The Implementation of Net Zero Energy Buildings in the Netherlands

A qualitative case study on Social Housing Associations

By

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PREFACE

In your hands or on your screen you find my thesis on “The implementation of Net Zero Energy Buildings in the Netherlands”. It has been written with the goal to graduate for the master Public Administration at the University of Twente. Some thanks are in place to those who contributed to the realization of this final product.

First, I thank the employees of the social housing associations that agreed to be respondents for this research. Without their valuable information from the conducted interviews this study could not have been completed in the desired manner. Furthermore I thank my supervisors Dr. Maarten J. Arentsen and Dr. Pieter-Jan Klok for their valuable feedback during the course of the research. Next, I want to express my gratitude to Imke Lammers, who, as a PhD candidate, helped me in the process of writing my thesis.

Finally, I also thank my family and friends for their support and distractions during my period as a student.

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ABSTRACT

Social housing associations (SHAs) in the Netherlands account for 35% of the new residential constructions built each year. This makes the social housing branch an important target group for sustainability ambitions in the building sector. In reaction on the increased importance of energy efficiency and lowering CO2 emissions, SHAs recently started to adopt an ambitious and innovative building concept into their housing projects, called a Net Zero Energy Building (NZEB), which is highly sustainable because it balances its energy consumption out by producing at least similar amounts of renewable energy. Still many SHAs, however, decide not to build with the concept. This studies aim is to find what factors contribute and hamper the implementation of the concept by SHAs. A multiple case study is performed among SHAs that have implemented the concept into a housing project and with SHAs that have not. The Contextual Interaction Theory is used as a framework to analyse the decision-making process of SHAs. The results indicated that the implementation of NZEBs is especially dependent on location and cognitions of the SHA. Furthermore network involvement and governmental policies contribute to the implementation of NZEBs. The novelty of NZEB technologies and the lack of feasible financial schemes seem to slow down SHAs in their application of the concept.

Table of Content

List of Figures and Tables

1 INTRODUCTION

The Dutch buildd environment faces various challenges in the years to come. Presumably the two main ones are the global energy transition, and the Dutch housing shortage. In the former the sector holds an important role considering that residential buildings are responsible for the 20 percent of Dutch CO2 emissions (Rijkswaterstaat, 2017). This makes the build environment a target sector with ample opportunities to reduce CO2 emissions. Now that renewable technologies are penetrating the market and become a proven alternative for fossil based energy technologies, governments expect and demand a contribution from the sector on sustainable development goals. The other challenge of fighting the housing shortage, is the result of the growing demand for housing. After the global economic crisis of 2008 the demand for housing dropped. However, now that the economy is up and running again, demand for housing has risen to a level that causes a shortage in affordable dwellings, especially in the larger cities. Dutch government consequently strives to increase the housing capacity by building 75.000 new dwellings each year for the coming years (Ollongren, 2018). Both challenges combined pressures the sector to increase efforts to realize new and sustainable dwellings.

With 2,4 million dwellings and a stake of over 30 percent of the total Dutch housing stock (Aedes, 2017a), the social housing sector is a substantial and influential part of the building sector, and therefore an important target group for realising building related ambitions (Ollongren, 2018). First of all, the social housing sector is an important stakeholder in the ambition to increase the construction of new dwellings. With 17.000 new houses on a yearly basis, the market share of social housing associations (SHAs) is 35% of the total new residential constructions in the Netherlands (Aedes, 2017a). Secondly, SHAs as owners of social dwellings are particularly influential in meeting national and regional sustainability goals (van Oorschot, Hofman, & Halman, 2016), since they hold certain characteristics that make them, as a target group for renewable energy policies, favourable to private owners. One of these features is that each SHA on average owns 7.000 dwellings (Aedes, 2017a), while private owners typically own only one dwelling. Therefor a target group of only 350 different SHAs can accomplish significant progress on the energy performance of the Dutch housing stock. Furthermore, SHAs have advantageous financial positions and accept a longer rate of return on their investments then private owners. As a result they can afford to make the extra initial investments that comes with implementing sustainable technologies.

As a reaction on the mentioned sustainability ambitions the building sector has developed a building concept called net zero energy buildings (NZEB). The NZEB is a type of building which in essence consumes as much energy as it can produce from renewable energy sources (RES), while also still connected to the energy grid (Sartori, Napolitano, & Voss, 2012). A Dutch variant of the NZEB that recently found its way into the build environment is the so called “Nul Op De Meter” (NOM) (In

English: Zero on the energy meter) concept (Rijksdienst voor Ondernemend Nederland, 2018)[1]. Currently NZEBs are being realised in the Netherlands as a way of constructing new social housing projects, but definitely not on a wide scale, even though it appears to be a future proof way of building and a beneficial development for Dutch energy ambitions. So, despite the fact that some SHAs decided to embrace the innovative concept in new construction projects, many have not. This raises the question what the differences between these two groups are and what factors influence the adoption of NZEBs by SHAs. Unfortunately, since the concept is rather new, particularly in the Dutch context, little is known in academic literature about the factors that influence this specific process. Research was predominantly concentrated on the renovation of the existing social housing stock (for example by (Crilly, Lemon, Wright, Cook, & Shaw, 2012; Hoppe, 2012; van Oorschot et al., 2016), instead of on the construction of new dwellings. This is not without reason, considering a turnover in the housing stock of only 1% each year. Hence, the quickest and the biggest progress can be made by retrofitting older homes. However, since the numbers of newly constructed dwellings by SHAs is expected to increase it is rather relevant to know if and how the diffusion of ambitious sustainable concepts can be increased in new building projects.

Therefore, this research will focus on both the implementing SHAs as on the non-implementing SHAs with the goal to recognize what the contributing and hampering factors are for the implementation of NZEBs by SHAs. Since the realization of NZEBs are, among other things, a result of climate policy, a considerable part of the research will focus on how governmental policy instruments influences the implementation process. Hereby providing insight in why what works and what does not in the diffusion of NZEBs in the social housing sector. To achieve these insights the following question will be answered in this research:

'What are contributing and hampering factors in the implementation of net zero energy buildings by Dutch social housing association in new housing projects?'

As theoretical basis for distinguishing what factors contribute or hamper the implementation of NZEB, use will be made of the Contextual Interaction Theory (CIT) developed by Bressers (2004). This deductive framework focusses on both the context of the implementation process as on the process arena in which actors interact with each other. However, since there are many contextual factors that conceivably influence the process, the framework channels these factors down to the core characteristics of the actors involved. Hence the basic assumption of the CIT is that: "the course and outcomes of the policy process depend not only on inputs …, but more crucially on the characteristics of the actors involved, particularly their motivation, information, and power." (Bressers, 2004, p. 288). The other

[1] Both the NZEB and NOM concept will be discussed in more detail in the next chapter.

assumptions of the framework and how it will fit to this particular research will be further elucidated in the theoretical chapter of this research (chapter 3).

The involved actors in this research predominantly are the SHAs, who form the decisive actor in the decision-making process towards NZEBs. The research will therefore consist of a multiple case study on ten SHAs of which one group has implemented NZEBs into at least one construction project, and of a group SHAs that has not. Seawright and Gerring (2008) call this type of case study the 'diverse case' method of which the primary objective is to achieve "maximum variance along relevant dimensions". To increase representativeness and insight in the population of SHAs, the cases are selected on variance in both the dependent variable − the implementation of NZEBs yes or no − and on several independent variables which are certain parameters of the SHAs such as size and geographic location. According to Seawright and Gerring (2008) including a total range of diversity positively effects the representativeness of the sample of cases, in particular for small-N samples. Making it well suited for this particular study since the goal is to provide insight in the total population of SHAs. The information of the research is gathered trough qualitative research methods. Mainly through interviews with involved employees of each SHA, but also by means of literature research to develop a theoretical framework and by desk research to establish further insight on the topics at hand and on the policy instruments that are at play to steer SHAs towards energy efficiency. Why and how these methods are used will be further explained in the methods section (chapter 4).

In the upcoming chapters of this research we first will start with a clarification of the social housing sector, providing background and context for the remainder of the research. The background chapter is followed by the theoretical chapter in which the assumptions and elements of the CIT will be further explained. Then the methodology chapter will provide insight in how the research is conducted and how the theoretical framework will be used in the empirical research. Subsequently the result chapter where the outcome of the case study is provided. The last chapters will consist of conclusions and topics for discussion

2 BACKGROUND

As mentioned earlier this research will focus on the Dutch social housing sector. In order to better understand the content of the study it is helpful to know, at least to some extent, the current situation in which SHAs are active. Therefore, a brief elaboration on the Dutch social housing sector will be provided here. Encompassing a short history of the sector and explaining relevant policies and regulations that have been applied by Dutch government, both to increase energy efficiency and the diffusion of NZEBs. But first the 'Net Zero Energy Building' as concept will be further clarified.

2.1 THE NET ZERO ENERGY BUILDING

In the quest to create a sustainable and energy neutral society, new building concepts are brought to the market. Innovative RES have been developed and are applied in newly constructed houses, offices and other buildings. Likewise isolation of buildings has improved, making the energy demand of new buildings considerably lower compared to relatively old buildings. The combination of these, and other, sustainable developments gave rise to a new concept in the sector, the Net Zero Energy Building (NZEB). Although the term sounds pretty straight forward, there is only to a certain extent agreement of the concept and its calculation methods. Therefor NZEB will be conceptualized with the help of literature.

A frontrunner of the NZEB is the ZEB (Zero Energy Buildings). Torcellini, Pless, Deru, and Crawley (2006) define the ZEB as either a residential or commercial building which is energy efficient to the extent that energy needs can be covered with RES, for instance from photovoltaics (PV) panels in combination with a heat pump. Sartori et al. (2012), agree with this definition. However, they state that it does not explicitly address that the building can still be connected to the energy grid. Therefore the word 'Net' is added. This clarifies that the NZEB is still connected to the energy infrastructure. The word 'Net' also underlines that there is a balance between the energy demand and supply from and to the grid (Sartori et al., 2012).

The most common strategy in creating NZEBs is first of all to build a very energy efficient building and then generate the remaining energy demand with RES. The "reduce, then produce" approach (Marszal et al., 2011).

Especially The manner of production can create difference in the definition. First of all there are on-site and off-site NZEBs (Torcellini et al., 2006). The former generates its renewable energy within the footprint of the building. The latter purchases or uses renewable energy available off-site from external generators or sources. Torcellini et al. (2006) furthermore mention that achieving zero energy is affected by the NZEB definition that is adopted by policy makers. This can depend on both the used metric as the boundary. They therefor propose four different definitions:

- Net zero site energy (Site ZEB): A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.
- Net Zero Source energy (Source ZEB): A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building's total source energy imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers

- Net Zero Energy Costs (Cost Zeb: In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.
- Net Zero Energy Emissions (Emission ZEB): A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emission-producing energy sources.

Furthermore variation is possible in what the requirements are of the NZEB on energy efficiency, indoor climate and building-grid interaction (Marszal et al., 2011). These requirements depend also on what the goals are from policy makers or other regulators.

Just as Jain (2018) we conclude that the concept of the NZEB is clearly understood in literature. However, the concept takes different forms a can be defined in different ways. This depends on various variables and decisions specified by the policy makers of a country. Since this research focusses on Dutch policy we will use the definitions and measurements as defined by Dutch laws and requirements. Accordingly, a building matches the Dutch NOM concept when it matches the following descriptions defined by Dutch law (Artikel 1c, Tijdelijke regeling hypothecair krediet, 2012)

"*a house with an energy index or an energy performance coefficient equal or below zero, or a house of which incoming and outgoing energy flows for building-related energy in a normal lifestyle are equal or lower than zero with an additional generation capacity for user-related energy of at least:*

1. *3.150 kWh for detached or semi-detached houses.*
2. *2.700 kWh for terraced houses.*
3. *1.780 kWh for apartments."*

Almost the same definition of the concept comes from an influential cooperation between several big contractors and housing associations called 'Stoomversnelling' (rapids in English). The cooperation's goal is and was to increase the speed in which the NOM concept is used in new construction and renovation projects. They adopted the previous definition for the greatest part, nevertheless added that houses have to comply with certain internal climate conditions established by Dutch norms (NEN 7120). These definitions are similar to the site ZEB definition of Torcellini et al. (2006). Since definitions are equal, in the remainder of this document we will exclusively use the abbreviation NZEB instead of NOM or ZEB.

2.2 DUTCH SOCIAL HOUSING ASSOCIATIONS

Social housing associations are obligated with the task to realise high quality living space for people who by themselves do not have the financial means to buy or rent a house in the free market. Until 1995 SHAs were public or semi-public organisations who were mostly financed by the Dutch

government. But as from 1995 SHAs were privatised and became autonomous in their decision making (Hoppe, 2012). After their privatisation the financial situation of the SHAs improved significantly as a result of low interest rates and the high price of houses. According to Hoekstra (2013) SHAs subsequently started to increase their activities and began to invest in neighbourhood regeneration, social programmes and public-purpose buildings instead of only investing in public housing. Simultaneously management cost started to increase, mainly the salaries of the directors became inappropriately high. This was possible due to the broad framework in which the SHAs operated and the lack of control on the execution of their tasks (De Jong, 2013). The consequence of this mismanagement was that SHAs took disproportionate risks. Especially in their commercial projects. Critical research on SHAs showed that the core tasks of SHAs should be much clearer to avoid further incidents.

The new Housing Act 2015 (In Dutch: Woningwet 1015) was the response on the findings of the research (Rijksoverheid, 2015). The aim of the Housing act is to improve the functioning of SHAs as private organisations with considerable social responsibilities. The new law puts increased emphasis on collaborations between municipalities and SHAs. Since SHAs have to contribute to a reasonable extent to the municipal social housing vision it is important to formulate agreements. Municipalities are not obligated to formulate such a housing vision. When this vision is missing performance agreements are not mandatory. When there is as a social housing vision, SHAs do have to formulate performance agreements in cooperation with municipalities and tenant organisations. These agreements address topics such as the amount of social dwellings that have to be build, affordability, housing of specific groups (students for instance), quality and, especially important for this research, sustainability (Rijksoverheid, 2015). These performance agreements provide municipalities with a tool to steer SHAs, and assess the functioning of SHAs.

2.3 RELATED POLICIES AND REGULATIONS

Besides the local performance agreements there are also national governmental instruments that are being applied to move the housing sector in the desired direction. Because the focus of the research is on energy matters some of the most relevant policies and regulations on this topic will be highlighted.

Since two decades new buildings are obligated by law to build within certain energy boundaries before permits are granted to contractors or developers. These regulations are in 1995 formalized in the Building Decree (Bouwbesluit) (Spyridaki, Ioannou, Flamos, & Oikonomou, 2016). To measure the energetic performance of buildings the so called Energy Performance Coefficient (EPC,) is applied as a calculation method. A value of 1,0 means that the energy performances is equal to the performance of an average building in 1990. In 2006 newly build houses had to comply with an EPC of 0,8. Which meant that they could use only 80% of the energy which a similar houses would use in 1990. In 2011 the EPC norm was sharpened to 0.6 and since 2015 the norm is at an EPC of 0,4 (Schilder, van Middelkoop, & van den Wijngaart, 2016).

For the future new and stricter norms are already formulated. The European Commission set the target, through the Energy Performance of Buildings Directive (Directive 2010/31/EC), that all new buildings must be nearly zero-energy buildings by the end of 2020. Since abbreviating nearly zero energy building would be the same as net zero-energy buildings, the Dutch abbreviation of nearly zero-energy buildings will be used: BENG (bijna energie neutrale gebouwen). BENG is measured on three indicators 1) maximum energy need (KWh/m2/year), 2) maximum primary fossil energy use (KWh/m2/year), and 3) minimum share of generated renewable energy (%). A BENG house, in the end, should be close to an EPC of 0. This would mean that building related energy demand is met by renewable energy generated on site. As opposed to NZEBs, the energy used by other applications is not included in the performance measurement.

2.3.1 Natural gas connection

In response to the closing of the natural gas fields in Groningen, Dutch government decided to change the law that provides people with the right of natural gas connection in their homes. More specifically this changed the obligation of distribution system operators (DSO) to provide a natural gas connection to all new buildings. Since the first of July 2018 this obligation is erased from the law, and since DSO's are only allowed to perform activities required by law, what comes in place is that all new buildings do not have a connection to natural gas, unless decided otherwise (Rijksdient voor Ondernemend Nederland, 2018).

2.3.2 The energy performance compensation scheme

More directly related to NZEBs is the law on the energy performance compensation (in Dutch: Energie prestatie vergoeding (EPV)). The EPV is an instrument for SHAs and other landlords, to receive compensation from tenants for part of the extra investment that is made to realize the NZEBs. This compensation is a substitute for the costs that would have been made to pay the traditional energy bill. The EPV is meant to make it more financially attractive for SHAs and landlords to invest in the energy efficient measures of the concept. To be allowed to ask the EPV from tenants, the house has to comply with, among other things, the following requirements (Rijksdient voor Ondernemend Nederland, 2016):

- The house has to be very well isolated
- The house produces on average the same amount of renewable energy as it uses.
- The landlord has to show that the rental property complies with the requirements of the EPV.
- Due to the high degree of isolation the house is not allowed to have a higher heat demand then 50 kWh/m2/year. Too ask the highest compensation of € 1,40/m2 per month, the head demand can't be higher than 30 kWh/m2/year.
- The building generates enough extra energy to power installations and meet the daily energy demands of tenants.

In summary, this chapter produced that the on-site NZEB fits best to the Dutch NOM concept. Furthermore we learned that the Dutch social housing sector has recently lost much of its autonomy and is now further regulated by national government on several aspects, among which sustainability. Important laws, regulations and schemes have been elaborated on that aim to increasing energy performance of the sector. This knowledge will be used first of all in providing context for the following theoretical chapter but will also help in the understanding of the empirical information.

3 THEORETICAL FRAMEWORK

The Contextual Interaction Theory (CIT) will be used as the underlying theoretical framework of this research. The CIT has been developed as a tool to explain and help understand the implementation of policy, whether successful or not. Implementation studies are vast and of considerable amounts. This chapter will therefore first provide a brief discussion on implementation theory and how perceptions developed over the years. Then the position of the CIT within this implementation literature will be discussed. Followed by a detailed explanation of how the CIT works and what its assumption are. The chapter ends discussing how the CIT will contribute in answering the research question posed earlier.

3.1 POLICY IMPLEMENTATION

In the CIT policy implementation is viewed as "the process(es) that concerns the application of relevant policy instruments" (Bressers, 2004, p. 284). The subject of policy implementation has a rich history of academic research. One of the first studies on policy implementation stems from Pressman and Wildavsky in 1973. They researched the gap between policy goals and their eventual results. In this study on federal policy in California they found mundane barriers for implementing policy. For instance, not maintaining agreements during the processes or not being able to effectively proceed through several approvals and clearances (Pressman and Wildavsky, 1973). In this pioneering work the researchers had a clear top-down view of the implementation process that failed due to poor policy planning. This was a very common perspective that characterizes the first generation of implementation research (De Boer, 2012). The second generation of implementation research took on itself an opposing view and research became known as the "bottom-up approach". Barrett (2004) explains this shift in perspective as the result of a difference of opinion about the roles of policy makers and executing actors. The top-down approach focused on the ideal situation in which the political top where the policy makers who came with clear goals and tasks for the lower levels to execute. The bottom-up approach paid much more attention to how policies were handled by the actors charged with the implementation of policy. To improve policy outcomes it was therefore necessary to better understand these implementing actors (Barrett, 2004). The approach was, however, criticized on the notion that it gave too much power and influence on the policy implementers and their ability to alter the initial goals of policy makers (De

Boer, 2012). The subsequent third generation of implementation policies tried to overcome the mentioned difficulties by combining both the top-down and bottom-up implementation approach (Matland, 1995), recognizing the complexness of policy implementation and considering implementation as a multi-actor process requiring cooperation and coordination (O'Toole, 2004). According to O'Toole (2004), however, most of the research that aims to find a synthesizes between the two, resulted in overcomplicated frameworks, while a heuristic approach is needed. One such approach, he mentions, is the Contextual Interaction Theory (CIT).

3.2 THE CONTEXTUAL INTERACTION THEORY

The CIT finds its roots in the instrumentation theory used by Bressers and Klok in 1988. Since then the framework has been refined over the years by Bressers and others. The framework is currently known as the Contextual Interaction Theory and has recently been used in various dissertations of PhD students at the University of Twente on topics related to sustainable development to understand why policy implementation took a certain direction (De Boer, 2012; Hoppe, 2009; Owens, 2008; Vinke-de Kruijf, 2013). This direction, or output, of the implementation process is the dependent variable of the CIT. The process output is according to the CIT the result of interaction process between involved actors and the influence on this interaction process by external circumstances (context). Among these external circumstances the CIT considers the active policy instruments aimed to steer the process in the right direction. The CIT, however, recognizes that policy instruments are only a piece of the whole context. Actors charged with the implementation of policies (the target group actors), may perceive these policy instruments as only a small part of the totality of influential factors from their environments. By acknowledging that policy instruments only influence the process in relation to other external circumstances the CIT avoids having a 'top-down' assumption on the policy implementation. Accordingly the basic assumption of the CIT is that:

> "the course and outcomes of the policy process depend not only on inputs, but more crucially on the characteristics of the actors involved, particularly their motivation, information, and power. All other factors that influence the process do so because, and in so far as, they influence the characteristics of the actors involved" (Bressers, 2004, p. 288)

The CIT is thus divided into two sets of independent variables. These are the external circumstance of the implementation process consisting of contextual factors, and the internal circumstance consisting of involved actors interacting with each other. This interaction process consist of human activities and all influences flow through the 'core characteristics' of the actors involved. These core characteristics are the actor's motives, cognitions and resources (figure 1).

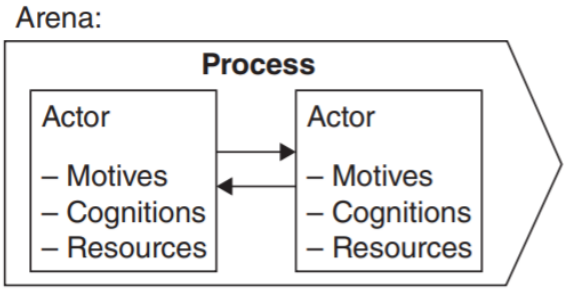


Figure 1: Process model with the actor characteristics used in the CIT (Bressers & de Boer, 2013)

3.2.1 The core characteristics

A focus of the theory is thus on actors and their interaction processes. In order to better understand this process between actors an analysis of the core characteristics motives, cognitions, and resources is required. Figure 2 visualizes the core characteristics and the interaction that takes place. It also show how the characteristics influence each other.

In figure 2 the motivation characteristic is divided into own goals and values, external pressure and self-effectiveness. Own goals and values refers to the motivation of the actors to implement policy to pursue own interests. External pressure as a motive can come from group pressure to conform to the view of the group. Last is the factor of self-effectiveness assessment, which can play an important role and refers "to the demotiovational [*sic*] effect that can occur when an actor perceived its preferred behaviour as beyond its capacity" (Bressers, 2009, p. 9).

Cognition of actors basically depends on the actor's interpretations of reality. These interpretations are influenced by filters, frames of reference and interactions with other actors (Bressers, 2009). An example is provided by Hoppe (2009). He states that one actor can perceive a subsidy as a necessity to be able to conform to a certain measure, while for the other it is only a drop in the ocean. Hence, the cognitions of actors involved can possibly differ. The amount of information or knowledge does also play an important role here.

Resources as an actor characteristic relates to the capacity and power of an actor to act in accordance with the implementation process. Resources that create the capacity and power of an actor for instance are money, skilled people, time and consensus (Bressers, 2009). Not only the personal access to these resources establishes a balance of power, but especially the dependency of one actor on the resources of others creates a specific balance. Other sources of power can come from formal rules, legal rights and other institutional rules (Bressers, 2009).

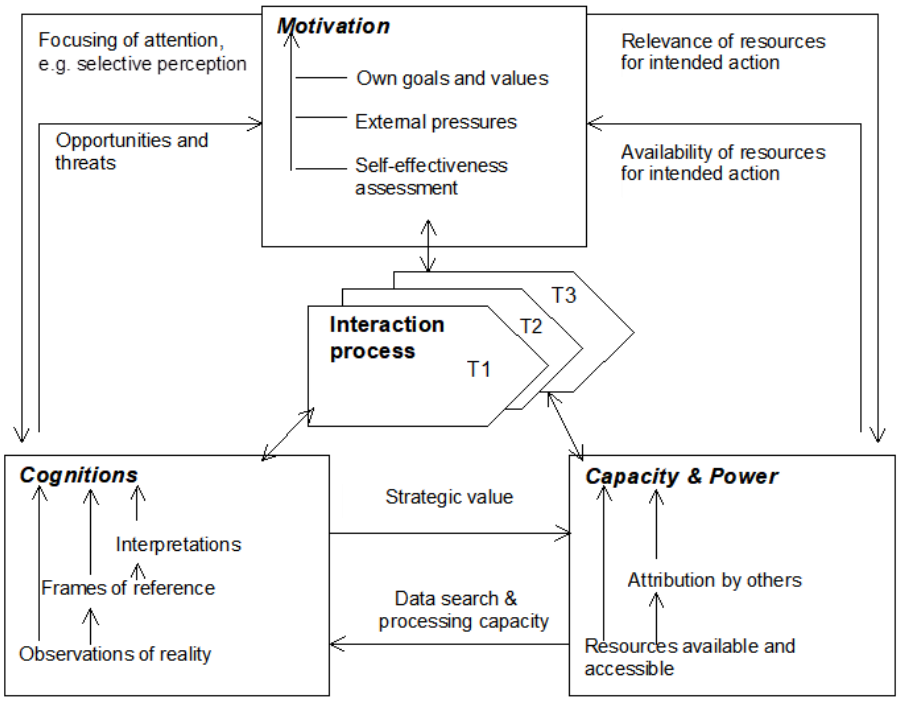


Figure 2: Dynamic interaction between the key actor-characteristics that drive social-interaction processes and in turn are reshaped by the process. Source: (Bressers, 2009)

3.2.2 Contextual layers

The mentioned second set of independent variables are the contextual factors that indirectly effect the outcome of the implementation process through influencing the core characteristics. In the CIT these factors are divided into three contextual layers: the specific-, structural and wider context (Bressers, 2009). As can be seen in figure 3, the layers are overlapping. From right to left each step means a new context for the previous circle. Still, however, each layer could also influence the process directly instead of through the previous layer.

The specific contextual layer relates to the direct context of the case. So, depending on the type of research and the unit of analyses, the level of the case specific context can differ. In this research the actors interact mostly on a local or municipal level. Hence this will be the level of the specific layer. Two things are important to consider in this context: (1) previous decisions, and (2) specific circumstances of cases (Bressers, 2009). Both could be a direct input of the process. Next is the structural layer. This layer is not case or actor specific, but is more or less the same for all cases. The layer consists mostly of aspects of governance, and can, according to Bressers (2009), be of effect of both the motivations and resources of actors involved. Lastly is the wider layer which mostly has an indirect effect on the interaction process. However, environment disasters, economic crises and technological breakthroughs could also affect the actors directly (Bressers, 2009). As noted by Mohlakoana (2014),

all layers can hold important factors influencing the implementation process through the mentioned actor characteristics. This is important to consider since the studies aim is to recognize contributing and hampering factors.

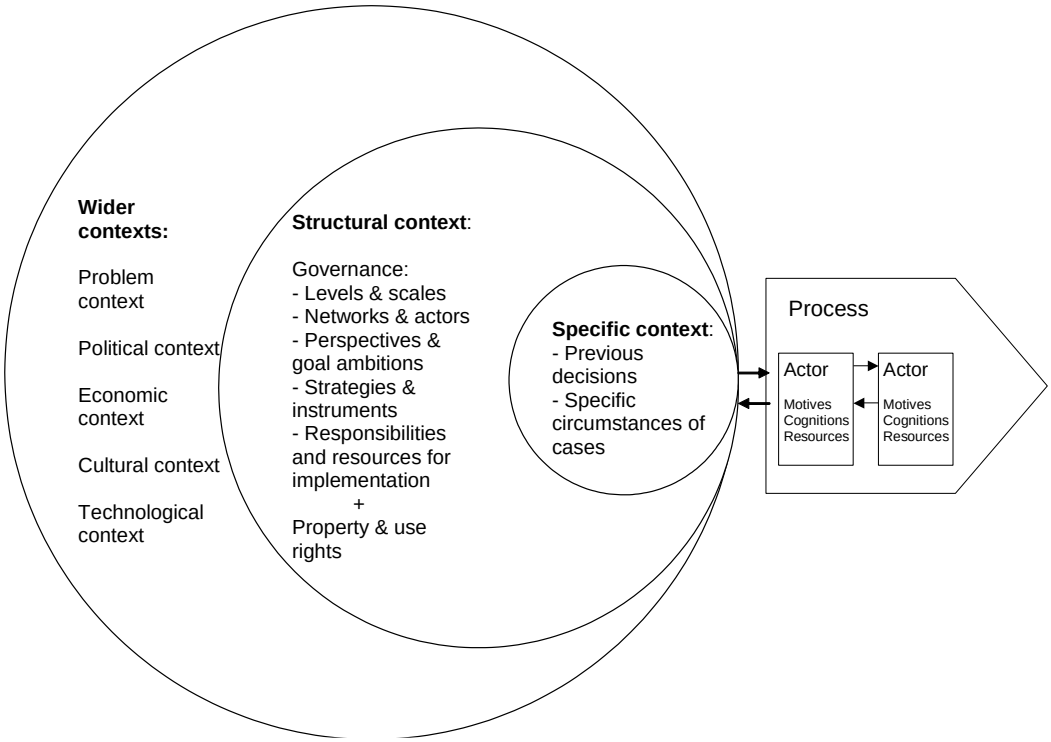


Figure 3: layers of contextual factors for actor characteristics (Bressers, 2009)

3.3 USE OF THE CONTEXTUAL INTERACTION THEORY

The CIT as theoretical framework has been chosen for several reasons. Firstly because it has found a parsimonious approach to analyse the complex implementation process without losing eye for the totality of possible influential factors. The second important reason why the CIT is very suitable for this research is that, even though its initial focus is the influence of policy instruments on the process outcome, it is still open to any other influential factor. And although many policy instruments aim at steering SHAs towards building more energy efficient, only one is explicitly directed at building NZEBs. It is thus highly conceivable that other contextual factors have had great influence on the process outcome. In short the open character of the framework is very suitable for the subject at hand in this research.

Nevertheless the application of the CIT will be different than it originally is meant to be used. In this study the interaction process between actors will be less of focus since in the decision making process on sustainability in new housing projects this interaction is barely present. SHAs are the dominant actor in this process and are highly autonomous in their operations on sustainability matters especially on choosing whether or not to build with the NZEB concept. Therefor only the SHA's actor

characteristics will be assessed. The influence of other actors on the process, such as national and local governments, are placed within the contextual layers and will be seen as a part of contextual factors influencing the SHA's core characteristics. For instance through the policies and schemes mentioned in the background chapter.

Furthermore since the core characteristics relate specifically to SHAs, the motivation, cognition and resources characteristics are operationalized in the manner that they relate to this specific actor and suite the research context. They are operationalized as followed:

Motivations are the goals and values of SHAs and how they relate to the effects of building with NZEBs, for instance on energy efficiency. This entails both intrinsic motivations as pressures from other actors towards the concept. It furthermore depend on the self-effectiveness assessment of the SHA on whether or not they can successfully build with the concept. A negative assessment can demotivate the SHA to implement concept

Cognitions can best be defined as how SHAs perceive NZEBs and to what extend it provide a feasible way of realizing new projects. This very much depends on the frames of reference and their observation of reality, which possibly differs between each SHAs due to different contexts. More specifically the analyses of cognitions of cases aims at what knowledge SHAs have on the building concept and if they see this way of building as an appropriate one.

Resources are operationalized as the available and accessible assets of the SHA to realize NZEBs. This can refer to financial resources, but also to time and organizational capacity. Another factor connected to resources is the power balance between actors. This balance is established through the dependence of actors on resources of others. For this study it is therefore important to know the power balance between authorities and SHAs when it comes to the building of new projects. Although all three characteristics relate to one another, especially the availability and accessibility of an actors resources is dependent and possibly influenced by the cognitions and motivations of an actor (Bressers & de Boer, 2013).

3.4 RESEARCH SPECIFIC CONTEXTUAL FACTORS

One assumption of the CIT is that all factors in the context affect the process through their influence on the actor's core characteristics (Bressers, 2004). However, since the framework also attributes high importance to the context, research should not merely focus on motivations, cognitions and resources of actors involved. Findings should also stipulate what parts of the context and which specific factors actually shape the core characteristics of the actors. Therefor this research also focuses on earlier research aimed at recognizing contributing and hampering factors on the process related to realising energy neutral NZEBs by social housing associations. These factors will provide guidance during the empirical research further on in this study. Below the results of the literature review on the factors is

presented. Not all factors are mentioned, only those attributed with the most relevance are treated. The factors are placed into the three contextual layers of CIT.

3.4.1 The specific layer

Local networks:

Social housing associations are important partners on a variation of topics in local communities. They work strongly together with local governments for the housing of people who require special care, but they are also important actors for contractors and other organizations. Therefor there is a certain kind of relation between these local actors. Trust and communication in these relationships is similarly important in order to successfully applicate renewables into social housing (Dewick & Miozzo, 2004; Hoppe, 2012). Hoppe (2012) states that trust and communication go hand in hand. So trusts breaks down when communication falls short. A network on the topic of energy innovations is in this respect a way of embedding relations with local actors. It is therefore that involvement in a local network on the topic of renewable energy should contribute to the application of NZEBs in new social housing projects.

Experimental experience:

Innovations come with new technologies. In the building sector this means new ways of building. This requires space for experimenting. Although NZEBs in the Netherlands have exceeded the status of a niche, it is still a concept which is developing and has similar characteristics as a niche. Important for niches to develop are protected spaces in which actors can learn about the design, user needs, and cultural and political acceptability of a niche (Schot & Rip, 1997). Hoppe (2012) learned that social housing associations also need sufficient experimental room in the application of innovative energy systems in their projects.

3.4.2 The structural layer

Adequate financial schemes:

Building NZEBs requires the application of new and often more expensive technologies and installations into the design of the building. This requires a higher investment from social housing associations. As Hoppe and Lulofs (2008) indicate it is important for social housing associations to pass on extra costs of investment to tenants. This, however, is hard due to regulation on tenant protection. This creates a split incentive for SHA considering that they are responsible for the investment while tenants receive the benefits. This does also apply when local authorities are involved, but do not support financially. In this case housing associations bare the financial costs while authorities benefit from the created political capital (Hoppe, 2012).

Therefore, it is important for the successful realization of renewables in the social housing sector to create proper and effective financial schemes. Also because the capacity to raise capital in this sector is low (Bodach & Hamhaber, 2010; Lyon-Collis, 2009; Saunders, Gross, & Wade, 2012; Walker, 2008).

Support from third parties helps to remediate the perceived risk of the innovative projects where uncertainty is higher than in conventional projects. Hoppe, Bressers, and Lulofs (2012) showed that adequate and appropriate policy instruments, such as subsidies, are important contributing success factors to the application of innovative energy technologies in social housing projects, and this experience could lead to more confidence in applying the technologies in future projects without the need for subsidy. The EPV, treated in chapter 2, is the active financial scheme meant to remediate extra risks and cover the costs of NZEBs. Therefor this will be the instrument under research when assessing the influence of active financial schemes.

Stimulating governmental policy and regulations:

Not only adequate financial schemes developed by government, but also other institutional factors could create an incentive to apply innovations in building projects. This institutional context consists of regulative, normative and cultural-cognitive rules.

Social housing association are embedded in a system of formal and informal rules which combined form the institutional context. The first are planned institutions such as state organizations and regulation. Whereas the latter are more evolved institutions characterized as ground rules. Together these institutions structure, but do not determine, the decision-making outcome of actors (Ostrom, 1990). Research showed that the diffusion of innovations requires a shift in the incumbent institutional context. So changes are needed to gain legitimacy with actors (van Oorschot et al., 2016). Institutional pressure could in this respect also result in the adoption of innovations while it is undesirable for the adopting organizations (Abrahamson, 1991). So institutional factors could be of great influence on adopting near energy neutral innovations.

According to van Oorschot et al. (2016) the institutional context of the social housing sector in the Netherlands is highly regulated. This means that governmental rules and policies, as part of the institutional context, are an important influential factor on the decision-making process (van Oorschot et al., 2016). Also when it comes to the adoption and diffusion of innovations. It is therefore expected that stimulating governmental policy and regulations, targeting the adoption of sustainable innovations, are important contributors to application of NZEBs in new social housing projects. In practice several instruments are related to this factor. The Building decree, for instance, with its increasing requirements on energy efficiency measures for new buildings, could be such an instrument since it brings the minimal requirements closer to the performance of an NZEB. This could stimulate the adoption of the concept. However also not mandatory instruments could stimulate adoption of the concept for instance through subsidies on PV-panels or information schemes.

3.4.3 The wider context:

Technological novelty:

It is often mentioned that the newness of the technologies is a barrier to the application of them (Crilly et al., 2012; Dewick & Miozzo, 2004; Kempton, 2014). The newness for instance creates uncertainties belonging to integration of the technologies into the construction (Kempton, 2014). Also the lack of feasible cases offering an example makes housing association hesitate to apply the technologies. Moreover, the technology and the coherent complexity of funding and maintenance of the used installations creates a barrier to some housing associations (Crilly et al., 2012; Dewick & Miozzo, 2004; Kempton, 2014). Hoppe et al. (2012) adds that absence of inter-organisational cooperation due to the novelty of the application forms a barrier to the application.

3.5 CHAPTER SUMMARY

In short, this research will apply the CIT as its theoretical framework. The value of the CIT is that it provides a deductive and parsimonious approach, and simplifies the complex context in which implementation processes take place by channelling all influential factors through three core actor characteristics motivation, cognition and resources. How these characteristics influence the process depends greatly on contextual factors from three contextual layers. Five possible factors that, according to earlier research, are of influence on the process of implementing sustainable technologies into social housing projects have been identified. These provide direction for the study of contributing and hampering factors on the process under research. How exactly the CIT will be used in in empirical part of this research will be explained in the following methods chapter.

4 METHODOLOGY

The knowledge developed in the two previous chapters will here be used to create an analytical framework that will contribute to answering the posed research question. This chapter starts by providing detailed information on the chosen research design. The multiple case study design will be explained and justified. Also explaining the case selection. In paragraph 4.2 we will outline how data has been collected from the researched cases. The last paragraph before the concluding remarks will describe how data will be analysed and documented in the results chapter following this chapter.

4.1 RESEARCH DESIGN

In order to find out what factors influence the decisions making process of SHAs into a certain direction, a case study design is chosen as the best suited design. Many different definitions of the case study exist. Highly cited is the work of Yin (2003) who states that a case study is an in depth research of a contemporary phenomenon in a real life situation. Another definition comes from Thomas (2011),

he states that a case study is the analyses of a system that is researched with a comprehensive view by a single or multiple case study method. The goal of the case study is not merely to understand the specific unit but is often meant to better understand the larger group of units. To better understand the population of units through a case study it is optional to research more than one case. Such a design is called the multiple case study design. By studying multiple cases it is possible to find differences or similarities between cases (Baxter & Jack, 2008), and compare findings within each situation and across situation (Yin, 2003). A multiple case study allows for a wider exploration of research questions and testing of theories (Eisenhardt & Graebner, 2007). As to practically every design also the multiple case study has disadvantages. It is for instance time consuming, it is argued that a single case study produces better theory, and for each extra case the observation time of the cases reduces. The multiple case study does however provides the researcher with the highest amount of representativeness (Gerring, 2004). All together the multiple case study is chosen as the best fit for this thesis of which the goal is to provide insight in the social housing sector as a whole, with the aim to generalize the results to this extent.

In order to increase the generalizability of the results, cases have been selected in a way that contributes to this objective. Seawright and Gerring (2008) provide a menu with case selection techniques that are best suited to specific types of case study research. First of all they note that random selection of cases is generally not viable for small-N cases studies because it often produces samples that are extensively unrepresentative for the population. Regardless, systematic selection does have the same objectives as randomization. Namely to provide "(1) a representative sample and (2) useful variation on the dimensions of theoretical interest" (Seawright & Gerring, 2008, p. 296). The cases selected for this study where first of all selected on the basis of whether or not the SHA has implemented NZEBs into a building project (the dependent variable). Both for the implementing cases as for the not implementing cases the starting point was to research five cases. Subsequently the intention was to select five cases that varied on the dimensions of size (measured by the amount of living units owned) and geographic location. The size was chosen because it has been indicated by Hoppe (2009) that organizational capacity increases together with the number of houses of an SHA. This should also mean that differentiation in tasks increases and thus more people are invested in the energy performance of the housing stock. Geographic location relates to two aspects of variance, firstly it was intended to select cases spread across the Netherlands and secondly to vary between rural and urban oriented SHAs. The latter because in urban regions building projects tent to consist of high-rise (more than three layers) buildings, such as such as apartment flats, and in rural regions homes mostly consist of low-rise (three or less layers) buildings, such as terraced houses. By selecting both types the study encompasses a wide range of building types. So size and geographic locations where chosen as most forthcoming independent variables to achieve high amounts of relevant variation.

This type of case selection Seawright and Gerring (2008) call the diverse case selection method of which the main objective is to maximize variance along relevant dimension of both the dependent

and independent variable. This variance is expected to increase representativeness of the small-N sample, more than in any other selection method (Seawright & Gerring, 2008).

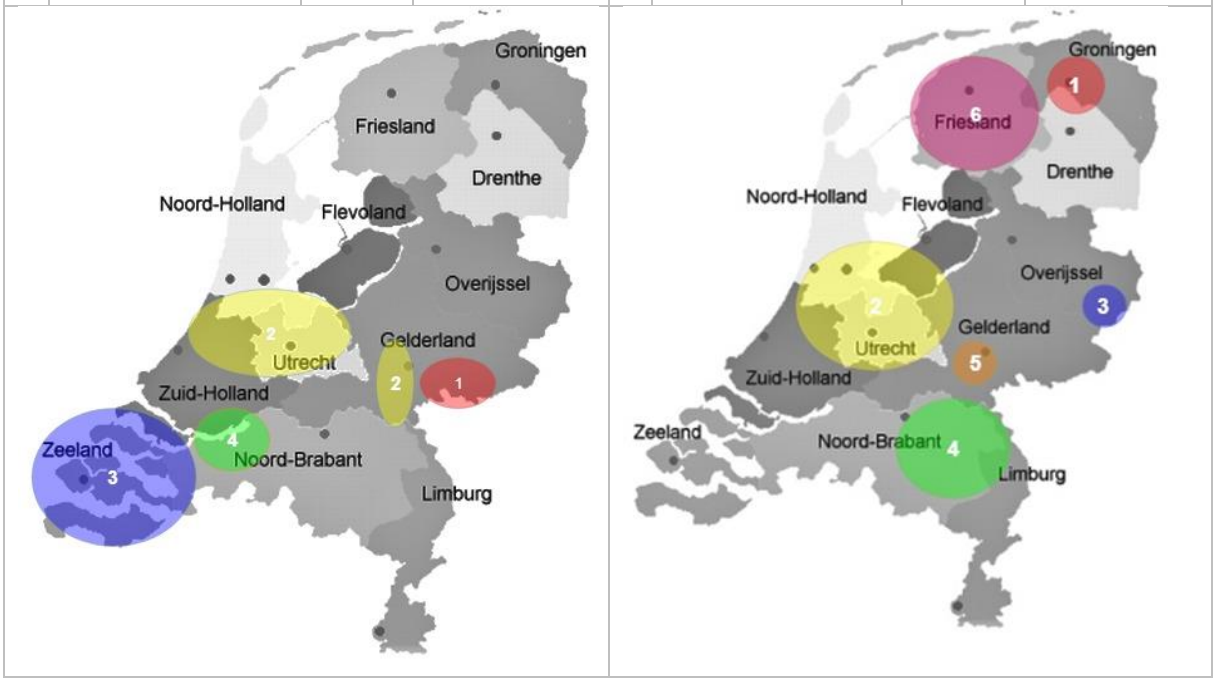
4.1.1 Case selection

Most of the actual selection of the cases has been done through a benchmark database of the branch organization of Dutch social housing associations called Aedes (2017b). In this excel file all SHAs connected to Aedes are listed with scores on topics investigated for the benchmark. Besides the benchmark, it also showed the province of all SHAs and their size measured by living units. This proofed to be helpful in finding variance in both dimensions. After filtering an SHA from the benchmark, the internet was searched and calls have been made to find out if and how new building projects have been constructed. If the SHA either recently started or already realized an NZEB project the SHA was approached through contact information available on their website. The same goes for SHAs that started or realized building projects without the implementation of the NZEB concept. In some cases the involved SHA did experiment with the concept, but this has not yet led to the integration of the concept in the uptake of a 'normal' (non-pilot) project. These cases therefore are considered as belonging to the 'not implementing' group. Over 40 SHAs have been approached in this manner. Nine agreed to cooperate with the study. One implementing case was contacted after receiving contact information from a case not implementing NZEBs. Table 1 shows the researched cases accompanied with size, building type and location on the map.

Due to non-response variation was not fully reached on the dimension of size. On average the living units owned by the SHAs in the sample is substantially higher than of the population of SHAs. The average of the sample is 20.600 units while of population it is just over 7000. This is not only the result of non-response of the approached smaller SHAs, but also from a few outliers with a very high amount of living units that highly deviates from the mean. This lower degree of variation is especially apparent in the not implementing cases, in which all SHA are bigger than the average. However, despite the non-response, variance on the dimensions of building type and location has been achieved.

Table 1 Overview of Cases with Size, Building Type, and Location (own figure)

Researched Cases							
Implementing the NZEB concept				**Not implementing the NZEB concept**			
	SHA	Size	High- or Low-Rise		SHA	Size	High- or low-rise
1	Wonion	4.000	Low	**1**	Nijestee	13.000	High
2	Portaal	47.000	Both	**2**	De Alliantie	53.000	High
3	CaseA	1300	Low	**3**	Domijn	15.000	Both
4	Thuisvester	13.500	Both	**4**	Mooiland	26.000	Both
				5	Volkshuisvesting	11.000	Both
				6	Woonfriesland	22.000	Both



4.2 DATA COLLECTION

Not only due to the small-N research but also due to the in-depth study of cases, the methods used for data collection fit to a qualitative research design. This is best suited for this study since we aim to better understand the complex context in which certain decisions are made by SHAs. The research methods used to achieve this aim are interviews and secondary data collection.

The main source of information from the cases are the interviews that have been conducted with one employee of each case. Although the influential contextual factors and the core characteristics from the CIT provided structure to the interviews, the interviews had a very open design. Meaning that the course of the interview was flexible and highly dependent on the given answers. Interviewees were provided with room to elaborate on specific topics when required, and follow-up questions were asked.

The goal of the interviews was to discover the influence of core characteristics and contextual factors of the particular SHA. Therefor the questions also related to the aspects belonging to the motivation, cognition and resources of the SHA as operationalized in the previous chapter. Furthermore the questions were based on the five contextual factors from literature. For both the core characteristics as the contextual factors the influence on the process are judged as either having a positive, negative or neutral effect on the process. Despite the open character of the interview, some questions needed to be answered in order to be able to compare the results and make reliable interpretations on the influence of each characteristics on the process. Therefor the questions in table 2 have been used as a checklist with questions on the core characteristics that had to be answered during the interview. These questions are asked directly or answered through answers on other questions. Furthermore questions were asked on the five contextual factors. These have been very straightforward. For instance, *were you involved in a NZEB related network? If so, how did this influence the decision of your SHA?* Or, *what influence do national policies have on the process on new building projects.*

Table 2 Interview Questions on Core Characteristics

Motivation	Own goals and Values	What are the SHAs goals with new building projects? What are the goals on sustainability with new building projects?
	External Pressure	What actors are involved in the decision making process towards new building projects? What influence did these actors have on the process?
	Self-effectiveness	Can your SHA successfully built NZEBs?
Cognition	Perceptions	How does your SHA perceive the NZEB concept? What are the advantages of building NZEB? What are the problems of building NZEB?
	Knowledge	(What) Did your SHA learn trough experimenting with the concept? (What) Did your SHA learn from others experiences on the NZEB concept?
Resources	Power	If any, are there actors other than the SHA in control over the decision on new construction projects?
	Capacity	Does your SHA have the resources available to build NZEBs?

For each case one interview was conducted with an employee involved with, and knowledgeable on the decision making process towards new building projects. The job titles of the interviewees differed between project manager, asset manager and strategic manager, or a title closely related to these. Due to the scope of the research doing more interviews per cases was unfavourable. Not only because the aspect of time, but also because the researcher considered it more valuable to research more cases with less depth instead of researching less cases with more depth. The interviews have been conducted in 2018 in the months May and June. Interviews have both been conducted in person and by telephone. All interviews have been recorded with the consent of the interviewee. In one case, unfortunately recording was not possible so notes have been made of the interview. Recordings have been transcribed through the editing transcription format, meaning that 'uhms' and laughs were not included in the transcription. Interviewees have been asked whether or not their SHA approved the use of the SHA's name in the research. All approved. One however did not reply after several attempts. So "CaseA will be used as code name when referring to that particular SHA. The region in which the SHA is located has also been widened on the map in table 1.

Besides the interviews secondary data sources have been used to retrieve information on the topics at hand. Documents have been studied to provide insight in the context in which SHA operate and how they operate. Some of this data has already been used in the previous chapters, but have also contributed in the understanding of the information from interviews. These documents entail among other thing, policy documents, policy reports, previous research on SHAs, and studies and reports from branch organization Aedes.

In addition on the interviews, the interviewees where requested to share valuable policy documents. Except for one, no documents were received from the SHAs. So most of the secondary date analysed are public and retrieved from the internet.

4.3 DATA ANALYSES

The analyses of the interviews was performed through the coding method. ATLAS.ti, which is a software program designed to assist with qualitative analyses, was used to structure and analyse the interviews and codes. The codes used for the analyses first of all consist of the five contextual factors found in literature, and the three core characteristics from the CIT. In addition the transcriptions are analysed on other contextual factors that influence the core characteristics and the decision making process of the SHAs. After this process each interview was summarized based on highlights. For each case the interview summary elaborates on the core characteristics of the case, on if and how the established factors from literature influence the process, and on what additional factors influence the SHA's motivation, cognition, or resources.

4.4 CHAPTER SUMMARY

This chapter established the methods used to gather and analyse the empirical data which is presented in the following results chapter. The studies aims is to provide a generalizable answer for both the non-implementing SHAs as for the implementing SHAs. Therefore the multiple case study design with maximum variance between cases is chosen as the most appropriate design. Ten SHAs are selected as cases and are interviewed to provide information on the factors that influence the decision-making process in a particular way. To connect and test these answers to the earlier established theoretical framework the interview questions are based on the core characteristics of the CIT and the factors found in earlier research.

5 RESULTS

In this chapter the results of the research are presented. The information form the research is connected to theoretical knowledge and other components of the previous chapters. The chapter is split into two parts. First two similar analyses will be performed on the two case groups. We start off with a close look at the three core characteristics of the cases and how these influenced the decision to build with or without the NZEB concepts. Next the contextual factors that affected the characteristics of the actors will be presented and elaborated. As a starting point the five factors retrieved from literature will be analysed on if and how they influenced the SHAs characteristics and thus the process. Likewise other factors that came up during the research will be analysed. However since the factors from literature are rather broad concepts many factors during the analyses can be placed within these concept. As can be seen shortly, not many factors were found that fall outside of these predetermined possibly influential contextual factors. The contextual factor analyses is subdivided on the contextual layers from the CIT, starting with the specific layer towards the wider context. Below the implementing cases are analysed first.

5.1 THE IMPLEMENTING CASES

Four cases make the group with the implementing SHAs. They have constructed housing projects in accordance with the requirements of the NZEB concept, meaning that houses have a guaranteed minimal on-site generation capacity of renewable energy and a low level energy consumption trough high amounts of isolation. Here the process of decision making will be analysed on the two parts of the CIT. Starting with the characteristics of the SHA an how these influenced the decision. Table 3 shows for each SHA how their motivation, information, and resources effected this process. For the characteristics of information and resources distinction will be made between high and low rise buildings since this influence the effect considerably for some cases.

Table 3 Influence of Core Characteristics of Implementing Cases on the Implementation Process

Social housing associations	**Core characteristics**				
	Motivation	Information		Resources	
		High	Low	High	Low
Wonion	+	n/a	+	n/a	+
Portaal*	+	-	+	-	+
CaseA	+	n/a	+	n/a	+
Thuisvester*	+	-	+	-	+

+: The core characteristic of the SHA had a positive influence on the process towards NZEBs

-: The core characteristic of the SHA had a negative influence on the process towards NZEBs

0: The core characteristic of the SHA had a neutral influence on the process towards NZEB

*Distinction has been made between high-rise and low-rise buildings. The left part of the box is the influence of the characteristic on high-rise buildings, and the right on low-rise buildings.

5.1.1 Motivation

Overall the results show that the motivations of the implementing cases is positive towards building NZEBs. Looking at the goals and values of SHAs, as an aspect that can result in the positive motivation of SHA, all see becoming energy neutral as the aim for the future. They currently have the ambition to make new buildings energy neutral, at least were deemed possible. For them NZEBs are a means to perform on this goal and thus they are intrinsically motivated due to the added value of the concept on their energy ambitions.

Furthermore, SHAs are pressured by actors and stakeholders on several topics. In the introduction of this research it is already mentioned that the social housing sector is politically pressured to increase the amount of newly constructed houses and to contribute to the sustainable development goals. On sustainability matters several SHAs mention that they do feel pressure to increase their overall performance on energy efficiency. Not only from politics via rules and policies, but also from society and there tenants. More and more people feel the responsibility to contribute to sustainability goals and hold SHAs responsible to act on in this respect. All cases indicate to some extent that the motivation to implement NZEB is influenced by the increasing attention from external parties.

The last partial influential aspect on motivation is the self-effectiveness of SHA to realize NZEBs. This aspect is rather close to the aspect of capacity and cognitions of the SHAs as we will see shortly. Self-effectiveness relates to whether or not an actor assesses itself with the ability to realize a certain policy output. All cases implementing NZEBs assessed building with the concept as something they were able to comply with. So this did not demotivate the SHA in the process. This however does only hold for low-rise projects. Two of the cases, who besides low-rise also builds high-rise buildings, assessed it as being out side of their capacity to make high-rise buildings conform to the specifications

of NZEBs. This is there for thus not interpreted as making the motivation partially negative because it already comes of effect in the cognition characteristic.

5.1.2 Cognitions/information

From the analyses of the cognition and information of SHA on NZEBs it appeared that in principle all cases interpret NZEBs as a suitable way of building when it comes to low-rise projects. This, for instance, comes from earlier experiences with the technologies used in the projects therefore SHAs know what they can expect in the building process. The implementing cases are confident that building with the concept will result in the desired effects. For Portaal and Thuisvester, the two SHAs also building high-rise buildings, this confidence does not apply on those projects. Especially due to the decrease of rooftop area per living unit buildings are unable to meet the required production of energy through PV-panels. Other forms of generation are needed to compensate the loss of solar energy. These are however still perceived as unfeasible due to high cost or uncertainties in their application.

5.1.3 Resources

The power component of this characteristic relates to the power balance between involved actors in the process. Normally SHAs are autonomous in making decisions and can choose their own way of building. However, some governmental actors do have hard instruments that limits this autonomy in constructing new projects. Laws and regulations on the minimal requirements are maybe the most forthcoming. But, although these requirements are getting closer to energy neutrality and the specifications of an NZEB, there are still alternatives for the SHAs to choose from. Another instrument is the performance agreement that municipalities make with SHA. These performance agreements also list sustainability performances with whom the SHA has to comply, and thus have the potential to commit to more ambitious measures. However only in the agreements made by Case04 it is explicitly mentioned that if possible new building projects are to be built as NZEBs. In the performance agreement of Wonion it is also mentioned that if possible projects have to be energy neutral. However not specifically as NZEB with on-site generation. So the performance agreements are used as a power instrument to put pressure on SHAs to some extent. Although it has to be mentioned that these are agreements made between local governments and the SHA together and are not forced upon them without mutual consent. So power remains at the SHA when it comes to whether or not to build NZEBs.

The other component of resources is more related to whether or not SHAs have the capacity to build NZEBs. Financially, building with the concept demands a higher initial investment of around 20.000 euro per living unit as opposed to building in accordance with the building decree. For the four implementing cases this proved not to be an impossible obstacle for different reasons. All cases mention that applying the EPV as a way of increasing profitability is important to make the concept financially attractive. Another reason why the extra investment is not too much of a problem are the positive financial positions of the SHAs, and the accessibility of financial capital from a fund called the WSW,

which provides capital with low interest rates. Also other forms of capacity, such as time or manpower, did not hamper the construction of NZEBs for the implementing cases.

5.2 THE CONTEXTUAL FACTORS OF INFLUENCE

In the same manner as with the core characteristics, table 4 show how the factors influence the decision making process towards building NZEBs. Below the influence of these and other factors will be further explained.

Table 4 Influence of Contextual Factors on Implementing Cases

Implementing Cases	Involvement in a network	Experimental experience	Available financial schemes	Policy and regulations	Technological novelty*	
					High	Low
Wonion	0	+	+	+	n/a	0
Portaal*	+	+	+	+	-	0
CaseA	+	+	+	+	n/a	0
Thuisvester*	+	0	+	+	-	0

+: The contextual factor had a positive influence on the process

0: The contextual factor had a neutral influence on the process

-: The contextual had a negative influence on the process

*Distinction has been made between high-rise and low-rise buildings. The left part of the box is the influence of the characteristic on high-rise buildings, and the right on low-rise buildings.

In the specific layer factors are placed that are different for each case. Here earlier decision made by the SHA, or other specific circumstance can be of influence on the process. The decision to get involved in a network or to choose to experiment with new technologies are two of the predetermined factors that fit in this layer. All of the implementing cases, except Wonion, mentions that they were involved in a NZEB related network, and that this positively affected the decision for building NZEBs. Portaal and Thuisvesterter were both involved in the ‘Stroomversnelling’ which is a network solely brought to existence to stimulate building NZEBs. The network provides the SHAs with an increased amount of knowledge on how to realize NZEBs. Also CaseA was involved in a network. However more locally with the municipality and other actors in the region. It is their ambition to become energy neutral as a municipality in 2020.

The other cases were also asked about the role the municipality had in their decision for NZEBs. Besides CaseA only Portaal indicates that sustainability is an important topic in some of the municipalities in which they are active. These municipalities also endorse this importance on the SHA. Wonion and Thuisvester however state that municipalities do not steer or stimulate them to increase

their sustainability measures in any way. Even though they feel this should be an important topic on the agenda of local authorities.

Wonion, as the only implementing case not involved in a network, developed its knowledge on the concept mainly through a multitude of experiments performed over the years. Portaal and CaseA also have accumulated knowledge through pilots and experiments with NZEB technologies. Thuisvester already learned enough about these technologies through their involvement in the Stroomversnelling and did not thought it necessary to acquire more knowledge through experiments. This factor is thus perceived as having no effect on Thuisverster.

In the following layer factors are not case specific anymore, but are similar for all cases. They can, however, have other implications among cases or can be perceived differently. This layer is called the structural layer and many aspects of governance can be found in it. Two different factors from literature are placed in this layer that especially relate to the policy instruments that are active to stimulate the realization of NZEBs. So instead of focusing on the broad governance concept the narrower concept of public policy is used. Available financial schemes, and rules and regulation are separated in two different factors. Starting with the former, it appears that the only financial scheme available, specifically for realizing NZEBs, is the EPV (already mentioned in the background chapter). NZEBs and the EPV seem to go hand in hand. All implementing SHAs apply the EPV on their NZEB projects to at least partially compensate the required extra investments. Three mention that the EPV is crucial for the business case, without it the project would be too unprofitable. Wonion, however, states that although it has been applied in previous projects, the EPV will be under discussion in the following projects. For them building NZEBs has become routine and the business case is almost profitable without the EPV, and has become superfluous. Regardless of their use of the EPV, all implementing cases mention that the EPV has quit some disadvantages. First of all it requires an extra investment to install the systems needed to monitor the performance of the buildings. Secondly the monitoring itself can be rather expensive, especially when outsourced to the constructor of the projects. Wonion and Thuisvester have therefor already decided to do the monitoring by their self or outsource to a cheaper third party. However still, a significant part of the EPV is used to cover the extra expenses made to be allowed to apply the EPV. Much of the compensation from tenants is thus wasted on overhead instead of on energy improvements. So although the EPV still has a positive effect on the implementation of NZEBs, SHAs do have complaints on its expediency.

The second factor in the structural layer is that of stimulating rules and regulations applicant on the sector. All implementing cases indicate that governmental policy and regulation on energy performance contributed to their application of NZEBs. Most indicate that due to the stricter regulations on energy performance and energy efficiency the more ambitious NZEB comes closer to building in accordance with the minimum requirements from the Building Decree. Especially with the new policy

of only building BENG from 2021 on forwards. Furthermore the law that restricts buildings to be connected to natural-gas makes it even more attractive to build NZEBs because it steers builders towards all-electric buildings. This, however, has not yet influenced the decisions in any of the projects under investigation since decisions on building specification where already made before the law became active.

In the third layer, the wider context, technological developments were considered as an important factor on the decision making process. Reason for this is that NZEBs consist of many novel and innovative technologies. The current affairs of technological developments can therefore have considerable impact on the favourability of the concept. For the four implementing cases this novelty proved not be an obstacle in the construction of NZEBs. The current status of technologies are sufficient to realize NZEBs. Nevertheless they do mention that the current situation is not ideal. The installations are still more expensive than conventional installations. They expect that future developments will make them more efficient and able to compete with the traditional installations such as boilers. Current technological status is thus considered as being of neutral effect on the implementing cases. However, only when related to low rise buildings. For the two cases with high-rise buildings the technological status does not provide feasible options to make high-rise buildings NZEBs. In those instances the factor is perceived as a negative influence on the implementation of the concept.

5.3 NOT IMPLEMENTING CASES

Six of the studied cases have not implemented the NZEB concept in a building project at the time of research. Instead they chose to build in other manners with lower performance on energy efficiency. For instance by building in line with the minimal requirements of the Building Decree or with the aim of an EPC of 0. Similar to the implementing group this group is analysed on both core characteristics and contextual factor. However here the focus is to find out what factors barrier the implementation of NZEBs. In table 5 the influence of the core characteristics of the not implementing SHA on the implementation process has been visualized. These will now be further explained, followed by an analyses of the contextual factors.

Table 5 Influence of Core Characteristic of Not Implementing Cases

Not **implementing Cases**	Motivation	cognition	Resources
Nijestee	+	-	-
De Alliantie	0	-	-
Domijn	0	-	0
Mooiland	+	-	0
Volkshuisvesting	+	-	0
WoonFriesland	0	-	0

+: The core characteristic had a positive influence on the process

0: The core characteristics had a neutral influence on the process

-: The core characteristic had a negative influence on the process

5.3.1 Motivation

Although in the end the NZEB concept was not implemented into a housing project, the motivation of three of the cases is interpreted as positive towards building NZEBs. This is mainly the result of their own goals and values and how these match with the energy effects of the concept. The three stipulate the ambition to better perform with their new building projects than is required. Prove of this positive motivation lies for Mooiland and Volkshuisvesting in their experimental work on building with the concept. For Nijestee it lies in the effort they put into realizing projects with equally high ambitions on energy performance, but achieved through of-site generation.

The motivation of the other three cases is perceived as neutral towards building with the NZEB concept. They do not stipulate over ambitions goals on performing on sustainability matters in new projects, because their main goal is to provide affordable housing for tenants, and do not have time to invest in extra energy measures. Own goals and values are thus less of a match with the energy effects of NZEBs. Furthermore, external pressures are not cause enough to become motivated for the concept. Additionally, for De Alliantie, who builds almost exclusively high-rise projects, the self-effectiveness assessment on building with the concept is demotivating. They are however not against the effects of making buildings NZEB, so also their motivation is perceived as neutral.

5.3.2 Cognitions

Without exception the cognitions of the non-implementing cases are negative towards building NZEBs. They perceive the concept as an undesirable way of realizing new projects because of the strict technical requirements of concept. This has several different reasons. For Nijestee and De Alliantie, the foremost reason is that they almost exclusively build high-rise projects. As mentioned before, this makes building with the on-site concept not only more expensive, but also of increased difficulty and with more risk of

failure. Mooiland and Volkshuisvesting mention that from observations, for instance through experiments or pilots, the concept is still attached to too many drawbacks. Multiple cases furthermore mention that the required guarantees on energy performance negatively influences their perceptions towards the concept. For Domijn cognitions are negative because of a lack in knowledge on recent developments with NZEBs. Years back the concept was perceived as too expensive. Currently policies are being formulated on energy neutrality, before this was not much of a focus and concepts such as the NZEB did not receive new attention.

5.3.3 Resources

On the balance of power the same goes for the not implementing cases as for the implementing cases. The not-implementing cases also have alternatives for building NZEBs and the decision is there for ultimately their own. Although performance agreements are present, and in some cases have and important focus on sustainability, they do not force the SHA into building NZEBs. So also here the influence of the SHA's resources on the process is the result of the accessibility and availability of capacity and not by the power balance.

The profitability of an investment is for SHAs very important to see whether or not a project is financially attractive. Nijestee and De Alliantie explicitly mention that the extra investment needed to realize NZEBs is too unprofitable to make. Even with compensation on investments from the EPV the gap remains too substantial. The four remaining cases, for which resources are neutral, also mention the additional investment as being considerable. However, if cognitions would be more advantageous towards NZEBs, the needed resources possibly could have been made available. They are therefor considered as neutral since they fully depend on other characteristics.

5.4 THE CONTEXTUAL FACTORS OF INFLUENCE

Now a closer look will be granted to how contextual factors have influenced the decision making process of the not implementing SHA. Table 6 already provides an oversight of the way the factors influenced the process towards building with NZEBs. More detail however will be provide now.

As part of the specific layer, involvement in a network and experimental experience are for the most part a neutral effect on the decision whether or not to build with NZEB concept. Only Nijestee was involved in a network cooperation -- in which also the municipality was also involved -- that aimed to realize buildings with a similar level on energy performance as NZEBs. However the goal of the network was to realize NZEB projects through collective geothermal of-site energy generation. Even though this has not yet been established due to safety issues, the network negatively influenced building with the on-site concept under researched here, since it focused on other forms of generation. For the other cases the factor was neither of a positive or a negative influence on the process since involvement in a network on building NZEBs was absent.

Table 6 Influence of Contextual Factors on Not Implementing Cases

Not Implementing Cases	Involvement in a network	Experimental experience	Available financial schemes	Policy and regulations	Technological novelty
Nijestee	-	-	-	0	-
De Alliantie	0	0	-	0	-
Domijn	0	0	-	+	-
Mooiland	0	-	-	+	-
Volkshuisvesting	0	-	-	+	-
Woonfriesland	0	0	-	+	-

+: The contextual factor had a positive influence on the process

0: The contextual factor had a neutral influence on the process

-: The contextual had a negative influence on the process

Furthermore cases where asked about the role of the municipality in the decision-making process and whether or not they stimulate SHAs towards increased sustainability measures. Besides Nijestee, also De Alliantie mentions that municipalities start to exert pressure on them to contribute to sustainability goals. But since they build only high-rise buildings, building BENG is already a challenge and demands a high extra investment. According to De Alliantie municipalities expect them to carry all cost. Doing more than they are doing at this moment is not an option for the SHA. The four other cases point out that they are in contact with local authorities on sustainability matters. But only to some extent. Certainly not to they extend that it pressured them towards building NZEBs. Domijn and Volkshuisvesting, both indicate that especially smaller municipalities still have to figure out their role on the topic of sustainability.

On the matter of experimental experience half of the cases mentioned that this had no effect on their decision. Domijn was at the moment of research still in the process of experimenting with NZEB technologies. Results were not yet in and it thus it did not affected their decisions on previous building projects. Both WoonFriesland and De Alliantie state that it is not in their strategy to do a lot of experimenting. Hence NZEB experiments were not conducted. Nijestee, Mooiland and Volkshuisvesting on the contrary did gain experience trough experimenting with the concept and its technologies. But they were not compelled by the results. Building with the concept was perceived as overcomplicated with too many drawbacks. Both technically, financially and on usability.

In the structural layer are the available financial schemes, or more specifically the EPV. Without exception all not implementing SHA perceive the EPV as inappropriate and insufficient. The reasons for this are similar to the disadvantages mentioned by the implementing cases. However more emphasis is placed on the fact that tenants, in the end, have to pay the EPV, of which a substantial part is lost to activities related to monitoring instead of increased sustainability. For these cases the lack of appropriate

financial schemes available is, at least partially, the reason to not build NZEBs. Typically they add they rather build a bit less ambitious than NZEBs, however still quit sustainable. Hereby lowering the energy bill for tenants and without the need to monitor for the EPV. For the not-implementing cases the available financial schemes are thus of a negative influence on the process towards NZEBs.

Then there are the rules and regulations that aim to steer the sector towards more sustainability. The four cases who do not exclusively build high-rise projects indicate that increased focus of national government on sustainability has had an influence on their projects. First of all, the minimal requirements on sustainability from the Building Decree that become stricter every few years. Furthermore it is mentioned that the ambition of energy neutrality in 2050 provides a goal for SHA to work towards. Also the prohibition of a gas connection will further pressure towards NZEB-like concepts. WoonFriesland for instance indicates that due to this law they skipped building BENG and decided to go for an EPC 0 in new projects. Without this law they might still have built with an EPC of 0.4. These rules and regulations have thus positively influenced the process of these SHAs. However other factors had a stronger negative effect on the decision to build NZEBs or not. Nijestee and De Alliantie also mention that they noticed the increased effort made by national government on sustainability matters. This has nevertheless not made them really consider the concept since the investments are still far too high compared to other options. For them the influence of policies and regulation is thus perceived as neutral.

The technological status, as part of the wider contextual layer, appears to have a negative influence on the process towards NZEBs for the not implementing cases. The innovative technologies still have too many downsides to compete with the more traditional ones. For the high-rise projects of Nijestee and De Alliantie the installations used for generation, such as pv-panels and heat pumps, are simply not efficient enough to meet the energy demand of their buildings. Volkshuisvesting and Mooiland furthermore learned from their experiments that shortcomings of the used technologies cause too many problems. They are too expensive and require a disproportionate amount of maintenance. Domijn states that they have too little confidence in the available installations and have therefore begun experimenting. WoonFriesland argues that current installations are still lacking efficiency and since they expect that this will change in the near future, they would rather postpone investing in them. This argument is also brought forward by some of the other SHAs. So all arguments together the current technological status negatively influences the uptake of NZEBs for the not implementing cases.

5.5 COMPARISON OF CORE CHARACTERISTICS BETWEEN GROUPS

Now that we have established for both groups the influence of the core characteristics and the context, a comparison can be made between the two groups of cases and discover what are the contributing and hampering factors on the application of NZEBs. Again we start with comparing the characteristics first followed by the contextual factors.

The motivation for all implementing cases is interpreted as positive towards the implementation of NZEBs. The same goes for half of the not implementing cases. This positive motivation is most often the result of a combination of external pressure and own goals and values of the SHA. However in different proportions. Some implementing SHAs indicate that they do not feel significant pressure from external actors to comply with the energy performance of NZEBs and the motivation for building NZEBs is for the most part the result of own ambitions. Others note that, for instance, especially the local sustainability goals put pressure on them to realize NZEBs and this motivated the SHA to do so. The difference between the cases that are positively motivated and the cases that are not is that both the internal and the external motivations are missing for the neutral cases. Nor they nor external actors stipulate explicit ambitions for realizing energy performance levels equal to NZEBs. Motivations are thus neither positive nor negative on the application of NZEBs.

A clear difference between groups becomes apparent when comparing the cognition characteristic. All implementing cases indicate that their knowledge and information specifically on the NZEB concept makes it that there cognitions are positively towards building with the concept. All not implementing SHAs, in contrast, indicate that there cognitions are negative towards the concept. There thus seems to be a divergence in perception on the applicability of technologies or on the concept as a whole. However for high-rise building there seems to be consensus among cases. Both the implementing as the not implementing cases stipulate that the expertise they possess on building high-rise NZEBs results in a negative cognitive assessment for these projects.

Furthermore, there are certain differences between the availability and accessibility of sufficient resources among the two groups. This is also the result of the motivation and cognition characteristic of the SHAs. As is mentioned by Bressers and de Boer (2013), resources become only significant when connected to other characteristics. When the combination of motivations and cognitions is positive, only then it is relevant if there are sufficient resources available. For the implementing cases the availability and accessibility of resources is interpreted as having a positive effect on the implementation process. For the not implementing cases however this is not the case. Resources are neutral for most SHAs since they could have been made available when cognitions would have been positive. For the cases who exclusively build high-rise housing projects the resource characteristic is negative, since the investment is too substantial. Again there is a consensus for these type of projects also among the implementing SHAs. For high-rise projects the demand for extra resources is currently simply too high to create an acceptable business case, and NZEBs are thus not implemented in these projects.

5.6 COMPARING CONTEXTUAL FACTORS

Being involved in a network seems to contribute to the implementation NZEBs. Three of the implementing cases are involved in a network with the aim to realize NZEBs while of the implementing cases none where involved in such a network. It therefore appears that network involvement can

contribute to choosing for NZEBs and has a positive effect on the cognitions and motivation of SHAs. It could however also be that SHAs are by itself already motivated to build NZEBs and subsequently join a network. This could especially be true for the cases that joined the 'Stroomversnelling'. Nevertheless the fact remains that only the cases with a positive motivation that are involved in a network have implemented the concept in their projects. The cases that are motivated but where not involved in a network in contrast have not.

Within this factor also the role of the municipalities has been assessed. It appeared that especially the more urban and bigger municipalities already formulated sustainability goals and are pressuring SHAs in their region to perform on this matter. Problematically, however, is the fact the SHAs in these urban municipalities mainly build high-rise projects. NZEBs are thus percieved as an inappropriate concept. Paradoxically, many of the rural municipalities are still figuring out what their role is in the matter, and are not pressuring SHAs to implement sustainable measurements in their projects. While here mainly low-rise projects are realized and NZEBs are much more feasible to build with.

Experience with the concept seems to have had divergent effects on the researched cases. Both in the implementing as in the non-implementing group three SHAs have experimented with the concept, or with the necessary technologies. For the former these influenced the decision-making positively while for the latter these proved to have negative influence on the process towards NZEBs. This can be the result of the different outcomes of the experiments or on the perception of the results. Regardless, the positive or negative assessment of the experiments has consequences for the cognitions of the SHA since it contributes to the observations and the perceptions of a case. Experimental experiences can thus both be a contributing factor as a barrier for the implementation of NZEBs.

The currently available financial schemes are also varying in influence on the case groups. Even though, these financial schemes are part of the structural layer, and therefore equally available for all cases. The foremost example comes from the perceptions of cases towards the EPV. All of the implementing cases state that the EPV is important in order to return investments and it therefore contributed positively towards building with the concept through the positive effect it has had on the availability of resources. The non-implementing cases, in contrast, state that the EPV is not an appropriate financial scheme to finance NZEBs because much of the compensation is spend on monitoring and administration, instead of on compensating the extra investments. This is also mentioned as a drawback of the EPV by many of the implementing cases. Hence, Wonion is will reconsider applying the EPV in future projects.

The present national governmental policies and regulations seem to positively contribute to the application of NZEBs or at least the serious consideration of them. All implementing case mention that stricter rules and higher minimal performance standards make it more attractive to choose for the concept because the investments costs do not differ as much as before. Also four of the non-

implementing cases agree that stricter regulations contribute towards increased sustainability measurements. The policy instruments used made SHAs consider the concept. However other factors have had a more decisive negative influence on these SHAs. For most cases the pressure form national government through policies and regulation contributes to the uptake of NZEB due to influence it has on the motivation characteristic as a form of external pressure. Only two cases do not feel this pressure, mostly because they exclusively build high rise projects.

The technological novelty forms a barrier for some of the cases and not for others. Especially the not implementing group is negative about the current status of the innovative technologies used to build NZEBs. Reason for this is that they still are very complex to build with, and score low on efficiency and cost effectiveness. And, although it not really barriers the application of NZEBs by the implementing cases, they also mention that technologies are still expensive and could improve on efficiency. A commonly shared perception on these technologies between groups is that in the coming years the efficiency will improve significantly. Making them more sufficient for implementation. Many of the not implementing cases mention that this was a reason to postpone the application of these technologies.

6 CONCLUSION

In this research ten social housing associations have been studied with the aim to identify the contributing and hampering factors on the implementation of an innovative and new building concept for social housing projects, called Net Zero Energy Buildings. As a theoretical basis the Contextual Interaction Theory was used as a lens through which the decision-making process on building projects could be analysed. Together with factors from earlier research this provided direction to find the factors of influence on the unit of analyses in this particular study. By investigating SHAs that realized NZEBs and SHAs that have not, a comparative analysis could provide insight in what caused this difference in building projects. First of all by focusing on motivation, cognition and resources as the three core characteristics of the SHAs, followed by an analyses of the contextual factors that influenced these characteristics.

One clear barrier should first be addressed since its effect on the process is shared among all cases. Although in theory there are options, in practice building high-rise NZEBs is seen as very unfeasible and no such projects have thus been realized by the researched cases. The installations that should generate the renewable energy for these buildings are still underdeveloped and lack efficiency, making them also financially undesirable. This both negatively influences the cognition and resources characteristics of SHAs. Nevertheless SHAs in urban and dense areas are very much dependent on high-rise buildings to meet the demand for social housing. Hence they have to build in this manner to be able

produce the required quantities. So, a decisive barricading contextual factor for the implementation of NZEBs in new building projects is the dependence on high-rise buildings by SHAs located in highly urban regions.

Looking at the core characteristics, especially the cognitions of SHAs appeared to have a strong influence on the decision making process. In all cases the final decision corresponded with the cognitive position towards NZEBs. All SHAs with a positive cognition implemented NZEBs and in contrast all cases with a negative cognition did not implement NZEBs. Regarding the two other characteristics, a positive motivation of SHAs towards NZEBs is much less a guarantee for the implementation of NZEBs. Besides all implementing cases, also three of the not implementing cases were motivated to build with the concept but did not, mostly due to negative cognitions. So although a positive motivation is needed, it does not assure the implementation of the concept. Resources, as the last characteristics, are primarily influenced by the combination of motivation and cognition. For the implementing cases resources were positive due to a positive motivation and cognition towards the concept. Resources of not implementing cases are neutral mostly due to the already negative cognition towards NZEBs. The power component is also important here. Because SHAs are in power, a negative combination of motivation and cognitions is reason enough to decide not to build with the concept. Resources are thus of no influence anymore for these cases.

The results furthermore showed what contextual factors contributed to the implementation of NZEBs and what factors formed a barrier. Especially involvement in a network and governmental policies and regulations contributed to the implementation of NZEBs. Additionally more pressure from municipalities in rural areas could contribute to the decision of SHAs for NZEBs. Experimental experience and available financial schemes as contextual factors are perceived differently between groups. While for the implementing cases both contributed to the implementation of the concept in new building projects, it formed a barrier for not implementing cases. More clearly is the role of the novelty aspect of the technologies that are to be used. All cases indicate that these are still underdeveloped, at least to some extent, and thus form a barrier for the further uptake of the concept even though they are already being applied in building projects.

7 DISCUSSION

In this thesis the Contextual Interaction Theory has been used as theoretical framework, albeit in slightly different manner then for which it was developed by Bressers (2004). Instead of focusing on the interaction process between actors, here the focus was particularly on one actor in the process, the Social Housing Association. Still the framework proved useful for analysing the decision-making process on new building projects for SHAs. Among other things, because of the determining role the SHA has in the process. Through first focusing on the SHAs core characteristics, and then on the

contextual factors that influence the tree core characteristics, contributing factors and barriers could be determined for the investigated cases. Although only ten cases have been researched the case selection scores high on representatives due to the deliberate selection of diverse cases on various variables (Seawright & Gerring, 2008).

In future research, however, it could prove useful to focus either on high-rise or low-rise buildings instead of on both. Reason for this is that high-rise buildings currently are a decisive barrier for the implementation of NZEBs by SHAs due to unfeasible current technologies. The main problem, evidently, is the absence of on-site generation capacity. When researching high-rise projects it could prove useful to include a wider definition for NZEBs than is done in this research. For instance by also including of-site generation. This could provide valuable insight on the actions that are being taken to improve energy performance of high-rise housing projects.

What is furthermore interesting is that all not implementing SHAs state that insufficient technologies are a reason for not implementing NZEBs. This seems to be a matter of perception or observations, since implementing SHAs state that technologies may be not ideal, but are sufficient for realizing NZEBs. What arguably could help change these differences are the contributing factors from the cases specific layer. That is to say involvement in a network or pressure from local municipalities. Both contributing factors are absent for the cases with a negative perception of current technologies. Moreover, it is important to further assess where municipalities could improve or increase their role and influence in the diffusion of sustainable technologies since they are, among other governmental actors, seen as the main facilitator of new sustainable concepts, such as the NZEB (Jain, Hoppe, & Bressers, 2017). This could especially be true in the rural municipalities where options are already available.

Noteworthy are the mixed perceptions on the EPV between groups. It seems that for cases of whom cognitions and motivations are already positive the EPV contributes to the implementation of NZEBs trough making extra financial resources available. It does however not succeed in taking away the doubts and uncertainties of the less positive cases. In addition, also cases who apply the EPV in their projects are sceptical about the expediency of the scheme. Especially because a substantial share of the compensation is lost on monitoring activities. Further research specifically on this topic could elucidate whether or not the EPV is a successful instrument to stimulate the implementation of NZEBs.

Lastly, the full range of active policy instruments appears to stimulate the diffusion of sustainability measures. Especially “hard” instruments, such as the building decree and the new law that prohibits a gas connection in new buildings, set out a new minimum on energy performance that comes closer to the standards of NZEBs. “Soft” instruments, however, are barely mentioned by SHAs as a contributing factor towards the application of NZEBs. This study did not go into further detail on the effects of specific policy instruments besides the EPV. Not only due to the scope of the study, but also since there are no other instruments specifically directed towards the concept under research. Since

policies mostly have a wider aim than only a specific concept, future research on a range of policy instruments should have a wider view than only one concept.

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9 APPENDIX

9.1 CASE SUMMARIES

NZEB implementing cases

Wonion
Total living units: 4000
Municipality: Oude Ijssel streek
Building type: Low-rise
Function interviewee: Project Manager

Wonion is located in a rural eastern region of the Netherlands and builds exclusively ground based low-rise homes. For the small SHA building NZEBs has become policy and all new houses are built with the concept. This general policy is the result of a combination of factors.

First of all Wonion made sustainability an important objective in its processes as a reaction on the increased requirements on the EPC of buildings by national government. They subsequently started experimenting with sustainable technologies through which they learned how to build with the technologies that make the NZEB. Due to this they have over a decade of experience with related technologies. Another important reason for building NZEBs is there financial feasibility and affordability, both for the SHA as for the tenant. Building with the concept in combination with the EPV is, according to Wonion's business case, the most cost effective alternative of realizing new projects. Wonion asks its tenant approximately 70 cents per m2 per month, half of what is the maximum. However, despite of the positives, Wonion will reconsider applying the EPV on future projects because the compensation scheme requires a very costly monitoring and administration process. Furthermore the novelty and complexity of technologies did not form a barrier for the realization of the NZEB projects. Wonion is not involved in a local network and has only little communication with local authorities on energy issues. This has therefore not effected de decision-making process in any way.

Portaal
Total living units: 47.000
Municipalities: Arnhem, Nijmegen, Amersfoort, Utrecht & Leiden
Building type: High- and Low-rise
Function interviewee: Program Manager

Located in the mainly urban municipalities, two thirds of Portaal's houses are high-rise buildings. Sustainability is very important for Portaal. Hence it completed several NZEB projects. A combination of factors caused the decision to build with the concept. First of all, they are one of the founding members of the 'Stoomversnelling'. The goal of this cooperation was to increase the developments of NZEBs and thus had a positive influence on the decision-making process. Also because the combined experience has increased expertise on the building concept. In addition, the ambitions of the local authorities with whom Portaal cooperates puts pressure to increase efforts towards becoming

energy neutral. Lastly the EPV contributes to the construction of NZEBs. The compensation is necessary to make the business case positive. Nevertheless, Portaal is also still searching for the best and cheapest way to deal with the required monitoring.

Despite being motivated to realize NZEB houses, Portaal has only succeeded in doing so in the form of low-rise buildings. The reason for this is that technologies have not yet developed in such a way that makes it possible and finically feasible for Portaal to create high-rise NZEBs. Among other things, a difference in low- and high-rise buildings is that the latter has significantly less roof surface per living unit. Which consequently makes it hard to generate sufficient energy through PV-panels for each unit.

CaseA
Total living units: 4000
Province: Zeeland
Building type: Low-rise
Function interviewee: Project Manager

Since 2016 this small SHA, active in a rural municipality in the province Zeeland, decided that all new constructed houses will be NZEBs. This decision was made partially because the island on which they are vested wants to be energy neutral in 2020, 30 years before the national goal of 2050. Involved municipalities are therefor financially stimulating SHAs to build with the NZEB concept. Also since a pilot with the concept showed to be successful. Furthermore, to make building NZEBs financially feasible, CaseA makes use of the EPV. They ask approximately €1,20 per m2 of its tenants. Monitoring the EPV is outsourced to the contractor for 25 years, because they are also made responsible for maintenance in this period. Another reasons for buildings is that they are futureproof. CaseA expects that their housing stock needs to be doubled by 2050. This is already hard to realize. And thus they want new buildings to be ready for the future.

Thuisvester
Total living units: 13.500
Building type: High- and Low-rise
Function interviewee: Innovation consultant

The housing stock of Thuisvester is spread over several municipalities in the north and middle of the province Noord-Brabant. These municipalities are mixture of rural an urban areas. Thuisvester therefore owns low- and high- rise buildings. Thuisvester decides for each project individually how it is going to be build. Low-rise projects are in principal NZEB and high-rise projects are not.

There are several contributors towards building with the concept. For starters Thuisvester is involved with the network cooperation ‘Stroomversnelling’. Thuisvester was member of a local predecessor of the network, which later was included in the national network. Through conjoined experiments from these networks, lessons were learned on how to build NZEBs. Additionally the EPV was of great importance on the decision-making process. They, however, note that it is still challenging to return investments with the EPV. Mainly because NZEBs should not cost tenants more than traditional

houses. While monitoring is still very expensive. Thuisvester has already lowered these cost by hiring other business for monitoring, instead of the contractor of the project. Also positively contributing to building NZEBs are stricter regulation from the national government.

Not implementing cases

Nijestee
Total living units: 13.000
Municipality: Groningen
Building type: High-rise
Function interviewee: Chief development

This SHA is located in the north of the Netherlands in the City Groningen. Due to its urban location the type of buildings owned by Nijestee are apartment flats. Nijestee has chosen not to build NZEBs mainly because of the disproportionate investment that is required for the realisation of the projects. This is regardless of the EPV, which is according to Nijestee insufficient due to its high monitoring costs. Furthermore the SHA is not convinced by the energy installations most commonly used to power NZEBs. Especially in relation to apartment flats Nijestee has experienced that they are not yet developed in such a way to be efficient enough. Nijestee does state that building NZEBs in the future is inevitable, but only when energy can be stored easily.

Even though they do not build with the concept, Nijestee still aims on building new housing projects with performances close to NZEBs. It does so in collaboration with local authorities and businesses. Their goal is to connect 10.000 houses on a collective geothermal project that provides the houses with heat so they can stop building with natural gas connections. The prospect was to already connect recently finished houses to the geo-thermal project, but due to fall backs this is not yet the case and temporary alternatives are needed.

The Alliantie
Total living units: 53.000
Municipalities: Amsterdam, Almere, ‘t Gooi & amersfoort
Building type: High-rise
Function interviewee: Project Manager

With more than 50.000 houses, The Alliantie is one of the bigger SHAs in the Netherlands. They are located in four urban municipalities in the Randstad area, and hence build exclusively high-rise buildings. The Alliantie is reluctant with expressing sustainability ambitions and upholds a rather traditional position in applying new technologies into their new housing projects. Consequently it does not build NZEBs, and sticks to building according to minimum national energy requirements. Local authorities try to move the SHA to do more than that, but the minimum requirements are already challenging.

There are several other reasons for not building NZEBs. First of all, the region is experiencing great scarcity of houses. The focus of the Alliantie is therefore on investing on availability of sufficient

amounts of housing instead of on building NZEBs. The EPV does not over a solution. Partly because of the high price of monitoring. Furthermore the Alliantie is not prepared to invest in technologies that are still developing and growing in efficiency. This, in combination with the high-rise buildings they construct, makes it for them unfeasible to invest in the options available at this time.

Domijn
Total living units: 15.000
Municipalities: Enschede, Losser & Haaksbergen
Building type: High- and Low-rise
Function interviewee: Manager real estate

Domijn is active in the eastern part of the Twente region. It owns dwellings in three municipalities of which Enschede is the most urban with a combination of high- and low-rise buildings, the two other can be characterized as mainly rural with low-rise houses. Domijn has always followed the steps in energy performance regulation as it comes to new housing projects. Only recently the started formulating new policy that focusses on sustainability and on becoming energy neutral in 2050. This however has not yet resulted in the realization of NZEBs, because they have been unknowing of the specifics of the concept. Currently they are piloting with the concept to become more experienced with how to build NZEBs. This, however, could be something for the future but has not influenced previous decisions on new housing projects. Furthermore, the extra investment required to build NZEBs scared the SHA a few years back, and the EPV was not attractive enough to cover those extra expanses.

Domijn moreover notes that before it was not necessary to build NZEB. Regulation was not strict enough to force towards the concept. Since the new regulation on building without natural gas this has changed. It has become more attractive financially to build with the concept because price levels become more equal. Also local authorities did not took it upon their selves to push the SHA in becoming more sustainable.

Mooiland
Total living units: 26.000
Building type: High and Low-rise
Function interviewee: Project Manager

SHA Mooiland possesses over 26.000 houses mainly situated in the rural northeast of Noord-Brabant. These buildings, hence, mainly low-rise buildings but also some are high-rise. The policy of Mooiland on sustainability follows from the performance agreements with local authorities. New housing projects are build according to the requirements from regulations. This means that it is now realizing BENG projects. In 2015 it has considered building NZEBs and did experiments with the building concept, but this proved to have its difficulties, thus they decided not to build with the concept. Especially the required generation capacity was a problem and the EPV was not yet available.

Moreover, Mooiland thought and thinks that the monitoring activities breakdown the compensating function of the EPV. But the foremost reason not to build with NZEBs is that technologies

that are currently applied have too many shortcomings. Mooiland demands technologies that have been proven. Current technologies are too expensive and require too much maintenance according to Mooiland.

Volkshuisvesting
Total living units: 11.000
Building type: High- and Low-rise
Function interviewee: Project Manager

Volkshuisvesting is active in the city Arnhem and owns a mix of low- and high-rise buildings. The SHA follows regulations and subsequently looks at what it can do additionally to increase energy performance, especially in relation to better isolation. New buildings are in principal all natural gas free.

The decision to not build with NZEBs is influenced by several factors. Starting with negative experience with the concept. Experiments with local contractors where rolled out, but varied in their success. Especially the installations used in NZEBs where not convincing. Mooiland foresees that these will further develop and increase in efficiency and financial feasibility. Furthermore the term NOM was confusing for tenants, because it appeared that they still had an energy bill at the end of the year. Also the extra investment is not returned ideally when applying the EPV due to a multitude of monitoring and administrative efforts.

WoonFriesland
Total living units: 22000
Building type: Both
Function interviewee: Asset manager

The houses of WoonFriesland are spread out over the province of Friesland, both in the rural as in the more urban parts of the province. New construction projects almost exclusively consist of two-story ground-based houses. Which makes it possible for the SHA to make these houses score high on energy performance. They, however, choose not to build NZEBs. WoonFriesland does own high-rise complexes. They do however not plan on building these in new projects due to the expected decline in population in the future.

There are several reasons why WoonFriesland is not building NZEBs currently. The main reason is that the EPV is an insufficient way of covering extra investments since it makes tenants, with already a small budget, pay for the investments. They furthermore do not wish to be stuck to the required guarantees needed for the EPV. They also think that technologies are currently underdeveloped. They would therefore rather postpone investing in them. Due to stricter rules on energy performance they are already building with some of the underdeveloped technologies, but they do not wish to make more unfeasible investments. Instead of NZEBs new building projects are thus build according to BENG requirements. On a local level WoonFriesland is not influenced to do more than national regulation by the ambitions of local authorities. Neither is it influenced by a network.