configuration HZBmGA.

A remarkable finding in the analysis is the case of Purmerend, which is a highly successful experiment. The 'Programma Aardgasvrije Wijken' shows that Purmerend is the first experiment where private homes have been made natural gas-free (PAW, 2019). However, it shows the configuration hZbmGA that is only applicable for his case. In this case, only the membership for the support for initiatives, a funding availability and an experienced leading actor are high. Thorough involvement of citizens was not present and there are also no competent participant present in the case. The case proves that with an experienced leading actor, funding availability and a neighborhood that is larger than the neighborhood level successful citizen mobilization can occur.

5.3 Consistent combinations of conditions for the reduction set

Clearly, with the number of possible combinations (64) there are more causally relevant combinations that can produce the outcome. These other combinations can be interpreted as sufficient for the outcome, when covering a high consistency score. Two values are needed to calculate the consistency score (that is calculated in the same way as sufficiency): The membership in the combination of conditions (Xi) and the membership scores in the outcome (Yi). The consistency score should ideally be close to 1. This is the case when most/all Xi values are less than or equal to

the Yi values. This means that one can make the statement that X is a subset of Y or 'if X then Y' (Ragin, 2006).

With the foregoing steps taken, it is important to analyze which combinations of conditions of successful citizen mobilization emerge when the complexity is reduced. It is important to first determine a cut-off value for combinations of conditions that are consistent with the outcome variable. Ragin (2006) elaborates on this cut-off value and argues that .70 is a low cutoff value for reducing the combinations of conditions. A more stringent cutoff value is formed with 0.80. This cutoff value is used in this research, as it results in more narrowly circumscribed formulas. The combinations of conditions that have a score that is higher or equal to this cut off value are given in the second column of table 15.

If the combinations (as a subset of the outcome) have a consistency score above this cut off value, these combinations are coded as consistent and are taken into the reduction. It can be argued that X is almost always sufficient for the outcome Y when the combinations are above this cut off value. The number of cases that have membership scores higher than 0.5 in the given combination of conditions are presented in column 3 of table 15.

In this research 'Logical Remainders' are also taken into the analysis. These are the rows in table 15 without cases. This means that there are no empirical instances for any of the combinations given, but the consistency of the combination is higher than 0.8. In this way an intermediate solution is analyzed. This means that the logical remainders are used, that according to the researcher's knowledge 'make sense' are incorporated.

Table 15: Consistent combinations (0.800)

Combination of conditions	Consistency score of the subset relation with the outcome	Number of cases with membership (>0,5) in causal combination)	Outcome based on consistency score
hzbmGa	1,000	0	Remainder
hzbmGA	1,000	0	Remainder
hzbMga	0,908	1	1
hzbMgA	1,000	0	Remainder
hzbMGa	1,000	0	Remainder
hzbMGA	1,000	0	Remainder
hzBmga	1,000	0	Remainder
hzBmgA	1,000	0	Remainder
hzBmGa	1,000	0	Remainder
hzBmGA	1,000	0	Remainder
hzBMga	1,000	0	Remainder

hzBMgA	1,000	0	Remainder
hzBMGa	1,000	0	Remainder
hzBMGA	1,000	0	Remainder
hZbmGa	0,912	1	1
hZbmGA	1,000	1	1
hZbMga	0,852	0	Remainder
hZbMgA	0,926	0	Remainder
hZbMGa	0,922	2	1
hZbMGA	0,911	3	1
hZBmga	1,000	0	Remainder
hZBmgA	1,000	0	Remainder
hZBmGa	1,000	0	Remainder
hZBmGA	1,000	0	Remainder
hZBMgA	0,998	0	Remainder
hZBMGa	1,000	1	1
hZBMGA	0,931	1	1
HzbmGa	1,000	0	Remainder
HzbmGA	1,000	0	Remainder
HzbMga	1,000	0	Remainder
HzbMgA	1,000	0	Remainder
HzbMGa	1,000	0	Remainder
HzbMGA	1,000	0	Remainder
HzBmga	0,861	0	Remainder
HzBmgA	0,879	0	Remainder
HzBmGa	1,000	0	Remainder
HzBmGA	1,000	0	Remainder
HzBMga	1,000	0	Remainder
HzBMgA	1,000	0	Remainder
HzBMGa	1,000	0	Remainder
HzBMGA	1,000	0	Remainder
HZbmGa	0,900	2	1
HZbmGA	0,981	1	1
HZbMga	0,881	0	Remainder
HZbMgA	1,000	1	1
HZbMGa	1,000	0	Remainder
HZbMGA	0,927	3	1
HZBmgA	0,874	0	Remainder
HZBmGa	1,000	0	Remainder
HZBmGA	1,000	2	1
HZBMga	1,000	0	Remainder
HZBMgA	1,000	0	Remainder
HZBMGa	1,000	0	Remainder
HZBMGA	0,980	4	1

5.4 Consistency and Coverage for final reduced subsets

With the use of Boolean Algebra, a minimum configuration reduction set can be achieved. Boolean Algebra builds on the notion that there are two possible membership scores for each set included that is 'in' (A) or 'out'(a). For example, when the combination ABC and ABc both produce the outcome. Logically the set C can be left out as it has no explainable value, because C can be present or not present. The consistent combinations presented in the previous paragraph are reduced (with Boolean Algebra) to the subsets addressed in table 15.

Table 15 also shows the consistency scores and the coverage scores for the subsets. Here again, set-theoretic consistency assesses the degree to which cases sharing a given combination of condition, agree in displaying the outcome (Ragin, 2006, p. 2). Ragin (2009) argues that the consistency has to be established first. After that, it can be established what the coverage scores are. The coverage scores assess the degree to which a cause or causal combinations accounts for instances of an outcome. Ragin (2006, p. 11) addresses that 'the measure of fuzzy set coverage is simply the overlap expressed as a proportion of the sum of the membership scores in the outcome (Y). The following formula can be used to calculate the coverage score:

"Coverage ($X_i \leq Y_i$) = $\sum(\min(X_i,Y_i)/ \sum(Y_i)$"

Within the final reduction subsets, a distinction is made between raw coverage and unique coverage. Raw coverage shows the total membership of the combination in the outcome. The coverage scores can be split up into raw coverage and unique coverage (Ragin, 2006, p. 2). The various subsets can overlap making it that the sum of raw coverage scores does not automatically lead to the total coverage. The unique coverages scores can be calculated by subtraction, indicating how instances of the outcome are assessed by the combination alone without other subsets (Ragin, 2006).

Underneath table 16, the scores are given for the total coverage and the consistency score. The consistency, the degree to which the empirical evidence is consistent with the outcome, proves to be moderate (0.725). This is probably due to the single subset funding availability, that has a relatively low consistency score in the final reduction subset. The relation could be stronger in order to claim that there is an 'explicit' connection between the subsets and successful citizen mobilization. An explicit connection between the subsets and the outcome could be found when the consistency score would be above the 0.800 level, that was addressed as the cutoff value. Still the subset relation is consistent with successful citizen mobilization. The coverage score is however relatively high (0.863), indicating that a substantial part of X is covered by Y. Meaning that the evidence found is empirically relevant. The unique coverage of most subsets shows that there is great overlap between

the subsets, indicating that they cannot produce the outcome on their own but are related to other subsets for successful citizen mobilization to occur.

Table 16: Overview of reduced subsets.

Subsets consistent for successful citizen mobilzation(reduced)	Raw coverage	Unique coverage	Solution consistency
1. neighborhoodscale* STCOMPETENTPARTICIPANTS * stcollectivemeetings (h B m)	0,095	0,003	1,000
2. stcompetentparticipants* STCOLLECTIVEMEETINGS (b M)	0,535	0,045	0,890
3. stsupporthaven* STCOMPETENTPARTICIPANTS (z B)	0,218	0,000	0,969
4. STCOMPETENTPARTICIPANTS* STLEADINGACTOR (B A)	0,461	0,000	0,953
5. NEIGHBORHOODSCALE* TCOLLECTIVEMEETINGS (H M)	0,365	0,010	0.871
6. STSUBSIDY (G)	0,644	0,134	0,690

Total coverage: 0.863

Solution consistency: 0.725

In table 16 subset 6 stands out, this is the condition funding availability (stsubsidy G). It has a relatively high raw coverage score in the outcome. However, the consistency score is low in comparison with the set value (.800) > (0.690). This means that the single set is a sufficient condition for successful citizen mobilization on its own. Thus, it does not matter for the funding availability if one of the other conditions has a high or low membership in the set for successful citizen mobilization to occur. The single set is therefore sufficient for successful citizen mobilization. It should be noted that there may be an undefined condition that, together with the condition of funding availability, can still result in successful citizen mobilization.

Subset 1 (hBm) suggests that when membership in the set of competent participants is high, the membership in the neighborhood level variable and the collective meetings variable can be low. This forms a perfect subset relation given the consistency score of the subset (1,000). The raw coverage shows, with a value of 10%, that only a small amount of the instances of successful citizen

mobilization is covered. The unique coverage also shows that the subset is part of alternate paths that are causally related to the outcome.

The competent participants condition, even when other conditions are low, is important for successful citizen mobilization. The reason is that when competent participants are present in an experiment, it is much easier to mobilize them. The low coverage could be explained out of the fact that there are a lot of cases that score low on the condition of competent participants (cumulative 85% below or on the neutral score). This can have two reasons, one being that the cases have deliberately chosen to experiment with neighborhoods that have participants that are 'hard' to mobilize. Or second, that within current neighborhoods there are not that many competent participants present.

These statements can be supported by subset 2 that is causally related to successful citizen mobilization. The combination addresses low membership in the set of competent participants and high membership in the set of collective meetings. The high consistency score (0. 890) indicates that there is a subset relation with successful citizen mobilization. With that the relatively high raw coverage (54%) shows that the subset has substantial empirical evidence for successful citizen mobilization. Still the unique coverage shows that this subset is part of alternative paths that are causally related to successful citizen mobilization. The intensive involvement of citizens can thus lead to successful mobilization, even if the citizens are not considered competent.

The following subset (3) shows that when there is high membership in the competent participants and low membership in the set indicating if there is support for initiatives in an experiment. The raw coverage score of 22% is relatively low. Indicating that there is relatively low relevant empirical evidence that the subset is causally related to successful citizen mobilization. The subset has a strong relation with successful citizen mobilization (0.969). The low membership in the set support for initiatives, is hard to explain as it is often argued that the acceptance of initiatives leads to successful mobilization of citizens (Rijksoverheid, 2019). An explanation could be that if there are competent participants the support for initiatives is no longer needed. Competent participants are already open for new knowledge or are a frontrunner in the experiment.

The following subset (4) that is formed in the analysis demonstrates that if the membership scores in both the conditions competent participants and experienced leading actor are high, successful citizen mobilization occurs. The subset is highly consistent with the outcome, meaning that there is a strong relation (0.953). The coverage score is with 46% relatively high, which indicates that the subset has deliberate empirical relevance to address that the subset is related to successful citizen mobilization.

This might possibly explain the relation between both single sets, that let successful citizen mobilization occur.

Subset 5 shows that when the membership in both the condition neighborhood level experiments and the collective meetings condition are high, successful citizen mobilization occurs. The relatively high consistency score of 0.871 and the substantial coverage score of 37% show, that it is relevant to state that there is a subset relation that has empirical relevance for successful citizen mobilization. The combination shows that the experiments should be placed at neighborhood level. It also shows that it is important to acquire knowledge and experience for making a neighborhood natural gas-free. This can only be done when there is intensive involvement and interaction with the participants in the neighborhood. The combination assessed is therefore a very important one in confirming that the recommended steps are taken and lead to successful mobilization of citizens.

In summary, several subsets are given that are reduced from the combinations that have a consistency score of above the 0.800. The combined subsets have a coverage that indicates that there is substantial empirical relevance for the subsets analyzed. Although the consistency score shows that there is a moderate connection between the outcome and the subset. With regard to the single sets it is noticed that the condition competent participants is most sufficient for successful citizen mobilization. This is also covered in the combinations where the competent participants condition shows that even if other conditions have low membership in the outcome set, successful citizen mobilization could still occur. The single set that alone is viewed as a subset of the outcome is the funding availability, indicating extra financial resources. The coverage of this subset is high, showing that there is empirical relevance in the subset for successful citizen mobilization. The subset funding availability alone is however not highly consistent with the outcome. Thus, there are undefined subsets that could produce the outcome together with the subset funding availability. Theoretical understandings show that extra financial resources do have a relation with the successfulness of citizen mobilization. The note is made that the extra financial resources are sometimes used for a purpose other than initially intended. Furthermore, both subsets indicating high membership of the conditions in the subset are proven to be consistent with the outcome variable, with that there is enough empirical evidence for the subsets. This means that with a variety of conditions with a high membership in the set, successful citizen mobilization occurs.

6 Conclusion and Discussion

This chapter shows the main findings of the study. With these findings, an attempt is made to provide an answer to the main question and the sub-questions. In the discussion the limitations of the study will be addressed. Based on the conclusion and discussion, recommendations can be made.

6.1 Conclusion

The research was primarily designed to gain a better understanding of the success of neighborhood approaches in the Dutch heat transition. In order to form a basis for this research, it was decided to build on earlier research into the functioning and success of experimenting for sustainability transitions. The cases chosen in this research are also experimental in nature. They are in fact exploring manners to make neighborhoods free of natural gas. The success factors used in this research are based on the studies by Van Buuren et al. (2016) & (Vreugdenhil et al., 2010). Both studies show that even with these factors it is not written in stone that success occurs. 41 cases from a total of 93 heat-related projects are empirically tested in this research. In this way, approximately 44% of the projects in the Dutch heat transition are covered in this study. It can therefore be assumed that this study provides reasonable evidence to give answers to the main question and sub questions.

Sub-question 1:

To what extent have citizens actually been mobilized in the experiments/initiatives, in the Dutch heat transition?

It turned out to be quite difficult to determine the measurement for successful citizen mobilization. This is not only the case for this research but is also experienced by other (research)organizations that focus on the projects in the heat transition (BZK, 2020). This is due to the fact that the goals that are set in the 'Programma Aardgasvrije Wijken' are constantly adjusted by the Dutch government. This research has chosen to base the measurement of success on the actual choices and perceptions of citizens regarding the implementation of sustainability measures. The absolute results from the cases in this research show that the majority of citizens are aware of sustainability measures and plan to implement them. In a slight minority of cases sustainability measures have been implemented by citizens to/in their households. Thus, the real steps to become natural gas free have yet to be made. However, awareness, to the point where citizens are convinced of taking sustainability measures, is an important but difficult goal to achieve. In addition, as described below, collective heat alternatives are often proposed. The actual implementation of these sustainability measures therefore depends on, for example, the installation of a heat network or another form alternative heating.

The report by the ‘Algemene Rekenkamer’ concludes that the development and implementation of the 'Programma Aardgasvrije Wijken' in its current form is insufficient to contribute to the objectives of the Minister. This is because only a few of the 2,000 houses targeted have been made natural gas-free. Ultimately, in contrast to the report of the 'Algemene Rekenkamer', this study shows that the focus should not be so much on the actual households that have been made natural gas-free (BZK, 2020). On the contrary, there should also be looked at the process of raising awareness in the neighborhoods. Here, learning about the task and being able to work on organizational preconditions is a key to success. Those successes are not only determined by hard pre-set hard targets. The goals should not be confused with the means to achieve an energy-neutral society. Natural gas-free can be a means to a more sustainable society, but there are also other sustainable measures to achieve this (SCP, 2020).

Sub-question 2:

What conditions drive the mobilization of citizens in the experiments/initiatives, in the Dutch heat transition?

In the analysis of this study, first of all the single sets have been described. Obviously, it is more interesting to look at patterns and relationships between different combinations of conditions and successful citizen mobilization. Below these conditions and combinations of conditions are elaborated.

At first the condition that shows the support for initiatives by the municipality is addressed. In the analysis the consistency for a necessary subset relation is high. This indicates that the condition ‘support for initiatives’ is necessary for successful citizen mobilization. The successful cases that are analyzed show a high membership in the set of support for initiatives. There is however low empirical evidence for the subsets where there is low support for initiatives and where, at the same time, the outcome does not occur. Therefore, it is hard to make substantial statements on the necessity of support for initiatives in experiments in the Dutch heat transition. This is also addressed in the subset where the support for initiatives has a low membership, but in combination high membership in the competent participants set successful citizen mobilization still occurs. As is addressed in multiple studies the support for initiatives and adapting to existing collectives is regarded as an important determinant for successful citizen mobilization (Arentsen & Bellekom, 2014; Hoppe, Graf, Warbroek, Lammers, & Lepping, 2015; PAW, 2019).

The intensive involvement of citizens turns out to be a sufficient condition. Even when other conditions have a low membership, still successful citizen mobilization occurs. This can be logically supported. First of all, by involving people, the local character of the neighborhood is taken into

account. In this way one connects to what is going on in the neighborhood (Heeger & Buitelaar, 2018). Next, people are given the opportunity to have a voice in the process, which can strongly influence the choice of citizens for taking sustainability measures. Communication is key as it leads to learning experiences from both sides. The analysis does however show that intensive involvement is not a necessary condition. For example, if there are competent participants in a neighborhood, there may be no need to thoroughly involve citizens

Competent participants are also important for the successful mobilization of citizens in a neighborhood approach. The main reason for this is that it is ultimately the citizens who make the choice to become more sustainable. This requires that the citizens are at least open to new knowledge about sustainability measures and/or that they themselves are frontrunners in the process. However, it seems that experiments are mainly carried out in neighborhoods where a marginal number of competent participants is present. There are two possible reasons for this: The neighborhoods are chosen because the subsidies given provide for extra room to influence these citizens and bridge the financial gap for citizens that could otherwise not take sustainable measures. The other reason may be that, currently, there are not that many neighborhoods where competent participants are present.

The funding availability is included in the final reduction as a single set. It could be that the funding availability is more sufficient for successful citizen mobilization by adding another unobserved condition. During the explorative interviews, several participants argued that funding availability is needed to get a positive financial result in the business case of a project. The subsidy given aims to finance that part of a sustainability measure that cannot be earned back by the measure that is implemented. The intention of this funding is thus to make alternative heating options more accessible to citizens. However, as also stated in the reflective monitor and the report by the Dutch ministry of BZK, the extra resources are meant as part of the 'Kennis & Leer Programma' (BZK, 2020; Rijksoverheid, 2020). Those extra resources are meant for learning processes in the experiments, but a learning process condition was not applied to the analysis. The lessons learned can be used to speed up the processes of making other neighborhoods natural gas-free. Probably, the funding availability combined with, for example, a condition indicating the importance of learning processes in a neighborhood approach could have led to higher consistency scores for successful citizen mobilization.

This research provides proof for the fact that an experienced leading actor is sufficient for successful citizen mobilization. In combination with already competent participants in the experiment the subset has an even higher consistency score to address that the former combination is sufficient for

successful citizen mobilization. It is clear that the two conditions reinforce each other. An experienced leading actor naturally benefits from participants who are open to sustainability measures. On the other hand, the participants benefit from a leader who ensures that sustainability measures can be made well and swiftly.

In the operationalization of the research, it was decided to make a separation between projects that are based on a collective technological implementation, and projects that are based on processes to socially engage people. However, this distinction is not entirely valid. In the cases researched this division is often not or hardly present. In fact, the two approaches are often combined. It is interesting to see that the vast majority of the cases have indicated that they want to implement a collective alternative as a heating solution. Literature on experiments shows that early studies on niche experiments, mainly address the experiments that are aimed at technological implementations (Kemp et al., 1998). Later, studies criticized the rather technological view and showed that the social processes were of particular importance for the success of an experiment (Brown & Vergragt, 2008; Seyfang & Haxeltine, 2012; van den Bosch & Rotmans, 2008). This is also adressed by the relevant conditions, which show that it is important to support initiatives, to have good participants in the neighborhood and to involve citizens intensively in the process. The social dimension is therefore important for the mobilization of citizens in an experiment. Because in the end, the citizens are the ones who have to make the choice for an alternative heat solution.

For the successfulness of an experiment and the mobilization of citizens in this experiment it is not necessary to be within neighborhood level. As a single set it is argued that experiments within neighborhood level are not sufficient successful citizen mobilization. In combination with competent participants, it could be that even with a low membership in the set successful citizen mobilization occurs. Here again, it is important to realize that the size of a project is also strongly dependent on the sustainability measure that is to be implemented.

Main question

What conditions influence the successfulness of local experiments/initiatives in the Dutch heat transition?

By answering the sub-questions above, an answer can be given to the main question in this research.

Important findings are that the right composition of participants who are open to knowledge or are themselves frontrunners in making their homes more sustainable and/or convince others to take sustainable measures. In this research there are not many cases that have many competent participants in their experiments. The low number (6%) of real competent participants is also

addressed in a report by the 'Sociaal Plan Bureau' (2020). This research indicates that there is a large group of citizens that have great doubt with regard to making their homes free of natural gas in current Dutch society. This is however not directly linked to the definition of competent participants in this research but does address the current context regarding the participants in Dutch Neighborhoods.

There are two singles sets that generate striking outcomes. One, the funding availability within experiments has proven to be sufficient for successful citizen mobilization on it is own. This is addressed as a logical conclusion, where sometimes the funding is however used in a different way than originally intended. Second, the support for initiatives could be regarded as a necessary condition for successful citizen mobilization. However, in the reduced subset where support for initiatives has low membership and the competent participants condition has high membership, still successful citizen mobilization occurs. This means that the condition support for initiatives is not necessary but sufficient. This is due to the fact that most cases in the research highly support initiatives. Here, almost no cases are found that do not support initiatives and where successful citizen mobilization does not occur at the same time.

A very important finding in this research is based on the condition 'Principled Engagement'. The intensive involvement of citizens appears to be an important success condition according to the literature. For example, participation ladders show that the more people are involved, the better a plan can be implemented. However, this study shows that intensive involvement is not always necessary. The degree of involvement strongly depends on the composition of citizens in the neighborhood. In other words, when there are already competent participants present in the experiment intensive involvement is not always needed. Conversely, if there are virtually no competent participants in an experiment, the citizens need to be intensively involved in order for the experiment to be a success.

One last key finding in this research is that when all conditions studied in this research are present in an experiment, citizens are successfully mobilized. Thus, it could be argued that the theoretical understandings are applicable to the experiments in the Dutch heat transition. A prudent conclusion can be drawn that the more conditions have a high membership in the set, the more likely it will be that citizens will be successfully mobilized and consequently that an experiment succeeds.

6.2 Discussion

This research originated from an exploratory question, where conditions and their relation to the successful mobilization of citizens in the Dutch heat transition in the built environment were examined. By building on existing research related to the success of experiments in sustainability

transitions, this research has a strong scientific basis. This research further expands this scientific knowledge by empirically testing the condition of success for a specific type of experiments in the sustainability transition. This data was collected by a self-designed survey, which made it possible to ask questions specific to the subject.

As a result, the self-made survey could be connected to the QCA method. This method turned out to be very suitable for this research, because there are many different complex processes underlying the heat transition. Each case also has its own approach and its own context in which it operates. With the aforementioned survey, the choice was made to add many open questions. This in order to clarify the complexity of some processes. By supplementing this with information from project documents and sites and by comparing the responses for closed question with the open answers, a number of values were adjusted later in the process. These manual adjustments may lead to a lower reliability, because other researchers may make different adjustments. However, the adjustments made are documented in the program that was used for analyzing and described in the chapter on data collection and preparation. Here, the changes made to variables are elaborated on behalf of the added data form project websites and open response questions in the data set.

It turns out to be difficult to obtain real in-depth knowledge about all the cases and thus to fill in all the values correctly. The project websites could be subject to bias from the project initiator themselves. There were also cases that showed other answers in the survey than on project websites. It is then almost impossible for the researcher to address which statements are based on true evidence.

An important benefit of the method is that the researcher is able to address cross-over scores, that indicate when a condition is more in than out the set (or vice versa). This applies to the questions where a Likert-scale measure was used to measure the viewpoints of the participants in the survey. When a neutral score is addressed in this measurement, no real statements can be made for that particular case. However, with deliberate elaboration the cross-over points in the QCA-analysis where set at a point where the neutral score would be in- or excluded. This was, for example, done for the success condition (outcome variable) in this research.

The cross-over point in the condition of successful resident mobilization has been set extra to 3.25, because there has to be actual mobilization. Here the neutral score is not regarded as contributing to successful citizen mobilization. In case of a neutral score, it may just be that a large proportion of the citizens are not even aware of sustainability measures yet. By taking a slightly higher cross-over point, this mobilization is guaranteed. With that, the indication of success takes good account of the current criticism of failure to achieve objectives. By not only starting from the ultimate goal (natural

gas-free) but also looking at awareness and whether the process in the experiments contributes to this awareness.

Finally, an important limitation of this study is that with a QCA method only a limited number of conditions can be investigated. If more conditions would be added to the analysis, this would constitute 'limited diversity'. This means that the representativeness of the (combinations of) conditions in the study decreases as more conditions are added. This is because with more conditions more combinations are possible. Ultimately the cases only explain a small part of the combinations and as a researcher it is then irrelevant to make statements. With 41 of in total 93 cases represented in the research the empirical evidence of this study is relatively high. With that it can be argued that 'limited diversity' is not a problem in this research as there is deliberately chosen to limit the number of conditions.

6.3 Recommendations

The results and conclusions presented show that this research contributes to empirical knowledge about the current situation of neighborhoods in the Dutch heat transition. The knowledge gained in this research shows the picture of current practice but can also be used to improve neighborhood approaches. This does not mean that the recommendations given will guarantee future successes.. In addition, the recommendations can provide guidance for emerging experiments to ensure that no resources and time are wasted in the process.

A very important recommendation for successfully mobilizing citizens in neighborhood approaches is that the characteristics of the neighborhood should be looked at. By getting a good picture of the context in advance with regard to the type of occupants, the size and the main alternative to heat, it may not be necessary to implement all conditions. This can be beneficial in the case of limited resources or time.

Another key recommendation is the relation between competent participants and principled engagement. If it turns out that when there are only limited competent participants in an experiment, it is important to involve citizens intensively. However, if many competent participants are already present in a neighborhood, it is not necessary to involve citizens intensively. The fact is, however, that only a small proportion of the current Dutch population is a truly competent participant, as meant in this study.

The condition 'support for initiatives' in the cases researched, is almost always valued with a high membership score in the set. This shows that the cases are particularly interested in initiatives and ideas from outside and try to involve these initiatives into the neighborhood approach. However, it

cannot be demonstrated whether this actually leads to successful resident mobilization. Too few cases in the study show that a low or even no 'support for initiatives' leads to unsuccessful resident mobilization.

At the moment, special attention is being paid in the ‘Programma Aardgasvrije Wijken’ on a range of topics. The attention is focused on financing, who bears the costs, and how do we guarantee cost neutrality for citizen. Laws and regulations, there needs to be a compelling incentive so that governments have a stick behind the door for the implementation of heating alternatives. To apply sustainability measures is at current the 'choice' of citizens. For example, ‘The Crisis en Herstelwet’ helps municipalities with citizens not wishing to voluntarily give up natural gas. With this law municipalities have the power to designate, in zoning plans, an area where gas connections of existing houses can be disconnected on a certain date (BRON). The role of manager; who's in charge, and where should the ownership lie? This research shows that it is sufficient for success that the leading actor has experience with former heat related projects, successful.

The conditions above are not addressed in this research and are thus important topics for future research. The costs addressed to different activities are measured in this research, however due to missing values and insufficient data it is irrelevant to make statements about it. The laws and regulations can only be tested when there are pilots addressed in the heat transition, this is however hardly the case. In this research only one case indicated that they had made use of a regulation that provides for extra space regarding law and regulations. This can be a topic for further, more in-depth, research on these specific conditions for successful experiments in the heat transition.

III References

Arentsen, M., & Bellekom, S. (2014). Power to the people: local energy initiatives as seedbeds of innovation? *Energy, sustainability and society, 4*(1), 2.

Arnstein, S. R. (1969). A Ladder Of Citizen Participation. *Journal of the American Planning Association*, 35: 34 216 - 224.

Basurto, X., & Speer, J. (2012). Structuring the calibration of qualitative data as sets for qualitative comparative analysis (QCA). *Field Methods, 24*(2), 155-174.

Berg-Schlosser, D., De Meur, G., Rihoux, B., & Ragin, C. C. (2009). Qualitative comparative analysis (QCA) as an approach. *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques, 1*, 18.

Berkhout, F., Angel, D., & Wieczorek, A. J. (2009). Asian development pathways and sustainable socio-technical regimes. *Technological Forecasting and Social Change, 76*(2), 218-228.

Berkhout, F., Verbong, G., Wieczorek, A. J., Raven, R., Lebel, L., & Bai, X. (2010). Sustainability experiments in Asia: innovations shaping alternative development pathways? *environmental science & policy, 13*(4), 261-271.

BijzonderStrafrecht (2019, juni 4). *Klimaatwet aangenomen door Eerste Kamer*. Retrieved from https://www.bijzonderstrafrecht.nl/home/klimaatwet-aangenomen-door-eerste-kamer

Brown, H. S., & Vergragt, P. J. (2008). Bounded socio-technical experiments as agents of systemic change: The case of a zero-energy residential building. *Technological Forecasting and Social Change, 75*(1), 107-130.

BZK, M. (2020). *Resultaten verantwoordingsonderzoek 2019 Ministerie van Binnenlandse Zaken en Koninkrijksrelaties* Retrieved from https://www.rekenkamer.nl/publicaties/rapporten/2020/05/20/resultaten-verantwoordingsonderzoek-2019-ministerie-van-binnenlandse-zaken-en-koninkrijksrelaties

CBS. (2020). *Kerncijfers wijken en buurten 2004-2019*. Retrieved from https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/wijk-en-buurtstatistieken

Edelenbos, J., & Monnikhof, R. (1998). *Spanning in interactie: een analyse van interactief beleid in lokale democratie*: Instituut voor Publiek en Politiek.

Foort, S., & Kevelam, J. (2015). Het waarborgen van duurzaamheid in de Omgevingswet (Ensuring Sustainability in the Dutch Environmental Planning Act). *Tijdschrift voor omgevingsrecht*(1), 8-19.

Gaventa, J., & McGee, R. (2010). Introduction: Making change happen-citizen action and national policy reform. *Citizen action and national policy reform: Making change happen*, 1-43.

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research policy, 39*(4), 495-510.

Gemeente-Heusden. (2020). Gemeente Heusden steunt Hedikhuizen duurzaam. Retrieved from https://www.heusden.nl/Home/Heel_Heusden_Duurzaam/Nieuwsbrieven/Gemeente_Heusden_steunt_Hedikhuizen_Duurzaam

Gemeente-Katwijk. (2018). *Uitvoeringsplan Smartpolder/ wijk Hoornes aardgasvrij*. Retrieved from Katwijk: https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/convenanten/2019/03/21/katwijk---convenant-over-grootschalige-proeftuin-met-een-aardgasvrije-wijk-kopie-3/2Bijlage+1+Uitvoeringsplan.pdf

Heeger, A., & Buitelaar, S. (2018). *Van het gas af in samenspraak met de bewoner* Retrieved from Den haag: https://www.platform31.nl/publicaties/van-het-gas-af-in-samenspraak-met-de-bewoner

Hieropgewekt. (2019). In 12 stappen naar een lokale warmteoplossing. Retrieved from https://www.hieropgewekt.nl/kennisdossiers/in-12-stappen-naar-een-lokale-warmteoplossing

Hoppe, T., Bressers, J. T. A., & Lulofs, K. R. (2011). Local government influence on energy conservation ambitions in existing housing sites—Plucking the low-hanging fruit? *Energy policy, 39*(2), 916-925.
Hoppe, T., Graf, A., Warbroek, B., Lammers, I., & Lepping, I. (2015). Local governments supporting local energy initiatives: Lessons from the best practices of Saerbeck (Germany) and Lochem (The Netherlands). *Sustainability, 7*(2), 1900-1931.
Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technology analysis & strategic management, 10*(2), 175-198.
Kivimaa, P., Hildén, M., Huitema, D., Jordan, A., & Newig, J. (2017). Experiments in climate governance–a systematic review of research on energy and built environment transitions. *Journal of Cleaner Production, 169*, 17-29.
Legewie, N. (2013). An introduction to applied data analysis wit qualitative comparative analysis (QCA). *FQS*, art. 15
Mackie, J. L. (1965). Causes and conditions. *American philosophical quarterly, 2*(4), 245-264.
Meadowcroft, J. (2009). What about the politics? Sustainable development, transition management, and long term energy transitions In *Policy Sci* (pp. 323-340). Ottawa: Carleton University.
Mill, J. S. (1884). *A system of logic, ratiocinative and inductive: Being a connected view of the principles of evidence and the methods of scientific investigation* (Vol. 1): Longmans, green, and Company.
Muro, M., & Jeffrey, P. (2008). A critical review of the theory and application of social learning in participatory natural resource management processes. *Journal of environmental planning and management, 51*(3), 325-344.
Naber, R., Raven, R., Kouw, M., & Dassen, T. (2017). Scaling up sustainable energy innovations. *Energy policy, 110*, 342-354.
Oliver, M., & Jackson, T. (1999). The market for solar photovoltaics. *Energy policy, 27*(7), 371-385.
Oteman, M., Kooij, H.-J., & Wiering, M. (2017). Pioneering renewable energy in an economic energy policy system: The history and development of Dutch grassroots initiatives. *Sustainability, 9*(4), 550.
PAW. (2019). *Covenant Purmerend*. Retrieved from https://www.rijksoverheid.nl/onderwerpen/aardgasvrije-wijken/documenten/convenanten/2019/01/29/purmerend---convenant-over-grootschalige-proeftuin-met-een-aardgasvrije-wijk
Ragin, C. C. (2006). Set relations in social research: Evaluating their consistency and coverage. *Political analysis, 14*(3), 291-310.
Ragin, C. C. (2009). Qualitative comparative analysis using fuzzy sets (fsQCA). *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques, 51*, 87-121.
Rihoux, B., & Lobe, B. (2009). The case for qualitative comparative analysis (QCA): Adding leverage for thick cross-case comparison. *The Sage handbook of case-based methods*, 222-242.
Rijksoverheid. (2019). *Klimaatakkoord*. Retrieved from Den Haag:
Rijksoverheid. (2020). *Voortgang & Leerervaringen 27 proeftuinen aargasvrije wijken*. Retrieved from https://www.rijksoverheid.nl/onderwerpen/aardgasvrije-wijken/documenten/rapporten/2020/01/22/voortgang-en-leerervaringen-27-proeftuinen-aardgasvrije-wijken
Rohlfing, I. (2020). The choice between crisp and fuzzy sets in Qualitative Comparative Analysis and the ambiguous consequences for finding consistent set relations. *Field Methods, 32*(1), 75-88.
Ros, J., Schure, K., Matthijsen, J., Vringer, C., Elzenga, H., Notenboom, J., . . . Hoen, A. (2016). *Opties voor energie-en klimaatbeleid*: Planbureau voor de Leefomgeving, PBL.
Rotmans, J. (2019). Een Transitie Aanpak voor Aardgasvrije Wijken. Retrieved from https://www.aardgasvrijewijken.nl/documenten/handlerdownloadfiles.ashx?idnv=1516866

RVO. (2015). *Infoblad Trias Energetica en energieneutraal bouwen* Retrieved from Utrecht
Schneider, C. Q., & Wagemann, C. (2010). Qualitative comparative analysis (QCA) and fuzzy-sets: Agenda for a research approach and a data analysis technique. *Comparative Sociology, 9*(3), 376-396.
Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology analysis & strategic management, 20*(5), 537-554.
SCP. (2020). Op weg naar aardgasvrij wonen. De energietransitie vanuit burgerperspectief. Retrieved from https://www.scp.nl/publicaties/publicaties/2020/05/25/op-weg-naar-aardgasvrij-wonen
Sengers, F., Wieczorek, A. J., & Raven, R. (2016). Experimenting for sustainability transitions: A systematic literature review. *Technological Forecasting and Social Change*.
Seyfang, G., & Haxeltine, A. (2012). Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions. In: SAGE Publications Sage UK: London, England.
Seyfang, G., & Smith, A. (2007). Grassroots innovations for sustainable development: Towards a new research and policy agenda. *Environmental politics, 16*(4), 584-603.
Smith, A., & Raven, R. (2012). What is protective space? Reconsidering niches in transitions to sustainability. *Research policy, 41*(6), 1025-1036.
Thomann, E. (2017). Qualitative comparative analysis (QCA) as an approach to comparative policy analysis. *Handbook of methodology for comparative policy analysis. Cheltenham, UK/Northampton, MA, USA: Edward Elgar*.
Van Buuren, A., & Loorbach, D. (2009). Policy innovation in isolation? Conditions for policy renewal by transition arenas and pilot projects. *Public Management Review, 11*(3), 375-392.
Van Buuren, A., Vreugdenhil, H., Verkerk, J. V. P., & Ellen, G. J. (2016). *Beyond the pilot paradox How the success conditions of pilots also hinder their up-scaling in climate governance*.
van den Bosch, S. S., & Rotmans, J. J. (2008). Deepening, Broadening and Scaling up: a Framework for Steering Transition Experiments.
van Houwelingen, P., Boele, A., & Dekker, P. (2014). *Burgermacht op eigen kracht?: Een brede verkenning van ontwikkelingen in burgerparticipatie* (Vol. 2014): Sociaal en Cultureel Planbureau.
Vreugdenhil, H., Slinger, J., Thissen, W., & Rault, P. K. (2010). Pilot projects in water management. *Ecology and Society, 15*(3).

Appendix I: Cases

Below a tabular overview is given of the cases represented in this research (Table 17). The green colored cases are the cases that are analyzed in this research. The red colored cases are cases where the participants opted (via mail) that in their eyes the project did not fit in this research, therefore they did not participate in the research. Yellow colored cases represent cases that are part of different programs. The cases that are not colored do not contain any specifics and address the cases that have not responded.

Table 17: Cases studied. Reference: Author.

Municipality	Neigborhood	Type project
Boxtel	Selissen	Greendeal
Leidschendam-Voorburg	Vlietvoorde	Greendeal
Nijmegen	Hengstdal	Greendeal
Rotterdam	Heindijk	Greendeal
Leiden	Several neighborhoods	Greendeal
De Fryske Marren	Balk	Warmte Initiatief
Ameland	Ameland	Warmte Initiatief
Sudwest Fryslan	Heeg	Warmte Initiatief
Wierden	Wierden-Enter	Warmte Initiatief
Deventer	Bathem	Warmte Initiatief
Apeldoorn	Leerschoten	Warmte Initiatief
Amsterdam	Wilhelminagasthuisterrein	Warmte Initiatief
oisterwijk	Oisterwijk	Warmte Initiatief
Tilburg	Reeshof	Warmte Initiatief
Amsterdam	Sloterplas	Warmte Initiatief
Heusden	Hedikhuizen	Warmte Initiatief
Haarlem	Haarlem	Warmte Initiatief
Eindhoven	Deurne	Warmte Initiatief
Limburg	Peel en Maas	Warmte Initiatief
Heusden	Heusden	Warmte Initiatief
Culemborg	Langsmeer	Warmte Initiatief
Midden-Drenhte	Hooghalen	Warmte Initiatief
Amsterdam	Voltaplein	Warmte Initiatief
Den Haag	Regentes	Warmte Initiatief
Zutphen	Noordveen	Warmte Initiatief
Drimmelen	Centrum van Terheijden	Proeftuin
Hengelo	Wijk de Nijverheid	Proeftuin
Tilburg	quirijnstok	Proeftuin
Vlieland	Duinwijck	Proeftuin
Delfzijl	Delfzijl-Noord	Proeftuin
Katwijk	Smartpolder	Proeftuin
Purmerend	Overwhere-zuid	Proeftuin
Eindhoven	Wijk 't ven	Proeftuin

Loppersum	Loppersum, 't zand en Westeremden	Proeftuin
Nijmegen	Dukenburg	Proeftuin
Noordoostpolder	Nagele	Proeftuin
Tytsjerksteradiel	Garyp	Proeftuin
Sliedrecht	Sliedrecht-Oost	Proeftuin
Nieuwolda-Wagenborgen	Oldambt	Proeftuin
Den Haag	Bouwlust/Vrederust	Proeftuin
Boven Pekela en de Doorsneebuurt	Pekela	Proeftuin
Castricum	Castricum	Warmte Initiatief
Hilversum	Hilversum	Warmte Initiatief
Lansingerland	Lansingerland	Warmte Initiatief
Texel	Texel	Warmte Initiatief
Amsterdam	Gaasperdam	Warmte Initiatief
Groningen	Selwerd	Greendeal
Middelburg	Essenvelt	Greendeal
Noordoostpolder	Emmelhage fase 2	Greendeal
Wageningen	Wijk Nude	Greendeal
Noord-Brabant	Eindhoven	Warmte Initiatief
Meppel	Nieuwveense landen	Greendeal
Veere	Domburg Singelgebied	Greendeal
Amsterdam	Van der Pekbuurt	Proeftuin
Appingedam	Opwierde-Zuid	Proeftuin
Assen	Lariks-west	Proeftuin
Brunssum	Brunssum-Noord	Proeftuin
Groningen	Paddepoel	Proeftuin
Middelburg	Dauwendaele	Proeftuin
Rotterdam	Pendrecht	Proeftuin
Sittard-Geleen	limbrichterveld-Noord	Proeftuin
Utrecht	Overvecht-noord	Proeftuin
Wageningen	Benedenbuurt	Proeftuin
Zoetermeer	Palenstein	Proeftuin
het Hogeland	Bedum	Warmte Initiatief
Noordenveld (Drenthe)	Roden	Warmte Initiatief
Dalfsen	Hoonhorst	Warmte Initiatief
Gelderland	Lochem	Warmte Initiatief
Arnhem	Spijkerwijk	Warmte Initiatief
Utrecht	Utrecht	Warmte Initiatief
Uitgeest	Uitgeest	Warmte Initiatief
Wijdemeren	Kortenhoef	Warmte Initiatief
Den Haag	Vruchtenbuurt	Warmte Initiatief
Den Haag	Statenkwartier	Warmte Initiatief
Den Haag	Ypenburg	Warmte Initiatief
Goeree-Overflakkee	Stad aan 't Haringvliet	Warmte Initiatief
Kaag en Braassem	Rijnstaterwoude	Warmte Initiatief

Oestgeest	Schilders en Zeeheldenbuurt	Warmte Initiatief
Breda	overakker	Warmte Initiatief
Leeuwaarden	Baard	Warmte Initiatief
Alkmaar	Choice not yet made	Greendeal
Almere	Almere-haven	Greendeal
Barendrecht	unknown	Greendeal
Delft	Voorhof	Greendeal
Maastricht	Centrum Maastricht	Greendeal
Schiedam	Groenoord	Greendeal
Veldhoven	Huysackers	Greendeal
Westland	Wijk Westerhonk	Greendeal
Westvoorne	Unknown	Greendeal
Winsum	Munster	Greendeal
Woerden	Schilderskwartier	Greendeal
Zaanstad	Zaanstad-Oost of Noord	Greendeal

Appendix II: Survey guide

Heat initiatives

1. Fill in your name:

_____

2. Fill in your position/function:

_____

3. Fill in the organization you work for:

_____

4. The project for which I am filling out this survey is:

The project in this survey is described as the planning process in which alternative heating facilities at neighborhood level are explored together with citizens, including initiating research and initiating projects.

_____

Characteristics of the project

5. How many households are part of the project?

_____

6. The project is aimed at the built environment

O Yes

O No

7. In the table below a number of types of projects are given, please indicate which forms apply to your project.

Multiple answers may apply.

Main Aim	Yes	No
This project experiments with specific technologies	O	O
This project focuses mainly on closing a business case	O	O

This project mainly tests new policies, with more influence for the participants.	O	O
This project tests a specific neighborhood approach	0	O

* With what type of technologies, does this projects experiment?

_____

* What type of business case, is experimented with?

_____

* If the project targets another type of project, what type of project is processed?

_____

8. Is there a time determined, for when the project has to be finished?

O Yes

O No

* When does the neighborhood have to be natural gas-free?

_____

9. Indicate whether or not the following activities have been applied in the process.

The different activities reflect different stages in the process towards a natural gas-free district.

	Applied	Not applied
Conducting an feasibility study / business case study.	O	O
Conduction a neighborhood energy plan	O	0
Conducting an implementation plan	O	0
The definite implementation	O	0

No activity is applied	O	0

* For every activity there is asked if the process was finished

* For every activity that is applied but not finished there is asked why the activity has not yet been finished.

* When no activity is applied, there is asked which activity is presented in the project.

10. Can you please give a brief description of the project (indicate when the project has started, what the duration is and what the main activities are)?

_____

Sustainability measure

11. Which sustainability measures are considered within the project?

More answers are possible

- Energy-saving measures
- Isolation measures
- PV-panels
- Alternative heating system
- Other, namely _____

12. For the following statements, please indicate what is applicable to your project, from start to finish:

Citizens are more aware of sustainability measures	O totally agree	O agree	O neutral	O disagree	O Totally disagree
Citizens are thinking about making their homes more sustainable**.**	O totally agree	O agree	O neutral	O disagree	O Totally disagree
Citizens make plans to make their households more sustainable	O totally agree	O agree	O neutral	O disagree	O Totally disagree
Citizens have made their homes more sustainable (have improved their energy label).	O totally agree	O agree	O neutral	O disagree	O Totally disagree

Room for experimentation

13. The project is allowed to fail.

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

14. Citizens are given enough room to form the process/initiative.

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

*Can you show how this room is provided?

_____

15. Is there an arrangement in the neighborhood that provides for extra room?

- o No
- o Yes, experimental arrangement as noticed in the 'Crisis en Herstelwet'
- o Yes, experimental arrangement as noticed in the electricity law
- o Yes, experimental arrangement as noticed in the gas law
- o Different, namely _____

16. The municipality offers enough space for projects/initiatives to be successful

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

Activities and financing

17. The following table focuses on the activities that may occur in a district/neighbourhood approach. Indicate what applies to your project:

Activities	Applied	Estimated Costs	Who finances the activity
Making up a process plan			
Process guidance with the neighborhood approach			
Organizing meetings			
Adding and organizing forms of communication			
Physical implementation of an alternative heat solution			
Drawing up a business case			
An application that monitors energy consumption at home level			

***** For this question a simplified overview is given in table below, this is done because the program Qualtrics offers fold-out options, these are hard to show in this textual overview. At first the question is asked what is applied. When a certain activity is applied there is asked for the estimated costs, and most important who finances the activity.

Competent participants

18. To what extent are frontrunner/energy ambassadors present in the neighborhood?

This means citizens who have already made sustainability investments in their homes.

O	O	O	O	O
More than 50%	30-40%	20-30%	10-20%	Minder dan 10%

19. To what extent are frontrunner/energy ambassadors present in the neighborhood?
In other words, citizens who are willing to invest more time or money in the process towards natural gas-free from a sustainability perspective?

O	O	O	O	O
More than 50%	30-40%	20-30%	10-20%	Minder dan 10%

20. Frontrunners influence other citizens in a positive manner

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

21 Which percentage of citizens in the project is open for new knowledge regarding a natural gas free environment?

O	O	O	O	O
> 80%	60-80%	40-60%	60-80%	80-100%

Leading actor

22. Is there a leading actor in the project?

O Yes

O No

23. Are you the leading actor

O Yes

O No

24. Which function does the leading actor have within the organization?

_____

25. How many hours can the leading actor spend in the project?

_____

26. The leading actor has gained experience in other heat transition related projects

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

Meetings and interaction

27. For the questions regarding meetings a number of fold-out options in Qualtrics are shown to the respondents. The table below gives an overview of the questions in the survey.

Meetings	How many meetings? (open response)	How many citizens attended meetings? (open response)	Did the attendance represent the neighborhood? (to be answered yes/no)
Information meetings			
Interactive sessions			
Work/projectgroup meetings			

Neighborhood activities			
Individual meetings			

28. The number of citizens that attends collective meetings has increased

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

29. The number of citizens that attends individual meetings has increased

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

30. The number of citizens that attends project/working group meetings has increased

O	O	O	O	O
Totally agree	Agree	Neutral	Disagree	Totally disagree

31. If there are any inconveniences or remarks, you can write them down below:

_____